Overview of Criminal Justice Projects at Sandia National Laboratories
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Introduction

Applications of technology to criminal justice have been sparse, and even those applications were not often successful. In many cases, the same tools are available today as were one or more centuries ago. Since the payoff could be large both in dollar and emotional currency, it makes sense to apply some of the nation's high technology to the problems of crime and personal safety and security.

The problems of crime are many:

- Prison populations have skyrocketed in the last few years, leading to massive prison building programs and a trend toward parole of increasingly violent prisoners to make room for new inmates. Across the nation, we see a push for such actions as reduced manning of prison guard towers. In addition, some security upgrades have the appearance of being more politically driven than need driven.
- Thirteen percent of police response requests are to commercial or residential alarms. The 99% of those alarms which are false alarms are costing tax dollars and making law enforcement less able to respond quickly to real problems.
- Large manufacturing industries, such as the semi-conductor industry, and financial entities, such as credit card companies, face huge losses due to fraud and theft.
- The nation has little standardization in the area of security. A smoke alarm has standardized and certified performance; a security system does not.

The problems of applying technology in the field of criminal justice are also many:

- Corrections and law enforcement are carried out primarily at the state and local level; thus the number of customers involved is huge, but most are small-dollar-value customers. This is a tough market for vendors.
- These local entities have operational budgets, but don't usually have budgets that easily permit spending for high-tech gear. When they do buy high-tech gear, the price must be free of sticker shock.
- Lack of national standardization means that high-tech solutions don't often work the first time, and second chances aren't usually offered.
- The federal government must “buy down” the initial cost of technology R&D, if it is to be widely used in criminal justice applications.

The Nuclear Security Systems Center at Sandia National Laboratories (SNL) has been actively involved in all phases of physical security for the protection of high-value, high-consequence national assets for the last few decades. This work, primarily for the Department of Energy (DOE), has included:

- Security systems engineering and integration,
- Research and development and/or test and evaluation of security components such as those for access control, identity verification, contraband detection, surveillance and assessment, tracking and monitoring, use control, intrusion detection, security information management, and delay technologies,
- Security-related modeling, simulation, and analysis, including vulnerability assessment of facilities and processes, and
- Development of security philosophies, methodologies, and tools.

This expertise should transfer directly into criminal justice areas, such as prisons, law enforcement, courts, and probation and parole.

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Statistics obtained from American Society for Industrial Security.

This work was supported by the United States Department of Energy under Contract DE-AC04-94AL85000.
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SNL’s methodology for implementing physical security addresses determination of system objectives, design of the physical security system, and evaluation of the design. Figure 1 shows the SNL design philosophy for Physical Protection Systems.

An overview of selected criminal justice projects at SNL will be given in the remainder of the paper. Those discussed will include three Less-Than-Lethal projects done for the National Institute of Justice (NIJ), a Southwest Border study done for the Office of National Drug Control Policy (ONDCP) through the Immigration and Naturalization Service (INS), and one involving corrections agencies.

**Smart Gun Project**

Firearms are used by assailants in most of the attacks on law enforcement officers that result in serious injury or death. In nearly one in seven of these attacks, the officer is killed by his or her own firearm. While the total number nationwide killed in this manner is not large, the potential threat is present for every officer facing violent and unpredictable subjects. Three officers were reported as being killed with their own gun in 1992 and four in 1993; in prior years as many as 12 deaths have occurred from an assailant’s use of the officer’s firearm.

Smart Gun is a term used to describe a firearm that “recognizes” the user and can only be fired by an authorized user. The project started with the determination of the requirements for such a gun. SNL is conducting an investigation into a variety of sensors that, in principle, have the ability to be useful in a smart gun, specifically a handgun suitable for use by law enforcement officers. Technologies given at least a preliminary evaluation include surface acoustic wave tagging, passive R.F. coding, touch memory, magnetic encoding, capacitive sensors/encoding, and remote R.F. disablement. Breadboard models of the most promising technologies are being fabricated to closely approximate the features that would be used in a final firearm. The goal is to fabricate models that maintain the same look and feel of an actual firearm, allowing further meaningful dialogue with law enforcement personnel about the advantages and disadvantages of each technology.

If the requirements of a smart gun for law enforcement officers can be successfully met and technology developed to produce a firearm incorporating this technology at a reasonable cost, there could be a considerable impact on domestic gun ownership. About 500 children and adolescents (age 1-19) die each year from gun violence. SNL is conducting an investigation into a variety of sensors that, in principle, have the ability to be useful in a smart gun, specifically a handgun suitable for use by law enforcement officers. Technologies given at least a preliminary evaluation include surface acoustic wave tagging, passive R.F. coding, touch memory, magnetic encoding, capacitive sensors/encoding, and remote R.F. disablement. Breadboard models of the most promising technologies are being fabricated to closely approximate the features that would be used in a final firearm. The goal is to fabricate models that maintain the same look and feel of an actual firearm, allowing further meaningful dialogue with law enforcement personnel about the advantages and disadvantages of each technology.

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3 Supported under Interagency Agreement #94-JJ-R021 from the National Institute of Justice, Office of Justice Programs, U.S. Department of Justice.

accidental discharge of firearm and approximately 1500 more from suicides and murder. Many of these type deaths could be avoided if guns in the home had authorized user safing mechanisms. There is also an obvious benefit in reducing the potential of stolen weapons being used in criminal activities.

**Restraining (Sticky) Foam Project**

In prison disturbances involving uncooperative inmates, correctional officers normally must use hands-on restraint. Even when mace or electrical stun devices are used, officers still must use hands-on restraint. Regardless of whether the inmate is armed, gaining the hands-on restraint can lead to officer or inmate injuries.

Sticky foam is an extremely tacky, tenacious material, developed at SNL, used to entangle and impair an individual. It is stored under pressure and expands over 30 times its stored volume when dispensed.

The objectives of the NIJ sticky foam project at SNL were to develop a gun capable of firing multiple shots of sticky foam to 35 feet, to conduct an extensive toxicology review of sticky foam, to test the gun and sticky foam effectiveness on SNL volunteers acting out prison and law enforcement scenarios, and to have the gun and sticky foam further evaluated by correctional representatives.

The project began at the end of 1992. Requirements were developed in conjunction with NIJ, the American Correctional Association (ACA), and the National Sheriffs' Association (NSA). A backpack-mounted gun was then developed and tested. Based on lessons learned from the backpack gun, a shoulder-slung prototype gun was developed, tested, and exceeded requirements.

Also, an extensive toxicology review was performed on the sticky foam. After an extensive safety and human subject testing review, on-skin testing of the material was completed. The on-skin testing found acceptable cleaners for removing sticky foam from skin and the typical times required for cleanup. Sticky foam dispensed on the skin for durations expected in these situations is of negligible toxicological risk. It can be removed from skin with time and effort using mineral oil (baby oil). Other nontoxic, nonhazardous, nonflammable, "green" cleaners can be used to remove sticky foam (again with time and effort) from walls, floors and equipment. However, cleanup remains a potential issue.

Next, prison scenario effectiveness testing was conducted. The prison scenarios tested, five cell-based and four day-room based, were developed by ACA and the Florida Department of Corrections (FDOC). Both organizations participated in the testing. Five general law enforcement type tests were also conducted. The seven SNL volunteers who participated in the sticky foam restraining effectiveness tests were approved by the SNL Medical Department to participate in the testing, received extensive training prior to the testing, and wore full protective gear for the tests.

The tests successfully identified the advantages and disadvantages that might be expected from sticky foam application in different types of prison disturbances. Formal evaluation of the sticky foam effectiveness testing was performed by the ACA and NIJ. The benefits of the technology are being weighed carefully against the potential safety risks and legal liability issues before proceeding with any further significant testing or development for justice applications.

**Aqueous Foam Project**

One of the technologies developed at SNL as part of the nuclear safeguards programs having potential utility for the application of less-than-lethal force is high expansion ratio aqueous

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5 Supported under Interagency Agreement #92-IJ-R035 from the National Institute of Justice, Office of Justice Programs, U.S. Department of Justice.


7 Supported under Interagency Agreement #92-IJ-R025 from the National Institute of Justice, Office of Justice Programs, U.S. Department of Justice.
foam. Aqueous foam has potential for use in prison cell extractions to reduce the force required with hands-on restraint, and also to quell area disturbances or riot situations.

High expansion aqueous foam is an aggregation of bubbles having the appearance of soap suds. It is mechanically generated by the movement of a large volume of air through a screen that is continuously wetted with an aqueous solution of a synthetic foam concentrate. The foam contains surfactants that are chemically similar to those used in hair shampoo and liquid soaps.

Aqueous foam systems were initially developed in the 1920’s for fighting coal-mine fires. It has been widely used since for fire fighting, dust suppression, oil and gas recovery in depleted deposits, and ore refining by froth flotation.

As used in security systems developed by SNL, aqueous foams have the following properties: obscures vision, blocks sound, suppresses fires, separates leaders from followers, makes surfaces slippery, creates difficult breathing, and can be used to transport irritants. Aqueous foam separates individuals both visually and acoustically. In crowd riot situations, the foam may also be effective in isolating instigators from others in the crowd. In riot and disturbance situations, aqueous foams also serve as beneficial fire retardants. Cleanup is relatively easy using a wet/dry vacuum.

The objective of the NIJ aqueous foam project is to investigate the potential application and effectiveness of aqueous foam in prison and jail disturbance situations. Specifically, project goals are to develop a non-toxic aqueous foam formulation specifically for corrections applications, evaluate physical characteristics of the foam, and conduct respiration simulation experiments. The project will investigate both cell and large facility application of aqueous foam in prisons or jails. Other issues that will be addressed as part of the project include acceptable foam knockdown techniques for retrieving inmates and an evaluation of safety risks associated with respiration of the foam. The project began in late 1994 and is continuing.

Work underway for correctional institutions involves a study of perimeter security. In this capacity, Sandia has had some interaction with perimeter security upgrade and new construction activities. Various tools and expertise show promise for improving current and future corrections security.

One tool Sandia developed many years ago for use in designing Department of Energy facilities is a computer program that simulates video assessment. When camera and facility layout specifics are input, a simulated video-monitor image of imaginary intruders at various locations is shown. The simulation allows one to judge how well the camera layout serves the video assessment needs of the facility. Figure 2 below shows what the camera could see in one plan for a facility.

![Figure 2](image-url)

*Video Simulation of Prison Perimeter*

We are considering various types of corrections perimeters which are in use, including:

- Older facilities, which often have thick masonry walls as an outer perimeter, and which may well have historical preservation requirements,
- Newer facilities, which often have double lines of chain-link fences, with a clear zone between, reminiscent of DOE facilities, and
- High-rise buildings in downtown settings, where the walls of the building are the perimeter.

All of these have requirements for:

- Detecting intruders, as well as inmates trying to escape,
• Delaying, after the detection, intruders and escapees until the response can arrive,
• Responding to and stopping intrusion/extrusion attempts, and
• Controlling entry of people, materials, and vehicles into the facility.

Southwest Border Study

In 1991, SNL was tasked by ONDCP, through INS, to conduct a systematic analysis of the security along the US/Mexico Border between Ports of Entry and to recommend measures by which control of the border could be improved. The study was completed in 1993. The study consisted of:

• Characterizing the current border security environment,
• Compiling a catalog of currently available or readily modifiable technologies,
• Developing an implementation plan that provided optimal use of these technologies based on present staffing levels, and
• Generating an implementation plan that allows a moderate increase in personnel.

This study recommended that the Border Patrol focus on preventing illegal entry instead of apprehending aliens once they have entered the country. It recommended prevention measures such as multiple barriers, enhanced checkpoint operations, and enhanced electronic surveillance equipment. This study has been cited in several reviews of Border Control by the General Accounting Office (GAO). ¹°¹¹

Summary

In conclusion, the nation’s technologies developed to protect nuclear and other high value assets have enormous potential to improve all our lives when applied to crime and personal safety. The difficult parts of doing this are simplifying the transfer of this technology to private industry and eventually to criminal justice practitioners, doing it efficiently and accurately enough to create cost-effective applications that work, and providing a way to make the cost for the new systems affordable by state and local agencies.

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Note of Special Thanks: I would like to thank Doug Weiss, SNL project manager of the Smart Gun Project; Tommy Goolsby, SNL project leader of the Restraining Foam and Aqueous Foam Projects; John Milloy, who is actively involved in the SNL work on corrections perimeter security; and J. D. Williams, project manager of the Southwest Border Study, for their invaluable input into this document, as well as for their excellent contribution to the aforementioned projects.