

SANDIA NATIONAL LABORATORIES

INDUSTRIAL
Partnerships

ANNUAL REPORT FY2010



**Saving Lives
in Afghanistan**



Sandia
National
Laboratories



innovation
through partnerships

About the cover:

An Airman demonstrates placement of Stingray, a water disruptor developed at Sandia, near its target in a simulated village used to train soldiers heading overseas. More on pages 18 and 19.

Table of Contents

4 Introduction

6 Strategic Industrial Partnerships Offer Big Pluses for All Concerned

Payoffs Come to Labs, Partners, the Public, the Economy

LONG-TERM PARTNERSHIPS

8 Goodyear, Sandia Have Strong Grip on Their Long-Term Partnership

Quick Modeling of a Tire's Mechanical Response Pays Off

10 Lockheed Martin, Sandia Share Visions That Garner Major Advancements

Nanomaterials, Optical Coatings Aid Pilot Safety

12 Sandia, Monsanto Tackle Bioenergy and Biofuels Challenges through Partnership

Looking for Plants as Liquid Transportation Fuels

14 New Fuel Cell System Lights Red Carpet at The Academy Awards®

Impressive Technology Emerges from a Multi-Member Partnership

NEW PARTNERSHIPS

16 Sandia, NIOSH, Mine Safety Administration Trying to Make Coal Mining Safer, More Survivable

Developing a Next-Gen Remote Rescue Robot

A YEAR 2010 NEWSMAKER

18 TEAM Technologies, Sandia Work to Kill the Explosive in IEDs

Stingray a Top Invention for 2010

INTERNATIONAL PARTNERSHIPS

20 Remarkable Research, Technology Emerge from International Partnerships

Work with Foreign Partners a Positive Global Engagement

INNOVATIVE PUBLIC-PRIVATE PARTNERSHIPS

22 Special Partnership with UNM, Adaptive Methods Leads to Low-Cost Detection of Pathogens

Addresses Both Medical Diagnostic Needs, Biodefense Applications

TECHNOLOGY-BASED ECONOMIC DEVELOPMENT PARTNERSHIPS

24 Better Eyesight and Seeing Deeper into Space: That's WaveFront Sciences

Company Born Out of Unique Entrepreneurial Program

26 SS&TP Recognized for Major Contributions to Community, Economic Health

Public-Private Partnership a Testament to Tech Commercialization

27 ICE-LOC® is Example of What NMSBA Does Year Round

28 Scorecard

32 Recognition

33 Awards

34 Contacts



Dr. J. Stephen Rottler
Vice President, Science and Technology
Chief Technology Officer
Sandia National Laboratories

Dr. Harold (Hal) Morgan
Senior Manager
Industrial Partnerships
and Strategy

“ We have appreciated the strong advocacy from Secretary Chu for industrial partnerships throughout the DOE complex and all they have and will contribute to the strengthening of our economy and to our nation’s continued strong security and contributions to world-wide peace. ”

Dr. J. Stephen Rottler
Vice President, Science and Technology
Chief Technology Officer
Sandia National Laboratories

The FY2010 Partnerships Annual Report

Another year has come and gone and Sandia National Laboratories’ Industrial Partnerships Program continues to garner headlines and awards. The program also continues to yield research, technologies, and products developed and marketed by our partners that not only are good for the United States, but for the world as a whole.

Some of the work and achievements covered in this FY2010 report have:

- Kept U.S. soldiers alive as they support efforts in Afghanistan
- Resulted in a new ability to detect pathogens, which is useful both for medical diagnostic needs and biodefense operations
- Increased the likelihood of rescuing miners trapped deep below ground
- Identified improved ways of fabricating nanomaterials that can make fighter jets safer, along with improving cyber defense

Additionally, a partnership covered here is headed, as it matures, toward development of ways to enhance farm productivity and food quality. Another made its way to the Red Carpet at the 2010 Academy Awards®.

Technology-based economic development once again rounded out Sandia’s comprehensive approach to

technology transfer in 2010. The Sandia Science & Technology Park continues to set the standard nationally for measuring the economic impact of the Park on the local economy at Sandia. Small tech-based companies spun out of the Labs by its entrepreneurial program continued to thrive and expand, and the New Mexico Small Business Assistance Program (NMSBA) helped 341 more small businesses overcome critical technical problems this year.

Industrial partnerships at Sandia – some with U.S. companies, some with foreign concerns, some with academia, and even other government agencies – have been carefully designed and implemented over the years to include players of many types and sizes, all with the intent of deriving benefit from Sandia’s broad technology base. Results of these endeavors are summarized in the Scorecard and in the Recognition sections.

This report covers a small collection of the diverse work performed through the Labs’ Industrial Partnerships Program, all of which is tied to Sandia’s mission. This work enhances Sandia’s overall capabilities to execute the Labs’ core national security mission while simultaneously enhancing the technology and research and development base in the U.S., and strengthening our partner companies, both technically and financially.

Strategic Industrial Partnerships Offer Big Pluses for All Concerned

The term “Industrial Partnerships” typically is associated with technology transfer at Sandia National Laboratories.

That is, Sandia helps to solve technical problems for industry or provides technologies for commercialization with the intent of creating jobs and keeping U.S. industry competitive.

For three decades, Sandia has been a leader in working with industry in this context. Occasionally, however, some have wondered whether these industrial partnerships truly contribute to Sandia’s national security mission. Well, they do. Industrial partnerships for mission success is a foundational requirement.

Examples of industrial partnerships contributing to mission success include several in energy, combustion, and biofuels research; nano-engineering; high-performance computing; and battery technology.

For example, although the 17-year partnership with Goodyear has focused on using Sandia’s technology for tire applications, the Labs’ national security mission has been well-served. Enhanced solution algorithms, resulting from Sandia’s collaborations with Goodyear, have enabled many computational mechanics simulations for nuclear weapons and other security applications. Highly accurate curing simulations for polymer encapsulants used in neutron generators, a critical weapon component, is one example. The simulation capability has been used to assess the integrity of polymer seals.

The chart on the following page provides a sampling of long-term, industrial partnerships,

how they have helped out Sandia’s partners, while being leveraged to Sandia’s national security missions needs.

More recently, the value of industrial partnerships has expanded beyond the context of technology transfer for industrial competitiveness. Today, national and global security problems (energy, cyber security, climate change, nuclear weapons, to name a few) are so difficult and complex that a single institution or national laboratory cannot solve them alone.

Perspectives of and participation from others are needed to ensure that the U.S. government and citizens receive the maximum value from investments in Sandia. Industry’s role in solving these national security problems is particularly important because it produces the products and owns delivery systems or infrastructure in which Sandia technologies become embedded as solutions to some of these important challenges.

In some cases, Sandia becomes the primary beneficiary of insights from industry. Some partners will help direct Sandia’s research in a particular area or provide insights on policy around particular technologies. Other partners may commercialize Sandia technologies.

In conclusion, as we look into the future of partnerships, we always must recognize the importance of providing proper incentives for industry to work with Sandia. The technological value to the partner must be clear from the beginning although realization of the benefit may be delayed well into the future.

“*Sandia’s Industrial Partnerships program lies at the heart of tech transfer. It is through these partnerships that intellectual capital creates value and that economic benefits accrue to the taxpayer. Partnerships being created today will ensure our nation’s future economic prosperity.*”

*Dr. Karina Edmonds
Technology Transfer Coordinator
U.S. Department of Energy*

Representative Sample of Long-Term* Industrial Partnerships

Industry Partner	R&D Focus	Key Sandia Mission Contributions
Goodyear	Advanced mechanics, materials R&D, tire dynamics	Computational mechanics simulations for weapons applications
Lockheed Martin	Advanced sensors, simulation of complex systems, energy & resource technologies	Reductions in design/fabrication cost & time, increased systems reliability, improved product quality
Intel	Integrated circuits manufacturing, rapid response for ES&H fabrication issues	MEMS, rad-hard MEMS, IC failure analysis, numerical modeling of fabrication issues
Boeing	Space, missile & aircraft R&D, microsystems science technology, manufacturing technologies	Materials & process science, modeling and simulation, pulsed power/directed energy sources
General Motors	Alternative fuels development, new & improved automobiles, automotive research & engineering	Energy efficiency, renewable energy, reduction of greenhouse gases, electric-based power systems
General Atomics	Radar systems manufacture/assembly, unmanned aerial vehicles (UAV), advanced system studies	Synthetic aperture radar (SAR)/ground motion target indication radars, SAR/UAV system integration, enhanced surveillance capabilities
Northrop Grumman	Space, missile, aircraft electronics; integrated military systems; border & maritime security	Modeling and simulation; microsystems science & technology and components; command, control, communications, intelligence; surveillance & reconnaissance
Raytheon	Weapons systems sustainment, integrated product & process design, advanced and emerging weapons	Predictive reliability & maintenance; robotics painting, coating, cleaning; reentry vehicle & hypersonics technologies
Stirling Energy Systems	Concentrating solar power	Renewable energy, energy security
Cray	Architectures for supercomputers	High-fidelity defense-related simulations, nuclear stockpile stewardship

*Long-term applies to relationships that have been on going for a decade or more.

Quick Modeling of a Tire's Mechanical Response Pays Off

“ This technology has helped us develop world-leading tires by analyzing thousands of design concepts and improvements that would not have been feasible to build and test. ”

*Dr. Pawan Handa
Director of Tire Performance Prediction
The Goodyear Tire & Rubber Company*

Simulations of tire performance guide the development of tire tread design for improved fuel economy.

Goodyear, Sandia Have a Strong Grip on Their Long-Term Partnership

When the long-term partnership between Sandia and The Goodyear Tire & Rubber Company was in its infancy, Goodyear was using commercial mechanics codes to model a tire's behavior.

These simulations had two major shortcomings: (1) They generally took weeks to complete; (2) Only crude models could be run. Consequently, the simulations were not much help in making key tire design decisions. About a year and a half into the partnership – in the mid-1990s – Sandia researchers adapted one of the Labs' nonlinear finite element codes, not available commercially, to Goodyear's tire design and testing applications.

The major breakthrough was the ability to do very detailed tire simulations very quickly. Accurately modeling the mechanical response of a tire as it goes into service on a vehicle including mounting on a rim, inflation, vehicle loading, and rolling on the road with braking and cornering enabled Goodyear to make a fundamental change in its tire design process allowing computational simulation to replace many prototype builds and tests.

With this technology, tire simulations with very high levels of detail could be run in a couple of days. Before the Sandia/Goodyear partnership, each tire design iteration was followed by the manufacture of a set of prototype tires that were then tested extensively. Results of tests guided modifications needed for the next design iteration. Since three to five iterations were typical, three to five sets of prototype tires had to be built and tested, a process that could take 2 years.

As the partnership continued, acceptance of faster, more accurate, and more complex

simulation tools by the Goodyear design community grew. In some cases, new tires were accepted on first submission by automakers for their new vehicle models. Goodyear's Assurance TripleTred is an example of a major tire product that was developed with simulation tools that helped to design its innovative features for maximum performance while bringing it to market in less than a year. Goodyear and Sandia jointly won an R&D 100 Award in 2005 as a result.

Over the past 5 years, this robust form of computational simulation has been used in the design of almost every new product including most recently Goodyear's Fuel Max line of tires.

Also, state-of-the-art rubber material models have been developed. They can represent the mechanical behavior of the various rubber compounds in a tire while including the effects of temperature, frequency, and strain level.

The Sandia/Goodyear strategic partnership has recently expanded to focus on high-speed rolling, noise modeling, snow and mud traction modeling, and fully coupled thermo/mechanical rolling simulations.

Fully coupled thermo/mechanical rolling simulations are needed in order to develop a tire with minimum rolling resistance. Tires with reduced rolling resistance will have major benefits for customers, vehicle manufacturers, and the nation due to the associated savings in energy and oil consumption. The Transportation Research Board estimated that a reduction of 50 percent in rolling resistance would save 10 billion gallons of fuel each year.

The Shared Vision strategic partnership between Sandia and Lockheed Martin has contributed to many mutual R&D initiatives.

“ We are proud of the Lockheed Martin-Sandia research team that developed this new award-winning chemical process. The award is yet another example of how Lockheed Martin leverages innovative ideas from across the nation to enable growth, drive affordability, and maintain the relevance of our products. We are pleased to have Sandia as a key partner in our Shared Vision program. ”

*Dr. John D. Evans
Corporate Vice President, Business Innovation
Lockheed Martin Corporation*

Lockheed Martin, Sandia Share Visions That Garner Major Advancements



A chemical process, refined by researchers at Sandia, the Lockheed Martin Corporation, and the University of New Mexico, has created new, more affordable commercial applications of nanomaterial and optical coatings. The technique, Multifunctional Optical Coatings by Rapid Self-Assembly, is the most recent Shared Vision research initiative to win an R&D 100 Award.

In the process film-like coatings are formed that are already widely used in consumer electronics, semiconductor devices, and high-performance glass and ceramics. Rather than high temperatures and/or the vacuum conditions required with current commercial processes to deposit films, the Sandia method simply disperses commercially available polymers by inserting the films in common solvents under ambient conditions. Then simple spin, dip, or spray techniques are used to coat surfaces. Evaporation of the solvents induces the polymers to self-assemble into multifunctional nanoparticles, as well as films with tailored optical properties and a nanostructured surface. Because the process is compatible with conventional spray processing, it can be applied directly to the coating of large or complex parts, a capability not easily accomplished by current commercial methods.

In addition to identifying a broader set of affordable industry applications for optical coatings, this research has developed uses of the technique for the Department of Defense, the DOE, and the National Aeronautics and

Space Administration (NASA). One application includes increasing the margin of safety for a fighter jet pilot. A typical fighter jet aircraft canopy loses eight to ten percent of its optical transmission from the intrinsic Fresnel lens loss as a result of the refractive index of the plastic or glass material. Applying an optimized anti-reflective coating with the new technique can inexpensively add an additional eight to nine percent transmission through the canopy.

Unlike conventional anti-reflective coatings, which must be repaired in a manufacturing facility after disassembly, the Shared Vision-developed coating is adaptable to field repairs.

An award-winning chemical process is just one example of the mutual benefits from the Shared Vision program – a long-term and diverse research partnership between Sandia and Lockheed Martin. Since the start of the partnership in 1999, Lockheed Martin has made a substantial investment to support Sandia-led technology research initiatives for projects important to the Labs' core national missions. Operating under an Operations & Maintenance contract for the DOE, the Shared Vision research initiatives create opportunities to provide cutting-edge, efficient, and more affordable solutions to Lockheed Martin's customers.

Other recent Shared Vision partnership projects include fiber-optic signal and data transmission in aircraft, cyber defense, and several biological and chemical applications.

Looking for Plants as Liquid Transportation Fuels

“Coupling hyperspectral fluorescence microscopy with Sandia’s proprietary analysis algorithms has enabled us to overcome the main limitations of traditional confocal microscopy and has paved the way to new discoveries.”

*Dr. Maria Cristina Ubach
Associate Fellow
Monsanto Corporation*

Sandia designed and built this hyperspectral confocal fluorescence microscope housed at the Crop Analytics department at Monsanto headquarters, St. Louis, Missouri.

Sandia, Monsanto Tackle Bioenergy and Biofuels Challenges through Partnership

Monsanto Company – a Delaware corporation headquartered in St. Louis, Missouri, and a leading global provider of technology-based solutions and agricultural products that improve farm productivity and food quality. Sandia – a government laboratory that provides science-based technologies to support national security by providing solutions to solve national and global threats to peace and freedom.

Is this a match? It surely is. A strategic relationship with Monsanto makes sense on many levels and has bolstered both partners' collective long-term objectives in bioenergy and biofuels. And, the collaboration makes use of an award-winning Sandia technology, a Hyperspectral Confocal Fluorescence Microscope System – that won an R&D 100 Award in 2009. This technology is a unique combo microscope-software system that allows the user to discover and quantify fluorescence species by detecting microscopic images. They do this by using a continuous spectrum of emitted light that other microscopes are not able to quantify, much less even see.

The Monsanto-specific vision for this collaboration, which is enabled by the patent-pending microscope-software system, has been to apply new and innovative scientific tools as an important part of how the company brings forward new technologies for the farmer. Recent advances in analytical detection and sensing technologies provide enhanced accuracy, precision, and throughput to these analytical technologies, thereby reducing cost and cycle time, and accelerating the pace at which healthy

and nutritious foods can be brought to the marketplace.

Monsanto's interest in the technology is to identify components and structure of plants – including grasses, trees, corn, soybean, and other crops – that can most easily be converted to liquid transportation fuels. Monsanto's crop analytics research program has played a role in discovering new products for farmers, including corn hybrids that offer more ethanol output per bushel and soybean varieties that produce healthier oils for consumers.

This collaboration provides a new opportunity to further augment an existing crop analytics program, offering researchers another way to better understand genomic profiles for seed and trait development.

Over the term of this partnership Sandia has been gaining experience with agricultural samples that have bioenergy/biofuels applications and other uses. Ancillary research focusing on the photosynthetic properties of various plants and microbes, for instance, is adding to the Labs' growing expertise in understanding the conversion of sunlight to sugars. The Sandia and Monsanto partnership is of particular interest to DOE and efforts to address potential national security concerns related to agro-terrorism. In addition, the partnership is relevant to the production of new fuels from biomass and is essential to the global carbon cycle and carbon sequestration.

Impressive Technology Emerges from a Multi-Member Partnership

“ *Multiquip has endorsed fuel cells as a future technology platform that could provide benefits to the user and environment in many of the products the company currently markets, as well as in future designs. Our partnership with Sandia is the first step in our attempt to take this technology through its development cycle.* ”

Torsten Erbel
*Engineering and Customer Support
Multiquip, Inc.*

Workers setting up a Fuel Cell Mobile Light for use at the 2010 Academy Awards® ceremony.

Photo Courtesy of A.M.P.A.S®



New Fuel Cell System Lights Red Carpet at The Academy Awards®

In March of 2008 the Sandia-Boeing Company partnership had already been up and running for more than 6 years yielding significant results in areas such as lightweight composites for commercial aircraft, next-generation space processors, as well as sensors and lighting for border security.

Then Boeing asked the Labs to lead an effort to bring hydrogen fuel cell technology to airport ground support equipment. With the aid of additional funding from the

DOE, the project goals were quickly broadened to address these and new and exciting applications.

The new vision: Bring clean fuel-cell-energy technology to the construction marketplace, reduce air pollution, stimulate demand for hydrogen, and proliferate the technology. Replacing diesel-fueled

mobile lighting towers with a quiet, non-polluting Fuel Cell Mobile Light became the goal.

With that, a brand new and unique engineering partnership was born. Led by Sandia, it consists of more than a dozen institutional partners including funding sponsors, fuel cell and lighting technology experts, equipment manufacturers, and a diverse set of end users.

The Fuel Cell Mobile Light is getting lots of attention. It has already won a prestigious Federal Laboratory Consortium technology transfer award. It was used at the 2010 Academy Awards® ceremony in Hollywood to construct the famed Red Carpet and to illuminate a Red Carpet entrance and security checkpoint.

Mobile lights are portable structures used primarily by highway construction crews, airport maintenance personnel, and even film crews. Traditionally, they have been powered by diesel generators that produce CO₂, NO_x (nitrogen oxides produced during combustion), and soot, making them less than ideal for the environment. In addition, diesel units are noisy, which creates a safety hazard for those using them.

The Fuel Cell Mobile Light is a reliable and attractive alternative to diesel-powered lighting. It is significantly quieter and is certified as a zero-emissions system due to its use of a fuel cell powered with pure hydrogen. In other words, a very green piece of equipment.

When formed during the 2008-2009 timeframe, the partnership targeted the development of a commercially available light system. This goal will be realized in 2011 and marketed by team member Multiquip, Inc., a leading U.S. manufacturer of construction and power equipment. A typical commercial unit will be able to operate 60 hours between hydrogen refills and will illuminate an area half the size of a football field.

Near-commercial units are being field tested in some interesting and challenging ways.

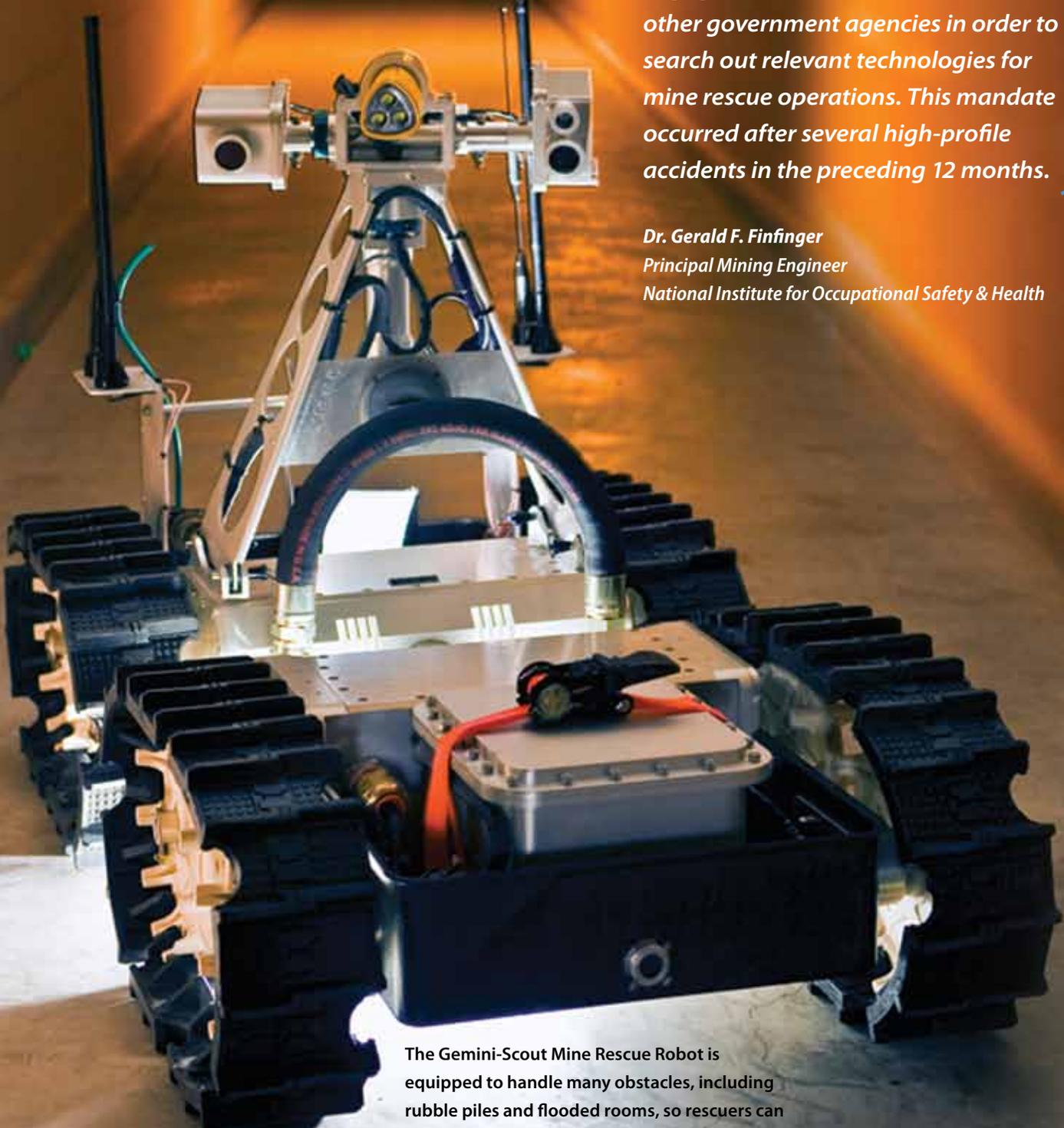
The San Francisco International Airport is testing a unit against the threat of rust, salt, rain, and wind. The California Department of Transportation is deploying a unit in the snowy Sierra Mountains to test against severe winter conditions. A unit at the Boeing Paine Field airstrip in Everett, Washington, is being challenged with sleet, rain, ice, and fog. At the NASA Kennedy Space Center, a unit is being tested against heat, humidity, and salt air. Finally, there will be a unit optimized for the entertainment industry with sound conditioning.



Developing a Next-Gen Remote Rescue Robot

“ Our relationship with Sandia at large started in late 2006 after Congress mandated that NIOSH and MSHA engage with the national labs and other government agencies in order to search out relevant technologies for mine rescue operations. This mandate occurred after several high-profile accidents in the preceding 12 months. ”

*Dr. Gerald F. Finfinger
Principal Mining Engineer
National Institute for Occupational Safety & Health*



The Gemini-Scout Mine Rescue Robot is equipped to handle many obstacles, including rubble piles and flooded rooms, so rescuers can reach trapped miners safely and efficiently.

Sandia, NIOSH, Mine Safety Administration Trying to Make Coal Mining Safer, More Survivable

Despite periodic good-news outcomes following serious mining accidents, the story all too often is tragic. However Sandia has developed a new robot, the Gemini-Scout Mine Rescue Robot, that the Labs and its partners believe holds very encouraging promise.

The robot is designed to alleviate some of the unknowns of mine rescue work and arm rescuers with the most valuable tool information.

Sandia's current partners in this endeavor are the National Institute for Occupational Safety and Health (NIOSH), which has funded the work, and the U.S. Department of Labor Mine Safety and Health Administration (MSHA). Sandia licensed its robot to Black-I Robotics. This robot allows Black-I to continue leading the field in offering affordable unmanned vehicles for hazardous/explosive evaluations.

The Gemini-Scout is 4 feet x 2 feet and has a camera turret above the body with an infrared camera that sees through smoke and dust. The vehicle body is in two parts with a flexible joint in the middle.

In a mining disaster, rescuers who move in before the dust settles face unknown obstacles and conditions that can be just as harrowing and dangerous as what faced the miners. They must overcome poisonous gases, flooded tunnels, explosive vapors, and unstable walls and roofs, all of which work against teams who are up against a ticking clock.

Combating those deadly challenges and helping rescue efforts move faster was the goal as Sandia robotics engineers designed the Gemini-Scout. Able to navigate through 18 inches of water

and crawl over boulders and rubble piles, the robot can go into dangerous situations ahead of rescuers to evaluate precarious environments and determine how operations should proceed.

Gemini-Scout is nimble enough to navigate around tight corners and over safety hatches a foot high. It is equipped with two-way communication radios and can bring provisions such as food, air packs, and medicine to those trapped underground. Additionally, it can be potentially configured to drag survivors to safety.

A number of challenges faced designers. They had to keep in mind the hazards typically found in mines. Methane and other gases could ignite if exposed to sparks, so the electronics are housed in casings designed to withstand an explosion. To ensure functionality in flooded tunnels, the Gemini-Scout controls and equipment are waterproof.

Engineers had to make sure the design is user-friendly enough to be intuitive to new operators who were trying to learn the system quickly. To achieve that, they used an Xbox 360 game controller to direct Gemini-Scout, and the screen feels much like a video game. "We anticipate this technology is broad enough to be appealing to other first responders, such as police, firefighters, and medical personnel," says Jon Salton, Sandia's project manager.

Currently, NIOSH, which has called upon Sandia for help in analyzing past mining accidents, is the Gemini-Scout's first user. Operations will be evaluated by NIOSH and if a safety certification comes, the robot could be fielded in numbers by the end of 2011.



TEAM Technologies, Sandia Work to Kill the Explosive in IEDs

To some a Stingray is a super fast car. To others it's a scary fish. But to a growing number of soldiers toiling in Afghanistan the Stingray developed by Sandia National Laboratories and its Albuquerque-based industry partner TEAM Technologies is a long-awaited lifesaver in the form of a shoebox-sized plastic structure that shoots a blade of water that cuts through steel and disables deadly improvised explosive devices (IEDs). IEDs have maimed or killed many soldiers and civilians as a consequence of the military operations in the Middle East during recent years.

Since mid-2010, at least 5,000 Stingrays have been deployed to the field, most in Afghanistan. Additionally, some law enforcement agencies have some in hand. And, since becoming available for order, the Transportation Security Administration has gotten some units to be used at various training events for its officers.

The Federal Laboratory Consortium has presented Stingray with a top Excellence in Technology Transfer Award. In addition, a national publication named Stingray as one of the top inventions in the United States in 2010.

Sandians Steve Todd and Juan Carlos Jakoboski, and Labs' contractor Chance Hughs, invented

Stingray, more technically called a fluid blade disablement tool. The clear plastic device is filled with water and an explosive that, when detonated, creates a shock wave, which travels through the water and accelerates it inward into a concave opening. Therefore, when the water collides, it produces a thin blade.

This very precise water blade penetrates and does a precision destruction of whatever IED it's going up against. Immediately behind the precision water blade is a water slug, which performs a general disruption that tears everything apart.

Unlike traditional explosives, which release energy equally in all directions when they go off, researchers have used shaped-charge technology to deliberately manipulate explosives so they create a specific shape when they explode. This allows the operator to focus IED-killing energy precisely where it's needed.

Interestingly, America's military was introduced to Stingray while training at Sandia in 2007, and requested it for the battlefield. This triggered efforts leading to the commercial patent licensing agreement between Sandia and TEAM Technologies that preceded Stingray's commercialization. Sandia designed its



From left: Soldiers receiving instructions on Stingray operation. Top center: Propane tank disabled by Stingray. Top right: TEAM Technologies employee packing Stingray units for shipment to Afghanistan.

precommercial version of Stingray for manufacturability, which gave TEAM Technologies a solid working model at the time of technology transfer. In fact, Paul Reynolds, TEAM Technologies' program manager, said his company really didn't need to spend much time on modifications to make Stingray ready for the market.

It did make some changes based on soldier input after final prototypes were exposed to dust, water, and banging around by the troops doing the testing. These improvements make assembly easier and make the unit more robust for robot deployment.

Reynolds also says "we have placed a high value on the relationship with Sandia. This endeavor illustrates the benefits of this relationship. With Sandia's help we were able to accelerate the commercialization of the Stingray, and deliver life saving tools to our military in 7 months, significantly faster than anticipated."

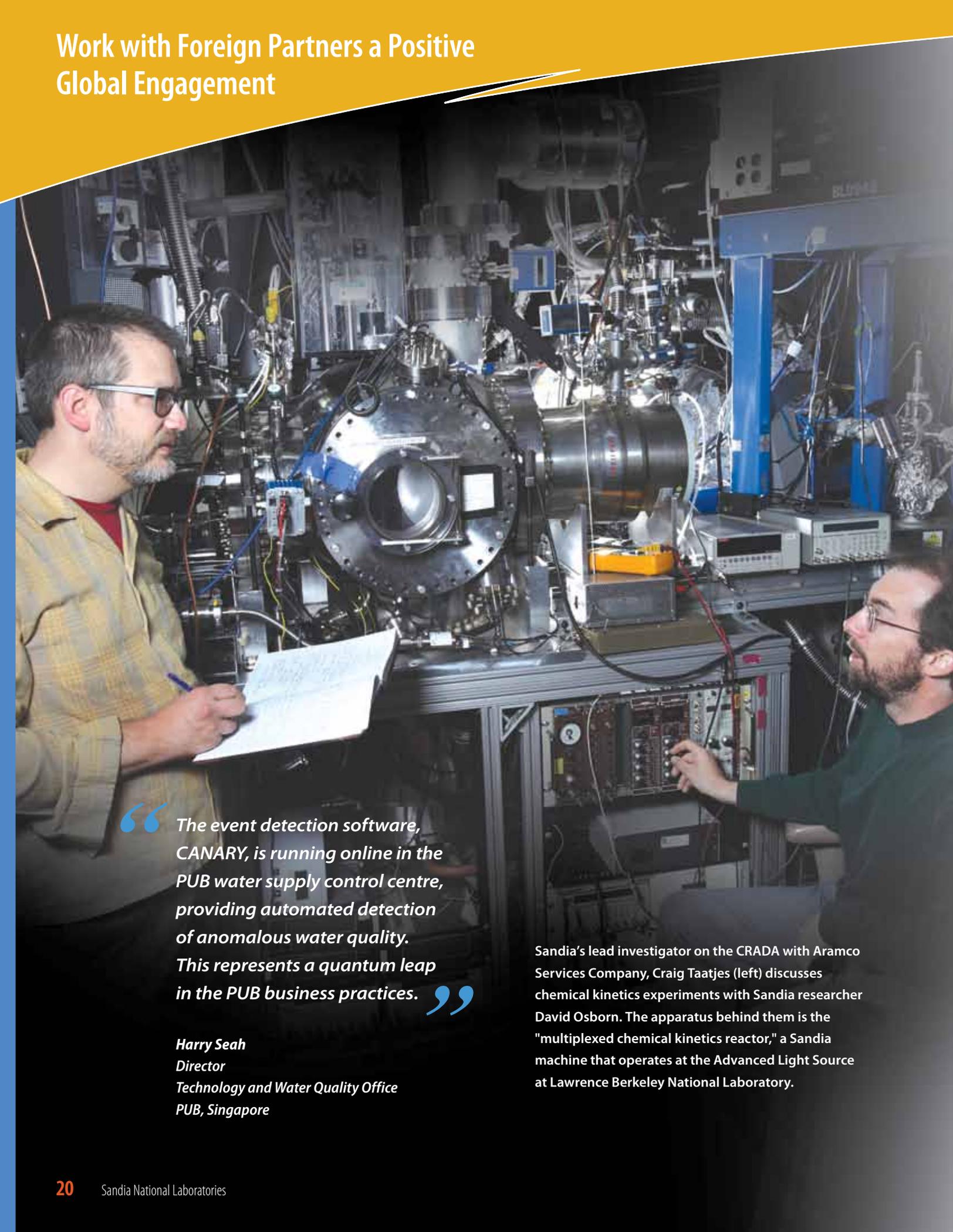
Current work focuses on some new versions of Stingray. The federal government has requested a scaled-down model that would still have the same effectiveness, but that could fit in the pocket of a soldier's cargo pants. And there's also work on a version bigger than the original.

All of those involved in Stingray's development and deployment are eager for some statistics about its actual field effectiveness. Although the data haven't arrived, Greg Scharrer, manager of Sandia's Energetic Systems Research Department, says, "We have been told that some soldiers would be alive today if they had deployed the Stingray."

“ Our relationship with Sandia benefits our military in lives saved, provides good return on tax dollars by helping the warfighter gain an advantage in the war on terror, and strengthens local industry, adding to our product base and creating jobs. Our products division is in a much stronger position because of our relationship with Sandia. ”

Paul Reynolds
Program Manager
TEAM Technologies

Work with Foreign Partners a Positive Global Engagement



“ The event detection software, CANARY, is running online in the PUB water supply control centre, providing automated detection of anomalous water quality. This represents a quantum leap in the PUB business practices. ”

Harry Seah
Director
Technology and Water Quality Office
PUB, Singapore

Sandia's lead investigator on the CRADA with Aramco Services Company, Craig Taatjes (left) discusses chemical kinetics experiments with Sandia researcher David Osborn. The apparatus behind them is the "multiplexed chemical kinetics reactor," a Sandia machine that operates at the Advanced Light Source at Lawrence Berkeley National Laboratory.

Remarkable Research, Technology Emerge from International Partnerships

The International Partnerships portion of Sandia's overall Industrial Partnerships initiative represents just a small set of the overall effort, but its results certainly aren't lightweight. A principle of the International Partnerships program is acknowledgment that global security is a critical component of national security. Through these international industrial partnerships, the Labs looks to facilitate broader international programs and engage in existing programs from international perspectives. Here we highlight briefly a few of these partnerships.

Water Resources Management Organization of Singapore

Sandia received an R&D 100 Award for a joint development effort with the U.S. Environmental Protection Agency (EPA), with additional support from the National Water Authority of Singapore (PUB), and several domestic municipalities as part of the EPA Water Security Initiative.

The technology, CANARY, is a software program that provides real-time, online detection of anomalous water quality events, ranging from accidental introduction of poor quality water to intentional injection of chemical or biological agents in municipal water distribution systems.

Aramco Services Company of Saudi Arabia

Another ongoing international partnership formalized in a Cooperative Research and Development Agreement (CRADA) is between the Labs and Aramco Services Company, a U.S. based subsidiary of Saudi Aramco, the state-

owned national oil company of Saudi Arabia. This research partnership uses laser-photolysis experiments to interrogate the chemistry of R+O₂ fuel reactions that control the magnitude of low-temperature heat release in the engine. The results will be employed to develop chemical-kinetic parameters that allow more accurate simulation of low-temperature heat release in advanced internal combustion engines. Improved modeling of these processes will accelerate design of cleaner and more efficient engines.

Zenergy Power of the United Kingdom

Sandia has teamed with Zenergy Power, a United Kingdom-based company with operations in the U.S. and the European Union, on a partnership to develop high-temperature superconducting tapes for lighter wind and hydro power generators, energy efficient industrial heating, and fault current limiter (FCL) technologies. FCLs protect the electrical distribution grid from power surges, thus preventing blackouts and other power transmission instabilities.

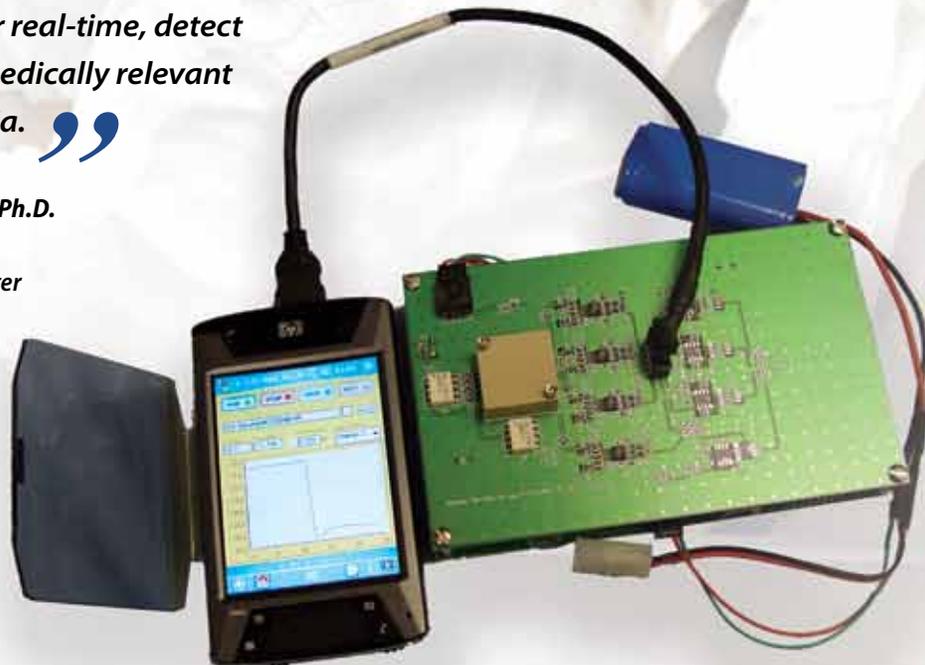
The Zenergy Power FCL has been in regular operation in the U.S. power grid since March 2009; Southern California Edison was the first electric utility company in the U.S. to use the device to protect a distribution circuit of its medium voltage grid. In addition, FCLs are a supporting technology in the Smart Grid, which is being actively studied and researched through the DOE Office of Electricity Delivery & Energy Reliability.

Addresses Both Medical Diagnostic Needs, Biodefense Applications

“ *With both of our skill sets we were able to merge our expertise, and in a way that would build a device that could actually, in real-time or near real-time, detect both deadly and medically relevant viruses and bacteria.* ”

*Dr. Richard Larson, M.D, Ph.D.
Vice President, Research
UNM Health Sciences Center*

Marco Bisoffi,
assistant professor
at the UNM Health
Sciences Center, and
research technician
in the Acoustic Wave
Biosensor laboratory.
Image of biosensor in
foreground.



Special Partnership with UNM, Adaptive Methods Leads to Low-Cost Detection of Pathogens

Sandia researchers have teamed with the University of New Mexico Health Sciences Center (UNM HSC) and Adaptive Methods, Inc. to develop a handheld device that performs rapid, point-of-care medical diagnostic analyses of viruses, proteins, bacteria, and DNA with little or no sample preparation. The device, the Acoustic Wave Biosensor, received an R&D 100 Award during the past year.

Sandia and UNM HSC worked on the initial development and fabrication of precommercial models of the device. They have also entered into an agreement with Adaptive Methods, Inc. to grant the Virginia-based company an exclusive license to further develop and market the innovative biosensor.

Detection of biological pathogens is a critical need for medical diagnostics and for biodefense, but no solution yet exists that gives healthcare providers, first responders, and military personnel the ability to identify them at the point of care or in the field with the necessary sensitivity, specificity, and speed. This technology addresses these needs in both medical diagnostic and biodefense applications.

This battery-powered detection system is capable of performing biomolecular signature detection at clinically relevant levels within minutes, not hours, at the point of care, whether that care is

in a physician's office, a hospital bed, or at the scene of a biodefense or biomedical emergency. This translates into fast, low-cost diagnostic results with as good or better sensitivity than traditional techniques. For example, this can be a lifesaver for disaster medical situations like those experienced recently in Haiti.

The technology is extremely versatile, useful in both biodefense applications and biomedical diagnostics. It can detect biological pathogens in complex, real-world environmental samples such as air, water, food, and soil.

The sensor array is packaged in a disposable plastic cartridge inserted by the user into the battery-powered electronics unit. For the current system, a drop of liquid – saliva, urine, or liquid extracted from a swab – is placed on the sensor input port. System control, data analysis, and reporting are performed by a personal digital assistant.

In comparison to technologies in commercial use today, this device will, for the first time, give medical staff the ability to identify a broad range of pathogens while the patient is in the office and therefore make an accurate and immediate diagnosis. This will allow, for example, a physician to distinguish between a bacterial and viral infection and to prescribe antibiotics only in instances where efficacy is assured.

Company Born Out of Unique Entrepreneurial Program

“*Sandia’s support of the ESTT and related programs enabled successful technology transfer and the establishment of real economic growth in Albuquerque, real technological growth in the industry and real innovation to be injected into several industries.*”

*Dan Neal
Research Fellow
Abbott Medical Optics WaveFront Sciences, LLC*

Dan Neal with iDesign, the latest wavefront aberrometer. This instrument provides high-resolution measurements of both the interior and exterior of the eye and replaces five different instruments in the ophthalmologist’s office.

iDesign

Better Eyesight and Seeing Deeper into Space: That's WaveFront Sciences

In 1996, Dan Neal and his close friend and colleague, Tim Turner, equipped with three licenses of Sandia wavefront sensor and binary optics technology, co-founded a company known currently as AMO WaveFront Sciences. This New Mexico-based company designs and manufactures binary/diffractive optics and wavefront sensor-based instrumentation. Dan took advantage of Sandia's Entrepreneurial Separation to Transfer Technology (ESTT) Program, which allows Sandia employees to terminate from the Labs with a guarantee of reemployment for up to 2 years.

WaveFront has enjoyed a series of positive outcomes over the years. It has designed and manufactured the industry's highest resolution Shack-Hartmann-based aberrometer, an instrument that precisely measures total refractive error and wavefront aberrations of the human eye as part of the wavefront-guided custom laser vision correction procedure. It has sold more than 800 aberrometers to ophthalmologists around the world. Neal estimates that "more than a million people see better today as a very direct benefit of the technology we developed."

But this company's agility also has it peering into outer space and working to make it more visible. An important innovation and commercial application of WaveFront's technology occurred

Since 1994, 139 Sandia scientists and engineers have made the decision to leave the Labs to start up or expand 92 small technology-based businesses under the auspices of the Entrepreneurial Separation to Transfer Technology (ESTT) Program. In August of 2010, eight current and former Sandians were honored as recipients of the inaugural Entrepreneurial Spirit Award (summary on page 32). One of them was Dan Neal.

from 2004 through 2007. That was when the company designed and built test-stations for the James Webb Space Telescope, a large, infrared-optimized space telescope, scheduled for launch in 2014.

This national asset will advance the science started with the Hubble Space Telescope. However, unlike the Hubble's low-Earth orbit, the James Webb Space Telescope will be placed in orbit at the Earth-Sun L2 point. Stated another way, that's approximately 1 million miles from Earth.

WaveFront's solutions related to the James Webb Space Telescope provide tremendous gains in efficiency and can be traced back to technology commercialization efforts at Sandia. The basic sensor architecture, software analysis, and measurement concepts are technology advancements originally licensed from Sandia by WaveFront.

These licenses have enabled co-founders Neal and Turner to attract venture capital and develop products that have been commercially successful in the science, industrial, and medical markets. The Scanning Shack-Hartman System expands these products to longer wavelengths and larger sizes, thereby helping to enable development and cost reductions to implement the pioneering James Webb Space Telescope science program.

Since its founding, Wavefront Sciences has grown from three employees to 54. In early 2007, it became part of publicly traded Advanced Medical Optics (AMO). In 2009, AMO was subsequently acquired by global, broad-based Abbott Laboratories.

"The technology originally licensed from Sandia has resulted in significant job creation in New Mexico, and, since the majority of products were sold in Europe, an improvement in our balance of trade," Neal says.

SS&TP Recognized for Major Contributions to Community, Economic Health

The Sandia Science & Technology Park (SS&TP) generated thousands of jobs and billions of dollars in economic activity over the past 12 years, according to an economic impact analysis of the Park.

The SS&TP, which was established in 1998, is home to 30 organizations, employing more than 2000 people in 18 buildings spread throughout the Park. Economic modeling by the Mid-Region Council of Governments (MRCOG) found that park-based operations paid \$2.3 billion in wages and produced \$57.5 million in gross receipts taxes for state government and \$8.2 million for the city of Albuquerque. Entities within the Park spent \$1.2 billion on goods and services since 1998.

The economic analysis was unveiled at a press event featuring speeches by Albuquerque Mayor

Richard J. Berry, MRCOG Director Dewey Cave, Sandia Science & Technology Park Development Corporation Chairman Sherman McCorkle, and Sandia National Laboratories Chief Technology Officer Steve Rottler. Park Executive Director Jackie Kerby Moore served as emcee of the event.

More than \$330 million has been invested in the Park, with approximately \$260 million invested by private tenants in land, buildings, and equipment. The public sector investment totaling \$70 million includes infrastructure improvements and the value of public lands.

Mayor Berry praised the SS&TP for helping bring high-paying research and development jobs to Albuquerque and for revitalizing a portion of the southeast heights.



ICE-LOC® is Example of What NMSBA Does Year Round

Ten years ago, ICE-LOC® inventor and CEO Dennis Salazar came home to find a burst attic pipe that had damaged his walls and floors.

This experience inspired him to invent an inexpensive, easy-to-use pipe protector. ICE-LOC®'s patented product uses a high-performance, Federal Drug Administration-approved flexible core. It requires a minimum number of tools to install, and needs no electricity, allowing it to be used in remote locations or during power outages.

Without an ability to demonstrate the product's performance scientifically and visually, Salazar had trouble convincing potential clients of ICE-LOC®'s effectiveness. This problem led the company to the New Mexico Small Business Assistance (NMSBA) Program. Created in 2000 by the New Mexico State Legislature, the NMSBA Program allows Sandia to provide technical assistance and consulting services to small business in New Mexico.

NMSBA paired ICE-LOC® with engineer Kevin Fleming from Sandia's Explosive Applications Team. The team placed an ICE-LOC®-fitted pipe and an unprotected pipe, both filled with water, into a temperature-controlled test chamber with a viewing window and dropped the temperature to -30°F. The pipe utilizing ICE-LOC® held through multiple tests, while the unprotected pipe exploded catastrophically each time.

This was captured on high-speed video shot through the chamber window, providing visual confirmation of the product's performance



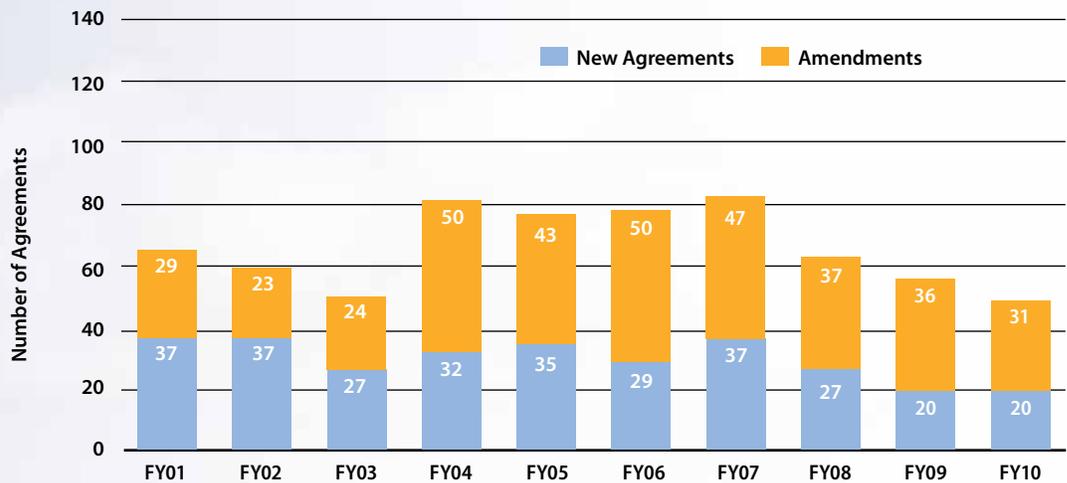
ICE-LOC® inventor and CEO Dennis Salazar

under harsh conditions. The report and video from the Sandia assistance provided important information to new customers, who gained assurance that the company had investigated its claims. This helped ICE-LOC® negotiate a contract with the State of New Mexico General Services Department, and the company is now in the final stages of becoming a Federal General Services Administration contractor.

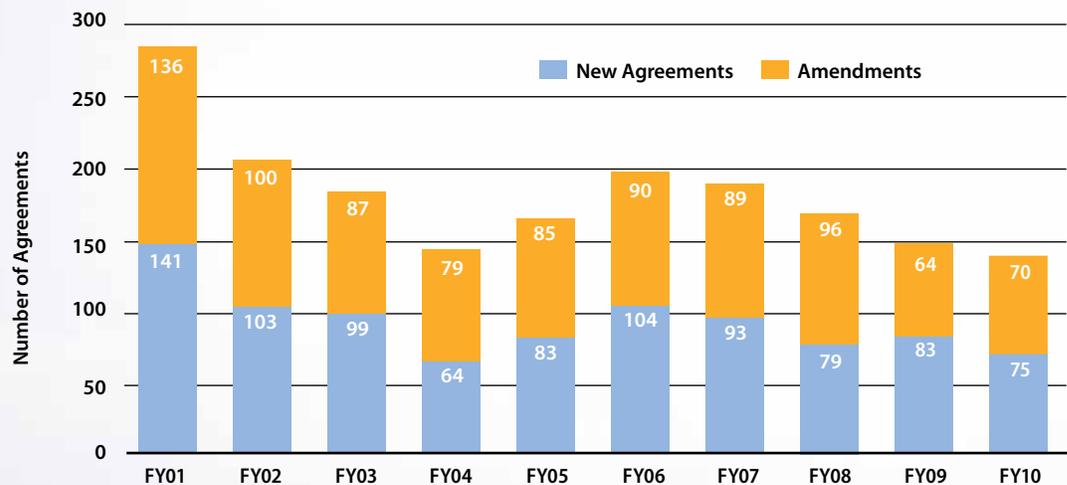
Sandia National Laboratories takes great pride in serving the nation in an “exceptional” manner. Indeed, Sandia has consistently received the performance rating of “outstanding” from the DOE/NNSA for many years, including FY2010. The Partnerships Program lends to that rating with its own “outstanding” grade and maintains a performance measurement system, summarized in this section. Included are data and information compiled around specific program metrics that are updated annually and presented to clearly communicate successes, trends, and accomplishments. The following pages offer numerous formats designed to demonstrate that Sandia continues to provide a robust, comprehensive, and successful portfolio of technology partnerships on behalf of the nation.

CRADAs and WFO-Industrial

Sandia CRADA Program Activity

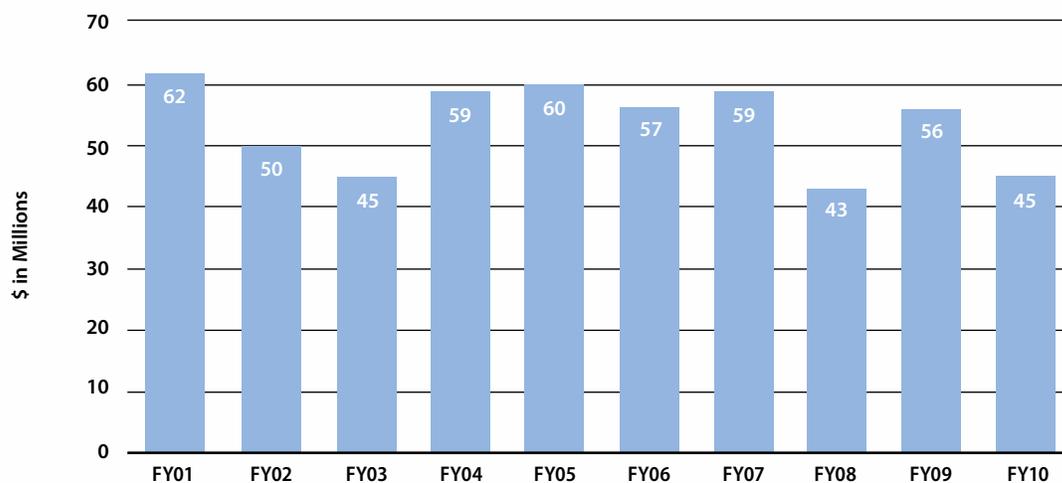


Sandia WFO-Industrial Partners Activity



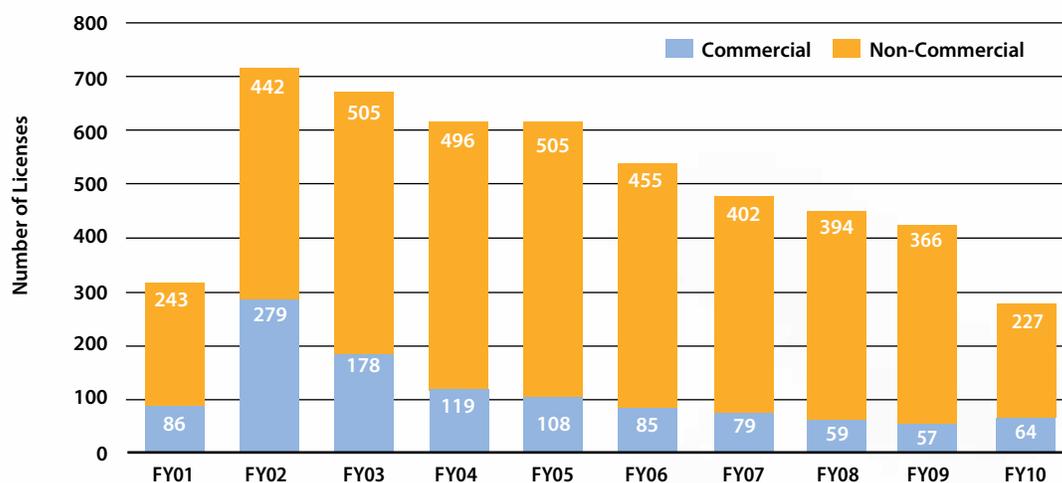
Industry Funds-In

Industry Funds-In to Sandia (\$M)

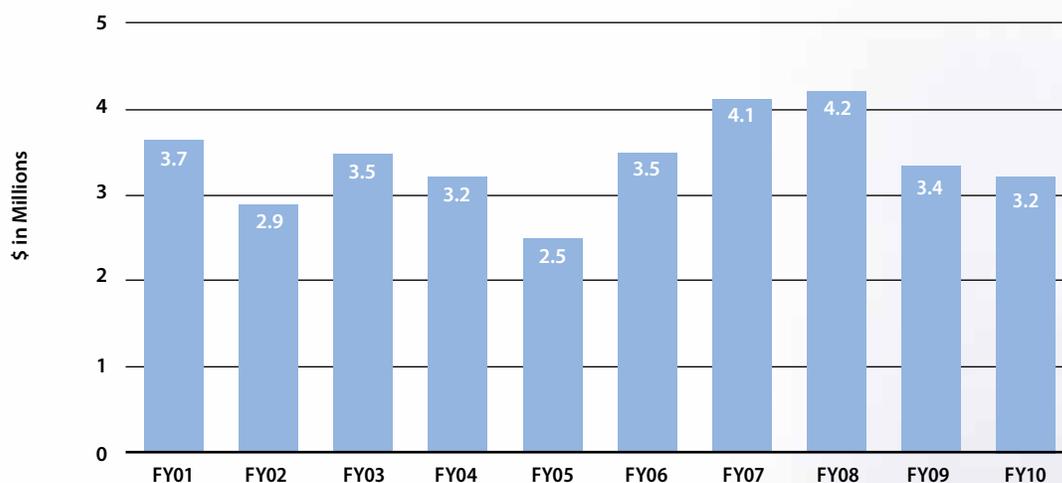


Licenses

Licenses

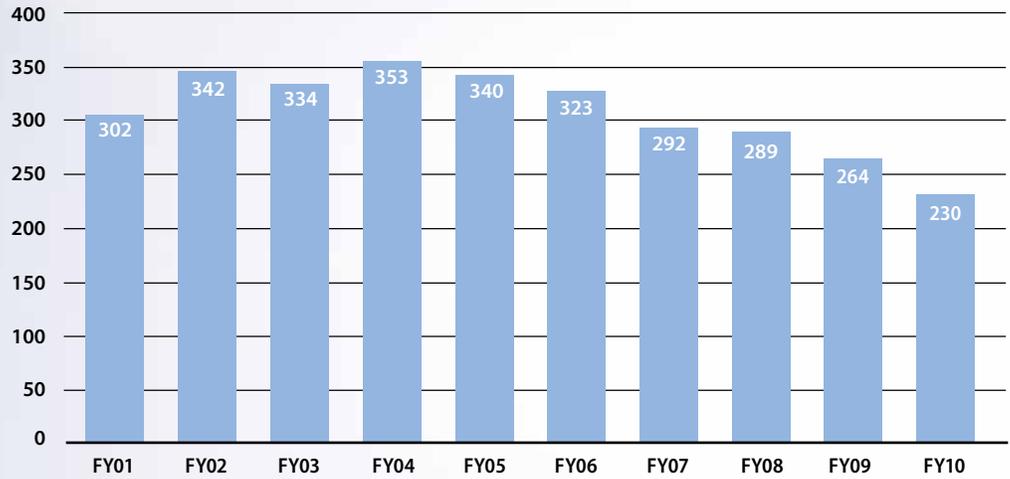


Licensing Income (\$M)



Patent Activity

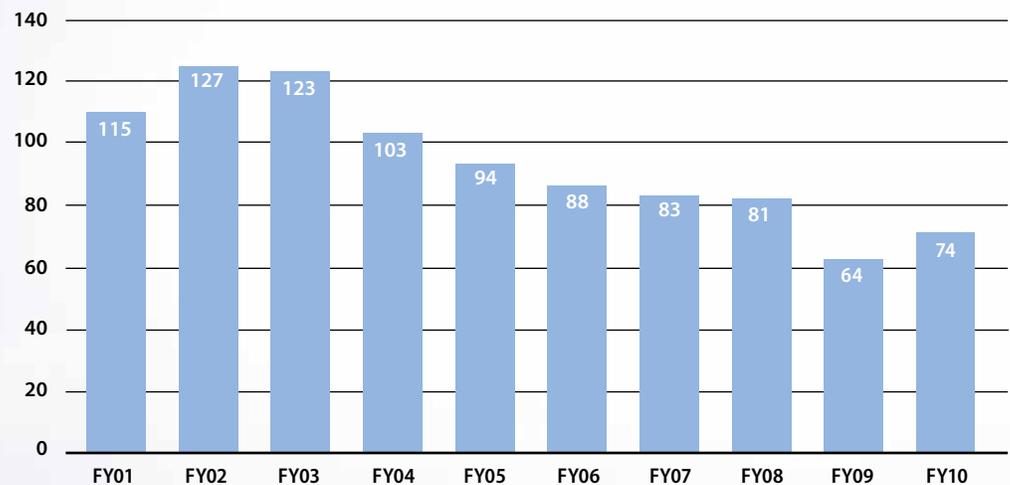
Invention Disclosures



Patent Applications



Patents Issued





Most SS&TP tenants either supply Sandia with goods and services, or have licensed and commercialized technologies that originated at the Labs.



The NMSBA Program has been at Sandia and Los Alamos national laboratories for 10 years supporting small businesses throughout New Mexico.



The ESTT Program is now in its 16th year and continues to serve as a technology transfer tool at the Labs.

Sandia Science & Technology Park (SS&TP)

Results

Number of companies	30
Number of employees	2,009
Number of buildings	18
Number of square feet	863K
Number of acres developed	67
Funds in to Sandia from tenants	\$17.7M
Contracts from Sandia to tenants	\$355.4M
Contracts among tenants	\$9.0M
Public investment	\$68.6M
Private investment	\$268.1M
Total investment	\$336.7M
Impact on wages and salaries	\$2.2B
Average salary of full-time jobs in park	\$71K
Average salary of full-time jobs in Metro Albuquerque	\$39K

Note: Park opened in 1998

New Mexico Small Business Assistance (NMSBA) Program

In 2010, the State of New Mexico along with Los Alamos National Laboratory and Sandia National Laboratories invested **\$4.6M** helping 339 small businesses in 27 counties to solve technical challenges.

2000 - 2009

Return on Investment (ROI)

1.24

(ROI is based on salaries of jobs created and retained)

Economic Impact

Small Business Jobs Created and Retained	1549
Mean Salary (\$)	\$38,574
Increase in Revenue (\$)	\$82,498,526
Small Business Decrease in Operating Costs (\$)	\$45,724,004
Investment in NM Goods/Services (\$)	\$19,534,614
New Funding/Financing Received (\$)	\$17,423,750

2000 - 2010

New Mexico Small Businesses Assisted

1736

Rural vs Urban Businesses

Rural	1120
Urban	616
Combined	1736

Dollar Amount of Assistance

\$25.2 M

Entrepreneurial Separation to Transfer Technology (ESTT) Program

Sandia scientists and engineers who left on ESTT

139

To start up companies	55 (40%)
To expand companies	84 (60%)

Companies impacted by ESTT

92

Start-ups	44
Expansions	48

Licenses for Sandia IP negotiated with ESTT companies

42

Inaugural Sandia “Entrepreneurial Spirit Week” Showcases Innovators

Late in FY2010, Sandia hosted its inaugural Entrepreneurial Spirit Week. The goal of this new series of events, which will take place annually, is to emphasize the importance of innovation and entrepreneurial spirit at the Labs. The inaugural week featured two major events – the Innovation and Intellectual Property Celebration and the Entrepreneurial Spirit Awards Luncheon. Both acknowledged, encouraged, and celebrated innovation and entrepreneurship.

Innovation and Intellectual Property Celebration

More than 200 people attended the Innovation and Intellectual Property Celebration, which recognized Sandia scientists and engineers whose technical work has created intellectual property (IP), thereby contributing to the Labs’ IP and licensing portfolios, royalty streams, and outstanding reputation in innovation and technology transfer. Recognized were Sandians who had patents issued or authored software copyrights that were licensed in 2009. Additionally, there was a first-ever Up-and-Coming Innovator award designed to recognize individuals who displayed enormous potential for supporting impactful innovations, who exhibited entrepreneurial talent, and who developed unique solutions to complex scientific challenges. Guest speakers included Sandia Vice President, Steve Rottler, and DOE Senior Advisor, Wendolyn Holland. The keynote speaker was Rep. Martin Heinrich (D-NM). Honored were 154 Sandians, including 73 copyright holders, 66 patent holders, and 15 Up-and-Coming Innovators.

Entrepreneurial Spirit Awards Luncheon

The inaugural Entrepreneurial Spirit Awards Luncheon, sponsored by Technology Ventures

Corporation, honored eight Sandia entrepreneurs. All of the honorees left Sandia to explore entrepreneurial opportunities in the private sector, and five of those people continue to enjoy success outside of Sandia. The remaining three honorees returned to Sandia, bringing with them valuable knowledge and skills obtained in the commercial world, each using those skills to achieve new levels of success back at Sandia. The following were recognized at this inaugural event:

- Tim Estes, founder of Conductor Analysis Technologies
- Dan Neal, founder of WaveFront Sciences
- Karl Gross, founder of Hy-Energy LLC and H2 Technology Consulting LLC
- Regan Stinnett, founder of Quantum Manufacturing Technologies (returned to Sandia)
- Ellen Stechel, spent 7 years with Ford Scientific Research Laboratory (returned to Sandia)
- Tom Brennan, founder of Micro-Optical Devices, Inc.
- Jeff Nelson, joined Uniroyal Optoelectronics as CTO; co-founded Medical Lighting Solutions (returned to Sandia)
- Hong Hou, joined Emcore Corporation where he is currently CEO

Awards



In 2010, Sandia researchers and their collaborators won four R&D 100 Awards, given by R&D Magazine to the 100 most significant technical products becoming available each year.

- Acoustic Wave Biosensors, Rapid Point-of-Care Medical Diagnostics – capable of multiplex identification of a wide range of medically relevant pathogens and their biomolecular signatures - viruses, bacteria, proteins, and DNA – all at clinically relevant levels.
- Multifunctional Optical Coatings by Rapid Self-Assembly – a simple, safe, and economical coating process that enables the development of paradigm-shifting multifunctional nanomaterials and optical coatings with architecture and properties not attainable by current processing methods.
- CANARY – Event Detection Software - enables online contaminant event detection for time-critical decision making in both routine and emergency water quality assessments, and is available to drinking water utilities of all sizes worldwide.
- Micro Power Source – an ultra-small form factor, energy-harvesting (self-charging) power source encapsulated in a polymer coating that functions by integrating a lithium-ion based solid-state battery with a thin photovoltaic (PV) collector.

The Federal Laboratory Consortium (FLC) is a nationwide network of over 250 members that provides a forum to develop strategies and opportunities for linking laboratory mission technologies and expertise with the marketplace.

Sandia received two National FLC Awards for Excellence in Technology Transfer.

- Stirling Energy Systems Strategic Partnership – Sandia and Stirling jointly developed unique

expertise in concentrating solar power (CSP) and related intellectual property owned by Stirling, resulting in SunCatcher™, a viable CSP technology option which began large-scale commercialization in 2010.

- Red Storm Massively Parallel Processor Supercomputer Architecture – Sandia and Cray Inc. deployed Red Storm, based on the Sandia-developed architectural design and several fundamental technologies. Cray commercialized the Red Storm Architecture and built several of the most powerful supercomputers in the world.

In the FLC Mid-Continent Region, Sandia received three awards.

- (Excellence in Technology Transfer) Stingray – based on a license of Sandia IP, TEAM Technologies, Inc. began manufacturing Stingray, the first coherent fluid blade disablement tool capable of addressing threats associated with improvised explosive devices (IEDs). Many have already been deployed to Afghanistan. In addition, a national publication named Stingray as one of the top inventions in the United States in 2010.
- (STEM) the National Institute for Nano-Engineering (NINE) – a public-private partnership formed to develop the next generation of innovation leaders for the U.S. by involving students in large-scale, multidisciplinary research projects focused on developing nano-engineering enabled solutions to important national problems.
- (Notable Technology Development) Fuel Cell Mobile Light – born out of Sandia's partnership with Boeing, this technology is a reliable and attractive alternative to diesel-powered lighting and is significantly quieter and certified as a zero-emissions system.



Sandia works closely with industry, small business, universities, and government agencies to bring new technologies to the marketplace. Sandia has been transferring technology to external partners for more than two decades, especially where such agreements benefit Sandia's primary mission for the Department of Energy.

For general questions or comments, contact partnerships@sandia.gov, or call 505-284-2001.

Information is also available for the following partnership areas:

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Jackie Kerby Moore, 505-845-8107, jskerby@sandia.gov

Technology Ventures Corporation (TVC)

George Friberg, 505-843-4286, george.j.friberg@lmco.com

Founded in 1993 by Lockheed Martin, TVC's charter is to facilitate the commercialization of technologies developed at Sandia, other laboratories, and research universities.



innovation
through partnerships

Partnerships Annual Report Staff

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