

SANDIA NATIONAL LABORATORIES

INDUSTRIAL  
**Partnerships**

ANNUAL REPORT FY2009



**Collaborations With  
Far-Reaching Impact**





**innovation**  
through partnerships

# Table of Contents

- 4 Introduction
- 6 Industry Partnerships Help Achieve Sandia's Missions  
*Mission Perspective*
- 8 Long-Term, Strategic Partnerships  
*Core Component of Sandia's Tech Transfer Program*  
*Improved Products, Strengthened Bottom Line*

## LONG-TERM PARTNERSHIPS

- 10 Sandia and General Motors  
*A Long-Term Strategic Alliance Focused on Clean Transportation*  
*Robust Strategic Alliance Looks to Future*
- 12 General Atomics Partnership Produces Valuable National Security Assets  
*Growing U.S. Economy, Bolstering National Security*
- 14 Cray, Sandia, and the Making of the World's Supercomputer  
*Benefitting the Worldwide Supercomputing Community*

## NEW PARTNERSHIPS

- 16 Sandia Engineers Key in Getting Start-Up, eSolar, to the Next Level  
*Verifying a Viable Option for Energy Security*

## A YEAR 2009 NEWSMAKER

- 18 Sandia MEMS, Polychromix, and Water on the Moon  
*Lunar "Dud" Becomes Watershed Event*

## INTERNATIONAL PARTNERSHIPS

- 20 International Partnerships From One Side of the World to Another  
*A Better World Through Technology*

## INNOVATIVE PUBLIC-PRIVATE PARTNERSHIPS

- 22 Sandia's Unique Capabilities Valued by the Joint BioEnergy Institute  
*Developing a Next Generation of Biofuels*

## TECHNOLOGY-BASED ECONOMIC DEVELOPMENT PARTNERSHIPS

- 24 Small Business Focus Rounds Out Sandia's Partnerships Strategy  
*Leveraging Science & Technology Creates Jobs*
- 26 EMCORE's Achievements Continue Through Recession  
*Pioneering R&D, Product to Market*

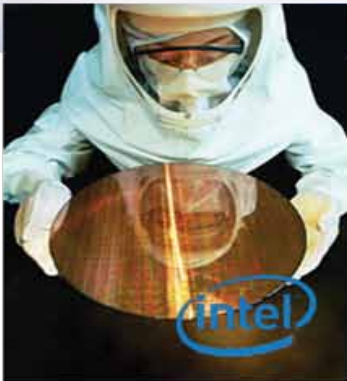
- 28 Scorecard & Recognition
- 34 Contacts



innovation  
through partnerships

“ *Industrial partnerships are an important element of Sandia’s commitment to technology transfer. These partnerships contribute directly to development and sustainment of capabilities that are critical to execution of the Labs’ national security mission. The partnerships also contribute significantly to success of our industrial partners by enabling them to accelerate commercialization of technologies and enhance their competitiveness in the marketplace, as evidenced by their willingness to provide direct support for the collaborations.* ”

**Steve Rottler**  
Vice President, Science and Technology  
Chief Technology Officer  
Sandia National Laboratories





**Hal Morgan**

*Senior Manager  
Industrial Partnerships and Strategy*



**Steve Rottler**

*Vice President, Science and Technology  
Chief Technology Officer  
Sandia National Laboratories*

## The FY2009 Partnerships Annual Report

Sandia National Laboratories and its diverse set of industry partners enjoyed another strong year of collaborations that have yielded and will continue to yield far-reaching results. This FY2009 Industrial Partnerships Annual Report touches on some of these efforts. Partnering with industry is a formal part of the Labs' mission, but the real value of these partnerships is that they, by strategic design, enhance Sandia's capabilities to execute the Labs' core national security missions while simultaneously enriching the technology and research and development (R&D) base in the United States and strengthening our partner companies, both technically and financially.

The foundation of the Labs' partnerships program is its long-term relationships with companies that have been working with Sandia for many years, some over 15 years. The longevity of these relationships is testimony to the value that both the companies and the Labs extract from the partnerships. We discuss these long-term partnerships in general and then describe several in detail. One is with General Motors, with whom we are exploring various alternative fuel technologies. Another example chronicles the long-term Sandia-Cray, Inc. partnership, a collaboration that has led to one of the world's fastest computers.

Although long-term industrial collaborations form the foundation of our partnerships initiative, a regular stream of new partnerships – some of which may become

long-term – are also important to the vitality of the industrial partnerships program. Examples of the more than 30 new industry-Labs partnerships that began during FY2009 are also highlighted. One multi-year collaboration literally reached to the moon when it aided scientists' search for water there.

The program also includes other forms of collaboration including international partnerships, new public-private partnerships with multiple national laboratories and multiple industry participants, and technology-based partnerships that aid local companies and the local economy. Profiles of these collaborations appear in the report.

The final section of this year's report, our Scorecard, provides quantitative details about the industrial partnerships program. The numbers indicate that despite the continuing trials and tribulations with the world's economy, funds coming into Sandia from its industry partners topped out at \$56M versus \$43M for FY2008. This illustrates that even in turbulent economic times our industry partners continue to recognize that working with Sandia helps them to compete in various ways, including bringing new products to market promptly. We are convinced that technology from Sandia is a viable mechanism for economic recovery and encourage other companies to explore collaborations with us.

## Industry Partnerships Help Achieve Sandia's Missions

**D**OE/NNSA and Sandia both recognize that partnerships are a critical element of Sandia's national security mission. Congressional legislation defines tech transfer to industry as a mission of the national labs, and economic competitiveness of U.S. industry is a national security issue. Beyond this, industrial partnerships are important to Sandia's strategic management units (SMUs) in achieving our primary national security missions in nuclear weapons, technology for the warfighter, energy security, and homeland security.

These partnerships provide Sandia's expertise and technology to industry, and their application to industrial problems provides new perspectives and more robust, new and/or improved technology for Sandia's mission applications. They also provide an avenue for commercializing Sandia technology developed for national security missions in accordance with mission customers' expectations. In addition, U.S. companies develop products using Sandia's R&D that strengthen our economy.

In a sense, tech transfer is a validation of the relevance of the R&D done at Sandia. It also helps ensure that the supplier base to the nuclear weapons program is viable and at the leading

edge of technology. All industry partnerships in which Sandia engages have ties to Sandia's primary national security missions.

Partnerships with industry leaders, such as Lockheed Martin, The Boeing Company, and the Goodyear Tire and Rubber Company, adapt key technologies developed for the nuclear

weapons programs to industry applications. Technologies advanced through partnerships include computational simulation and analysis tools, materials research, and fabrication of parts. In return, results of research with Goodyear, for example, have contributed to many enhanced and new capabilities in our engineering codes for nuclear weapons, including more effective finite element code

equation solvers, advanced methods for modeling very large deformations by using an automatic remeshing capability, and advanced nonlinear polymer material models.

Industry partnerships ensure that Sandia technology can be utilized by the warfighter. Key industry partners include such companies as Lockheed Martin, Raytheon, Northrop Grumman, and General Atomics. For example, General Atomics and Sandia are reducing the size, weight, and power requirements of a new

**“Clearly our partnerships have far-reaching impact in an impressive variety of ways that contribute to the Labs' missions while also contributing in a positive way to the lives of people around the world.”**

**Al Romig**  
*Executive Vice President,  
Deputy Labs Director and  
Chief Operating Officer  
Sandia National Laboratories*

synthetic aperture radar system for unmanned aerial systems. The new Lynx® radar provides all-weather precision capability to detect time-sensitive targets and offers a long-range, wide-area surveillance capacity.

Partnerships are also key to Sandia's mission in energy security. Partners include major oil and gas companies and automotive companies interested in alternative fuels and better recovery and use of conventional fuels. In addition, Sandia partners with such companies as EMCORE and Stirling Energy Systems (SES) on alternative energy technologies. Sandia and SES received the Popular Mechanics Breakthrough Innovator Award, which celebrates the top ten innovations poised to change the world, for achieving record efficiency for solar-driven Stirling engines. SES and Tessera Solar recently unveiled four newly designed solar power collection dishes at Sandia's National Solar Thermal Test Facility.

Partnerships are critical to deploying Sandia technology for homeland security. Partners in this area are diverse and include such companies as Applied Research Associates, Tenix, Canberra, and Thermo Fisher Scientific. Technologies support a variety of needs, from having secure and safe water to supporting first responders during national disasters. Sandia recently concluded an agreement with Thermo Fisher Scientific (formerly Thermo Electron Corporation) that licensed the Sandia-developed FitToDB algorithm for commercial use in a spectroscopic portal that identifies concealed nuclear devices in America's ports. Thermo Fisher Scientific has developed ARIS.net, a state-of-the-art Advanced Radiological Identification/Detection System using Sandia's

**“ These partnerships enable our laboratories to synergistically work with the broader science and industrial communities to accelerate the pace of scientific discovery, technical innovation, and technology deployment — ultimately strengthening our nation's security. ”**

**Dan Sanchez**  
*DOE Technology Partnerships Manager*  
*NNSA Sandia Site Office*

scanning algorithms that enhance the probability of threat detection.

Finally, working with industry enhances Sandia's core science, technology, and engineering capabilities that underpin all of its missions. In fact, most of Sandia's industrial partnerships involve these core capabilities. Partners in this area include Intel, IBM, Goodyear, Monsanto, 3M, Corning, BASF, and Procter & Gamble. The Nanoparticle Flow Consortium collaboration involves multiple partners including 3M, Corning, Procter & Gamble, BASF, and ICI. This collaboration benefits the nation by developing a competitive advantage in “nano-manufacturing.”

## Long-Term, Strategic Partnerships *Core Component of Sandia's Tech Transfer Program*

**O**ver the years, Sandia has developed long-term relationships with some companies that have become a core component of the Labs' industrial partnerships program. Several are highlighted in upcoming pages of this report, but it also is appropriate to acknowledge the important role all strategic partners play in our industrial partnership program.

Several prerequisites need to be met for a partnership to truly earn the title of "long-term" and "strategic" like those Sandia National Laboratories has enjoyed with the likes of Boeing, Intel, Goodyear, General Motors, General Atomics, and Lockheed Martin.

Of the Labs' more than 60 official partnerships, these long-term arrangements are the foundational part of the overall partnerships program. They are critical in helping the Labs' enduring national security mission.

Additionally, there must be a strong, positive impact on our partner company. This could include improved products and a strengthened bottom line for its shareholders. For example, statistics show Sandia's longstanding partnership

with the Goodyear Tire and Rubber Company has coincided with impressive sales revenue increases over the past several years for the company.

These special partnerships support the Labs' core competencies in a cost-efficient manner, by providing funds that enable pioneering scientific research and technology development through the synergy of cooperation.

Often forgotten, but critical in any successful long-term industrial partnership, is realization that industry best practices are imported into the Labs and that strong relationships between Sandia and its long-term partners provide vital mutual understanding of cultures and business approaches that have been leveraged to the positive for both parties.

The Sandia-Goodyear strategic partnership is approaching the two-decade mark. Goodyear's investment of more than \$40 million into Sandia is a strong indicator that this sole remaining U.S.-owned tire company, which provides original equipment on new vehicles, has and continues to reap value from working with Sandia. The partnership is a critical part of



**“The existence of long-term partnerships validates the relevance of Sandia technology to industry and our ability to transfer technology to industrial partners. It also indicates the value provided to the Labs’ national security missions from its partners.”**

**Hal Morgan**  
Senior Manager  
Industrial Partnerships and Strategy

Goodyear’s business strategy. During this partnership there have been win-win collaborations in computational mechanics, structural dynamics, materials R&D, nanotechnology, and even computer security.

The Sandia-Intel relationship, another decade-plus partnership, resulted in the world’s leading chip manufacturer providing a no-fee license for its Pentium® processor design to Sandia for development of custom-made microprocessors for U.S. space and defense purposes. In addition, Sandia’s Extreme Ultraviolet Lithography advanced microchip-patterning technology provided new processing options for Intel’s products.

Sandia’s partnering with Lockheed Martin, largely conducted under the umbrella of Lockheed’s Shared Vision program, has provided numerous mutual benefits over the 17-year relationship between the two. Just one example is the SnifferStar™, a micro-chemical analysis system developed jointly by the two for deployment on Unmanned Aerial Vehicles (UAVs).

Sandia’s partnership with Lockheed Martin on the Dakota Project has provided noteworthy technological advancement to the United States by increasing the efficiency of the nation’s weapons and satellite systems.

The Boeing-Sandia partnership has involved a variety of diverse collaborations. One of the most mutually successful is sharing complex computational techniques – peridynamics – that provide for a vastly improved analysis of fracture/failure mechanisms in composite materials, which are being used more extensively in the aerospace industry. In this collaboration, Sandia develops codes and performs computational predictions while Boeing performs experiments to verify the Sandia codes. The enhanced knowledge that flows from this collaboration is particularly important to the Labs because the knowledge is directly applicable to national security, and to energy development and security interests. The extension of eight collaborative projects into the next year is an indication of the value of the relationship to our industry partner.

One example of a growing long-term partnership is the Labs’ work with Northrop Grumman. Sandia and Northrop Grumman Electronic Systems signed the first-ever, five-year agreement between the two entities. This accord acknowledges Sandia as a strategic partner to one of the world’s largest defense contractors.

# Robust Strategic Alliance Looks to Future

“ *General Motors places great value on our long-standing collaborations with Sandia on advanced combustion, biofuels, hydrogen storage, and other key areas of energy and materials research. We believe our partnership is accelerating development of clean and efficient technologies, processes, and infrastructure that will help strengthen the American auto industry and the U.S. economy.* ”

*Alan Taub  
Vice President  
Research & Development  
General Motors Company*



Sandia engineer Terry Johnson surveys various components of the hydrogen storage system he and his team designed for General Motors.

## Sandia and General Motors *A Long-Term Strategic Alliance Focused on Clean Transportation*

It was a day back in the mid-1970s when Dan Hartley, a now-retired Sandia VP, got a call from General Motors headquarters in Michigan. A group of GM execs had heard about the Labs' concept for a Combustion Research Facility (CRF) at its Livermore, California, site. They wanted to come for a visit.

During that first visit, the Labs and GM jointly defined a partnership vision that remains essentially intact today. Sandia would do research on combustion and materials aimed at making GM's engines more reliable and efficient. It would be akin to work Sandia also conducts in support of its enduring national security mission.

Today this collaborative approach continues between the two and has become an even more robust and diverse strategic alliance that survives despite very trying economic challenges. The two alliance partners also are looking at innovative ways to continue their coalition long into the future.

The GM-Sandia alliance operates through various Cooperative Research and Development Agreements (CRADAs), Work for Others (WFO) agreements, and government funding through programs conducted primarily at the CRF.

At the highest level, this national security lab alliance with the 100-year-old worldwide auto manufacturer has always focused on working

with a vision of providing clean, efficient transportation to the world's population so that "we can take the auto industry out of the environmental impact equation."

In fact, during the past year Sandia successfully completed a laboratory prototype hydrogen storage system for GM vehicles. Sandia researchers designed and demonstrated key features and performance of a storage system that uses a complex metal hydride material. The associated Sandia design tools now allow GM to save significant costs and time when developing hydrogen storage systems for onboard vehicular applications.

Almost concurrently, an in-depth collaborative examination called the 90-Billion Gallon Biofuel Deployment Study found that plant and forestry waste, along with dedicated energy crops, could sustainably replace nearly a third of gasoline use by 2030, assuming continued investment in technical and scientific progress.

And, this partnership now has provided Sandia an unexpected entrée into China through GM China ([www.gmchina.com](http://www.gmchina.com)) and the opportunity to work directly with some Chinese students from Tsinghua University in Beijing. Their effort will focus on exploring high-level strategies for alternative fuel development and deployment such as biofuels in Asia.



The Predator Unmanned Aerial Vehicle can be equipped with the Lynx® SAR.

“ For nearly three decades, American taxpayers have received a generous return on their investment in Sandia’s work on Synthetic Aperture Radar. From the early R&D stages to the point of achieving commercialization potential in the 1990s, SAR research and development was principally supported by federal funds. Private industry subsequently began to show interest, resulting in numerous industry partnerships – our partnership with General Atomics stands out as perhaps the most enduring and fruitful. GA and Sandia take great pride in jointly advancing this important work to further strengthen national security. ”

**Jim Hudgens**  
Senior Manager  
Microwave Imaging Systems  
Sandia National Laboratories

## General Atomics Partnership Produces Valuable National Security Assets

**S**andia's Synthetic Aperture Radar (SAR) is a prime example of how technology transfer and commercialization was intended to work when the National Competitiveness Technology Transfer Act was passed in 1989. Funded solely by the American taxpayer via DOE and DoD during the 1980s through the mid-1990s, SAR matured to the point of attracting substantial additional funding from private industry partners, and in particular General Atomics Aeronautical Systems, Inc. (GA-ASI).

Environmental monitoring, earth resource mapping, and military systems require broad-area imaging at high resolutions. Many times the imagery must be acquired in inclement weather, sandstorms, fog, or at night. SAR provides such a capability, which can be applied to treaty verification and nonproliferation, reconnaissance and surveillance, moving target indication, and change detection. The radar can reach more than 50 miles, from a height of 50,000 feet.

Sandia's fruitful partnership with General Atomics (GA) ([www.ga.com](http://www.ga.com)) and its affiliate GA-ASI ([www.ga-asi.com](http://www.ga-asi.com)) began in 1996, when the San Diego-based company set out to develop an advanced, light-weight SAR system. Searching the early internet, they discovered a site about SAR, created by Sandian Armin Doerry. It discussed Sandia's pioneering SAR development work for the Army that had been under way for nearly a decade.

At that time, GA-ASI was producing the MQ-1 Predator UAV for the Air Force, equipped with an older, less capable non-Sandia SAR radar. This radar was not suited for the UAV mission. GA-ASI, in an effort to bring the best technology to the warfighter, contacted Sandia's SAR team for a possible partnership.

The Sandia team met with one of GA's owners, Neal Blue, and presented a summary of the Labs' capabilities along with a proposal to develop the needed radar. While the team was having dinner at the San Diego Airport before boarding their flight back to Albuquerque, GA Executive VP Dave Roberts found them and let them know that GA wanted to proceed with a radar development partnership. That led to a Work for Others agreement focused on building a SAR that could be integrated better with the rest of the Predator's sensor systems and provide higher-resolution images than the legacy SAR. Sandia project leader Bill Hensley named the project Lynx<sup>®</sup>, after a family camping trip in the New Mexico mountains, where they had spotted "a small predator that can see exceptionally well in the dark."

In 2008, a CRADA was established to grow the partnership and continue development of the Lynx<sup>®</sup> SAR, a radar that provides unmatched performance for reconnaissance and surveillance in adverse weather conditions. The Lynx<sup>®</sup> SAR is a lightweight, user-friendly system with extended range and superb resolution. GA-ASI has produced more than a hundred units for the DoD and State Department. These new SAR systems enhance the surveillance capability of GA-ASI's UAVs and other reconnaissance aircraft.

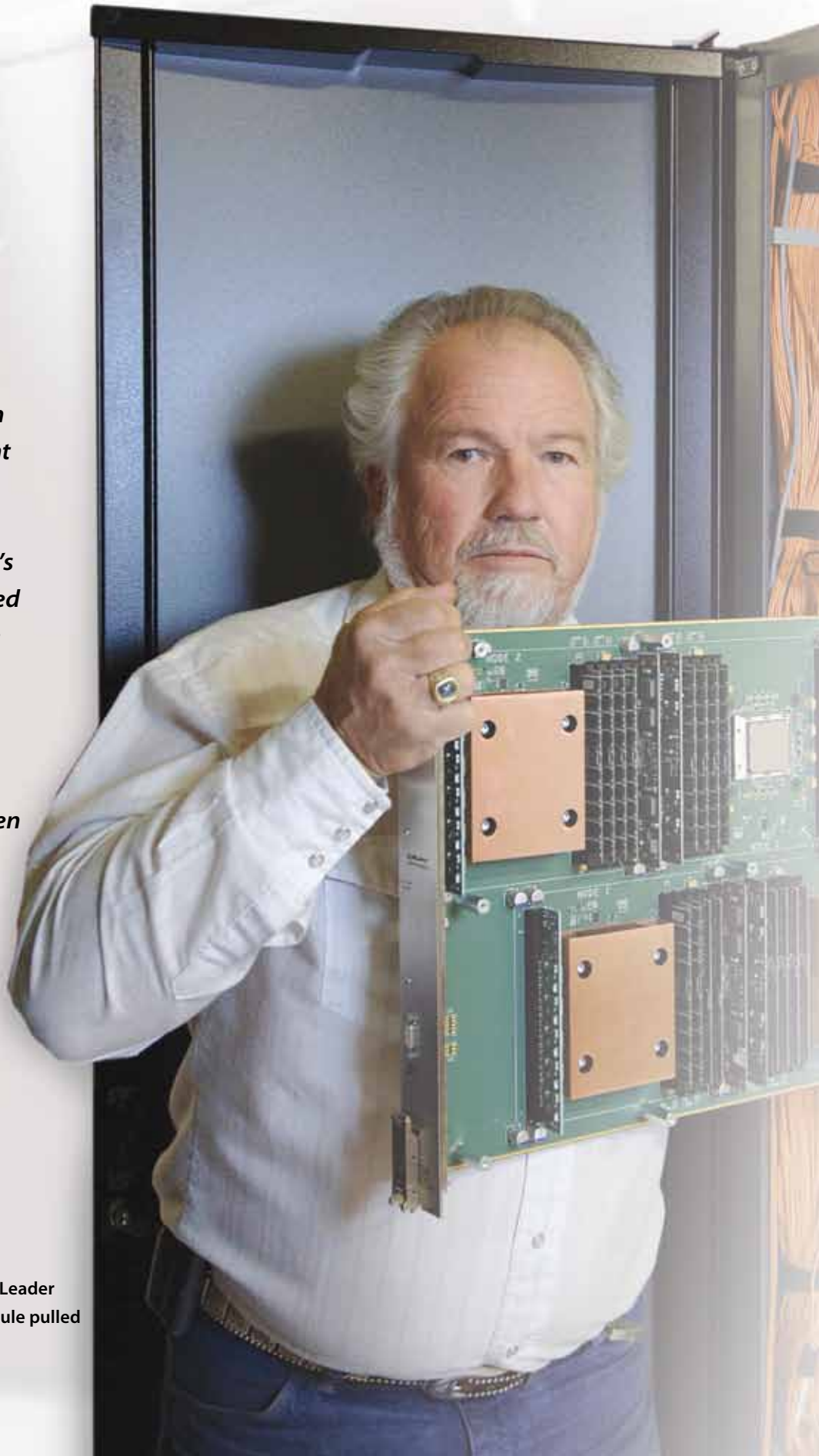
Sandia and GA-ASI continue to explore ways to improve the Lynx<sup>®</sup> SAR. Future upgrades could include an inverse SAR mode for imaging of seaborne targets, interferometric SAR (requiring the use of two antennas) for three-dimensional imaging, and radio-frequency tagging—both for combat identification and for precision strike applications. This enduring partnership will continue to grow the U.S. economy and bolster national security.

“ Without a doubt, Cray’s partnership with Sandia has been one of the most significant partnerships in the company’s history. Not only did our collaboration on Red Storm result in significant scientific advancements and accomplishments in support of the Department of Energy’s NNSA mission, it also spawned a very successful, proven line of Cray XT supercomputers starting with our XT3 system launched in 2005.

All of this would not have been possible without the unique combination of talent and dedication that our partnership enabled. ”

**Peter Ungaro**  
Cray President

Sandia Computer Operations Team Leader  
Archie Gibson with a compute module pulled  
from a Red Storm cabinet.



## Cray, Sandia, and the Making of the World's Supercomputer

In November 2007 *The Wall Street Journal* reported that Cray, Inc., was feeling super amid a company turnaround and heading towards its first profits in four years. During 2008 Cray enjoyed a 52 percent revenue growth, at a time when many other U.S. companies suffered tremendously and the stock market was down.

With more than 1,000 cabinets sold through 2009, the Cray XT product line has become the most successful supercomputer in history. And just before the end of 2009, the largest Cray XT5 machine, which is an offspring of the Sandia-developed Red Storm computing architecture, was certified as the world's fastest supercomputer. It resides in the National Center for Computational Sciences at Oak Ridge National Laboratory.

But without the long-term, multi-faceted relationship that Sandia and Cray established in 2002, it is unlikely these achievements for the Seattle-based 800-employee company would have ever occurred.

Bill Camp, now retired from Sandia, directed the Labs' first Accelerated Strategic Computing Initiative program. He recalls that talks started with Cray about how the two could combine forces to design and build a radically new

generation of supercomputers. The new partnership that was established – there have been CRADAs, licenses, and WFO agreements throughout the years – was seen as very risky by all involved. Camp recalls that, over the first few years, a variety of technical, manufacturing, and cost challenges needed to be conquered, but the first Sandia-Cray Red Storm supercomputer arrived in mid-2005.

There's been no looking back since. Early on in the relationship, Sandia insisted that Cray pledge to commercialize the product realized by the collaboration. Cray did so, despite known significant risks. But the results speak volumes about the success. In addition to lofty sales figures and other upbeat financials for Cray, its machines located at Lawrence Berkeley and Oak Ridge national laboratories perform stellar work for the U.S. Department of Energy's Office of Science. The machine at Oak Ridge also has been the site of Gordon Bell Prize winning supercomputing work for the past two years.

Cray and Sandia do not have plans to part ways either, although the focus of the work is evolving more into a traditional customer/supplier mode as the Labs continues to use these supercomputers, rooted in the two organizations, in direct support of the DOE's national security missions.

# Verifying a Viable Option for Energy Security

*“ eSolar is proving that California’s energy and environmental leadership are advancing carbon-free, cost-effective energy that can be used around the world. ”*

*Arnold Schwarzenegger  
Governor of California*

Key to eSolar’s technology is precise, automated calibration and control of thousands of their mass-produced sun-tracking heliostats.



## Sandia Engineers Key in Getting Start-Up, eSolar, to the Next Level

**E**ach year Sandia enters into 30 new industrial partnerships on average in support of the Labs' mission. History shows that some of these new collaborations evolve into long-term partnerships, the foundation piece in Sandia's technology transfer strategy. In FY 2009, Sandia formed new partnerships with companies located across the nation. Examples include Air Products of Allentown, Pennsylvania; NG Electronic Systems Division of Linthicum, Maryland; Forest City Residential Group of Cleveland, Ohio; Ultramet, Inc. of Pacoima, California; Verdant Power, Inc. of Burlington, Vermont, and the company featured in this story —eSolar of Pasadena, California.

Craig Tyner and Jim Pacheco spent a combined 33 years at Sandia designing, building, and testing concentrating solar power (CSP) systems under the auspices of the U.S. Department of Energy's "Concentrating Solar Power Program." Craig, Jim, and the CSP team established a valuable knowledge base of CSP, largely because of their ability to make use of Sandia's massive, state-of-the-art "National Solar Thermal Test Facility," located in Albuquerque. This unique national resource enabled researchers to demonstrate that CSP was, in fact, a viable technology option for national energy security.

In 2007, while the CSP team and its industry partners were expediting technology maturation for ultimate commercialization of CSP systems, the California start-up, eSolar, was founded to produce scalable solar thermal power plants designed to address the complex issues surrounding large or utility-scale power projects. A "convergence" was in the making between eSolar and Sandia.

In what can be described as the ultimate form of technology transfer, Craig and Jim joined eSolar in the fall of 2008. Craig retired, and Jim took advantage of Sandia's entrepreneurial separation program. Both joined eSolar's executive management team and immediately went to work applying their extensive and unique CSP expertise to help the small company realize its primary business goal to make solar electricity for less than the price of coal, without subsidies.

In June 2009, El Paso Electric signed a power purchase agreement for the full capacity of a 92-megawatt (MW) CSP plant to be developed in southern New Mexico by NRG Energy, a national Fortune 500 energy provider, and eSolar. When fully operational, the plant is expected to be the first commercial-scale solar thermal project in New Mexico. This project is part of NRG and eSolar's plans to develop up to 500 MW of solar thermal power in California and across the Southwestern United States. eSolar also has development partnerships with the ACME group and Penglai to build 1000 MW in India and 2000 MW in China, respectively. The company is also seeking agreements in Europe, the Middle East, Australia, Asia, and South Africa.

At first, Craig and Jim were not sure they would be taken seriously and valued by their eSolar colleagues, given their "non-industry" experience at a national lab. But that changed quickly. "Sandia was better training for this type of world than you might think... We're having fun and making things happen!" said Craig.



## Sandia MEMS, Polychromix, And Water on the Moon

**L**ast October when a highly touted scientific payload plowed into our moon’s surface near its south pole many people, even some newscasters, said, “What a dud.” Some of these folks even had hoped, it was reported, to see the impact from earth. But that did not happen.

However, about a month later, as analyses of the instruments on board the LCROSS (Lunar Crater Observation and Sensing Satellite) become more complete, it turned out the craft and its various on-board instruments had, in effect, made quite a splashdown.


The Associated Press reported the news this way: “The lunar dud for space enthusiasts has become a watershed event for NASA. Spacecraft that crashed into the moon last month kicked up a relatively small plume [of lunar debris]. But scientists have confirmed the debris contained water – 25 gallons of it – making lunar exploration exciting again.”

Key to verification of water in such a significant amount were two near-infrared spectrometers that NASA had obtained from Polychromix, Inc.,

of Wilmington, Massachusetts. Simply put, the spectrometers looked at reflected sunlight from the lunar debris for features characteristic of water and found them. Other equipment on board, such as a visible ultraviolet spectrometer and a couple of infrared imaging cameras, gave further verification of the water located in the permanently shadowed region of Cabeus crater.

A number of current and former Sandia scientists had been paying particular attention to this NASA operation because the space-traveling Polychromix spectrometers are direct descendants of a device they had developed and patented several years earlier – a MEMS-based diffractive optical component.

MEMS (micro-electromechanical systems) involve using semiconductor silicon fabrication technology to build devices that perform myriad mechanical or optical-mechanical functions. MEMS enable construction of inexpensive, rugged, high-precision, low-power miniaturized devices that over the years have found their way into consumer goods – vehicle airbags and suspensions, mountain-bike altimeters, cell



**“ Polychromix was honored that our technology was selected by NASA and are of course delighted that our systems were reported to have “worked perfectly” during the entire LCROSS mission. We see this as further validation of the enabling power of the MEMS NIR technology originally envisioned by Drs. Senturia and Butler. Here on earth, Polychromix is busy leveraging this same technology in our latest generation of microPHAZIR (TM) handheld analyzers in fighting the counterfeit pharmaceutical trade, screening of explosives and narcotics threats, increasing polymer recycling efforts, and reducing manufacturer’s QA/QC testing costs. ”**

**Dan Klevisha**  
Vice President  
Polychromix

phones, and event video games – along with NASA spacecraft.

Michael Butler, one of the Sandia inventors, had left Sandia in 2001 to become a founding vice president at Polychromix, joining Prof. Stephen Senturia of MIT, a former Sandia consultant and co-inventor of the technology. Butler recalls the original work on their MEMS-based diffractive optical component involved teaming with MIT and Honeywell and was supported to the tune of \$8M by the Defense Advanced Research Projects Agency (DARPA), an agency of the Department of Defense and responsible for development of new military technology. DARPA was interested in the component for possible use in remote sensing.

Although that application which interested DARPA has never been commercialized, Polychromix saw value in the Sandia device, which by that time had been christened the Polychromator. Polychromix obtained an exclusive license and adapted the Sandia device and technology initially to optical telecommunications needs, but has further

improved and modified it for use in the company’s evolving focus areas. For example, its PHAZIR™ near-infrared material analyzer can be used for tasks related to pharmaceutical manufacturing, polymer recycling, feed ingredients analysis, and explosives and narcotics detection.

Sandia-based MEMS devices arriving on the moon actually was not their first venture into space. Back in 2006 NASA launched microsattellites weighing about 55 pounds and roughly the size of a wedding cake. Some were equipped with MEMS-controlled variable-emittance louvers, or shutters, used to help regulate interior microsattellite temperatures. These microlouvers were the product of a partnership between the Labs and Johns Hopkins University’s Applied Physics Lab.

So, it is fair to say that Sandia and its research partners had some of the first MEMS devices in space, with the microlouvers, and the first MEMS on the moon.

*“ Sandia’s International Partnerships are a valuable component of our broad partnerships program. These international projects allow Sandia to apply its capabilities across a wide range of global problems and ultimately to promote U.S. national security by helping to create a more secure and prosperous world. ”*

*Deborah Payne  
Work for Others/CRADA Agreements Department  
Sandia National Laboratories*

Downtown Singapore

## International Partnerships From One Side of the World to Another

**A**s Sandia's portfolio of partnership types evolves, it is easy to recognize the impressive number of ongoing and emerging collaborations that fall into the category of International Partnerships.

At their core is application of Labs' technologies and capabilities developed in support of its core national security missions but to a broader goal of energy, non-proliferation, and security at a global level.

Entering into these partnerships with a diverse collection of foreign entities, the Labs believes, will permit it to achieve a vision of "helping the nation secure a peaceful and free world through technology."

### Some partnership examples

**Energy Market Authority (EMA) and the Singapore Water Resources Management Organization (PUB), Singapore**—Sandia provides expertise, software tools, and educational components to address future energy strategies. Work with the EMA is focused on development of dynamic simulation models for determining trade-offs between cost and greenhouse gas emissions for different future electricity generation options in Singapore. Work with PUB has developed a networked continuous water quality monitoring system for Singapore along with optimal sampling protocols for improved security and management of water resources. Discussions are under way that may lead to additional interactions with both EMA and PUB.


**Areva Federal Services, France**—Through a battery of severe environmental tests, Sandia

will perform supplementary certification for the TRUPACT-III transportation package, which is used to safeguard and protect nuclear materials transported in various countries. The 8.2 x 8.7 x 14-foot stainless steel, 55,000-pound package is designed with multiple layers to protect its cargo. It also is used to transport transuranic waste from various spots in the United States to the Waste Isolation Pilot Plant near Carlsbad, New Mexico.

**Health & Safety Executive Nuclear Directorate (HSE ND), United Kingdom**—For this recently established partnership, Sandia is providing technical support that will permit HSE ND to complete its work relating to a Generic Design Assessment and subsequent site-specific licensing processes for new nuclear power reactor designs in the United Kingdom. In particular, Sandia's support will involve external hazards and radiation protection assessments, and probabilistic safety and deterministic safety analyses.

**Defence Science & Technology Laboratory (DSTL), United Kingdom**—Sandia has been teaming with the DSTL for many years because of shared needs pertaining to cooperative mobile robotic systems and their applicability for emergency response and counterterrorism missions. This collaboration is fostering development of an advanced visual targeting system to help robot operators more accurately manipulate a new mobile robotic system, called Cutlass, in its mission execution while reducing the burden on the operator.

# Developing a Next Generation of Biofuels



**“ We have the opportunity to do research that will lead to transportation fuels that you can put in your automobile today, that we can put into jet engines, that we can use to power our economy going forward into our children’s and grandchildren’s generations. ”**

**Jay Keasling**  
Chief Executive Officer  
Joint BioEnergy Institute

Plants engineered for biofuels development.

## Sandia's Unique Capabilities Valued by the Joint BioEnergy Institute

**M**ajor challenges to our nation's security and prosperity are being addressed by powerful, innovative collaborations called Public-Private Partnerships. Sandia participates in several such partnerships, bringing to bear a number of the Labs' core competencies and unique capabilities, in conjunction with complementary strengths of other national labs, universities, and industry partners. A prime example is Sandia's membership in the Joint BioEnergy Institute (JBEI).

JBEI is one of three DOE Bioenergy Research Centers established to lay the foundation for a plant-based energy economy. Research performed by the Centers provides the nascent bioenergy industry with the critical, commercially viable technologies, methods, and tools needed to make production of cellulosic biofuels (biofuels made from nonfood plant fiber) efficient, economical, and sustainable.

To this end, JBEI's mission is to advance development of the next generation of biofuels, which are liquid fuels derived from the solar energy stored in plant biomass. JBEI opened in October 2007, funded for five years with a \$134M grant. Former Secretary of Energy Samuel Bodman, upon launching JBEI and the two other partnerships, pointed out that the goal was to make cellulosic ethanol cost-competitive with gasoline by 2012 and assist in reducing America's gasoline consumption by 20 percent in 10 years. In the U.S. alone, 225 billion gallons of transportation fuels are burned every year.

Six partners, led by Lawrence Berkeley National Laboratory, comprise JBEI. The others are Sandia and Lawrence Livermore national laboratories, UC-Berkeley, UC-Davis, and the Carnegie Institution of Science. This past year, several private companies began to evaluate

outputs of JBEI's research, including enzymes best suited to break down biomass into fuel and new metabolic pathways for advanced biofuel production. Industry partners are expected to license these and other JBEI technologies, putting companies in position to advance the commercialization of these discoveries. To assist in this regard, an Industrial Advisory Committee, with representatives from industry representing everything from agricultural feedstocks to automobile companies, keeps JBEI's research connected to commercial realities.

Sandia's role in JBEI builds on its expertise in science-based engineering, computational science, and microsystems. The Labs' capabilities in enzyme engineering, advanced imaging and spectroscopy, systems biology, membrane transport, and protein expression contribute significantly to JBEI's mission. Sandia facilities, including the Center for Integrated Nanotechnologies (CINT), Microsystems and Engineering Sciences Applications (MESA), and the Combustion Research Facility (CRF), play leading roles. Bioenergy-related research at Sandia also enhances JBEI's efforts. Examples include the examination of the photosynthetic properties and cell wall composition of various plants and microbes; analysis of extremophile enzymes; and related engineering methods that can facilitate the processing of cellulosic biomass.

Says Sandia Manager and JBEI Vice President Blake Simmons, "The ultimate goal and mission of JBEI is to mitigate the greenhouse gas emissions derived from fossil fuels, as well as decrease our dependence on foreign oil. We are doing a lot of fundamental research into looking at advanced enzymes, pretreatments, feedstocks, and organisms that can more efficiently assist in the conversion of biomass into biofuels."

“ *The NMSBA Program and Sandia National Laboratories have allowed what was once just an idea to develop into a reality.* ”

*Frank McDonald  
Owner of Biosphere Environmental  
Science and Technologies*



B.E.S.T. water cleaning equipment.





## Small Business Focus Rounds Out Sandia's Partnerships Strategy

Since the beginning of its technology transfer journey more than two decades ago, Sandia has maintained a robust, comprehensive repertoire of partnership programs and initiatives. Indeed, Sandia is viewed as a national leader in technology transfer largely due to this approach. Rounding out this successful model are technology-based economic development partnerships – a set of programs designed to leverage Sandia's world-class science and technology to create jobs.

In this arena, Sandia uses several tools to deploy and commercialize its technology. One is the Sandia Science & Technology Park (SS&TP), in which 30 tenants employing almost 2000 people currently reside. Park tenants have a business or technology transfer connection to Sandia. Another important tool is the Entrepreneurial Separation to Transfer Technology (ESTT) Program, which has made it possible for 138 Sandians to leave the Labs since 1994 to start up or help expand 91 small businesses. The third tool is the New Mexico Small Business Assistance (NMSBA) Program, a distinctive partnership that includes Sandia, Los Alamos National Laboratory, and the State of New Mexico. NMSBA is specifically chartered to provide unique Laboratory-based technical assistance to New Mexico small businesses – almost 1600 such businesses to date. The two success stories below and the two-page spread that follows exemplify this facet of Sandia's partnerships mission.

### NMSBA Four Corners Project

Biosphere Environmental Science and Technologies (B.E.S.T.) operates several projects related to water supply and water use systems. While designing a reverse osmosis system to desalinate water produced from oil and gas

production, B.E.S.T. found that chemicals and minerals from the produced water reduced the effectiveness of filtration membranes within the reverse osmosis system. They needed a pretreatment system to increase the life of these membranes. Two Sandia engineers teamed with B.E.S.T. and other companies at a site near Farmington, New Mexico, to test the performance of a new pretreatment and reverse osmosis system for untreated produced water. The system, designed with help from the NMSBA Program, is expected to reduce costs from \$120 to \$3 per thousand gallons to treat produced water and will reduce the disposal cost for New Mexico oil and gas operations while restoring natural vegetation at well sites.

### NMSBA Giggling Springs Project

Located along the Jemez River in north central New Mexico, Giggling Springs Spa taps an outdoor mineral water pool fed by hot water from an underground geothermal spring to provide therapeutic soaking and relaxation. Spa operators approached the NMSBA Program to investigate a heating system for both its buildings and therapeutic pool using geothermal energy from the native hot spring. A Sandia specialist in fluid and thermo dynamics calculated the amount of energy available for use from the geothermal water, then proposed heat exchange and cabin heating systems that operated effectively while leaving sufficient heat in the system for the therapeutic pool. Once built, the new heating system also allowed Giggling Springs to reduce the need for supplemental heating by directing the geothermal heat preferentially to the most frequently used cabins. The spa saw an immediate decrease in energy costs and became much less dependent on other energy sources to operate.

“ *EMCORE has been expanding in Albuquerque over the past decade. Many of the product lines EMCORE offers today are a direct result of successful technology transfer and commercialization from Sandia National Laboratories. As we continue our investment and introduction of our disruptive solar renewable energy products based on our concentrator photovoltaics technology, we are committed to continue our expansion at SS&TP. And, as we celebrate our landmark achievement with PNM as the first commercial solar distributed generation project, we look forward with our utility partners to many more applications in the future.* ”

**Hong Q. Hou**  
Chief Executive Officer  
EMCORE Corporation

EMCORE's third-generation solar cell photovoltaic array.



## EMCORE's Achievements Continue Through Recession

**E**MCORE, the anchor tenant of the SS&TP in Albuquerque, has grown since its historic 1998 arrival in New Mexico to be a leading provider of compound semiconductor-based components for the world's fiber optics and solar markets. The high-tech company of 70 employees, which eventually moved its corporate headquarters to the SS&TP in 2006, has continued on an upward spiral despite trying economic times that have challenged most businesses during the recent past.

In 2008, for example, EMCORE's Solar Photovoltaics Division received a prestigious R&D 100 Award for its new world record-setting Inverted Metamorphic (IMM) solar cell technology. It provides the platform for EMCORE's next-generation photovoltaic products. Solar cells built using this technology have achieved a record conversion efficiency of up to 33 percent. EMCORE researchers expect that efficiency to hit 42 to 45 percent when IMM technology-based solar cells are adapted for terrestrial concentrator photovoltaic (CPV) systems.

These ongoing achievements are even more impressive when one recalls that the solar cell technology EMCORE licensed from Sandia back in the early 1990s continues to serve as the basis for its high-efficiency solar cells used to generate solar power for terrestrial applications.

EMCORE Fiber Optics, its other division headquartered at the SS&TP, introduced a tunable XFP product line in March 2009. This product can replace fixed-wavelength XFPs and 300-pin multisource transponders with a single product, thus reducing inventory and spares customers have to carry.

Then in June 2009, EMCORE signed a forward-looking agreement with the Public Service Company of New Mexico (PNM) to become the first company to join that utility's Distributed Energy Solar Power Program. The 20-year

agreement involves 114 kilowatts of solar power being produced onsite at EMCORE's corporate headquarters in the SS&TP.

These are just some of the most recent examples of pioneering R&D and actual product entering the marketplace emerging from the multifaceted Sandia-EMCORE partnership.

It is a private sector-national laboratory partnership that, since its inception, has created hundreds of new, high-paying jobs and has made an important contribution to the local technical community as well as the economy.

And, through technology transfer and commercialization, Sandia has gained private sector funding that supports the Labs' core national security mission and the local Mid-Rio Grande economy of New Mexico.

### EMCORE-Sandia Partnership Uses Various Approaches

EMCORE's story, from its roots in New Jersey through its 2006 corporate headquarters move to the SS&TP, highlights how one publicly traded company used several technology transfer tools offered by Sandia to enable its growth and success. These tools include *License Agreements*, *Cooperative Research & Development Agreements (CRADAs)*, *Work-for-Others (WFO) Agreements*, *Entrepreneurial Separation to Transfer Technology (ESTT)*, and the *New Mexico Small Business Assistance (NMSBA) Program*.

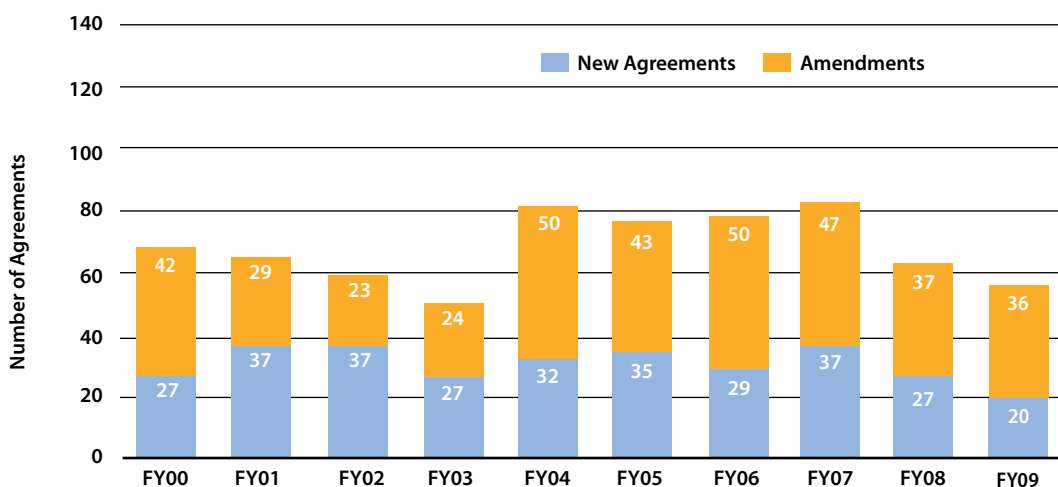
In addition, through much of its existence EMCORE has benefited from the services of Technology Ventures Corporation, which was established by Lockheed Martin in 1993 to help start-up companies that are developing technology from the national laboratories.

Sandia National Laboratories' partnerships program is committed to principles of quality management and continuous improvement. Tracking our work over time, we demonstrate a consistent return on investment for the American taxpayer and assure the DOE/NNSA that Sandia strongly supports its technology transfer mission. The graphs and summaries that follow depict year-by-year and cumulative levels of activity for our most important partnership metrics over the past decade and beyond. The *Scorecard* shows that Sandia has maintained a robust, wide-ranging, and abundantly successful portfolio of technology partnerships for many years.

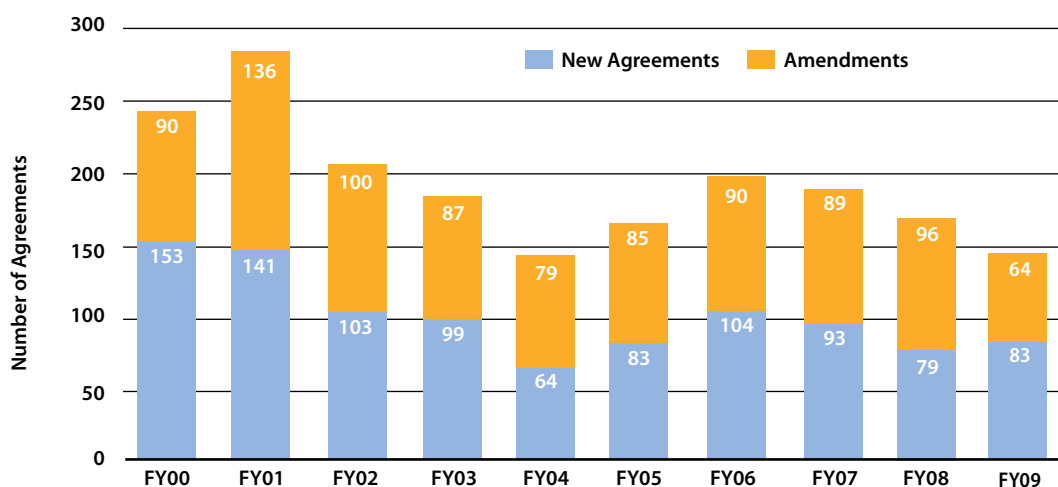
## CRADAs and WFO-Industrial

The number of executed CRADAs and Funds-In Agreements decreased slightly in FY2009; however, the funds-in from these agreements increased.

### Sandia CRADA Program Activity



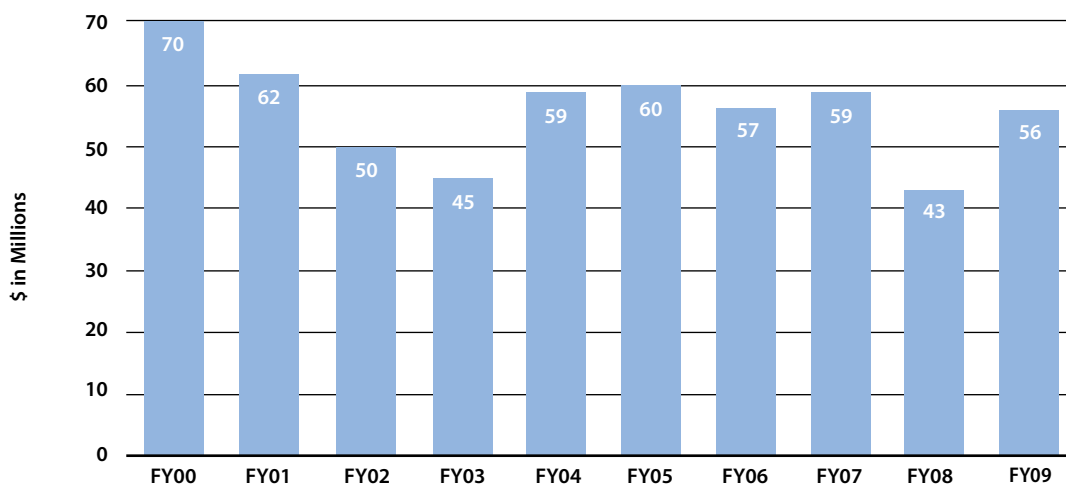
### Sandia WFO-Industrial Partners Activity



# Industry Funds-In

Industry funds-in increased in FY2009.

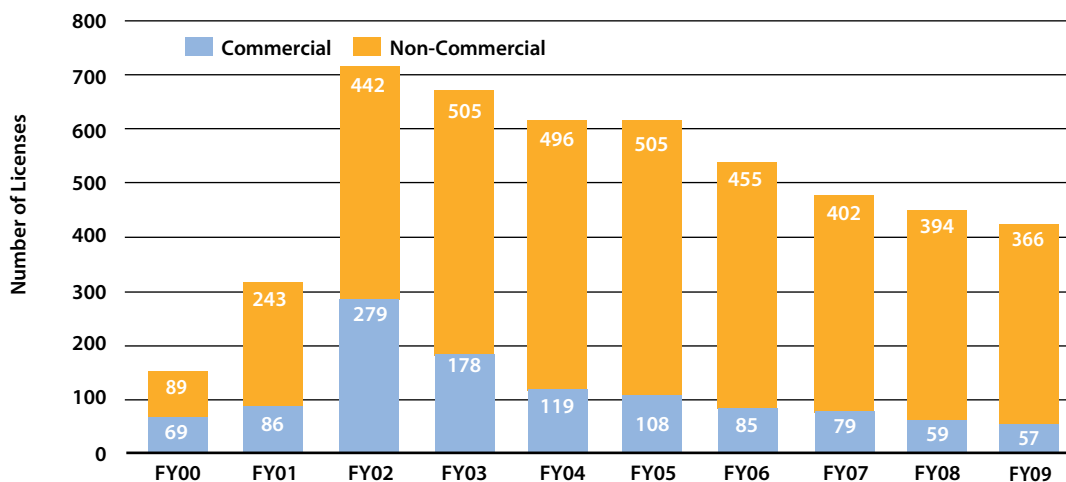
## Industry Funds-In to Sandia (\$M)



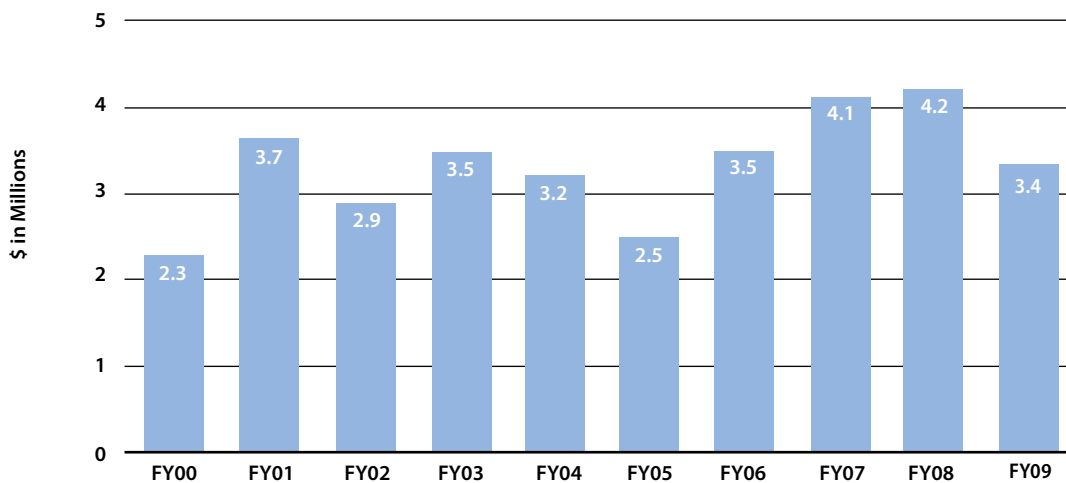
# Licenses

Licensing activity and income remained at healthy levels.

## Licenses



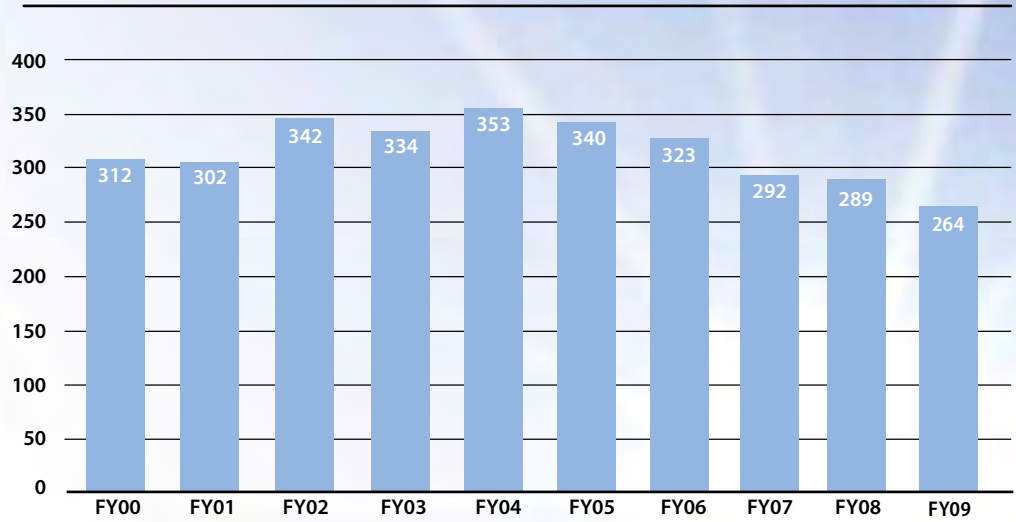
## Licensing Income (\$M)



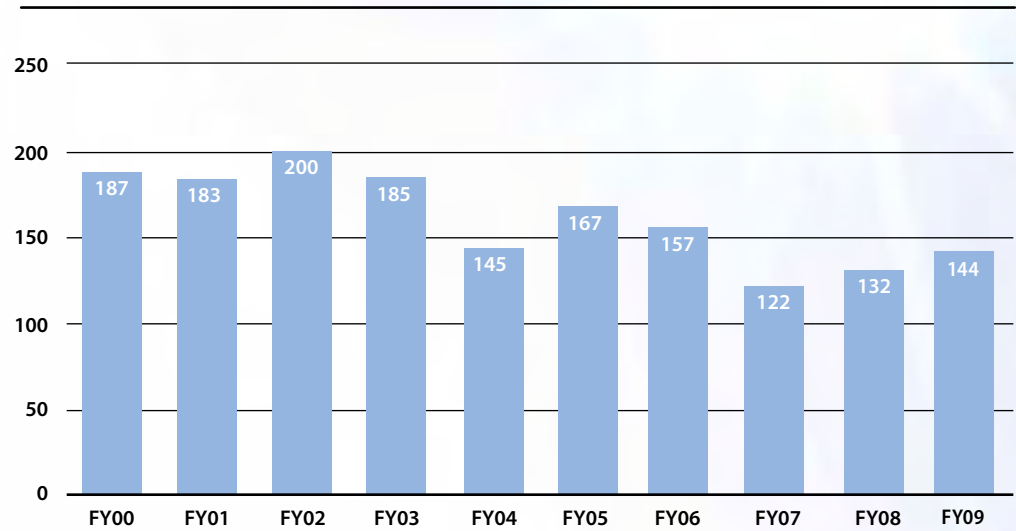
## Patent Activity

Sandia continues to build a strong patent portfolio.

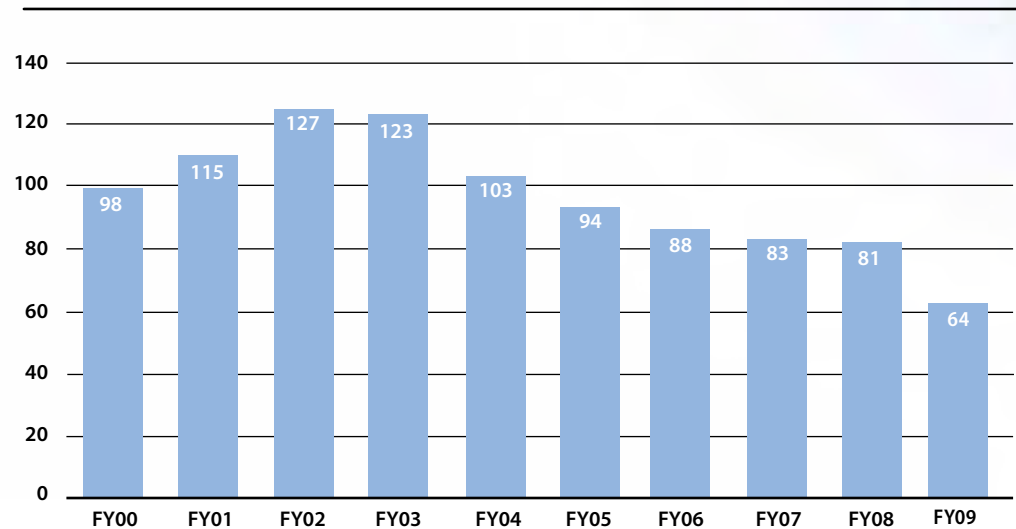
### Invention Disclosures



### Patent Applications



### Patents Issued





Our technology community continues to thrive as companies within the Park increase their business with each other.

## Sandia Science & Technology Park (SS&TP)

### Results

Number of companies	30
Number of employees	1,942
Number of buildings	18
Number of square feet	869K
Number of acres developed	67
Funds in to Sandia from tenants	\$17.6M
Contracts from Sandia to tenants	\$319.5M
Contracts among tenants	\$8.3M
Public investment	\$68.2M
Private investment	\$257.5M
Total investment	\$325.7M
Impact on wages and salaries	\$1.5B
Average salary of full-time jobs in park	\$70K
Average salary of full-time jobs in Metro Albuquerque	\$37K

Note: Park opened in 1998



Providing small business assistance to NM companies is having significant payoff even during tough economic times.

## New Mexico Small Business Assistance (NMSBA) Program

In 2009 the State of New Mexico along with Los Alamos National Laboratory and Sandia National Laboratories invested **\$4.3M** helping **320** small businesses in **25** counties to solve technical challenges.

### 2000 - 2008

#### Return on Investment (ROI)

1.34

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

#### Economic Impact

Small Business Jobs Created and Retained	1020
Mean Salary (\$)	\$39,063
Increase in Revenue (\$)	\$39,698,900
Small Business Decrease in Operating Costs (\$)	\$28,319,800
Investment in NM Goods/Services (\$)	\$11,144,870
New Funding/Financing Received (\$)	\$10,733,000

### 2000 - 2009

#### New Mexico Small Businesses Assisted

LANL	189
SNL	1408
Combined	1597

#### Rural vs Urban Businesses

Rural	1020
Urban	577
Combined	1597

#### Dollar Amount of Assistance

**\$20.7M**

## ESTT

Entrepreneurial Separation  
to Transfer Technology

An economic impact study of ESTT start-up companies found that these companies created significantly higher paying jobs compared to overall average salaries in New Mexico and California.

### Entrepreneurial Separation to Transfer Technology (ESTT) Program

<b>Sandia scientists and engineers who left on ESTT</b>	138
To start up companies	55 (40%)
To expand companies	83 (60%)
<b>Companies impacted by ESTT</b>	91
Start-ups	44
Expansions	47
<b>Licenses for Sandia IP negotiated with ESTT companies</b>	42
<b>ESTT companies that became Sandia suppliers</b>	29
<b>Economic impact of ESTT start-ups (16 respondents)</b>	
Jobs directly created	277
In New Mexico	166
Outside New Mexico (CA)	111
Average salary - all 277 jobs	\$60,556
Average salary - 166 NM jobs	\$47,454
Average NM wage paid in 2007	\$35,980
Average salary - 111 CA jobs	\$80,150
Average CA wage paid in 2007	\$50,182
Sales revenue of 16 companies in last FY	\$22M
License fees paid to Sandia by ESTT companies in last FY	\$242,500
<b>Partnering with Technology Ventures Corporation (TVC)</b>	
Joint clients of ESTT and TVC	35
Venture funding attracted by these 35 companies	\$311M
Jobs created by these 35 companies	3,615
TVC funding events involving Sandia technology	42
Funding events for ESTT companies	28 (67%)

*Note: Program began in 1994*



# Recognition



In 2009, Sandia researchers and their collaborators won six **R&D 100 Awards**, given by R&D Magazine to the 100 most significant technical products becoming available each year.

- **Ultralow-Power Silicon Microphotonic Communications Platform**—Enables optical data transmission and routing on a silicon platform at nanosecond switching speeds for use in high-performance computers.
- **Hyperspectral Confocal Fluorescence Microscope System**—Creates ability to discover and quantify fluorescing species in 3D, which other microscopes are not able to distinguish or quantify.
- **NanoCoral™**—Produces novel size and shape controlled platinum nanostructures and is expected to reduce significantly the platinum metal usage and thus the cost of platinum catalysts for use in the renewable energy sector.
- **SiCPower Module (high-temperature silicon carbide power module)**—More efficiently converts electrical energy from one form to another, which could save hundreds of millions of dollars to produce hybrid and electric vehicles, renewable energy interfaces, and aircraft.
- **Catamount N-Way (CNW) Lightweight Kernel**—Delivers significant improvements in data access performance for today's parallel computing applications.
- **Artificial Retina Project (public-private partnership funded by DOE)**—Teamed with researchers from four other national laboratories, four universities, and an industrial partner to move research forward to enable the blind to see.

The **Federal Laboratory Consortium** 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 one National FLC Award for Excellence in Technology Transfer.*

- **Novel Dendritic Platinum Catalysts for Fuel Cells**—In addition to winning an R&D 100 Award (NanoCoral™), this technology received a 2009 National FLC Award.

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

- **New Mexico Small Business Assistance Program (Outstanding Regional Partnership category)**—A joint program between Sandia and Los Alamos National Laboratory that assists New Mexico small businesses by providing them technical expertise in exchange for receiving gross receipts tax credits from the State of New Mexico.
- **Sandia Cognitive Framework (Notable Technology Development category)**—The basis for technologies that augment human decision making, offering our nation a critical and improved capability to address a wide range of national security situations.
- **Flash-Bang (Excellence in Technology Transfer category)**—A safe, nonlethal diversionary device used by law enforcement and the military to temporarily distract or disorient adversaries.



The National Institute for Nano Engineering (NINE), a public-private partnership in which Sandia is the

host laboratory, won the 2009 Deal of Distinction Award from the **Licensing Executives Society (LES)**. The Deal of Distinction Award is the highest honor the LES gives to deals nominated from across the United States and Canada.

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](mailto:partnerships@sandia.gov), or call (505) 284-2001.

**Information is also available for the following partnership areas:**

**Industrial Partnerships and Strategy**

Harold Morgan, 505-844-7045, [hsmorga@sandia.gov](mailto:hsmorga@sandia.gov)

**Intellectual Property Management, Alliances and Licensing**

Mark S. Allen, 505-844-7197, [msallen@sandia.gov](mailto:msallen@sandia.gov)

**Agreements**

Deborah Payne, 505-845-8449, [dnpayne@sandia.gov](mailto:dnpayne@sandia.gov)

**Partnerships Business Development**

Mary Monson, 505-844-3289, [mamonso@sandia.gov](mailto:mamonso@sandia.gov)

**Business Development (California)**

Devon Powers, 925-294-1470, [dpowers@sandia.gov](mailto:dpowers@sandia.gov)

**Technology and Economic Development**

Jackie Kerby Moore, 505-845-8107, [jskerby@sandia.gov](mailto:jskerby@sandia.gov)

**Technology Ventures Corporation (TVC)**

George Friberg, 505-843-4286, [george.j.friberg@lmco.com](mailto: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**

**Sandia National Laboratories**

*Jackie Kerby Moore*

*Richard Fairbanks*

*Chris Brigman*

**Sandia Staffing Alliance, LLC**

*Rod Geer*



**innovation**  
through partnerships



**Sandia  
National  
Laboratories**

For more information on Sandia's technologies:  
[partnerships@sandia.gov](mailto:partnerships@sandia.gov) or (505) 284-2001

Sandia is a multiprogram laboratory operated by Sandia Corporation, a Lockheed Martin Company, for the United States Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000.

SAND number: 2010-1185P



**innovation**  
through partnerships