NIST & Law Enforcement:

Technical Partnerships for Public Safety and Security

Kathleen Higgins
Director
Office of Law Enforcement Standards
National Institute of Standards and Technology

Thousands of men and women working in law enforcement and public safety are alive today because of the work NIST has done over the past 30 years -- particularly NIST's Office of Law Enforcement Standards (OLES). Tens of thousands feel safer and more confident on the job each day. And consequently, millions of American citizens can feel more secure about the protection their police, firefighters, and corrections facilities provide.

NIST's contributions to the law enforcement and public safety communities are extensive. OLES works directly with these communities through a variety of pathways and relationships. It helps them develop their annual and long-range technical priorities, conducts and manages standards-development and research projects that match those priorities, and receives virtually all its funding from them. In addition, work done by other organizations within NIST, although not primarily related to criminal justice or public safety, has found applications in these areas.

History

How did NIST, an agency of the U.S. Department of Commerce, become involved law enforcement? The answer goes back to 1910, the year that a French scientist, Dr. Edmond Locard, opened the world's first forensic laboratory. It was a little

two-room operation on the second floor of the courthouse in Lyon, France, and it had only two pieces of equipment: a microscope and a spectroscope. Yet it was enough to begin a revolution. In no time, forensic science demonstrated its prowess in several prominent murder cases, and suddenly every criminal justice system in the Western world wanted a forensic capability.

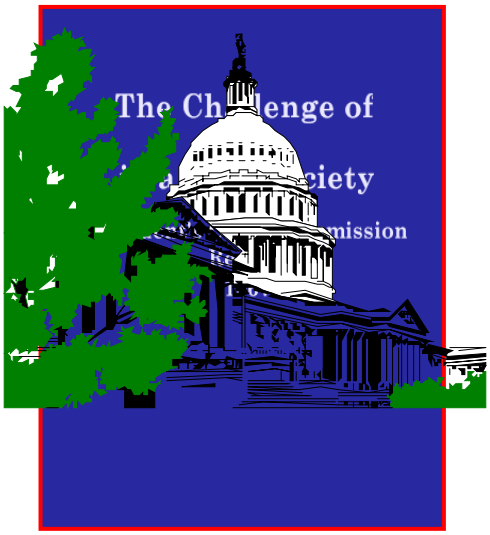
In the United States, NIST (then called the National Bureau of Standards, or NBS) had been in business only ten years, and already its measurement and testing laboratories had a world-class reputation. Since forensics largely involve precise measuring and testing, NBS was a logical place for the U.S. criminal justice community to turn to for forensic services.

Wilmer Souder

Thus, NBS was America's original federal crime laboratory, predating the famous Federal Bureau of Investigation (FBI) laboratory by some nineteen years. In fact, when the FBI opened its laboratory, it was an NBS scientist, Wilmer Souder who trained the Bureau's forensic investigators. Throughout his career, Souder contributed to hundreds of investigations. He is most famous as one of the handwriting experts who worked on the Lindbergh baby case, and when he retired from NBS in 1954, the *Washington Post* named him "one of the nation's best and least known criminologists."

Today, there are hundreds of forensic laboratories in this country, and NIST is no longer involved in criminal investigations. Instead, NIST has assumed an even wider and more important role in criminal justice and public safety.

This new role came about as result of the work of a special Presidential Commission in 1967. The Commission's report, *The Challenge of Crime in a Free Society*, revealed a nationwide crisis. It showed that law enforcement officers, particularly at the state and local levels, were inadequately equipped to protect themselves and the public. Two factors were responsible: lack of adequate funding and lack of reliable information on the quality and performance of available equipment.

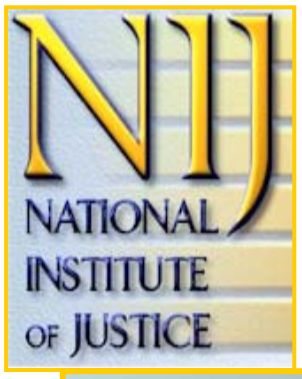


When a police chief in New York City or a sheriff in Union County, New Mexico needed to buy something -- protective clothing, radios, handcuffs, firearms -- they were on their own. Not only did they have severely limited funds to work with, but they had no guidance as to which products from which manufacturers were safe and reliable. There was no equivalent of *Consumer Reports* magazine in the law enforcement or public safety communities. In fact, there were no established performance standards or user guides for anything used in the field. Consequently, that police chief and that sheriff had only two sources of information to base their buying decisions on: the manufacturers' sales brochures and whatever they could find out through the law enforcement grapevine.

Lacking any scientific basis for their procurements, state and local law enforcement agencies in the late 1960s were wasting money by the truckload. Worse, because they could not rely on any equipment to perform as advertised, police officers did not feel confident in dangerous situations. This lack of confidence undermined their performance and put the public at further risk.

Congress directed the Department of Justice (DoJ) to remedy the situation. DoJ's research arm, the National Institute of Justice (NIJ) came to NIST for assistance. And in 1971, an agreement between the Department of Commerce and the Department

of Justice, established NIST's Office of Law Enforcement Standards (OLES).



OLES Mission & Activities

OLES' mission is relatively straightforward. It develops standards, test methods and procedures for evaluating technologies used by the criminal justice and public safety communities, which include law enforcement, corrections, forensic sciences, and the fire service. OLES publishes reports and guidelines to help state and local agencies make wise buying decisions and use equipment properly. And through projects sponsored primarily by NIJ, OLES provides technical assistance and advice to criminal justice and public safety organizations.

OLES Mission:

Standards

Test Methods & Procedures

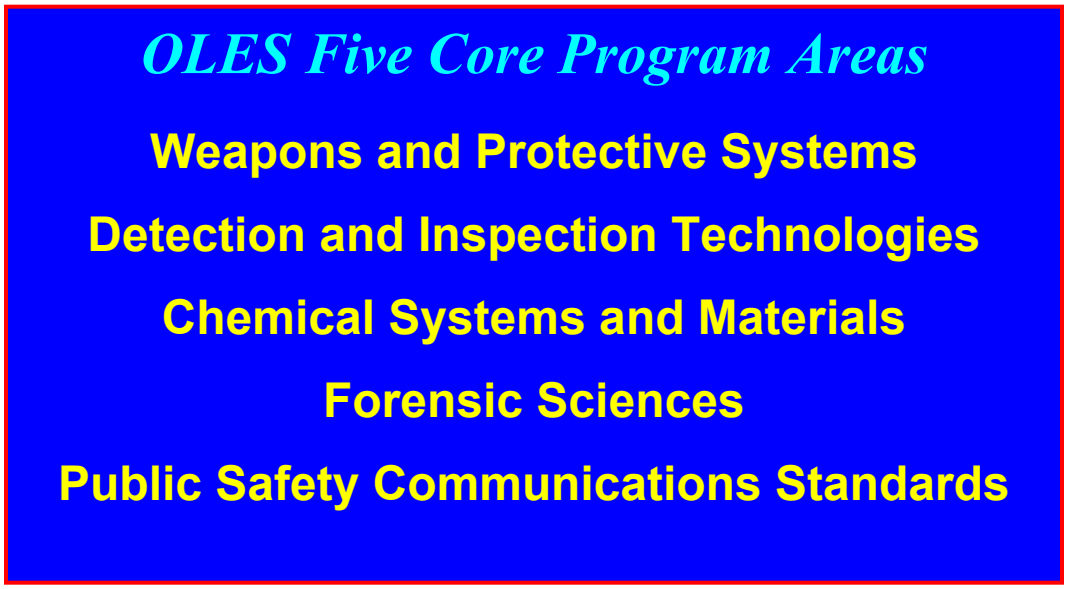
Technical Reports

User Guides

Technical Advice & Assistance

Although OLES does some work, such as ballistics research, in-house, the office is essentially a matrix management organization. The criminal justice and public safety communities come to OLES to solve technical challenges, and OLES pulls together the teams and resources needed to do the work.

Over the years OLES has evolved five core program offices to meet that mission. They are:



.

The Office has published more than 230 standards, guidelines and technical reports, and its staff is active in dozens of *ad hoc* and standing committees, panels, commissions and working groups that support law enforcement and public safety.

OLES is especially active in major international efforts. It holds positions in the International Standards Organization's Technical Advisory Group on Personal Protection Equipment; five working groups on personal protection within the British Standards Institute; and NATO's Task Group on Behind-Armor Blunt Trauma. For years OLES was the only non-military member of this paticular task group -- law enforcement's lone voice in NATO.

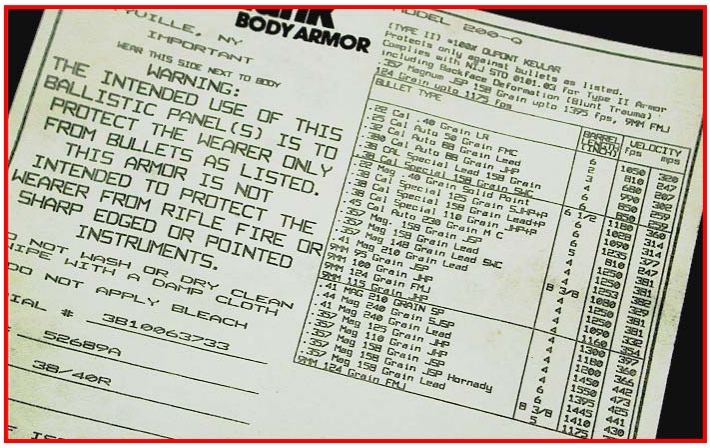
Lifesaving Work

Unlike the work of many scientific and technical organizations throughout the world, the work OLES does often has an immediate and clear-cut impact on the world at large. One example is its ongoing efforts related to performance standards for soft body armor, more commonly referred to as bullet-resistant vests.

There are many types and numerous manufacturers of soft body armor. If you are in the market to buy one, whose should you buy? Which vest can you trust with your life? And if you are responsible for outfitting a police force, whose vest can you trust with the lives of 500 officers?

Soft Body Armor (Bullet-Resistant Vest)

The answer is simple: you read the label. You look to see if the vest is "NIJ Certified" -- that is, certified as meeting specific minimum performance standards, which OLES developed in-house. Minimum performance standards are not guarantees, but they go a long way toward giving the people who <u>buy</u> equipment confidence in their decisions. And they give people who <u>use</u> equipment -- no matter where they are -- confidence in its reliability. When a police officer in Ogden, Utah straps on an NIJ-certified Level 2 bullet-resistant vest manufactured in Minnesota, he can be sure of the same minimum level of protection as an officer in Sydney, Berlin or Tokyo wearing a Level 2 vest manufactured in England or Germany.



NIJ Certification Label for Ballistic-Resistant Soft Body Armor

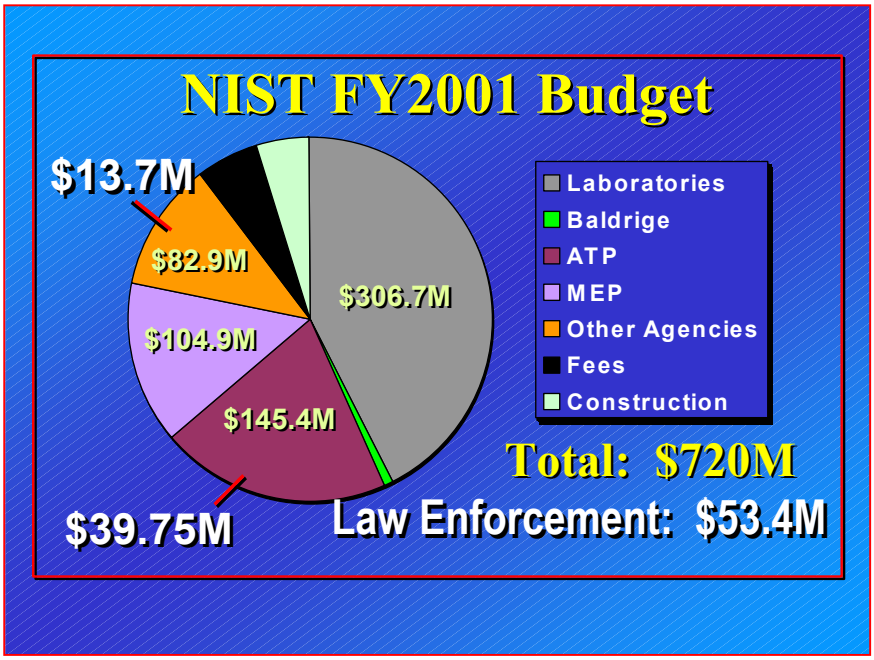
In 1975, the first NIJ-certified bullet-resistant soft body armor was issued to 5000 officers in 15 major cities. Within six weeks, the first officer's life was saved. Since then, the number of lives saved by body armor -- in gun battles, vehicle

accidents, and similar incidents -- has climbed to more than twenty-five hundred. This mean that, in an average month, eight officers survive as a direct result of OLES' work.

No less important are the dozens of other standards NIST has developed for equipment related to communications, restraining devices, weapons, personal protection gear, fire prevention and investigation, vehicles, traffic enforcement, surveillance, field and laboratory forensics, and much more. The bottom line is that there are more than 52,000 state and local law enforcement and public safety agencies in this country. And through the Department of Commerce's agreement with NIJ, OLES is tasked with making sure that the meager dollars available to those agencies are spent on products and equipment that do what they're supposed to do.

Slim Budgets and Growing Challenges

This is important work. Yet, of NIST's total FY2001 budget of roughly $720 million, only about $53 million, little more than 7 percent, is dedicated to it.



What is significant, however, is the volume of funds from other agencies that go to criminal justice- and public safety-related projects. Of the $82.9 million that have come to NIST from outside sources in FY2001, $13.7 million (16.5 percent) is for projects that are either directly related to criminal justice and public safety or have secondary criminal justice and public safety applications. This seems to indicate that organizations outside NIST see a real need for this kind of work, and consider NIST the right people to do it.

And there is a lot of work still undone. The 230-plus standards and guidelines OLES has published only scratch the surface of what's needed. The universe of technologies that the criminal justice and public safety communities need is vast. There are the basics to cover -- standards for items like handcuffs, gun holsters, vehicle sirens, and traffic enforcement equipment -- and new threats to consider.

Criminals are not just becoming better armed, they are also becoming more sophisticated. Over the past five years, the computer has become a potent criminal weapon. Cybercrime is already gnawing away at the U.S. economy and threatening its national security, and law enforcement is far behind in developing reliable tools to curb it.

Defense attorneys are finding new ways to chip away at ballistics and DNA test results. Cases that should be airtight are being thrown out of court, and prosecutors and forensic investigators are desperate for standards that can make forensic test results less disputable.

Everyone is looking for more practical and effective detectors to prevent children from walking into schools with firearms and keep passengers from boarding planes with bombs. Recent events clearly demonstrate that what law enforcement and security organizations are using now is simply not always good enough.

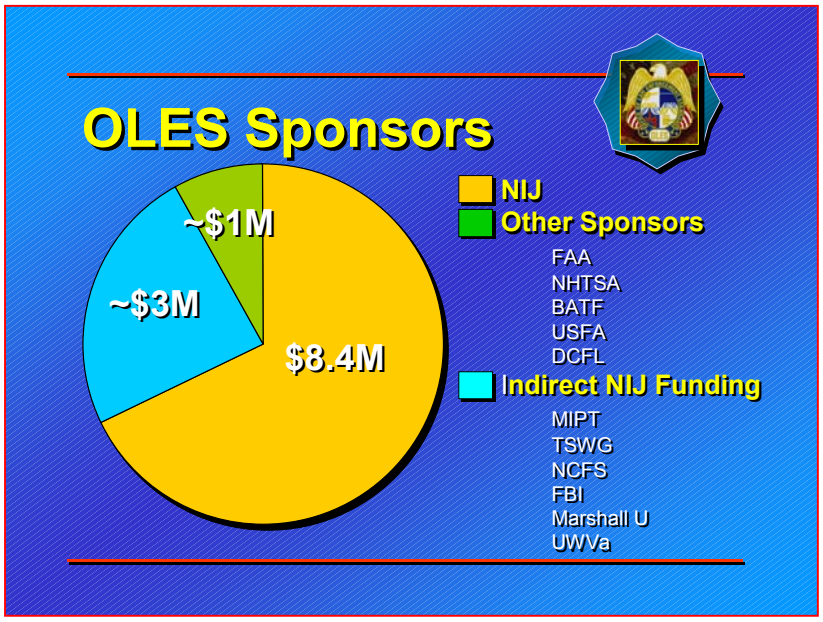
Most ominous is the rising specter of domestic terrorism and the possible use of weapons of mass destruction -- anthrax, nerve gas, plutonium dust, and black market nuclear weapons, just to name a few. Within military and law enforcement circles, the consensus is that it is not a matter of <u>if</u> such an attack will occur, but <u>when</u>. Everyone from the Secretary of Defense down to the local fire chief is trying to prepare for that day, and discovering that, as a nation, the United States is tragically unequipped to meet the challenge.

With so much old ground still to cover, so many new developments on the horizon, and so little money in the pot, some things can be done -- and some can't. Still, OLES and the other organizations within NIST are doing all they can to give the criminal justice and public safety communities the technical support they need most.

A Closer Look at OLES

Within NIST, the programs and projects most closely related to law enforcement and public safety are those conducted or managed by OLES. OLES' total budget for FY2001 is $12.4 million, and every penny directly addresses the stated priorities of the criminal justice and public safety communities. Every program OLES manages and every project within each program directly meets the needs of these groups, and is specifically funded with those needs in mind.

All OLES funding comes from outside of NIST, from what NIST calls OAs, or outside agencies. OLES receives no internal funding. In other words, the Office lives or dies by how well it satisfies its customers' needs.



Most of OLES' $12.4 million FY2001 budget comes directly from NIJ, the research arm of the Department of Justice. For 30 years, NIJ has been OLES' largest sponsor. As the "OLES Sponsors" graphic shows, however, OLES also receives funding from several other outside organizations.

To date, $140,000 of the Office's FY2001 budget is from the Federal Aviation Administration (FAA). Approximately $100,000 comes from the National Highway Traffic Safety Administration (NHTSA) each year. The Bureau of Alcohol, Tobacco and Firearms (BATF) and the U.S. Fire Administration (USFA) contribute funds directly to NIST's Building & Fire Research Laboratory in support of specific OLES projects. DCFL -- the Department of Defense Computer Forensics Laboratory -- provides OLES with equipment and software.

The sponsors listed under "Indirect NIJ Funding" -- the Memorial Institute for Prevention of Terrorism, in Oklahoma City (MIPT); the Technical and Scientific Working Group (TSWG); the National Center for Forensic Science (NCFS); the Federal Bureau of Investigation (FBI); Marshall University (Marshall U); and the University of West Virginia (UWVa) -- fund OLES projects with money they receive from NIJ. Each year NIJ awards grants for specific types of law enforcement and public safety research to organizations and academic institutions like these. And since OLES is doing research in the areas for which these funds are earmarked, it has been able to attract these funds to support its programs.

NIJ and Setting Priorities

NIJ is OLES' largest sponsor. NIJ's FY2001 budget is just over $250 million -- $200 million of which funds projects through its Office of Science and Technology (OS&T), the office with which OLES is associated. OS&T's budget includes $8.4 million earmarked for the development and support of standards. Every cent of that $8.4 comes to OLES.

NIJ provides OLES with more than just funding. They also set the priorities for how OLES spends its funds. OLES, however, actively participates in setting those priorities. The Office is helping NIJ's Office of Science and Technology develop its strategic plan. It is also a major component of OS&T's Product Implementation

Process, which aims at ensuring that all OS&T projects meet the needs of the criminal justice and public safety communities by incorporating technology assistance, testing and standards development.

Setting priorities that meet real-world needs demands input from the front lines. NIJ and OLES get that input from LECTAC, the Law Enforcement and Corrections Technology Advisory Council. LECTAC is a group of about 125 criminal justice and public safety practitioners from across the country who act as a kind of industry advisory board. Additional guidance comes from organizations like the International Association of Chiefs of Police (IACP) Research Committee, which provides a global context for evaluating user needs.

Throughout the process of setting priorities, OLES contributes its own unique knowledge. Because of its involvement in a broad range of technical organizations, and because its staff is endlessly querying the laboratories at NIST for ideas and resources that can help in their work, OLES often sees farther over the horizon than many others. As a result, OLES serves as a kind of early warning system to alert groups that set priorities and policies about little-known technological developments that are likely to have a big impact on law enforcement and public safety in the future.

OLES Project Flow

Once annual priorities are established, it is up to OLES to meet them.

For each project, OLES starts by identifying both a progrom manager within its organization (the head of one of its five core program areas) and a principal investigator (an organization with the technical and scientific expertise needed to get the work done). OLES first looks within NIST for principal investigators. If none of the NIST laboratories is available or exactly suited to a project, it turns to outside agencies, institutions, and private companies.

OLES discusses the project with the proposed principal investigator, gets the investigator's verbal commitment to do the work, and then prepares a draft of the project description and budget, based on those discussions. OLES submits a draft of a compilation of these project sheets in the form of an annual program plan to the program sponsor -- in most cases, NIJ -- and upon that sponsor's approval of the program plan and budget, funds are transferred to the Administrative Officer at NIST's Electronics and Electrical Engineering Laboratory (EEEL). EEEL is OLES' parent organization and manages all of its receipts, disbursements and accounting.

With program funds in hand, OLES works with the principal investigator to develop a detailed work plan and milestones. Then work begins.

Throughout the course of the project, OLES' program manager meets regularly with the leaders of the principal investigator's team. OLES reviews the program's monthly and quarterly status reports. The OLES Director meets with the program manager and the principal investigators' team leaders, as appropriate, submits quarterly progress reports to NIJ management, and meets with NIJ and EEEL management to review accomplishments and discuss problems. This cycle of reviews continues until the research or technical development is completed.

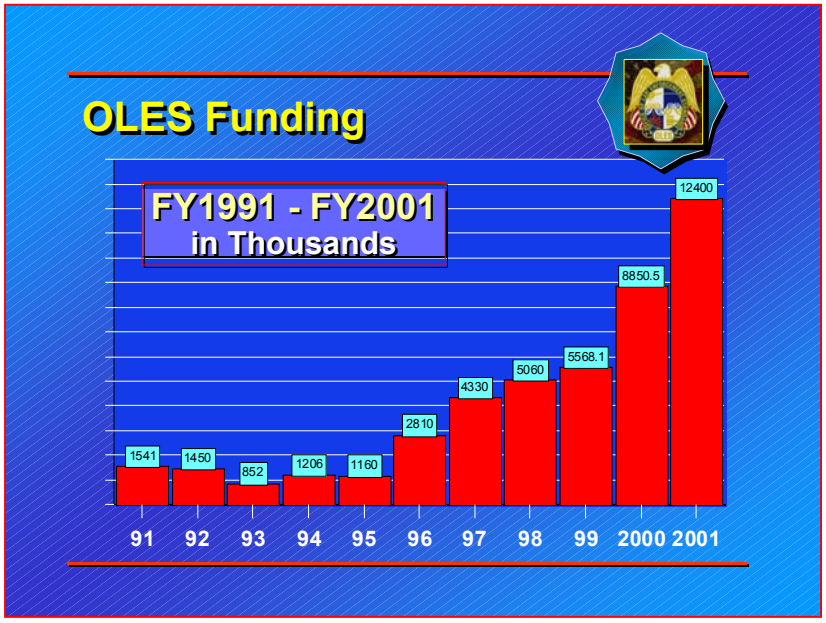
The end product of most OLES' programs is a performance standard, a user guide, or both. So once the basic research and technical work is done, the program team shifts into a publishing phase.

The principal investigator submits a draft of the proposed document. OLES reviews it to make sure it not only meets requirements for technical content but also follows a uniform format. If necessary, OLES requests from the principal investigator whatever additional information is needed to complete the document.

When OLES is satisfied that the draft meets the project's objectives, it sends it out for review. Depending on the subject and whether the document is a standard, a technical report or a user guide, copies are sent to as few as 75 or as many as 800 reviewers, ranging from LECTAC and IACP committee members to federal agencies, police departments, subject matter experts, and equipment manufacturers. The goal is to ensure that the end result is practical for the real world -- that it establishes performance limits high enough to screen out inferior products but not so high that no product can pass the test.

The project team reviews all comments with merit, makes the appropriate revisions, and submits the revised draft to two high-level review panels -- one at NIST, the other at NIJ. With their approval, the document is made camera ready, goes to press, and is made available to the criminal justice and public safety communities across the country, and often to OLES' colleagues around the world.

Two Benchmarks of Success



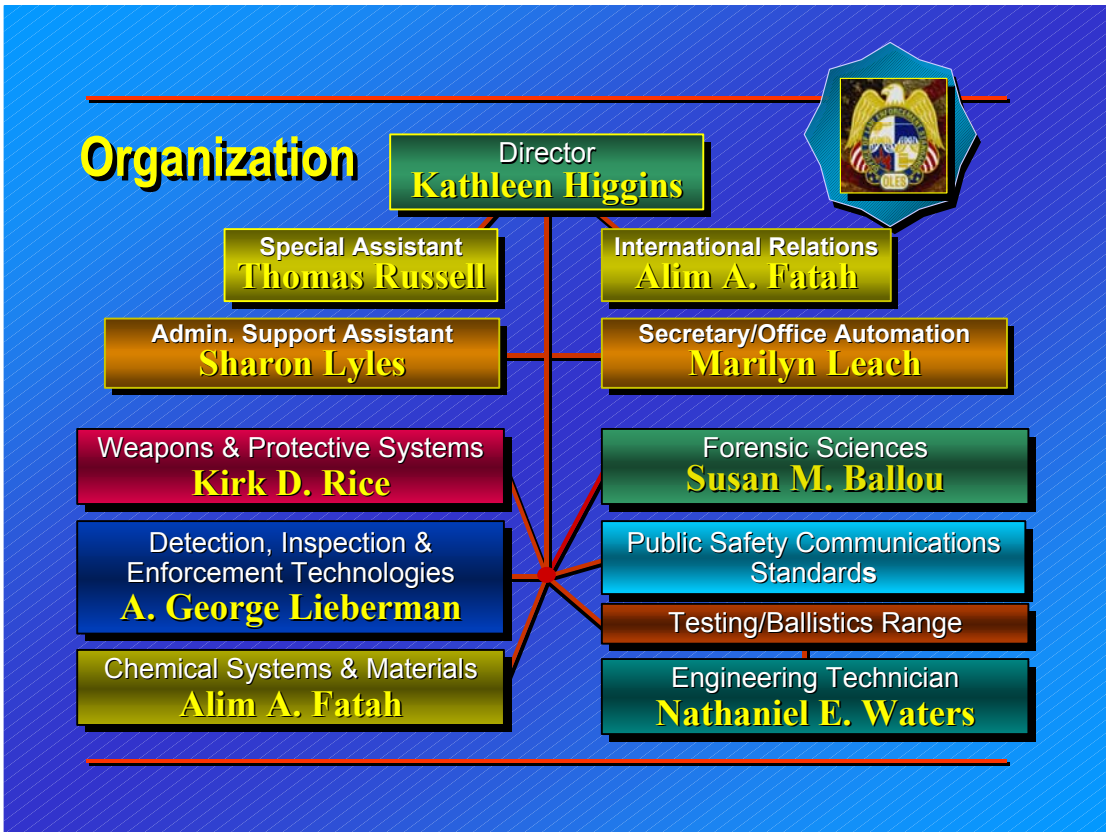
Two indications of the success of OLES' tried-and-true project flow are: the steady increase over the past ten years of funding by sponsors (see "OLES Funding" graphic) and the increasing number of

programs and projects offered to OLES by the criminal justice and public safety communities. These factors demonstrate that the law enforcement and public safety communities value the work OLES does and how it does it, and feel that they are getting their money's worth.

OLES Organization and Partners

A flow chart is not the only key to success. To maintain growth and value, an organization must have in place elements that keep things flowing smoothly. In OLES' case, those elements are its organizational structure, the expertise of its personnel, its development of specialized facilities, and its access to a vast array of resources both within and outside of NIST.

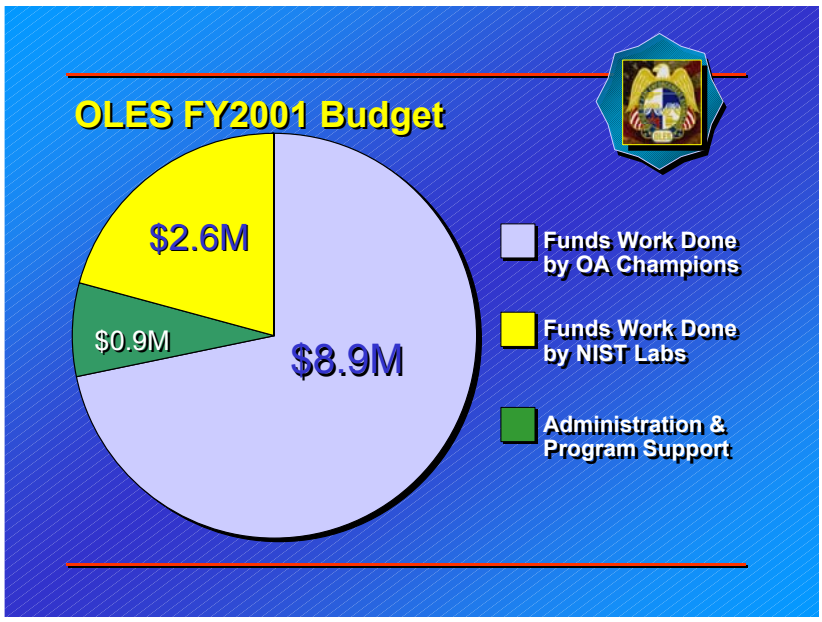
OLES' five core program areas cover virtually the entire spectrum of technical issues within the criminal justice and public safety arenas, and among them, these five offices are currently managing or conducting 51 different projects. Despite this workload, OLES' organization is very small -- just nine people. The organizational chart, however, shows more than nine blocks. This is because some OLES staff members are pulling double duty. The manager of the Chemical Systems and Materials program, for example, also serves as OLES' International Relations manager. And the Office's Public Safety Communications Standards program and its Research Test Facility (RTF) are without full-time program managers.



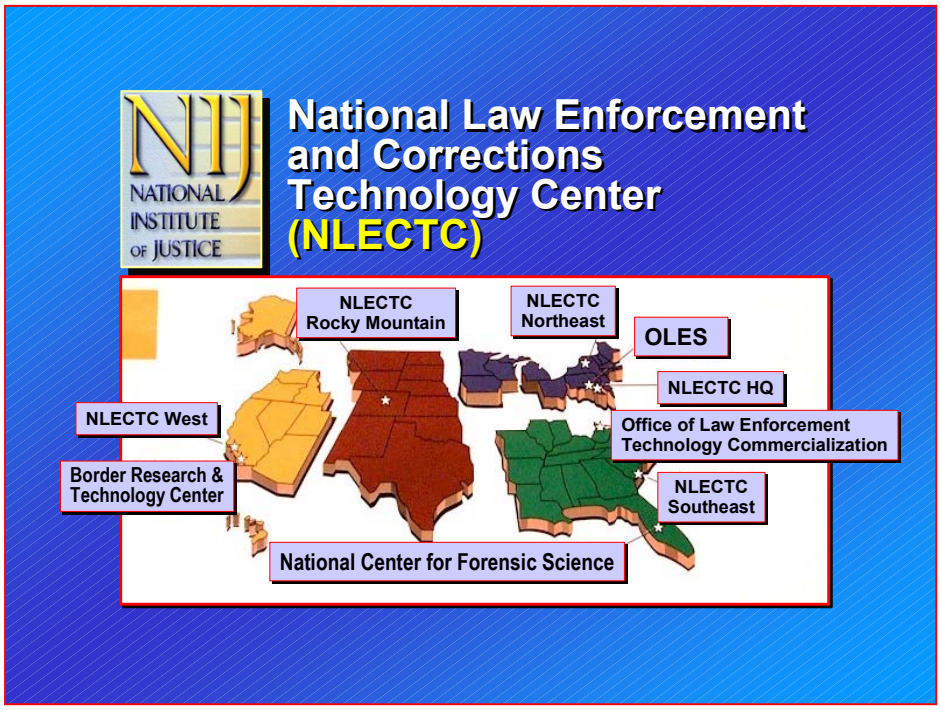
OLES Organizational Chart

Being shorthanded, however, has not compromised OLES' work in any way. One reason is that its staff members are a group of true over-achievers. The other is that, as a largely management organization, OLES relies heavily on the support and expertise of others. Much of that support and expertise is within NIST. NIST's Manufacturing Engineering Laboratory, Chemical Science and Technology Laboratory, Materials Science and Engineering Laboratory, Building and Fire Research Laboratory, Information Technology Laboratory, and Electronics and Electrical Engineering Laboratory, are all participating in current OLES programs.

As the OLES FY2001 Budget graphic shows, of the Office's total $12.4 million in total funds, almost $2.6 million is going to these organizations to pay for the scientific and technical research they do in support of the Office's programs.



OLES gets further support and assistance from its membership in a community of organizations under the banner of NIJ's National Law Enforcement and Corrections Technology Center -- NLECTC. Under this program, NIJ operates four regional centers, and a national center in Rockville, Maryland. Each one provides technical assistance to state and local agencies and specializes in a specific area of research and development. The Border Research and Technology Center, the Office of Law Enforcement Technology Commercialization, and the National Center for Forensic Science are also part of this community. These organizations provide facilities and expertise that play a large role in

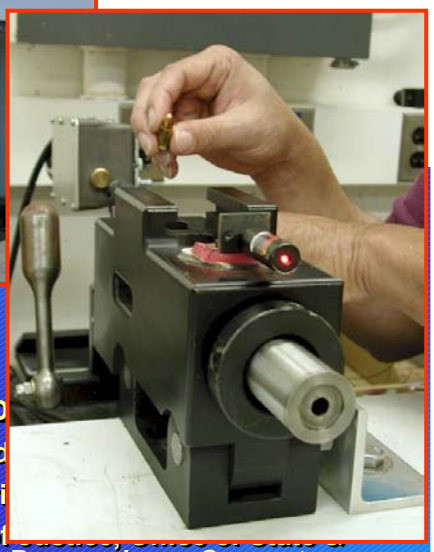


the work OLES does.

Two other keys to OLES' success are its professional affiliations and its project collaborators, which greatly extend the Office's reach into the scientific and technical community. OLES' professional affiliations include organizations involved in both general scientific disciplines and disciplines specifically related to criminal justice and public safety. Many are international in scope and give OLES a truly global perspective of criminal justice, public safety and antiterrorism developments around the world.

OLES' project collaborators -- or "champions" (*see graphic, next page*) -- are those that lend special assistance in individual project areas. There are dozens of them, and each represents a partnership dedicated to solving a particular set of problems today and finding innovative solutions for the long-term challenges over the horizon. In FY2001, almost three-quarters of OLES' budget -- about $9 million -- is going to these organizations to pay for scientific and technical research in support of OLES' programs. OLES and its customers in law enforcement and public safety are indebted to them for their contributions.

That brings up the most important question of all: exactly what kind of programs and projects does OLES do? Below is a brief description of a few sample projects now underway in each of OLES' fiv



Weapons & Protective Syst

OLES' Weapons and P personal protection -- body armor, protective gloves, helmets, face shields, handcuffs, firearms, and the like. Total FY2001 funding for the program is just under $864,000.

The largest single chunk of that, about $300,000, is earmarked for the relocation and improvement of the OLES Research Test Facility, or RTF. The RTF is where OLES conducts ballistics testing and evaluates ballistic materials and firearm technologies. Over the years it has served OLES, other NIST organizations, and the criminal justice and public safety communities well.

- Police Scientific D
- Royal Canad
- FBI Engineeri
- U.S. Department of
- Local Domestic Preparedness Support
- DoD Computer Forensics Laboratory
- University of Utah, Center for Human Toxicology
- Institute for Social Analysis

- National Cybercrime Training Partnership
- University of Texas at Dallas
- Institute for Telecommunication Sciences, National Telecommunications and Information Administration
- United States Army Soldier Systems Command
- University of Maryland at College Park Center for Automation Research

earch Te

Left Photo - Interior
Middle Photo - Exterior
Right Photo - Ballistics Testing Device

The RTF is unique, in more ways than one. Not only is it the only R&D facility of its kind, but it is housed in an underground concrete bunker at an abandoned NIKE missile site. The ceiling leaks. It has no indoor toilet facilities.

It is time for the RTF to have a new home, not only for the obvious reasons but also because the number of OLES projects using the facility is growing. Weapons and Protective Systems now has seven programs that involve evaluating weapons, ammunition and ballistic materials, including high-visibility programs related to gun locks and "smart" guns. A better-equipped, more up-to-date RTF will soon open in an unused portion of NIST's Industrial Building, and it will give OLES the tools to handle these new programs and take on even more work of this type.

Four of those seven Weapons and Protective Systems projects mentioned above are related to the development of improved body armor. The fact is, body armor hasn't kept pace with advances in weaponry. Cop-killer bullets and armor-piercing rounds, for example, weren't available on the street back in the 1970s, when OLES developed the first soft body armor standards. There were fewer automatic weapons, so bullet-

resistant vests were not being subjected to multiple, nearly isochronic impacts, as they are today. Today there are far more women police officers, and a growing need for more detailed study of female body armor. In addition, a lot of body armor out in the field is aging and exposed to harsh environments, yet there is little information about the effects of time and environmental factors on useful life-cycle.

Finally, OLES and NIJ need better ways to evaluate how ballistic-resistant materials dissipate energy and the extent of the body trauma that occurs behind the armor. Right now, the RTF uses clay blocks as a backing material during testing, and examines the deformation of clay to characterize the effects of bullet impact and the ability of the body armor to dissipate energy.

Clay Block Used to Evaluate Ballistic Impact

Together with investigators from The Tekne Group, Inc. and EEEL's Electricity Division, OLES is now conducting two projects which address all of these issues. OLES is particularly excited over the work that will be done by the Electricity Division on the feasibility of electronic and opto-electronic methods for measuring impact energies and material deformations. Such advances could lead to automated test systems which would increase test accuracy, shorten test times and lower test costs.

Soft Body Armor Multiple-Impact Test

Two other body armor studies focus on stab-resistance. More police

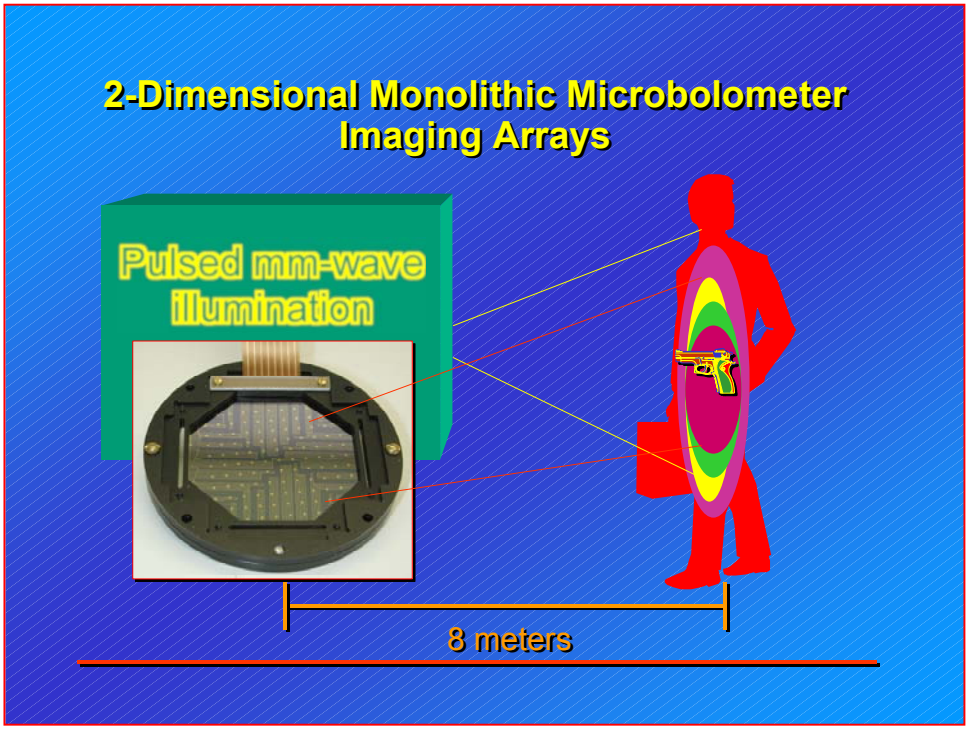
officers and corrections officers today are being attacked with knives, shivs and razor blades, and they are discovering that today's ballistic-resistant armor is not designed to withstand stabbing and slashing. In response to this situation, in FY2000 OLES published the first standard for stab-resistant body armor. The Weapons and Protective Systems group is now following through by monitoring the testing and certification program and continuing studies to add information for revising the standard, as necessary.

Detection, Inspection and Enforcement Technologies

OLES' Detection, Inspection & Enforcement Technologies program focuses on a wide range of technologies, particularly those for detection and imaging, video surveillance, emergency vehicles, traffic enforcement, and managing police vehicle fleets.

The program's FY2001 budget is $1.3 million, and almost half of those funds ($638,000) is earmarked for seven programs related to detecting concealed weapons and explosives. The need is clear. Airports and jetliners used to be the prime targets for assailants using guns and bombs. Now schools and office buildings are targets of choice, and law enforcement's ability to head off incidents is crippled by the lack of fast, accurate and affordable detection devices.

Among the seven programs, perhaps the most technically interesting is the development of 2-dimensional monolithic microbolometer imaging arrays and the accompanying imaging system. The challenge posed by law enforcement is to develop a device that, at a range of 8 meters, can image metallic objects concealed under clothing. Eight meters is considered the "officer-safe distance," the distance an average assailant can cover in the time it takes an officer to draw his weapon.



The spatial resolution of the imaging system must be great enough to resolve a hidden object through clothing. It must have a high enough signal to noise ratio and dynamic range to be used indoors or outdoors, and still maintain the privacy of the individual's anatomy. It must also have a fast enough frame rate to allow real-time imaging.

Using work done at Bell Laboratories as a starting point, OLES' principal investigators in EEEL's Electricity Division and Electro-magnetic Technology Division have done the research and are building a prototype of an imager that meets these operational specifications. It will illuminate the target with pulsed millimeter-wave

illumination, which easily penetrates garments, and use the radiation reflected from the target to create an image. The reflected radiation is detected using uncooled antenna-coupled niobium microbolometers integrated into arrays. This configuration meets all the resolution, signal-to-noise ratio, and real-time imaging requirements.

Through use of special antenna designs and an algorithm in the image processing stage, the resulting displayed image can be designed to show information on metal objects against a far-less-detailed IR image of the subject's anatomy.

Additional technical information can be found in the three papers presented by the project team at the 2001 Aerosense meeting at the International Society for Optical Engineers, in Orlando in April.

Law enforcement organizations are very excited by this development. It offers the potential of a practical device that is more sensitive, more rugged and far less expensive than the hybrid systems now in use. These units could easily be mounted on police cruisers or set up at the entrances of school buildings to do unobtrusive, real-time weapons and explosives detection.

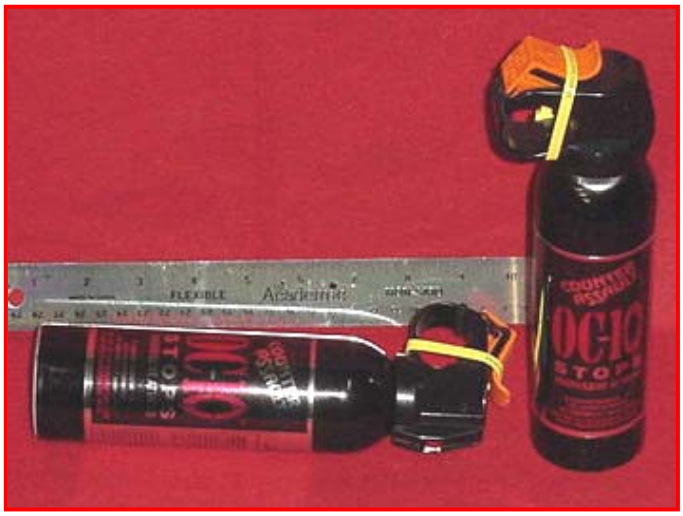
The Federal Aviation Administration is particularly interested. It has helped to fund the research to date, and based on early results has begun discussing a large-scale, multi-million-dollar program to complete development and begin manufacturing and implementation in airports around the country. The potential of the device for doing nonintrusive searches of passengers and luggage, without inconveniencing or delaying travelers, has broad economic as well as safety implications.

Other applications for NIST’s microbolometer imaging technology are also being explored. One is related to the school safety program sponsored by the Federal government. In this case, the imager would be used in a portal application where, as a student walks through the portal, only metal objects on his/her body are displayed. The FAA has also expressed interest in this type of application for the detection of metal

objects. The second application is in anti-personnel mine detection where the imager would be used to locate dielectric materials buried in the soil. The imaging capability would be used in conjunction with conventional metal detection to improve detection probability under different soil conditions.

Chemical Systems and Materials

The work of OLES' Chemical Systems and Materials program is equally important and dramatic, focusing on protective clothing, drugs of abuse, less-than-lethal technologies, and weapons of mass destruction. Through NIST's Chemical Science and Technology Laboratory, OLES is developing a standard reference material (SRM) for smokeless gunpowder, and the Manufacturing Engineering Laboratory is doing the same for bullets and casings. These SRMs are high priorities for forensic investigators across the country.



Pepper Spray Canisters

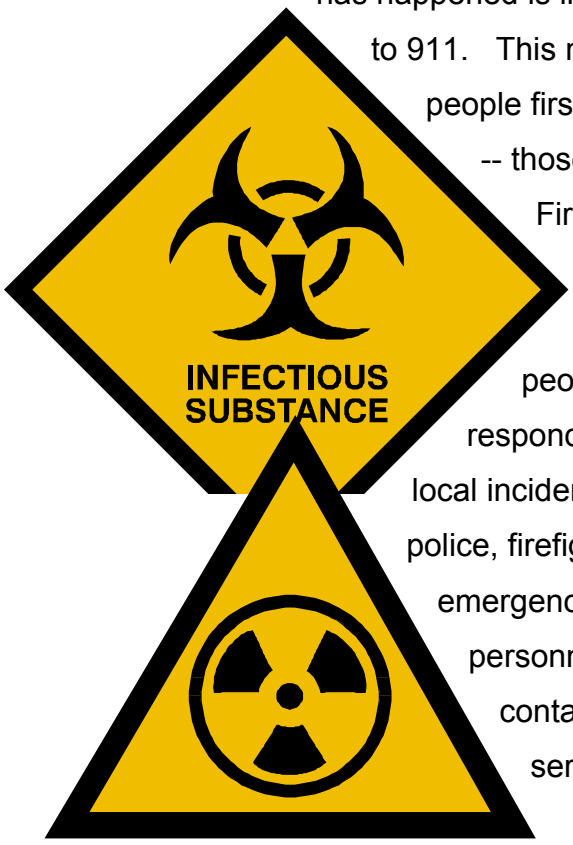
Together with the University of Utah's Center for Human Toxicology, the Chemical Systems and Materials program is investigating pepper spray and pepper spray canisters. Less-than-lethal technologies such as pepper spray are gaining wider use among law enforcement agencies, but the current lack of standards and quality control among manufacturers is creating serious safety and liability issues.

The effort that dominates the work of OLES' Chemical Systems and Materials program -- accounting for almost 95 percent of its $4.1 million FY2001 budget -- is supporting the country's Domestic Preparedness effort, which means preparing for terrorist attacks in which weapons of

mass destruction are used.

U.S. intelligence agencies know that terrorists have stockpiles of CBRNE weapons -- that is, chemical, biological, radiological, nuclear and explosive weapons. And they know that they are planning to use them. Likely scenarios include nerve gas attacks in crowded shopping malls and sports stadiums; massive releases of anthrax in crowded cities; lacing community water supplies with radioactive materials; pumping lethal fumes through the ventilation systems of office buildings and subway tunnels; and detonating a nuclear device anywhere. Casualty rates will be in the thousands, the tens of thousands, or worse.

Again, it is not a matter of whether such attacks will occur, but when and where. And the first indication that something terrible has happened is likely be a call to 911. This means that the people first on the scene -- those referred to as First Responders -- are going to be the same people who respond first to every local incident everyday: police, firefighters and emergency medical personnel. Without suitable training and equipment, instead of containing and controlling the situation, these public servants will become victims themselves.



In 1998, the Department of Defense and the Department of Justice joined forces

to create the Interagency Board for Equipment Standardization and Interoperability, known simply as the IAB. The IAB's core mission is to make sure that state and local agencies are properly equipped to protect their own personnel and minimize the consequences of an attack.

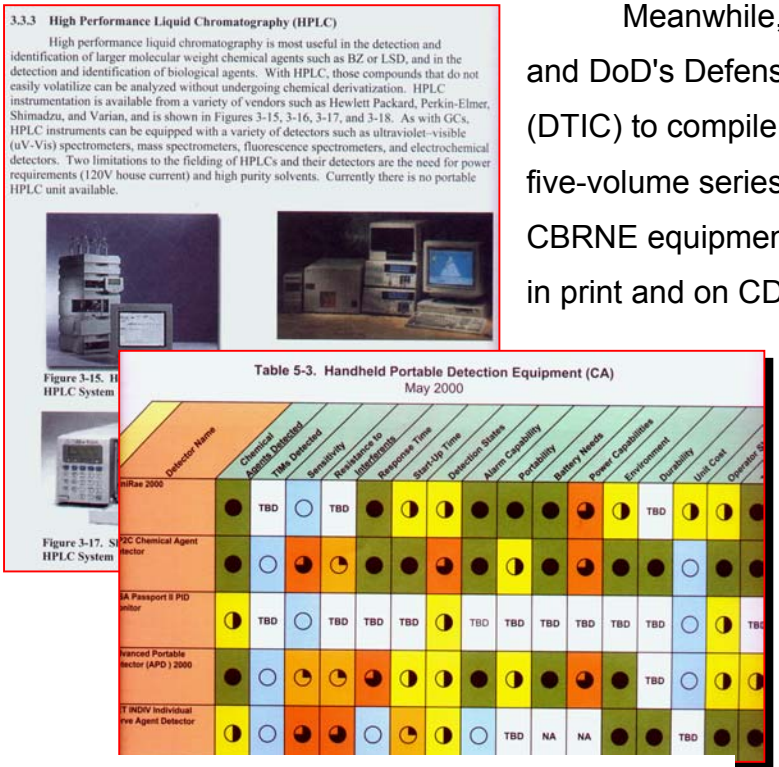
The IAB has developed and maintains a Standard Equipment List (SEL) which includes hundreds of items essential for responding to CBRNE incidents. The SEL is a practical idea, but as it stands now it has a tragic flaw. It is just a list. It says, for example, that First Responders must have chemical resistant gloves, rechargeable batteries and battery chargers, and laptop computers. Yet it gives no standards or specifications for these, or any other, items. Consequently, state and local agencies are on their own in determining which vendor's chemical resistant gloves are best, which batteries charge fastest and hold a charge longest, and which laptop computer is the most rugged and what software it should have. In other words, when it comes to the threat of domestic terrorism, law enforcement and public safety organizations are back to the situation they were in in 1967.

OLES was invited to serve on the IAB Standards Coordination Committee, which is chaired by the National Institute for Occupational Safety and Health (NIOSH) and the National Fire Protection Association (NFPA). In much the same way that NIJ and LECTAC set priorities for criminal justice and public safety research, the IAB sets priorities for domestic preparedness research. Its first priority is the development of standards for CBRNE Personal Protection Equipment (PPE), in particular, respiratory devices, and it wants these standards yesterday.

Because of OLES' track record, the Office has been appointed program manager for the effort. Through 5-year Interagency Agreements, OLES has contracted NIOSH to

fill the lead technical role and the U.S. Army Soldier and Biological, Chemical Command (SBCCOM), which is DoD's national center for research and development in chemical and biological defense, to support NIOSH's efforts.

In less than eighteen months, the team has almost completed identifying baseline hazardous exposures that CBRNE equipment must protect against, and begun setting respirator certification standards. NIOSH is completing a new state-of-the-art gas and organic vapor chemical laboratory for developing standards testing and operational procedures. SBCCOM is evaluating existing test methods for suitability as standards test methods.



3.3.3 High Performance Liquid Chromatography (HPLC)

High performance liquid chromatography is most useful in the detection and identification of larger molecular weight chemical agents such as BZ or LSD, and in the detection and identification of biological agents. With HPLC, those compounds that do not easily volatilize can be analyzed without undergoing chemical derivatization. HPLC instrumentation is available from a variety of vendors such as Hewlett Packard, Perkin-Elmer, Shimadzu, and Varian, and is shown in Figures 3-15, 3-16, 3-17, and 3-18. As with GCs, HPLC instruments can be equipped with a variety of detectors such as ultraviolet–visible (uV-Vis) spectrometers, mass spectrometers, fluorescence spectrometers, and electrochemical detectors. Two limitations to the fielding of HPLCs and their detectors are the need for power requirements (120V house current) and high purity solvents. Currently there is no portable HPLC unit available.

Figure 3-15. H
HPLC System

Figure 3-17. SI
HPLC System

Table 5-3. Handheld Portable Detection Equipment (CA)
May 2000

Detector Name	Chemical Agents Detected	TIMs Detected	Sensitivity	Resistance to Interferants	Response Time	Start-Up Time	Detection States	Alarm Capability	Portability	Battery Needs	Power Capabilities	Environment	Durability	Unit Cost	Operator S
niRae 2000	●	TBD	○	TBD	●	◑	◑	●	●	●	◕	◑	TBD	◑	◑	●
2C Chemical Agent tector	●	○	◕	◔	●	●	◕	●	◑	●	◕	●	●	○	●	●
A Passport II PID nitor	◑	TBD	○	TBD	TBD	TBD	◑	TBD	TBD	TBD	TBD	TBD	TBD	○	◑	TBD
vanced Portable tector (APD) 2000	●	○	◔	◔	◕	◑	◑	●	◑	●	◕	●	TBD	○	◑	◑
T INDIV Individual ve Agent Detector	◑	○	◕	◕	○	◔	◑	○	TBD	NA	NA	●	●	TBD	●	●

Pages from First Volume of New CBRNE Equipment Users Guide

Meanwhile, OLES teamed up with Battelle and DoD's Defense Technical Information Center (DTIC) to compile and publish the first volume of a five-volume series of user guides on existing CBRNE equipment. The team is issuing the series in print and on CD-ROM and incorporating a format that makes it easy for state and local First Responders to compare the characteristics of each piece of equipment.

Together, OLES and SBCCOM are also developing a computer-based simulation tool for evaluating hazards posed by specific types of CBRNE attacks. The program models three outdoor incidents: a mustard gas attack on the boardwalk on July 4th; a VX nerve agent attack in a sports stadium; and a GB nerve agent attack in a city center. The objective is to model probable agents and delivery systems, and

estimate the exposure to protected and unprotected First Responders.

The bottom line is that OLES' Chemical Systems and Materials program and its partners are doing everything they an as quickly as they can to prepare for the day when the kind of terrorism so often seen overseas comes full-force to the U.S. homeland.

Forensic Sciences

OLES' Forensic Sciences program has a very broad focus. It is currently conducting 18 different projects, which touch on computer crime, drugs of abuse, gunpowder residues, tools for forensic field and laboratory analyses, burn patterns in building fires, storing and analyzing human DNA, training and educating forensic investigators, and developing standard reference materials (SRMs) like the DNA profiling standard and the drugs-of-abuse SRMs that have been produced previously. It is a wide stretch for a budget of less than one-and-a-half million dollars.

Last year, 100 million people are estimated to have used the Internet, and an increasing number are committing serious crimes in cyberspace. For trading in child pornography, stolen goods and counterfeited intellectual property, running insurance and investment scams, hacking into high security computer networks, illegally transferring funds across international borders, and keeping sets of cooked books, the universal tool of choice is the computer. And the place to find evidence of such crimes is a computer's hard drive.

A hard drive is a complicated place. There are usually between 5,000 and 20,000 files, and criminals have become very sophisticated about camouflaging the ones they do not want investigators to find. The biggest

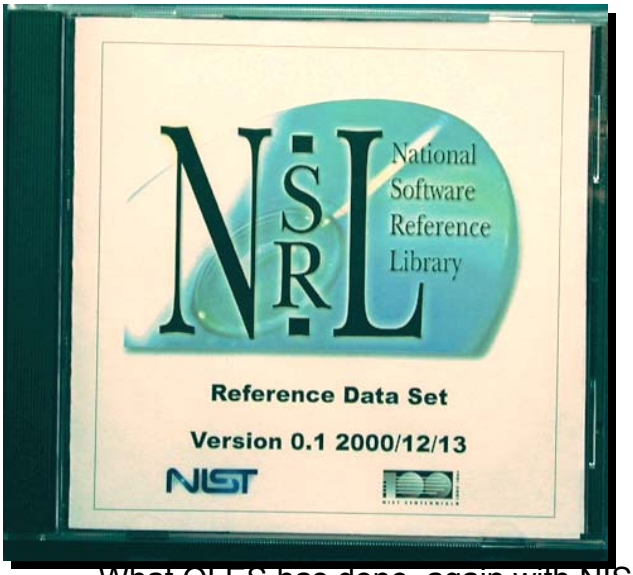
obstacle to law enforcement, though, is the fact that forensic investigators often are prevented from directly examining the data on a suspect's computer. Instead, they have to make a working copy of the data.

Getting a truly accurate copy (image) of a hard drive -- one that will stand up in court -- is more difficult than it sounds. Several commercial off-the-shelf programs are available, but they only guarantee accuracy when used on systems with specific configurations. Is the suspect's computer running Windows 98? That's fine. Windows 2000 or Windows Me? Possible problems there. Is the suspect's computer on a network? Are the hard drives SCSIs or IDEs? With each change in configuration, the guaranteed accuracy of the imaging software drops. Defense attorneys know this, and they have been arguing very successfully that evidence gathered from an image of a hard drive is unreliable.

In response, one of OLES' Forensic Sciences projects is establishing an SRM that validates imaging software. With NIST's Information Technology Laboratory (ITL) as principal investigator, OLES has tested each of the leading imaging software programs on just about every imaginable computer configuration -- forty-four configurations so far. The team has identified when each program works and when it doesn't. Once published, this information should result in far fewer cybercrime cases being thrown out of court on technicalities.

Once forensic investigators get that coveted exact image of a hard drive, they face the daunting task of sifting through tens of thousands of files to find the evidence they need. And, as mentioned above, criminals are becoming increasingly sophisticated in their ability to camouflage pornography files and phony accounting files to look like legitimate parts of Adobe Acrobat® or WordPerfect® or just about anything else.

The camouflage, however, is never perfect.



What OLES has done, again with NIST's Information Technology Laboratory, is assemble the National Software Reference Library Reference Data Set. It is a library of all the known legitimate hash codes (machine language signatures) for almost 1,000 commercial-off-the-shelf software programs, so far. A forensic investigator slips the library CD-ROM into their computer and runs a program that compares each file on the hard drive against the hash codes in the library. The program then spits out a list of the files that seem suspect. Instead of sifting through 15,000 files, the investigator only has to sift through maybe 1,500. This represents an enormous savings in time and taxpayer dollars.

This National Software Reference Library Reference Data Set is available

through NIJ, and OLES publishes updates on its website. (www.nsrl.nist.gov)

OLES' Forensic Science program is also conducting three interrelated projects linked to an increasingly important area of criminalistics: fire investigation. All three involve NIST's Building and Fire Research Laboratory (BFRL) as principal investigator. One is establishing how flammable liquids burn inside a home or an office, and is aimed at giving fire investigators baseline information on the burn patterns and behavior of fuels commonly used by arsonists. The other is an update of a major project NIST did in the 1970s. Back then, NIST created a reference that listed the ignition temperature, heat value, fuel potential, etc. of just about every material found in a typical home or office. If anyone wanted to know the temperature at which their orange shag carpet would burst into flames, or how hot their avocado can opener would burn, this book told them. From simulated leather and polyester draperies to metal office desks and plastic everything, NIST's reference publication covered it all.

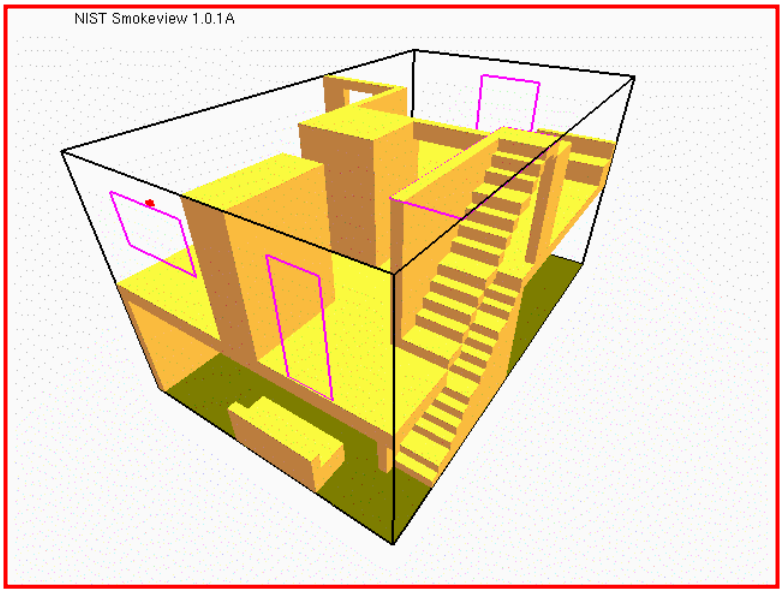
Today, however, desks and home furnishings are largely particle board, every house and office is crammed full of electronic gear, and almost nothing contains avocado dyes. The venerable NIST reference is useless. Because there is a critical need for updated information, however, OLES is resuscitating the publication with a long-term project to completely revise and update it.

OLES' third fire investigation project builds on the other two. In 2000, two tragic fires occurred at around the same time. One was in a girls' dormitory in New Jersey;

the other in a town home in Washington, D.C. In both cases, fire investigators were puzzled by what happened. So they came to NIST.

BFRL has combined data from the flammable liquids studies with the information on the burn characteristics of building and furnishing materials, and developed the capability to simulate building fires. The team recreated both fires, and what the simulations revealed is both amazing and frightening.

In the town home fire in Washington D.C., two firefighters were killed and a third critically burned. Initially, investigators were certain that the three had failed to follow procedures. When they entered the building and saw flames at the bottom of a stairway, they should have retreated back outside, out of harm's way. Instead, they remained inside, positioned one behind the other at the top of the stairs. Within seconds, the firefighter closest to the stairs and the firefighter closest to the outside door were killed. What was puzzling is that the firefighter standing between them, although badly burned, survived. Why?



NIST's simulation gave investigators the answer. After sending an initial burst of flame up the stairwell, the downstairs fire seems to die down just as the firefighters enter the building. Consequently, they saw smoke but no flames. In other words, they saw no immediate danger.

What happened next happened fast. Fed by air coming in through the downstairs entrance, the fire suddenly intensified. A huge plume of flame and hot gas shot up the stairway, instantly killing the first firefighter. The plume ricocheted off the ceiling and killed the firefighter at the back of the line. But because he was standing between the other two, the firefighter in the middle was somewhat shielded.

Those three men did not violate procedures. They found themselves in a situation that no one had ever imagined. The sequence of events and the sudden motion of the flames and hot gases surprised the investigators, and this new insight into how certain fires behave is allowing the fire service to amend its procedures and training so that no more lives are lost in similar incidents.

Oklahoma City Bombing
Photos Courtesy of CNN

Public Safety Communications Standards

OLES' Public Safety Communications Standards program is unique in that it is a program devoted entirely to a single project -- establishing seamless communications and data exchange among law enforcement and public safety personnel.

When the federal building in Oklahoma City was bombed, fire departments, emergency medical teams, state and local police, the FBI, and others quickly converged on the

scene. It was exactly the kind of multi-jurisdictional response such events require. Yet it threatened to become a fiasco. The various agencies on site could not communicate with each other. Their radios were incompatible, which meant that they were unable to coordinate their efforts. This led to confusion, frustration, and a lot of wasted time during the first critical hours. Emergency personnel from different agencies wound up using hand signals to communicate over distances, and exchanging cell phone numbers so they could talk to each other that way.

Interagency communication during the Columbine High School incident was just as poor. With the assailants still holding hostages and hundreds of students and staff at risk, the law enforcement, firefighting and emergency medical, and incident response teams who took up positions around the building-- and those trying to track and coordinate developments from local command centers -- had no way to talk to each other or share crucial information.

Columbine High School
Photos Courtesy of Jefferson County Sheriff's Department

Even during routine operations, whenever a fire fighter has to communicate with a police officer, a state trooper has to radio a local sheriff, or a forensic investigator in one state tries to share data files with a colleague in another state, there are problems.

Why? Because there are 52,000-plus law enforcement and fire and emergency medical organizations in the United States. Each one buys equipment and software to suit its own particular needs and budget from a growing universe of hundreds of different devices developed and marketed by manufacturers who are trying to outdo each other with their own proprietary designs and communication modes. Plus, law enforcement and public safety radio frequencies are distributed across four isolated bands -- from low-band VHF all the way up to 869 megahertz -- and no universally available or affordable radio can operate across the entire range.

Once again it comes down to standards. There are none that provide a common, nationwide approach for communicating and sharing information among local, state and Federal agencies.

To stem this crisis, NIJ developed a program called AGILE -- Advanced Generation of Interoperability for Law Enforcement. AGILE aims at developing and implementing interoperability standards for wireless telecommunications and information technology within the criminal justice and public safety communities.

OLES' Public Safety Communications Standards program supports AGILE. The Office's principal investigators at the Institute for Telecommunication Sciences in Boulder, Colorado -- part of the Department of Commerce's National Telecommunications and Information Administration -- are working to develop NIJ standards for voice, data, image, and video transfers. And because it will be years

before these standards are in place they are also evaluating commercial devices and services that can provide state and local agencies with some degree of interoperability in the interim.

OLES expects to be able to adopt or modify existing information technology (IT) and wireless standards to meet the needs of the AGILE program. This means that standards will not have to be developed from scratch. It does mean, however, reviewing and evaluating all current standards to determine which ones fit NIJ's needs.

This is an enormous undertaking. There are between 5,000 and 10,000 documents relating to wireless and IT standards. Various standards development organizations already have in place some 1,200 specifications and agreements. The Internet Engineering Task Force alone has more than 450 documents specifying elements of the Internet and its operation.

While this may appear to be the grand-daddy of all literature searches, the program team hopes to facilitate the selection of standards by first working with users to define a network architectural scheme and operational concepts. This will reduce the challenge to selecting standards to fill in the pieces of the architectural puzzle.

Funding for this program in FY2001 amounts to just over $2 million and covers four project areas: IT interoperability standardization, technology evaluation and engineering support, wireless standards, and support and participation in IT and wireless standards committees. The last item is the smallest slice of the budget but is extremely important. Implementing AGILE requires universal cooperation within the law enforcement and public safety communities.

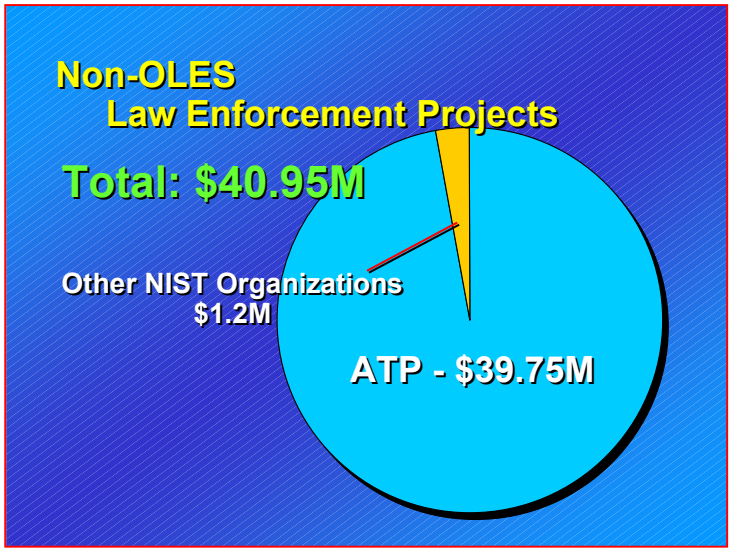
That cooperation must begin with the creation of high-level committees that will give all members of those communities a voice in the standards process and will arrive at a consensus on what's needed and how to achieve it. Working groups of IT and

wireless experts are also required to answer the tough technical questions that will arise out of the decisions that the committees make. OLES is now establishing these committees and working groups, and finding that three decades of partnering with law enforcement and public safety agencies and building teams to solve technical challenges are once again paying off.

NIST's Non-OLES Projects

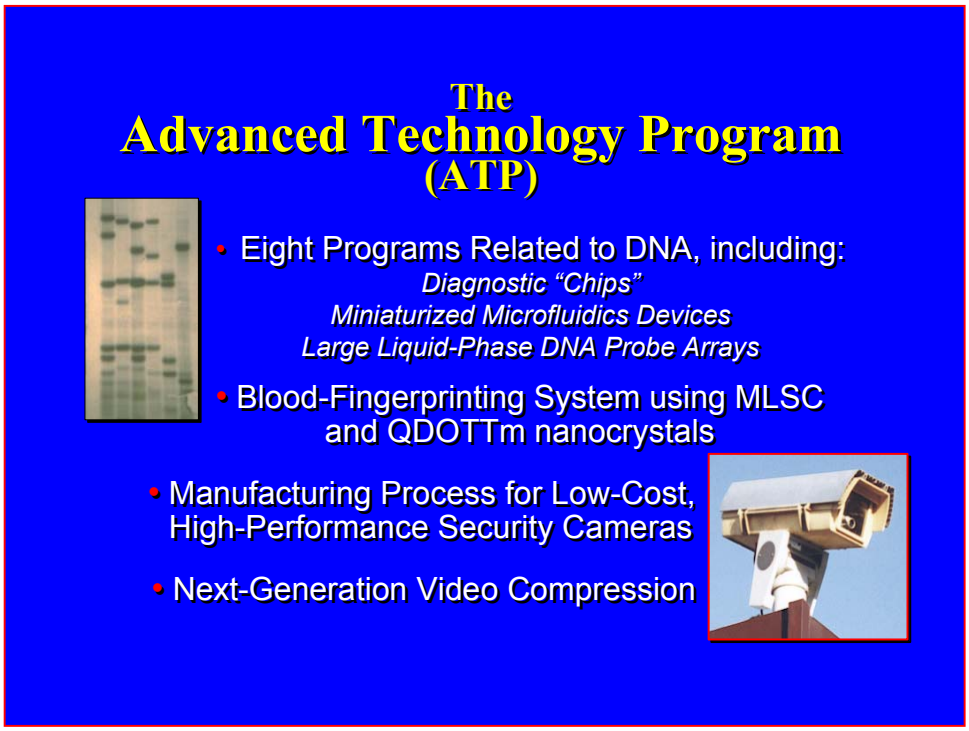
In addition to criminal justice and public safety projects conducted by OLES in direct response to priorities set by these communities, several non-OLES projects within NIST also have criminal justice and public safety applications. These are projects conducted by other NIST organizations and in some cases funded directly by the program sponsors. OLES sometimes consults on these programs, but has no management involvement.

FY2001 funding for projects in this category amounts to almost $41 million. As the "Non-OLES Law Enforcement Projects" graphic shows, all but $1.2 million of that goes into research financed by NIST's Advanced Technology Program, the ATP.



This $41 million certainly dwarfs OLES' budget of just over $12 million. However, it is important to remember that the vast majority of that $41 million -- including all the funds shown for the ATP -- go to projects that are not necessarily funded by the criminal justice or public safety communities or designed with the needs of these communities in mind. They are projects that just happen to have secondary applications in these areas.

The ATP co-funds research into high-risk, enabling technologies that promise significant commercial payoffs and widespread benefits for the U.S. economy. It provides anywhere from 40 to 75 percent of the total funds for a project, with the balance coming from industry sponsors. The budget figure of $39.75 million is only NIST's share of project costs.



Several ATP projects have possible applications in criminal justice and public safety. Eight ATP projects, for example, focus on new approaches to DNA analysis -- from novel DNA diagnostic "chips" that eliminate the need for sample preparation and DNA amplification, to disposable, miniaturized devices, based on microfluidics, that automatically extract purified DNA from biosamples and amplify those samples, and large arrays of liquid-phase DNA probes -- up to a million probes in each array cell -- capable of doing millions of DNA assays at a time.

Another ATP program is developing a novel blood-fingerprinting system, based on microvolume laser scanning cytometry and light-emitting nanocrystals, to rapidly analyze whole blood. And two projects deal with innovative surveillance technologies that have criminal justice and public safety applications. One is developing a new

manufacturing process for low-cost, high-performance, low-light level cameras for security applications. The other is investigating the next-generation of video compression technologies to enable digital video to be delivered to personal computers.

Outside of ATP are non-OLES projects with direct law enforcement and public safety orientation. NIST's Information Technology Laboratory (ITL) has received FY2001 funds from the Federal Bureau of Investigation (FBI) to develop standards and

measurements for advanced biometric identification technologies. The Bureau of Alcohol, Tobacco and Firearms (BATF) is funding research being done by NIST's Building and Fire Research Laboratory to support the Bureau's arson investigation efforts and is also funding a project to train fire researchers. Finally, the FBI, the National Security Agency (NSA), and NIST are cooperatively funding a project in NIST's Electronics and Electrical Engineering Laboratory to develop magneto-resistive imaging methods for recovering and enhancing information on magnetic storage devices. Using these developments, forensic investigators will be able to recover data from a wiped hard drive or even reconstruct erased signals on audio tape. The team is hoping someday to have a crack at the erased portions of the Nixon White House tapes.

Challenges Facing OLES

OLES is clearly NIST's lead organization in helping to match its unique facilities and resources to the needs of the criminal justice and public safety communities, and in coordinating organizations around the country and around the world in this important work. OLES, however, would like to do more.

In particular, it would like to resolve two challenges.

The first involves funding. Because all of OLES' money comes from outside agencies, the Office can not be certain from year to year whether it will be able to cover staff salaries and basic expenses like office equipment and necessary travel. These basics currently amount to under $1.5 million a year.

The other challenge is to find a way for the OLES team to keep an even closer eye on developments related to law enforcement and public safety, both within NIST and in the public and private sectors beyond these walls. The time that the OLES staff spends talking to NIST program managers, science and engineering groups, criminal justice and public safety agencies, equipment manufacturers and the like, enhances its efforts and adds real value to the work it does. OLES would like to find a way to extend that activity.

One possibility is to give OLES an active role within NIST's new National Industrial Liaison Office (NILO). The Office of Microelectronics Programs was recently assigned such a role, making it NIST's official representative to the semiconductor industry. If OLES could do the same -- serving as liaison, clearinghouse, and single point of contact on matters of criminal justice and public safety, for both NIST and the industry it serves -- it could strengthen its programs and better apply the spectrum of NIST's capabilities in these areas. OLES is confident that it has not only the expertise that the role requires, but also the necessary trust of organizations both inside NIST and among its colleagues around the world.

In the end, it all comes back to standards. Webster's dictionary lists nine definitions for the word. The one the OLES team like best is this one:

People who work in the field of law criminal justice and public safety tend to become passionate about what they do. Every day they come face-to-face with issues that are critical to their own communities, their own families, and they begin to see standards in a whole new way -- not as dry, impersonal specifications, but as a means of saving lives and making this country safer and more secure.

A lot of great work in a lot of different disciplines is going on at NIST. Many programs have bigger budgets and deal with much more glamorous technologies and science much closer to the bleeding edge. But when the OLES team reads on the front page that a jury has convicted a murderer because one of their projects made the evidence more convincing -- or when they open the monthly journal of the International Association of Chiefs of Police and read that three more officers were saved by soft body armor, they would not trade what they do for any other job in the world.

Office of Law Enforcement Standards

at the

National Institute of Standards and Technology

Building 225, Room A323, Gaithersburg, MD 20899
(301) 975-2757 (voice)
(301) 948-0978 (fax)

www.eeel.nist.gov/oles