

## 60 Ways Sandia has impacted the nation

### 1 **Microelectronics industry.**

When Sandian Willis Whitfield came up with the idea for the laminar airflow clean room, it was intended to provide a dust-free environment for close-tolerance weapons parts. Little did he — or anyone else — know that his idea would become a basic enabling technology for the \$1.2 trillion electronics industry.

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### 2 **Anthrax decontamination.**

In 2001, federal authorities used a decontamination foam developed at Sandia to help rid Capitol Hill buildings of anthrax. The foam, a cocktail that includes ordinary household substances such as those found in hair conditioner and toothpaste, neutralizes chemical and biological agents in minutes, and is nontoxic and environmentally friendly.

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### 3 **Computation-based product design.**

Goodyear's Assurance TripleTred tire, Consumer Reports' most recommended all-season tire for passenger cars, was the result of a partnership with Sandia. Sandia's powerful computer codes allowed Goodyear to produce innovative tires in record times by eliminating the need for repeated prototype development, testing, and redesign.

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### 4 **Community support.**

Since Sandia's employee giving plan started in 1957, Sandia employees and retirees have provided at least 15 percent of the United Way of Central New Mexico's annual contributions, with a total of more than \$55 million contributed to date.

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### 5 **Space exploration.**

The ability of the Galileo spacecraft to survive Jupiter's radiation belts was made possible by radiation-hardened components designed and built by Sandia. Launched in 1989, Galileo traveled 2.8 billion miles and survived more than four times the dose of Jovian radiation it was designed to withstand before disintegrating in Jupiter's atmosphere in 2003.

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### 6 **Drilling technology.**

In the 1970s a promising new rock drilling technology — the polycrystalline diamond compact (PDC) drill bit — was introduced, but results in the field were disappointing: cutters broke, separated from bits, or wore too quickly. As a result of Sandia research, industry collaboration, and field testing, design deficiencies were identified and corrected, and now PDC bits account for about two-thirds of all oil and gas drilling because of their efficiency and resistance to wear.

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### 7 **Antiterrorism/Aviation security.**

The familiar walkthrough portals at many airport security checkpoints use Sandia-patented technology to screen airline passengers for explosives. Even trace amounts of explosives on an individual's skin or clothing can be collected and identified using the technology.

## **8 Supercomputing.**

Sandia's Red Storm supercomputer can compute many tens of trillions' worth of calculations in a month, making it a popular tool for U.S. government agencies, universities, and customers worldwide. Designed to run nuclear stockpile calculations, Red Storm has modeled the amount of explosive powder it would take to destroy an asteroid, how fire affects critical components in devices, and how changes in the composition of Earth's atmosphere affect climate.

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## **9 Airbag sensors.**

Invented in the 1960s by Sandian Don Wilkes, rolamites were used to trigger the deployment of automobile airbags until they were replaced in the mid-1990s by electronic triggering sensors. Originally developed to detect a nuclear warhead's acceleration pattern, the rolamite switch is a basic mechanical device consisting of a roller suspended within a tensioned band.

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## **10 Nonproliferation & treaty verification.**

Beginning with the VELA satellite program for detecting nuclear bursts in the 1960s, Sandia has designed sensors and accompanying ground processing systems to support verification of international arms control agreements. Payloads and ground processing systems have been fielded for 23 Defense Support Program satellites and 51 Global Positioning System satellites.

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## **11 Airport chem/bio defense.**

In 2005, Sandia and Lawrence Berkeley national lab researchers published recommendations for protecting U.S. airports against chemical and biological terrorism through planning, training, facility hardening, and effective response. The Transportation Security Administration (TSA) distributed the recommendations to airports nationwide and incorporated them into its own guidance documents.

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## **12 Anthrax investigation.**

Sandia researchers assisted the FBI in its investigation of anthrax-containing letters mailed in 2001 to several news media offices and two U.S. senators. Using advanced microanalysis tools developed for nuclear weapons work, they analyzed hundreds of samples and determined the anthrax in the letters was not prepared to disperse more readily through the use of additives — a crucial finding that helped guide the FBI's investigation.

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## **13 Wind energy efficiency.**

An innovative wind turbine blade, developed by Sandia and Knight & Carver Wind Group, produces up to 10 percent more energy than traditional linear blade designs, without increasing wear and tear on the machine. The 27.5-meter blade with its gently curved tip is specially designed for low-wind-speed regions, greatly increasing the amount of land available for wind energy development.

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## **14 Antiterrorism.**

A Sandia chemical monitoring system called SNIFFER has been keeping watch for the past several years over a number of large indoor and outdoor events: the Super Bowl, Rose Bowl, Oakland A's baseball games, and the 2008 Democratic National Convention. SNIFFER is able to detect and provide early warning of airborne chemical agents that might be used in a terrorist attack.

## 15 **Nuclear stockpile stewardship.**

Sandia plays a key role in efforts to extend the life of nuclear weapons currently in the nation's stockpile, most of which were produced 30 to 40 years ago. Sandia is continually evaluating components, subsystems, and system performance to ensure the ongoing safety and reliability of the existing arsenal.

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## 16 **Aviation safety.**

Takeoffs, landings, pressurization, and temperature changes take their toll on commercial aircraft, causing tiny cracks in the aluminum skin that must be patched and contained. An improved fuselage patch developed by Sandia and partners Delta Airlines, Textron Systems Division, and Lockheed Martin, and approved by the FAA, repairs cracks using a flexible composite material instead of the old riveted metal plates, which can cause cracks themselves.

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## 17 **Bomb disablement.**

The shoe bomb Richard Reid allegedly tried to detonate on a trans-Atlantic flight and a device found in the cabin of convicted Unabomber Theodore Kazcynski were disabled using an advanced bomb squad tool originally developed at Sandia. The device, called the Percussion-Actuated Nonelectric (PAN) Disrupter, is manufactured by Ideal Products of Lexington, Ky., and is used by bomb squads nationwide.

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## 18 **Combustion science.**

Since 1981, researchers at Sandia's Combustion Research Facility have developed ways to detect and measure chemical species in flames, reduce air pollution from engines and coal-powered utility plants, and characterize combustion taking place inside automobile and truck engines. They have revolutionized current understanding of combustion and continue to work with industry to develop more efficient, cleaner-burning combustion processes and devices.

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## 19 **Asteroid tracking.**

A global team that included Sandians Mark Boslough and Dick Spalding was able for the first time to detect and track an asteroid heading toward Earth in October 2008 and predict its time and place of impact. While the small asteroid posed no danger, the ability to provide early warning could be critical for larger asteroids, which strike the Earth a few times a century.

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## 20 **Mine safety.**

The January 2006 explosion that killed 12 miners in West Virginia's Sago Mine was likely triggered by the effects of a lightning strike traveling deep into the mine, a Sandia investigation concluded. The findings were included in a report issued by the U.S. Mine Safety and Health Administration, which has led to proposed new safety measures for mines.

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## 21 **Chemical attack detection.**

In 2003, PROTECT became the nation's first permanently installed detection and response system for chemical attacks in a public facility when it was deployed in the Washington, D.C., Metro. In this multilab project that began in 1998, Sandia selected and field tested available commercial detectors and designed the advanced sensor network for the system, which also assists transit operators with emergency response to attacks, potentially saving lives.

## **22 Aviation safety.**

Airline technicians can now spot dangerous short-circuits before — not after — they happen. A Sandia technique called Pulse Arrested Spark Discharge (PASD) reveals weak spots in wiring insulation while the plane is still on the ground.

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## **23 Economic development.**

In 1998 Sandia broke ground for the Sandia Science & Technology Park, a 200-acre technology community that provides tenants with easy access to world-class technologies, facilities, scientists, and engineers. Today, the park is home to 28 companies and employs about 2,300 people, with an average wage of \$70,400, compared to an average of \$37,300 for the Albuquerque metropolitan area.

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## **24 Drinking water arsenic removal.**

Helping communities find cost-effective methods for removing arsenic from drinking water and meet new federal arsenic standards was the goal of Sandia-led partnerships that conducted five demonstration water treatment sites in New Mexico, including two on tribal lands. Test results from the demonstration projects have been compiled on a website examining the effectiveness of alternative technologies under a variety of site conditions, along with costs associated with each.

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## **25 Law enforcement.**

Diversionary devices called flash-bangs or stun grenades that are used by law enforcement and the military to temporarily distract or disorient an adversary can result in serious injuries because they function by creating a small explosion. Sandia has developed a safer, nonexplosive flash-bang technology and in 2008 licensed it to Defense Technology Corporation of America.

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## **26 Aviation security.**

To assess the threat of onboard explosions from terrorist bombs, Sandia developed computer models that predict the damage caused by different types of explosives in various locations of passenger aircraft. This work, done in conjunction with homemade explosives testing, is being used by the Transportation Security Administration to develop new requirements for explosives detection technology used for security checkpoints, checked baggage, and air cargo.

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## **27 Military support.**

Sandia is a world leader in the advancement of synthetic aperture radar (SAR), a type of radar able to produce high-resolution, almost photo-like images of terrain and structures through inclement weather and at night. Sandia-developed SAR systems have been used by the military in high-profile conflicts such as Desert Storm and the Kosovo Conflict.

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## **28 Chemistry**

In the late 1970s, scientists at Sandia's Combustion Research Facility needed a more efficient way of solving combustion problems involving complex chemical kinetics phenomena. Their homegrown code became CHEMKIN, a software suite licensed by Reaction Design and used worldwide in the microelectronics, combustion, and chemical processing industries.

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## **29 Nuclear deterrence.**

Since 1949, Sandia has applied its engineering and scientific expertise to the development, testing, and maintenance of the nation's nuclear weapons stockpile. Nuclear deterrence has long been a core element of U.S. national security strategy and played a significant role in ending the Cold War.

## **30 Planetary exploration.**

When the Pathfinder spacecraft hit the surface of Mars on July 4, 1997, it bounced and rolled rather than crash landed, largely as a result of airbags designed by Sandia and NASA's Jet Propulsion Laboratory. The airbags were based on parachute technology developed for nuclear weapons.

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## **31 Climate change.**

Sandia scientists are members of an international research team whose work at the Atmospheric Radiation Measurement Climate Research Facility in northern Alaska is providing data for global climate models and helping transform scientific understanding of the Earth's future climate. Their work at this Department of Energy facility focuses on making long-term measurements of cloud formation and its influence on atmospheric heating.

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## **32 Nonproliferation.**

Sandia conducts major efforts aimed at preventing the global spread of nuclear weapons and other weapons of mass destruction. Technologies range from microscopic sensors to large intelligence-gathering systems that help monitor compliance with international treaties, theft or diversion of nuclear materials, and biological and chemical weapons programs.

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## **33 International cooperation.**

Since 1994, Sandia's Cooperative Monitoring Center has brought individuals from 125 countries to neutral ground to develop technical solutions to mutual security problems. Unique in the world, the center develops and offers training in an array of technologies for improving regional security, building trust among nations, and preventing the proliferation of weapons of mass destruction.

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## **34 Community support.**

In 1956, two Sandia scientists decided to buy new shoes for needy children instead of exchanging gifts with one another. Their grassroots effort continues to this day as a corporate-sponsored project and to date has provided new shoes for more than 11,500 Albuquerque children.

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## **35 Explosives destruction.**

The Explosive Destruction System (EDS) developed by Sandia for the Army in the late 1990s safely neutralizes and discards recovered chemical warfare material in an environmentally sound manner. The Army uses EDS to destroy World War I and World War II vintage chemical warfare materials, but it can also treat biological agents, biocontaminated containers, and improvised biological devices.

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## **36 Next-generation microelectronics.**

A milestone in microprocessor technology was achieved in 2001 when Sandia, Lawrence Livermore, and Lawrence Berkeley labs, and a consortium of chipmakers developed and demonstrated an extreme ultraviolet lithography (EUVL) system for producing the next generation of more powerful microchips. EUVL enables patterning of silicon wafers with a much shorter wavelength of light than current systems, enabling more densely packed transistors and therefore higher speeds and better performance, and is forecast to be in commercial use by 2013.

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## **37 Columbia accident investigation.**

Sandia's expertise in materials and engineering science played a key role in helping NASA determine the cause of the 2003 space shuttle Columbia disaster. Using supercomputer simulations and materials characterization experimental data, Sandia showed that the most probable cause of the accident was damage to the shuttle's wing from foam debris.

## **38 Nonproliferation & treaty verification.**

In 2000, Sandia launched the Multispectral Thermal Imager (MTI) satellite — the first satellite designed and built wholly by Sandia. MTI is still used today to monitor treaty provisions, map chemical spills, detect pollution from waste streams in lakes and rivers, and detect volcanic activity.

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## **39 TWA Flight 800 investigation.**

Sandia computer modeling efforts supported and helped guide the National Transportation Safety Board (NTSB) investigation of the July 1997 TWA Flight 800 accident, which killed all 230 people on board. The international investigative team concluded that the accident most likely was caused by unintended ignition of fuel-air vapors in the jetliner's central fuel tank, leading to a mid-air explosion.

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## **40 Cyber security.**

Sandia's Center for Cyber Defenders program trains students from colleges and universities to protect and defend computer systems and networks from attack. Through their projects, the students actively help secure computers nationwide.

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## **41 Hydrogen monitoring.**

The ability to detect and monitor hydrogen — a colorless, odorless, flammable gas — is critical wherever hydrogen is produced, used, stored, or transported. A Sandia-developed sensor with the ability to detect a wide range of hydrogen concentrations has been commercialized by H2scan of Valencia, Calif., and is now used in a variety of areas such as petroleum refining, hydrogen production, and nuclear facilities.

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## **42 Law enforcement.**

Police officers are now able to instantly determine whether a suspect has recently fired a gun using a chemical test developed by Sandia and Law Enforcement Technologies, Inc. The "instant shooter ID kit" detects gunshot residue in a matter of minutes, eliminating the need to wait for lab tests, which often took weeks.

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## **43 Military support.**

During the Vietnam War, Sandia developed a family of earth-penetrating, air-dropped sensors for use in detecting enemy forces, particularly convoys or troops moving into South Vietnam along the Ho Chi Minh Trail. Capable of detecting even human footsteps, the highly sensitive seismic intrusion detectors were credited with helping break the siege of Khe Sanh in 1968.

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## **44 Nuclear power safety.**

In 1989, Sandia first released MELCOR, computer software for analyzing severe accidents in nuclear power plants. The software — updated numerous times since then — incorporates the results of nuclear power plant safety research since the 1979 Three Mile Island accident and is the de facto standard among utilities and nuclear regulators in the U.S. and abroad for evaluating plant safety.

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## **45 Strategic Petroleum Reserve.**

America's emergency crude oil is stored in natural salt caverns along the Gulf Coast at depths up to 5,000 feet. Since 1977 Sandia has provided the Department of Energy with scientific and engineering assistance on the Strategic Petroleum Reserve, including helping DOE evaluate and choose additional storage sites when SPR was increased to its authorized one billion barrel capacity.

**46 Modern electronics.** In the 1980s Sandia scientist Gordon Osbourn originated the field of strained layer superlattices by making the first calculations predicting their unique electrical and optical properties. This work led to revolutionary advances in electronics and optoelectronics.

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**47 Solar power.** Since 1996, Sandia has helped bring power to some 400 homes on the Navajo reservation using solar technologies such as photovoltaics. Through the Department of Energy Tribal Energy Program, Sandia personnel provide technical assistance in procuring the equipment and teaching residents how to maintain and manage it.

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**48 Small business assistance.** Since 2000, Sandia has provided technical assistance to more than 1,455 businesses, courtesy of the New Mexico Small Business Assistance program, which provides the lab with gross receipts tax credits for help provided. Projects have ranged from assisting Rio Nambé Pueblo in creating a water distribution model to analyzing metals used in locomotive repair for the Cumbres & Toltec Scenic Railroad.

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**49 Mold control.** A decontamination formula developed at Sandia to render harmless a wide variety of chemical and biological agents also combats a common household problem — mold and mildew. Mold Control 500, licensed to Modec, Inc., and distributed by Scott's Liquid Gold, is based on Sandia's "decon foam" and available in hardware stores nationwide.

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**50 National security.** If a nuclear detonation occurs in space or the Earth's atmosphere, the U.S. Air Force is responsible for determining the event's significance using data from the U.S. Nuclear Detonation Detection System, a network of satellites, detectors, and ground stations. The Integrated Correlation and Display System developed at Sandia helps simplify the work of Air Force personnel by gathering, correlating, and making sense of USNDS satellite data before an operator ever sees it.

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**51 Satellite interception.** In February 2008, Sandia's Red Storm high-performance computer was used to help the U.S. military plan and carry out the successful interception of a defective spy satellite that threatened to fall to Earth. A Sandia team ran hundreds of impact calculations using advanced modeling and simulation tools to determine the best way to ensure the car-sized satellite — traveling at 17,000 miles per hour 153 miles above the Earth — was destroyed with a single missile shot.

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**52 Space exploration.** After the Challenger and Columbia space shuttle disasters, NASA needed a way to inspect the shuttle's thermal protection shield prior to landing. A Sandia-developed sensor and robotic arm system that allows the crew to check for tiny cracks and other damage has flown on 12 space shuttle missions.

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**53 USS Iowa investigation.** A Sandia investigation for the U.S. Senate Armed Services Committee of the 1989 explosion aboard the USS Iowa found that an overram of the powder bags as the gun was being loaded was the likely cause of the explosion; the Navy disagreed, concluding the cause could not be determined. The Sandia team also found no evidence to support the theory that crew member Clayton Hartwig used a detonator to set off the explosion that killed him and 46 other crew members.

**54 Yucca Mountain.** Since the late 1970s Sandia has been involved in various capacities with Yucca Mountain, America's first planned repository for spent nuclear fuel rods and solidified high-level radioactive waste. In 2006 Sandia was named the lead scientific laboratory for the project and continues to provide technical guidance for the submitted Nuclear Regulatory Commission license to operate the project.

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**55 Cryptology & authentication.** Retired cryptologist Gustavus Simmons pioneered the theory of authentication, used to verify adherence to the Comprehensive Test Ban Treaty for nuclear weapons. All e-commerce now depends upon Simmons' work in authentication.

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**56 Automated wheelchair cushion.** Pressure sores among wheelchair users are a common problem, often leading to serious complications and death. Sandia and Numotech, Inc., have developed a wheelchair cushion based on micro-processor-controlled inflatable air pockets that inflate and deflate to help prevent and heal pressure ulcers.

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**57 Digital paleontology.** In 1997, scientists at Sandia and the New Mexico Museum of Natural History and Science recreated a vocalization of a crested dinosaur that lived 75 million years ago. Using powerful computers, computed tomography (CT scans), and a rare Parasaurolophus skull, they produced a low-frequency rumbling sound that the dinosaur could have made.

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**58 Cold War cleanup.** Serving as scientific advisors, Sandia scientists and engineers helped select the site for the Waste Isolation Pilot Plant (WIPP), provided the facility's conceptual design, and provided the scientific understanding that formed the basis for the Environmental Protection Agency's certification of WIPP in 1999. WIPP, the nation's first underground repository for nuclear waste left over from the Cold War, was constructed in salt beds more than 2,000 feet below the surface near Carlsbad, New Mexico.

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**59 Nuclear weapons security.** Concerns about the safety of nuclear weapons led to Sandia's introduction in 1960 of the permissive action link (PAL), a coded electromechanical security lock preventing unauthorized use of a U.S. nuclear weapon. The development helped reassure the public that a scenario involving a stolen nuclear weapon was quite impossible.

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**60 Solar power.** Molten salt technology for capturing and storing the sun's heat was developed and advanced at Sandia and was an integral part of Solar Two, a solar power plant near Barstow, Calif. Solar Two produced enough power to supply 10,000 homes and operated from 1996 to 1999.