LOS ALAMOS NATIONAL LABORATORY ◆ SUMMER 2024

NATIONAL ★ SECURITY SCIENCE

THE NEW MEXICO ISSUE

Norris Bradbury: The Lab's second director ensured the survival of Los Alamos after World War II.

Flying high over the Land of Enchantment: Location helps scientists test new technology.

Mentor of methods and mountains: A physicist and mountaineer celebrates 55 years at the Lab.

From coal to clean: The Four Corners Rapid Response Team facilitates a shift away from fossil fuels.

+PLUS:

Made in NM: pits, detonators, explosives, and more	A director emeritus remembers growing up in Los Alamos	The Laboratory collaborates with noteworthy neighbors

PHOTOBOMB

Three targets manufactured at Los Alamos National Laboratory's Target Fabrication Facility are displayed on top of a New Mexico quarter for scale. Each target contains components only a few microns in size (one micron is one-millionth of a meter). The largest target and the tiny target in the center of the Zia will be used at Lawrence Livermore National Laboratory's National Ignition Facility to conduct fusion and high-energy-density physics experiments. The third target will be used in experiments at the University of Rochester's Omega Laser Facility. Learn more about these targets and other items that are manufactured at Los Alamos on page 6. ★


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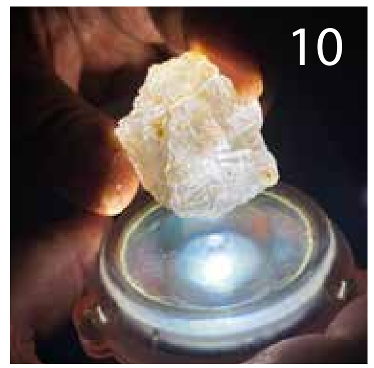
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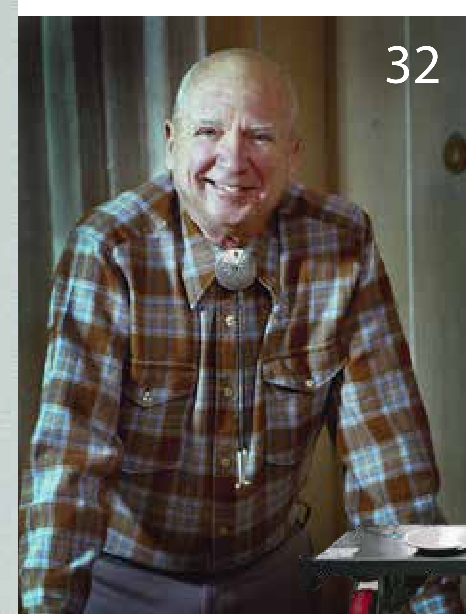
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FEATURES

About the cover: New Mexico abounds with places to see the stars, thanks to low levels of light pollution. With that in mind, Los Alamos National Laboratory student Aerin Jacobson set out one August evening to photograph the Milky Way above this radio telescope, which is located on Lab property and is part of the Very Long Baseline Array—a network of 10 radio telescopes across the United States that is operated from the Array Operations Center in Socorro, New Mexico. Scientists use the radio telescopes to study radio signals from astronomical sources. ★

THE NEW MEXICO ISSUE

Los Alamos National Laboratory's home state is rich with partners and people committed to national and global security.

BY JAMES OWEN
ASSOCIATE LABORATORY DIRECTOR FOR WEAPONS ENGINEERING & CHIEF ENGINEER

This issue of *National Security Science* focuses on the state—New Mexico—where Los Alamos National Laboratory is located. In the following pages, you'll read about the Laboratory's work and partnerships that span the Land of Enchantment—from clean-energy efforts in the Four Corners area to transuranic waste storage near Carlsbad. This issue also highlights the Laboratory's many Albuquerque-based partners (including Sandia National Laboratories and Kirtland Air Force Base), our academic connections at many colleges and universities, and our colleagues at Spaceport America and White Sands Missile Range who are critical to the success of our flight-testing program.

Of course, the Laboratory's largest impact is local, which I can speak to personally. I grew up in a close-knit community about 50 miles northeast of Los Alamos. As a kid, that distance seemed very far—until one day in high school when a teacher said we were taking a field trip to the Lab's Bradbury Science Museum. Little did I know that field trip would change my life. That visit sparked my interest in science and technology. I began participating in STEM (science, technology, engineering, and math) programs at the Laboratory. Fast forward nearly 30 years, and I've made a career here.

Moving from student to employee isn't unusual at Los Alamos. Every summer, the Laboratory hosts hundreds of students, many of whom are eventually hired on as staff members following graduation. Whether employees are native New Mexicans, like me, or they come from other corners of the country and even the world, they come here to support national and global security and pursue meaningful careers.

The work we do at the Laboratory is like no other. In the Weapons Engineering associate directorate, we ensure and sustain credible scientific and engineering expertise in support of the nation's deployed nuclear weapons stockpile. We work in areas of high explosives, weapons assembly, production engineering, ground and flight testing, hydrodynamics, and many other interdisciplinary fields.

Many people who don't plan to settle in New Mexico end up committed to both the Laboratory and the Land of Enchantment. That was certainly the case for Norris Bradbury, the Lab's second director (and the Bradbury Science Museum's namesake). Bradbury came to Los Alamos for a short-term position and ended up retiring from the Lab more than a quarter-century later. You can read more about his legacy on page 32.

J. Robert Oppenheimer was, of course, our first director, and he's often quoted as saying "my two great loves are physics and New Mexico." Although I am an engineer, not a physicist, I still appreciate his sentiment, and I hope that you discover the magic of both the Laboratory and New Mexico in these pages. ★

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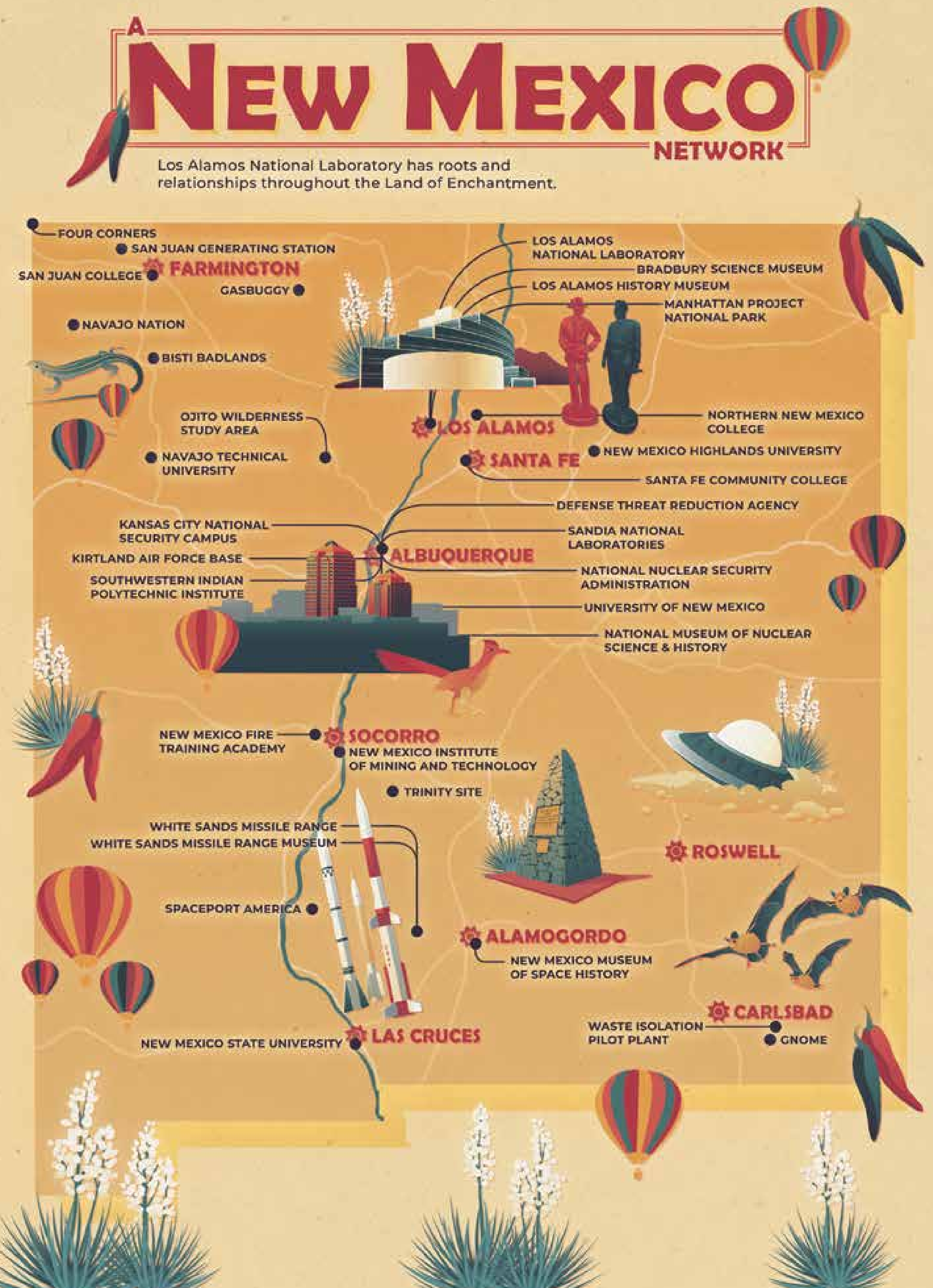
NSS STAFF SPOTLIGHT

En route to a spring break adventure in Big Bend National Park in Texas, editor Whitney Spivey and her family camped at a missile silo just east of Roswell, New Mexico. Twelve of these sites were built around Roswell in the early 1960s; each cost $22 million to construct, and each held a nuclear-tipped Atlas F intercontinental ballistic missile—the first ICBMs ever developed by the United States. Spivey's family toured the site, which included going underground to see the launch control center and a short tunnel that leads to the 186-foot-deep silo (for context, the Leaning Tower of Pisa is 183 feet). Here, she and her twin daughters cartwheel across the silo door. ★



THE INTERSECTION

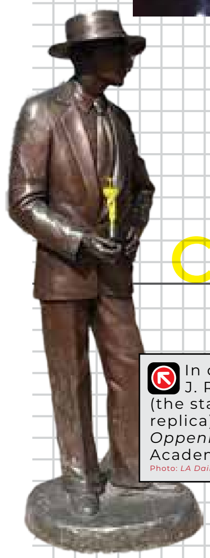
Science and culture converge in northern New Mexico—and beyond.

SCIENCE

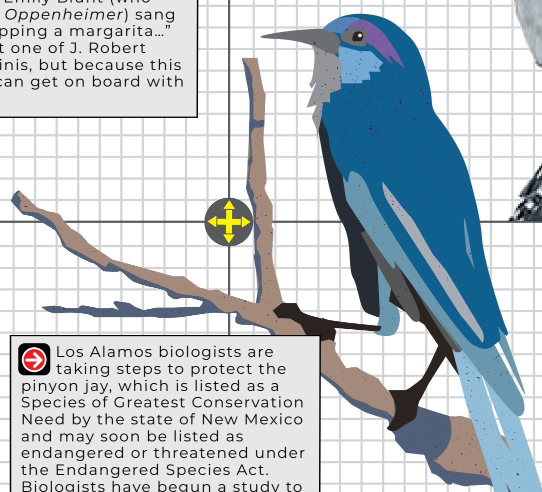
CULTURE

In the early 1950s, Los Alamos physicist George Irving Bell contributed to the design of the first thermonuclear weapon. In 1960, Bell made the first ascent of Masherbrum, the 22nd highest peak in the world. Located in Pakistan, Masherbrum is 25,659 feet above sea level. To read about another Los Alamos scientist and mountaineer, turn to p. 54.

Dancing Oppenheimers and a model of the Gadget appeared toward the end of actor Ryan Gosling's April 13 *Saturday Night Live* monologue, in which actress Emily Blunt (who played Kitty Oppenheimer in *Oppenheimer*) sang "talking to Albert Einstein, sipping a margarita…" We are pretty sure she meant one of J. Robert Oppenheimer's famous martinis, but because this is the New Mexico issue, we can get on board with a margarita. Photo: Universal Studios



In downtown Los Alamos, J. Robert Oppenheimer (the statue) holds an Oscar (a replica) shortly after the *Oppenheimer* film won seven Academy Awards in March. Photo: *LA Daily Post*



Los Alamos biologists are taking steps to protect the pinyon jay, which is listed as a Species of Greatest Conservation Need by the state of New Mexico and may soon be listed as endangered or threatened under the Endangered Species Act. Biologists have begun a study to monitor the birds, understand their use of Lab habitats, and ensure their safety on site.

The Laboratory's Sigma facility is located in Technical Area 66; a sign on the building is reminiscent of U.S. Route 66, which runs across central New Mexico.

Building manager James Valdez poses with his lowrider—a customized vehicle with hydraulic jacks that allow the chassis to be lowered nearly to the road. Española, New Mexico, just 20 minutes from the Lab, is often called the lowrider capital of the world. Photo courtesy James Valdez

A capacitive discharge unit, also called a fireset, is a device that supplies electrical energy to detonators (see p. 6). This particular fireset was designed in 2022 and decorated to match the New Mexico state flag. The red sun symbol is called a Zia and "was put on this fireset to represent the Laboratory wherever the fireset went," says fireset engineer Tim Walrath, who explains that the device traveled to sites across the nuclear security enterprise. "Since then, the decals have received a lot of positive feedback," he notes.

BY THE NUMBERS

As one of New Mexico's largest employers, Los Alamos National Laboratory has a substantial economic impact across the state.

$4.65B total Laboratory budget

1,133 number of contractors employed by the Lab

15,932 number of regular employees

$931M amount the Lab spent with New Mexico businesses

$1.8B total salaries earned by employees (contractor salaries not included)

$616M amount spent with New Mexico small businesses

1,433 number of union employees at the Laboratory

$155M amount the Lab paid in New Mexico gross receipts tax

28.8% percentage of regular employees who have at least one degree from a New Mexico college or university

39.6% percentage of regular employees who are native New Mexicans

65% percentage of employees who live outside of Los Alamos County, benefitting their home communities

$130M contracts with New Mexico–based Native American–owned businesses

$61M contracts with New Mexico–based veteran-owned businesses

$48M contracts with New Mexico–based women-owned small businesses

*Numbers are for fiscal year 2023

Getting involved

Many Lab leaders serve on the board of local nonprofits.

Thom Mason
Laboratory Director
LANL Foundation

Mission: to inspire excellence in education and learning in northern New Mexico through innovative programming, collaboration, and advocacy.

Frances Chadwick
Laboratory Staff Director
Los Alamos Historical Society

Mission: to preserve, promote, and communicate the remarkable history and inspiring stories of Los Alamos and its people for our community, for the global audience, and for future generations.

Angela Mielke
Executive Officer for Science, Technology, and Engineering
Española Pathways Shelter

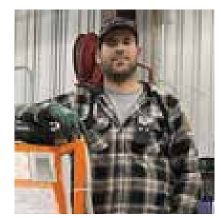
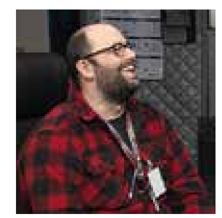
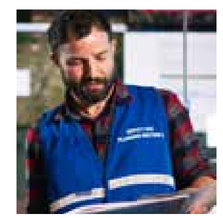
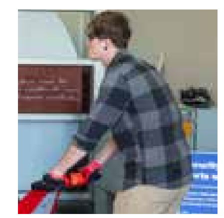
Mission: to help provide individuals and their families access to emergency shelter, transitional housing, comprehensive care, and essential supportive services.

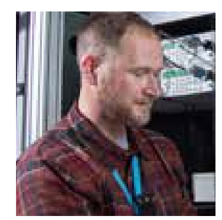
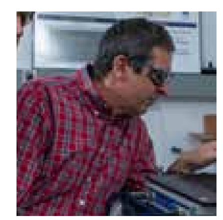
"Los Alamos National Laboratory plays a critical role in New Mexico's economy and its communities. We feel strongly that it is our responsibility as a significant employer in New Mexico to support the places where we live and work."

—**Laboratory Director Thom Mason**

DID SOMEONE SAY FLANNEL?

A journalist recently wrote that the acronym for Los Alamos National Laboratory is "LANL, pronounced like *flannel* minus the *f.*" Flannel, coincidentally, is the fabric of choice for many LANL employees. This was confirmed by a quick scroll through the Lab's image library, which revealed the following:


MADE IN LOS ALAMOS

Los Alamos National Laboratory produces key components for national security, space exploration, and more.

BY WHITNEY SPIVEY

Although Los Alamos National Laboratory is primarily a research and development institution, the Laboratory has always done some manufacturing work. Here are seven products that are made right here at Los Alamos. ★

Detonator production

Heat sources

For more than 50 years, the Laboratory has manufactured heat sources, which are power sources made from plutonium-238. The radioactive isotope generates heat as it decays. This heat is converted to electricity by a generator and can power a device in deep space for a very long time. In addition to powering the Mars rovers, heat sources manufactured at Los Alamos have powered the Galileo mission to Jupiter and the Cassini mission to Saturn. In 2027, plutonium-238 will power the Dragonfly mission to Saturn's largest moon, Titan.

Targets

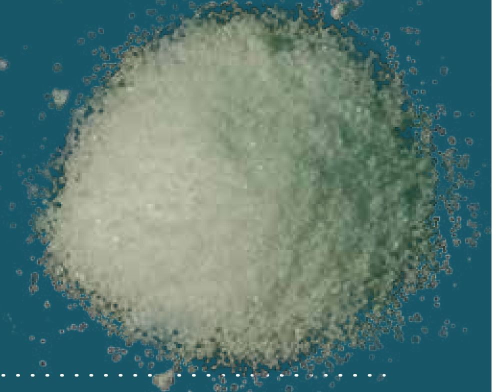
At the Laboratory's Target Fabrication Facility, engineers create one-of-a-kind targets for experiments carried out at Lawrence Livermore National Laboratory's National Ignition Facility (NIF) and other locations. At NIF, a target is bombarded with laser beams, which causes a tiny fuel capsule inside the target to implode and produce fusion—creating more energy than was initially put in by the laser beams. For more on targets, see the inside front cover of this issue.

Detonators

For a plutonium pit to implode inside a nuclear weapon, the pit must be compressed uniformly by the high explosives that surround it. The high explosives are triggered by small devices called detonators. Since 1989, the detonators for all nuclear weapons in the U.S. stockpile have been manufactured by Los Alamos.

Accelerator cells

The Laboratory designed the accelerator cell modules that are key components of the 400-foot-long Scorpius linear accelerator, which will create radiographic images of subcritical plutonium experiments. When completed, Scorpius will be located in a tunnel nearly 1,000 feet underground in the Principal Underground Laboratory for Subcritical Experiments at the Nevada National Security Site. The first two modules are being built at Los Alamos this year. For more, see p. 26.



Explosives

The Laboratory's High Explosives Science and Technology group develops and manufactures precision high explosives to meet current and future national security needs. This work involves chemical synthesis of new explosives, materials research, performance testing, and related problem-solving. The plastic-bonded explosives developed by this group were the first truly precision explosives controlled down to the micron scale; they can be pressed and machined to the most exacting tolerances. Los Alamos also produces the explosives that are used in detonators.

Plutonium pits

A plutonium pit is the core of a nuclear weapon; when compressed by explosives inside a warhead or bomb, a pit generates incredible amounts of energy. Los Alamos is currently developing the processes for manufacturing at least 30 pits per year, starting with pits for the W87-1 warhead. The first stockpile-bound pit is on track to be produced this summer.

Space instruments

The Lab's Intelligence and Space Research division creates and delivers innovative sensing systems for space-based instrumentation for national security applications. Two examples are ChemCam, which performs rapid chemical and microscopic reconnaissance aboard the Mars Curiosity rover, and SuperCam, which collects geologic data and samples aboard the Mars Perseverance rover.

Supercam

A B61-12 joint test assembly at the Pantex Plant in Amarillo, Texas
Photo: Pantex

COMING SOON: THE B61-13

A new variant of the gravity bomb is in development.

BY WHITNEY SPIVEY

Congress has approved and funded a new variant of the B61 gravity bomb, the B61-13. As the national laboratory responsible for the B61 family of bombs, Los Alamos will oversee the design, development, testing, and eventual certification of the B61-13.

Upon completion, scheduled for the spring of 2026, the B61-13 will be deliverable by modern aircraft, including the forthcoming B-21 Raider stealth bomber. According to a news release from the Department of Defense (DOD), "the B61-13 will strengthen deterrence of adversaries and assurance of allies and partners by providing the President with additional options against certain harder and large-area military targets."

The B61-13 will rely on the current, established production capabilities supporting the B61-12, a recently updated version of the B61 that has been in production since 2022 (B61-12s are entering the stockpile as they are completed). The B61-13 will incorporate the same modern safety, security, and accuracy features as the B61-12.

"By taking advantage of ongoing B61-12 production activities, we will be able to quickly and effectively implement novel updates to the weapons system," explains Dan Borovina, the B61 program manager at Los Alamos.

The yield (explosive power) of the B61-13 will be similar to that of the B61-7 (which is higher than the yield of the B61-12). The B61-13 will replace some of the B61-7s in the current stockpile and therefore will not increase the overall number of weapons in the U.S. stockpile.

"This initiative follows several months of review and consideration," stated the DOD news release. "The fielding of the B61-13 is not in response to any specific current event; it reflects an ongoing assessment of a changing security environment." ★

NOTEWORTHY NEIGHBORS

Los Alamos National Laboratory's convenient colleagues ensure mutually beneficial partnerships.

BY JILL GIBSON

J. Robert Oppenheimer, the first director of what is now Los Alamos National Laboratory, wasn't thinking about neighbors when he decided where to build the atomic bomb. In fact, Oppenheimer picked the remote and mountainous New Mexico location because of the absence of neighbors. Los Alamos was the secret city—unknown and isolated. Today, that has changed.

Located in northern New Mexico, Los Alamos benefits from the proximity of several noteworthy neighbors that provide partnership and support in achieving the Lab's national security mission. The convenient locations of these colleagues facilitates collaboration in ways that Oppenheimer could have never anticipated when he chose the Pajarito Plateau as the place to set up shop.

National Nuclear Security Administration

Albuquerque, New Mexico is home to one of the three main offices of the National Nuclear Security Administration (NNSA), which also has a field office in Los Alamos. NNSA oversees the nation's nuclear security enterprise—three national labs, three fabrication and materials production plants, one assembly and disassembly site, and one research and testing site—whose combined 50,000 employees and contractors are collectively responsible for the health of America's nuclear weapons and related work.

The proximity of these offices streamlines collaboration and communication between Los Alamos National Laboratory and NNSA. "Communication is a piece of everything we do here," says Ted Wyka, NNSA Los Alamos field office manager. "We're all part of the same mission. We're all part of the same nuclear security enterprise."

Sandia National Laboratories

The United States has three national nuclear security laboratories, and two of them call New Mexico home. Sandia National Laboratories, in Albuquerque, is less than two hours away from Los Alamos and originated as a branch of Oppenheimer's lab. Now, it's a separate sister laboratory with additional sites in California, Hawaii, and Nevada. "Sandia's role within the complex is unique," says Jim Handrock, Sandia Weapons Systems Engineering director. "We have the design engineering responsibility for the nonnuclear components [of nuclear weapons] and also the key systems integration role to put all the individual parts [of the weapon] together to make sure that everything does what needs to be done to provide the full system to the military."

Sandia's Albuquerque location makes it convenient for Los Alamos scientists to conduct experiments there and vice versa. Los Alamos researchers make use of key Sandia facilities such as the Z Machine, the world's largest high-current pulsed power machine, and the Annular Core Research Reactor, which is used to test objects in a mixed photon and neutron irradiation environment. Likewise, Sandia researchers head up the hill to Los Alamos to conduct experiments at the Dual-Axis Radiographic Hydrodynamic Test (DARHT) facility, which captures high-speed radiographs of implosion experiments, and the Los Alamos Neutron Science Center (LANSCE), a linear accelerator that provides sources of neutrons and protons for scientific research.

Sandia and Los Alamos even share a facility—the Center for Integrated Nanotechnologies, or CINT. "We are one facility with two locations," says Stacy Baker, CINT outreach coordinator. "One in Albuquerque and one in Los Alamos."

Location is also a factor in allowing Sandia and Los Alamos to work together to help boost the New Mexico economy. Both labs take part in programs that help New Mexico businesses with technology transfer initiatives (see p. 30), providing double the potential for growth.

From joint committees, research sharing, and ideas exchange, Sandia's nearby location paves the way for collaboration. "Here in New Mexico, we are fortunate to have two large labs just an hour and a half away," says Elizabeth Keller, a former Sandia employee who now works for the Center for National Security and International Studies at Los Alamos. "This opens tremendous opportunities for in-person exchanges and ongoing collaboration."

Kirtland Air Force Base

When Los Alamos' Z Division, the organization that would become Sandia National Laboratories, was first established, it was located on a Department of Defense (DOD) installation in southeast Albuquerque known as Sandia Base. In 1948, Z Division became Sandia National Laboratory, and in 1949, it separated from Los Alamos, remaining on Sandia Base. Meanwhile, the military responsibilities at the base continued to grow. In 1971, DOD merged Sandia Base, the nearby Kirtland Air Base (formerly Albuquerque Army Air Base), and Manzano Base into Kirtland Air Force Base.

Kirtland AFB's missions include research and development, testing and evaluation, combat search and rescue, and supporting the Air Force's nuclear enterprise. The base employs approximately 22,000 active-duty military, civilians, contractors, guards, and reserve personnel and is situated on more than 51,000 acres. Kirtland is home to the 377th Air Base Wing, the 58th and 150th special operations wings, the 21st Ordnance Company, and a host of directorates, centers, and offices.

Kirtland Air Force Base is part of Air Force Global Strike Command (AFGSC), which is headquartered at Barksdale Air Force Base, Louisiana. AFGSC is responsible for the nation's three intercontinental ballistic missile wings, the Air Force's entire bomber force, and operational and maintenance support to organizations within the nuclear enterprise.

One of Los Alamos' key partners, located at Kirtland, is the Air Force Nuclear Weapons Center. The nuclear-focused center synchronizes all aspects of nuclear materiel management to support AFGSC, U.S. Strategic Command, and the U.S. Air Forces in Europe.

"The proximity of Los Alamos to the Air Force Nuclear Weapons Center facilitates better in-person and timely collaborations on high-priority nuclear security enterprise activities," says Michael Port, a senior Los Alamos staff member stationed at AFGSC. "This will become even more critical as both the Department of Defense and the Department of Energy continue to modernize their weapon systems in a dynamic geopolitical environment."

The Defense Threat Reduction Agency

Another noteworthy neighbor that calls Albuquerque and Kirtland Air Force Base home is a branch of the Defense Threat Reduction Agency, or DTRA.

DTRA is a combat support agency aimed at reducing the threat of chemical, biological, radiological, and nuclear weapons. Most personnel are stationed at DTRA headquarters at Fort Belvoir, Virginia, but approximately 15 percent of DTRA's more than 2,000 civilians and uniformed service members support the U.S. military's nuclear mission at Kirtland Air Force Base, White Sands Missile Range, and the Nevada National Security Sites.

A large portion of DTRA's New Mexico contingent works in the Defense Threat Reduction Information Analysis Center (DTRIAC), managing the agency's nuclear testing archives and other government collections. DTRIAC's mission is to provide electronic access to all nuclear weapons test data for programs supporting nuclear deterrence.

Andrew Gordon, the head librarian at Los Alamos' National Security Research Center, says he and his staff partner frequently with both the DTRIAC and colleagues at Sandia. "Our geographic proximity to Sandia National Labs and DTRIAC is mutually beneficial," Gordon says. "We regularly communicate with these organizations to facilitate each other's research needs, and this proximity allows researchers to travel between sites to find information for their work. We're all working towards the same mission of national security, and regular collaboration makes us successful as a whole."

Kansas City National Security Campus

You might think Kansas City is too far away to be considered a neighbor, but the New Mexico Operations (NMO) site of the Kansas City National Security Campus (KCNSC) is located in Albuquerque. As a production agency in the nuclear enterprise, KCNSC makes 80 percent of the nonnuclear components in America's nuclear weapons. Many of those components go into weapons that Los Alamos National Laboratory has designed. KCNSC NMO, where approximately 350 people work, frequently makes parts for Los Alamos. "We provide a variety of machining tasks for the Lab," says Melissa Dineen, senior communications specialist for KCNSC NMO. "The process is pretty straightforward. Once Lab researchers provide us with part drawings that they'd like us to machine, we create an estimate and a delivery schedule."

Although Los Alamos does have its own machining and additive manufacturing capabilities, Dineen says KCNSC has equipment and facilities to build larger parts and use different materials—for example, the 3D-printed titanium rocket part featured on p. 46.

White Sands Missile Range

You have to follow in Oppenheimer's shoes and travel about four and a half hours south of Los Alamos to meet the next noteworthy neighbor: White Sands Missile Range (WSMR), home to the Trinity site, where the world's first atomic detonation occurred in July 1945.

A U.S. Army installation, White Sands supports numerous tests and operations and is the only overland range for extended-range missile, munitions, and artillery testing.

WSMR also houses specialized labs and facilities that scientists use to create conditions to emulate nuclear weapons detonation environments and evaluate the survivability of military equipment within them.

Known for its history of rocket research, White Sands works closely with Los Alamos, the National Aeronautic and Space Administration, and private aerospace companies to develop and launch spacecraft and test components. "By partnering with White Sands Missile Range, we have dramatically increased the speed and convenience of conducting flight tests for essential technology," says Stephen Judd, director of the Los Alamos Stockpile Responsiveness program (see p. 46). "We have been able to do more, faster, and at lower cost because we have this resource right in our backyard."

Waste Isolation Pilot Plant

New Mexico also offers a safe location for waste disposal. The Waste Isolation Pilot Plant (WIPP) near Carlsbad permanently stores transuranic waste, which is a byproduct of the nation's nuclear weapons work. This waste, which is contained in drums, typically consists of protective clothing, tools, and equipment contaminated with radioactive elements, such as plutonium. Drums are placed deep underground in the middle of a half-a-mile thick layer of salt. Over time, the salt encloses the waste, sealing it in place and permanently isolating it from the environment.

In 1999, Los Alamos became the first Department of Energy organization to send a waste shipment to WIPP. In March 2024, the Lab marked 25 years of shipments, which included a total of 68 shipments in 2023. Los Alamos is the fourth-biggest shipper of transuranic waste to WIPP in the nation. ★

For more about WIPP, see p. 10.

■ "The Waste Isolation Pilot Plant is a resource," explains Doug Weaver (left), Los Alamos division leader for Repository Science and Operations. "There's only one like it in the country." Photo: WIPP/Roy Neese

HEAD SOUTH FOR SALT

A little-known Los Alamos division facilitates research at the Waste Isolation Pilot Plant.

BY JILL GIBSON

The six-passenger cart bounces across the rocky ground as we travel through a dark tunnel. Embedded crystals on the walls and ceiling sparkle, catching the light from the miner's lamp on my hard hat, part of the stylish ensemble of protective gear issued to me before this journey began. The weight of the emergency breathing device in my safety vest pocket serves as a reminder that between me and the Earth's surface are more than 2,100 feet of rock and salt.

I am deep inside the Waste Isolation Pilot Plant, or WIPP—a transuranic waste repository in the remote desert of southeastern New Mexico. I have joined a handful of my Los Alamos National Laboratory coworkers to learn more about our Carlsbad-based colleagues who work at the site, which opened in 1999.

About 250 million years ago, the Permian Sea covered this part of the desert. Over time, repeated evaporation cycles created a thick salt bed, forming an ideal, geologically stable environment for storing low-level radioactive waste. Most of the waste consists of things like contaminated clothing, equipment, and gloves used for nuclear weapons work dating back to the Manhattan Project.

Operated by the U.S. Department of Energy, WIPP is the only waste disposal facility of its kind in the nation. Waste arrives at WIPP weekly from "generator sites" across the country, where trained operators pack it into sealed containers that are then placed into larger, specially designed shipping containers approved for use by the U.S. Nuclear Regulatory Commission. The journey from Los Alamos to WIPP is 315 miles, but some shipments travel from as far away as Idaho and South Carolina.

Once unloaded at the repository, the waste containers head 2,150 feet underground where they are placed in 300-foot-long tunnels that have been mined through the ancient salt formation. The surrounding salt eventually encapsulates the waste containers, permanently isolating them. Today, 25 years after it received the first shipment, the facility is approximately 44 percent full.

Doug Weaver, the Lab's division leader for Repository Science and Operations, is leading the visit underground, which began when we entered the large, cage-like, hoist-operated conveyance that also transports waste drums to their final resting place. "Salt is a great natural barrier," Weaver says. "This is the perfect geologic media for disposal of defense-related transuranic waste." In 2023, Los Alamos sent 68 shipments to WIPP. That number could increase as Los Alamos continues the cleanup of various locations and begins production of plutonium pits—the cores of nuclear weapons.

WIPP employs more than 1,400 people, most of whom focus on waste disposal, but it's also an experimental facility where scientists conduct research. Weaver is among the 50-plus Los Alamos employees who support WIPP and the National Transuranic Program. Scientist Shawn Otto, a member of the Test Coordination Office team, facilitates research that can only be done in this one-of-a-kind place. "Researchers have a section that has been mined out. Sometimes it's referred to as Salt Disposal Investigations or the Underground Research Laboratory," Otto says. "A lot of people at Los Alamos don't know that this facility exists for research where salt is the right place to do certain kinds of work."

Our cart rounds a corner and we disembark, walking deep into a tunnel to examine some of the research Otto helps facilitate. I lick my lips, tasting the salt that lingers in the air, as we walk toward a series of round holes bored into the wall. Tangles of wires emerge from the holes to transmit underground research data.

What kind of research is suited to taking place underground in a quarter-billion-year-old salt bed? "Physics-based experiments where you are shielded from cosmic and terrestrial radiation," Otto says. The deep underground setting offers dry conditions and extremely low levels of naturally occurring radioactive materials, making it the perfect place for research on everything from particle astrophysics to geophysics. Other experiments examine how the salt bed reacts to storing heat-generating substances, which will help determine if salt deposits would be appropriate for storing different types of radioactive waste. "We take samples for laboratory studies and examine in situ the chemistry, hydrology, and geomechanics under thermal loads," Weaver explains. Additional research areas "in the underground" involve operational testing of robotics, experiments focused on storing hydrogen, and studies of biological effects of small organisms in low-background radiation environments.

As we drive through what seems like a complicated maze of tunnels, Weaver, who clearly knows his way around underground, points out that the walls of the mine are always moving. In fact, at one point, the ceiling above us is bowed, hanging in a "U" shape. We pass small chunks of fallen salt and areas where the movement of the walls has caused rock bolts in the ceiling to shear and break. Weaver assures us that the tunnels are routinely examined for structural soundness. "It is all constantly monitored," he says. "Salt creeps continuously over time and is very predictable."

■ Carts are used to travel through the approximately six miles of underground tunnels that make up the Waste Isolation Pilot Plant. Photo: WIPP/Roy Neese

Monitoring and regulations are as integral to WIPP as the salt is. The New Mexico Environment Department, the Environmental Protection Agency, the Department of Energy, and many other players ensure that everything that goes on at the facility is controlled and safe.

The visit ends with the opportunity to select a few golf-ball-sized chunks of salt from the mine to bring home as souvenirs. We gather around a pile, examining the pieces for trapped water bubbles. Once I'm back aboveground, I text a photo of my salt souvenirs to my daughter, and she asks, "Can I eat it?" The salt isn't at all radioactive, but I still say "no." ★

■ Transuranic waste travels to WIPP in special shipping containers. Photo: WIPP

PROTECTING PUEBLOAN PLACES

The Lab executes its mission while respecting the living history of the land.

BY IAN LAIRD

From approximately 100 to 1600 CE, a prehistoric Native American civilization thrived in the Four Corners region of the United States. Northern New Mexico's Pajarito Plateau—now mostly occupied by Los Alamos National Laboratory—was among the places the Ancestral Puebloan people called home. Today, their descendants include members of New Mexico's 19 Pueblos. One of these Pueblos, the Pueblo de San Ildefonso, shares a border with the Laboratory. Others are just a short drive away.

"This place—the land used by the Lab—has a lot of history behind it," says Gerald Martinez, an environmental technician at the Laboratory and member of the Pueblo de San Ildefonso. "And this place is still important to us now."

That's why Laboratory archaeologists Ali Livesay and Sam Linford describe the landscape as living.

"To the descendants of Ancestral Puebloan peoples, these aren't dead places," Livesay says. "To them, their ancestors still reside there, so the question is how do you impact their ancestors and cultural heritage as little as possible?"

Answering this question is difficult, given the Lab's evolving national security mission, which has meant a constant and consistent increase in its number and size of facilities. With this growth, it is impossible for the Lab not to encroach on historical sites.

"My people's ancestors were here for centuries across this whole place," Martinez says. "We've been able to regain rights to some places, but there are others that have been built over."

■ Lab archaeologists enable access to Puebloan sites on Lab property through tours and youth engagement. In 2019, Hispanic and Pueblo students from the Los Alamos Employees' Scholarship Fund (LAESF) toured the Nake'muu site. Pictured is Los Alamos summer student, LAESF recipient, and member of Santa Clara Pueblo Ashlyn Lovato.

Linford agrees. "Pretty much anywhere there is a building, there probably was an archaeological site. They just didn't have rules about removing things in the early years of the Lab," she says.

As Livesay and Linford explain it, the land can't be thought of as a collection of singular sites that are cordoned off from each other. The entirety of the landscape was used by the Lab's predecessors.

In 1950, the Lab hired its first professional archaeologist. In the decades since, efforts to involve stakeholders, such as Puebloan descendant communities, have increased. Livesay, Linford, and other members of the Laboratory's Environmental Stewardship group often serve as the conduit to communicate with Lab leadership, external groups, and state and federal agencies. The group members help assess the impact that any ongoing or future work might have on sites; support the Department of Energy and National Nuclear Security Administration in consultation with the state, Pueblos, and tribes on the protection eligibility of sites; and educate Lab staff and leadership on the importance of site stewardship.

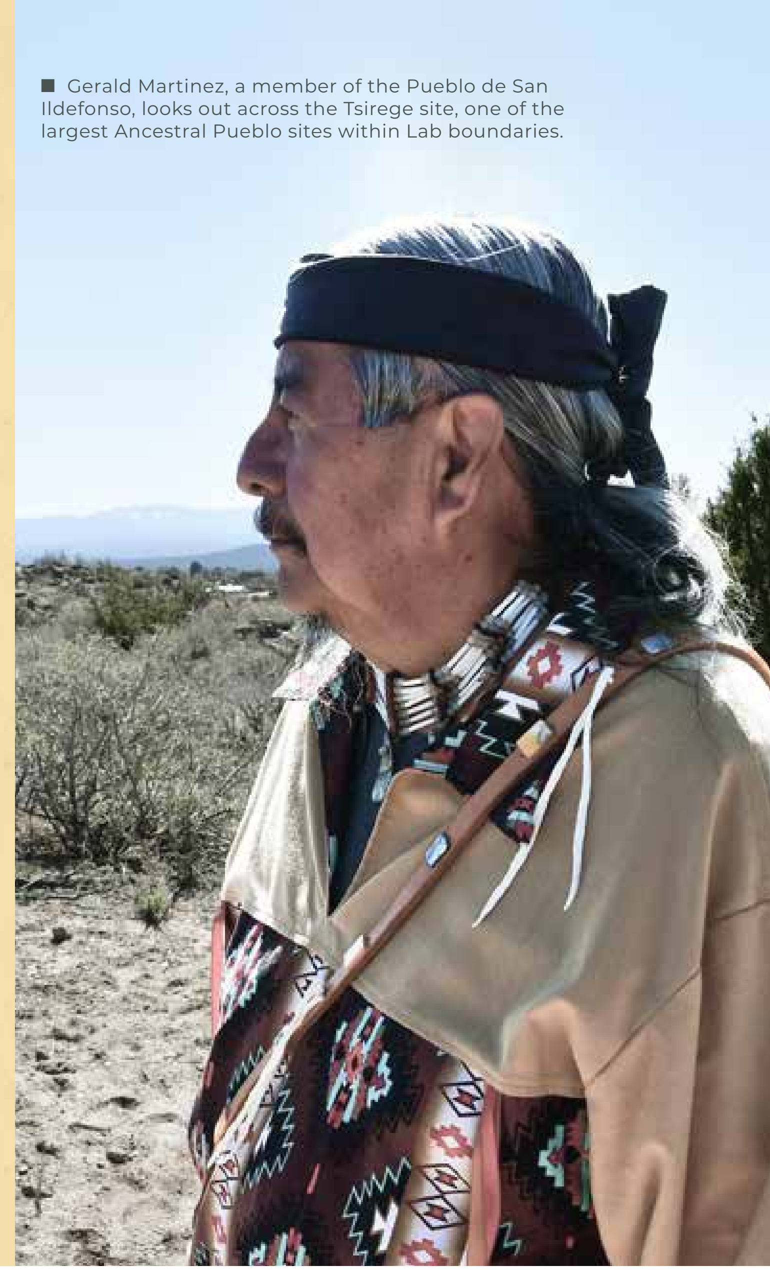
The level of security at the Lab can make it difficult for Puebloan descendants to access their ancestral places. Livesay and Linford say this has led to some members communicating that they feel cut off and would prefer more access, which is why the Lab has made efforts to coordinate visits for Pueblo youth and other members. For Martinez, reconnecting current generations with their long and storied past is an important way to honor the rich cultural heritage they come from.

"Learning about the stories, the history, it's huge," Martinez says. "It's why we try and get the younger generations up here and participating in things so that knowledge can be passed down."

Striking a balance of meeting the Lab's mission without washing away history is a difficult task, but one that Lab archaeologists say they are approaching with a collaborative and positive mindset.

"We try our best to leverage our unique situation as a national laboratory that shares a property boundary with a Pueblo community to build and strengthen those relationships," Livesay says. "We've got some really dedicated people, coworkers, and management that are really trying to do a lot." ★

■ Gerald Martinez, a member of the Pueblo de San Ildefonso, looks out across the Tsirege site, one of the largest Ancestral Pueblo sites within Lab boundaries.



THE ERAS TOUR

(Los Alamos version)

Ancestral Puebloan

For hundreds of years, these Native Americans inhabited the area known as the Pajarito Plateau. Likely driven by drought, the Ancestral Pueblo people eventually moved to the fertile Rio Grande Valley. Today, the remains of many Ancestral Puebloan structures are on Laboratory property.

Homestead

Hispanos from the Rio Grande Valley, descendants of early Spanish settlers, farmed the Pajarito Plateau during the summer. They and other settlers staked claims to their plots under the Homestead Act.

Los Alamos Ranch School

The Los Alamos Ranch School, a boarding school for boys, strengthened mind and body with its unique combination of college preparatory academics and rigorous outdoor life.

Project Y

The Manhattan Project was the government's top-secret effort to develop atomic weapons to help end World War II. Project Y, located in Los Alamos, was one of many Manhattan Project sites across the country. The name helped keep the location and purpose of the laboratory secret. However, most people working there simply referred to the lab as "the Hill" because of its mesa-top location.

Los Alamos Scientific Lab

After World War II, Project Y's location no longer needed to be a secret, and so Project Y became Los Alamos Scientific Laboratory. The first known reference to this name change is in October 1945, at which time Norris Bradbury (see p. 32) became the Lab director.

Los Alamos National Lab

In 1981, Los Alamos Scientific Laboratory became Los Alamos National Laboratory. This change was prompted by Congress' decision that the Department of Energy's laboratories would all have "national" in their official names to emphasize the breadth of the work they perform on behalf of our nation's interests.

■ A 3D image of the Bisti Beast (or more formally *Bistahieversor sealeyi*), which was found in the Bisti Badlands in New Mexico and imaged at Los

DIGGING FOR DINOSAURS

More than 30 years ago, Los Alamos scientists helped detect and date the bones of the world's longest sauropod.

BY WHITNEY SPIVEY

In 1985, David Gillette, a paleontologist at the New Mexico Museum of Natural History, gave a lecture at Los Alamos National Laboratory. Hikers had recently stumbled across eight large dinosaur vertebrae embedded in sandstone in the Ojito Wilderness Study Area, just northwest of Albuquerque. Gillette wanted to know more about the creature that was presumably contained in the rock. He posed a question to his audience of scientists: Is there a way to "see" into the ground to know where to dig for bones?

"Los Alamos scientists took up the challenge," Gillette wrote in his 1994 book *Seismosaurus: The Earth Shaker*. And not only did Los Alamos scientists volunteer their time and equipment, but they also invited colleagues from Sandia and Oak Ridge national laboratories to do the same.

Before long, Gillette wrote, the excavation became "a multifaceted experiment involving not just traditional paleontology, but also chemistry, physics, engineering, electronics, and a little bit of magic—magical science and magical friendships."

Over the course of about six years, scientists conducted a range of experiments to detect and date the bones of "Sam," the first known Seismosaurus and the longest known dinosaur at the time of its discovery. "The joke around here is that Seismosaurus has become the largest project at Los Alamos," electron microscopist Roland Hagan told *The Scientist* magazine in 1991. (Seismosaurus was later recategorized as a species of Diplodocus, *Diplodocus hallorum*.)

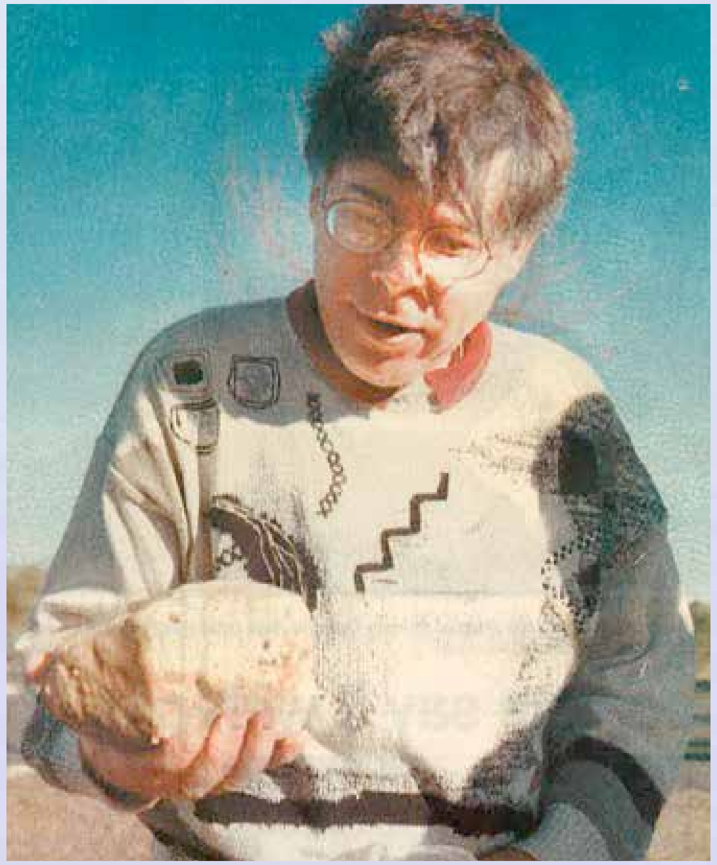
One of the first experiments involved holding one of Sam's bones under ultraviolet light in a men's bathroom at the Laboratory. Why the men's bathroom? "It can be made absolutely dark," Gillette wrote. "So, several of us crowded in, turned on the ultraviolet lamp, and turned off the lights." The result? "The fossil bone glowed," Gillette wrote. "The glow comes not from uranium minerals in the fossil bone but from the natural fluorescence of the hydroxyapatite, a crystalline mineral found in all living bone and probably all fossil bone in its original state." The follow-up experiment involved black lights at the excavation site on a moonless night.

Many experiments had to do with locating bones deep within the sandstone using technologies such as gamma ray detectors, sonar, ground penetrating radar, and magnetometry. Some of these technologies had been successfully deployed in other fields, for example, to search for buried pyramids and detect fault lines, but as Gillette explained, "Dinosaur bones, even the largest bones of a skeleton, were two or three orders of magnitude smaller than the underground targets archaeologists and geologists had their sights on." The use of these tools for paleontology was unprecedented and, in the end, semi-successful. Scientists were able to identify potential targets, many of which were later verified during excavation.

Some targets, however, were duds. Physicist and engineer Bob Webster, a new Laboratory employee at the time (and now deputy director for Weapons), was involved in the excavation and recalls that an anomaly—a different density in the sand—was detected in an area below the surface. Hoping he might unearth a piece of Sam, Webster spent an entire summer on repeat: jackhammering a few inches of rock, carefully sweeping it away, and then carefully looking for bone. Alas, he says, "we got down to the target depth, and it was just wet sand."

In the 30-plus years since the Seismosaurus project, Los Alamos has occasionally lent its expertise to other paleontology projects. For example, in 2017, the Laboratory's unique neutron-imaging and high-energy x-ray capabilities exposed the inner structures of the 40-inch-long fossil skull of the Bisti Beast, a 74-million-year-old tyrannosauroid dinosaur discovered near Farmington, New Mexico, in 1996. The high-resolution images allowed scientists to determine the skull's sinus and cranial structure, including the presence of unerupted teeth and the pathways of some nerves and blood vessels.

Involvement in these types of projects is "a classic example of why a national lab exists," Hagan told *The Scientist*. "There's no commercial value in excavating dinosaur bones, so no private company is going to fund the work. And a university isn't likely to have all the different equipment that you'd need to do the job right. But here at Los Alamos, we cut across all disciplinary boundaries. And we have resources that aren't available anywhere in the world." ★



■ Paisner holds part of a mammoth tooth in 1997.
Photo: *The Oakland Tribune*

A mammoth discovery

Los Alamos isn't the only nuclear weapons laboratory to dabble in paleontology. In 1997, the remains of a prehistoric mammoth were unearthed during the construction of the National Ignition Facility at Lawrence Livermore National Laboratory in California.

Jeff Paisner, currently a project-program manager at Los Alamos, was overseeing construction when a skull and jawbone were unearthed, followed soon thereafter by additional bones and a tusk. Livermore's accelerator mass spectrometer was used to help date the remains, which are currently estimated to be about 10,000 years old. "It's somewhat surrealistic to see this modern-day construction taking place on one side of the site and, in this corner, paleontologists working on bones," Paisner told KCBS News Radio shortly after the discovery. ★

■ *Diplodocus hallorum* (formerly Seismosaurus) lived 150 million years ago and was approximately 140 feet long. The dinosaur weighed roughly 80 tons (the equivalent of about 16 elephants).

The Gnome test, which was conducted near Carlsbad, New Mexico, in 1961, was the first in a series of U.S. nuclear tests that explored the possibility of using nuclear detonations for peaceful purposes. This is a salt dome cavity created by the test. For scale, a man wearing a hard hat is standing on the rubble pile.

TRINITY AND BEYOND

New Mexico's nuclear tests reflect the nation's atomic history.

BY JAKE BARTMAN

The Trinity test, which was the world's first nuclear detonation, was conducted in New Mexico in July 1945. Trinity, however, wasn't the only nuclear test to take place in the Land of Enchantment. In fact, in the 1960s, New Mexico hosted two others: Gnome and Gasbuggy.

Unlike Trinity, which was part of the Manhattan Project—the World War II–era endeavor to develop the first nuclear weapons—Gnome and Gasbuggy were conducted to assess whether nuclear explosions could be harnessed for peaceful purposes. Neither test produced the results that researchers hoped for, however, and in the intervening decades, the tests have been largely forgotten.

Today, New Mexico's three nuclear tests are reminders of the complex legacy of the United States' nuclear testing, which the nation halted after a moratorium was declared in 1992.

The Gadget is prepared for testing at the Trinity site in July 1945.

Trinity

During the Manhattan Project, scientists at a top-secret laboratory in Los Alamos, New Mexico (what is today Los Alamos National Laboratory), designed two kinds of nuclear devices. Their confidence in the first device, a uranium-powered weapon, was such that they felt that no test was necessary. But researchers had enough doubt about the second device, a plutonium-powered implosion design, that they decided to conduct a test in the U.S. Army's Alamogordo Bombing and Gunnery Range, southeast of Socorro, New Mexico.

The Gadget, as the device was code-named, was detonated atop a 100-foot steel tower at around 5:30 a.m. on July 16, 1945. Today, the Trinity test site is part of White Sands Missile Range, which is administered by the U.S. Army.

Gnome

Unlike Trinity, which was conducted in secret, the Gnome test involved significant fanfare.

In the 1950s, President Dwight Eisenhower popularized the idea of using nuclear technologies for non-military purposes through his Atoms for Peace campaign. This campaign led in turn to the development of Project Plowshare—a series of 27 tests related to the peaceful uses of nuclear explosions. In the early 1960s, U.S. Senator Clinton P. Anderson of New Mexico successfully lobbied the Atomic Energy Commission (AEC, the predecessor of today's Department of Energy) to make his state the site of Project Plowshare's debut test, which would be called Gnome.

The Gnome test was conducted in an underground salt bed near the town of Carlsbad, New Mexico, on December 10, 1961. The device was detonated at a depth of some 1,200 feet. On hand were 71 members of the media to document that the blast caused the ground to jump as much as 4 feet into the air, producing an underground salt cavern 70 feet high and 150 feet in diameter.

Researchers from Lawrence Livermore National Laboratory, which led the test, had hoped that the explosion would create an underground heat reservoir. The idea was that this reservoir could be used to turn water into steam that might be harnessed as a geothermal energy source. No such reservoir was forthcoming, however, and the AEC scrapped plans for a follow-up test.

Although Gnome's results weren't what the AEC had hoped, the test did provide data that was later used in Project Pacer, which Los Alamos National Laboratory conducted in the early 1970s to explore the feasibility of using nuclear detonations for steam power generation. After a years-long cleanup, the Gnome test site was turned over to the Bureau of Land Management in 1980.

Gasbuggy

New Mexico's third nuclear test took place in northwestern New Mexico, near the town of Dulce, in 1967. The test, which was led by Livermore, was named "Gasbuggy" after its designers' goal: to use a nuclear detonation to improve the flow of natural gas (which would make it easier to collect the gas).

Gasbuggy was a collaboration between the AEC, the U.S. Department of the Interior, and El Paso Natural Gas. Although the test attracted attention from local media, by 1967, interest in the Atoms for Peace program had subsided, which was why the test received almost no national coverage.

On December 10, 1967, the Gasbuggy device was detonated 4,227 feet below ground, creating an underground cavern 160 feet in diameter. However, drilling revealed that the explosion had decreased, rather than increased, the pressure of the natural gas in the belowground reservoir. Worse, the natural gas itself had become radioactive. Two similar tests—Project Rulison, which was led by Los Alamos in Colorado in 1969, and Project Rio Blanco, which was led by Livermore in Colorado in 1973—resulted in similarly radioactive gas, helping to rule out the use of nuclear explosions in natural gas production.

In the intervening decades, the Department of Energy has monitored surface water, ground water, and natural gas near the Gasbuggy test site, which is in the Carson National Forest and managed by the U.S. Forest Service. To date, no Gasbuggy-related contamination has been detected in any nearby water or natural gas. ★

The Gasbuggy test, which was conducted near the town of Dulce, New Mexico, in 1967, attempted to use a nuclear detonation to stimulate the flow of natural gas from an underground reservoir.

As seen from Moe Hill, an explosives test is detonated at the Minie firing site. The origin of the names "Minie" and "Moe" is lost to history.

BY ANY OTHER NAME

From streets to facilities, *National Security Science* explores the meaning behind names.

BY JILL GIBSON

Literature is filled with commentary about the importance of names and naming. "What's in a name?" pondered English playwright William Shakespeare. The Chinese philosopher Confucius is credited with saying that "the beginning of all wisdom is to call things by their proper name." Likewise, the *Tao Te Ching*, the foundational work of Taoism, points out that "naming is the origin of all particular things," and French author Albert Camus gained fame for his quote "To name things wrongly is to add to the misfortune of the world."

With this hallowed heritage in mind, *National Security Science* eagerly set out to uncover the history of naming at Los Alamos National Laboratory. We embarked on an exploration of the significant and inspirational names that brilliant scientists had chosen through the decades—names worthy of one of the largest and most advanced scientific and technical institutions in the world.

Here's what we found: Eenie, Meenie, Minie, and Moe.

Lab historians and Lab retirees assure us that there's a story behind these four Los Alamos site names. Before we get to that, let's start at the beginning, which, like all Los Alamos stories, begins with (you guessed it) the Manhattan Project, the United States' top-secret effort to build the world's first atomic bombs to help end World War II. Much of that effort took place at Los Alamos in the early 1940s.

"During the Manhattan Project, the military approach kind of dominated things, and the buildings were generally given letters that indicated what they were," explains Alan Carr, the Lab's senior historian. Those letters live on in the names of sites and roads at the Laboratory, such as V-Site and R-Site. (Although most of the letters assigned to sites and roads are meaningless, the S in S-Site refers to Sawmill, as there was a prewar sawmill operation there, and the TD in TD Site stands for Trap Door Site, a reference to a feature on the Fat Man bomb dropped on Nagasaki, Japan).

Slowly, the military traditions that dominated the early days of the Lab began fading. "Over time, as Los Alamos became a permanent community, the Laboratory's personality started to develop, and that came out in some of these names that we see today," Carr says.

Drive around the Lab, and you will see street names that reflect locations where nuclear tests once occurred. Bikini Atoll Drive and Enewetak Drive were named after testing sites in the Marshall Islands, and Mercury Road was named after the base camp at the Nevada Test Site (now the Nevada National Security Sites, NNSS).

Other streets pay tribute to significant experimental machines and technology, historic scientific experiments, and programs. Tokamak (a magnetic fusion machine), Clementine (the world's first fast neutron reactor), and even Jumbino (small-scale versions of Jumbo, a containment vessel built to recover plutonium from the Trinity test in case the test failed) come to mind.

"I think there was a tremendous amount of pride in the innovation that came out of the Laboratory," Carr says. "You see that pride reflected both in the streets and facilities at the Lab."

Some of the names at the Lab are based on local geographic sites, such as Puye, Pajarito, and Chama, paying tribute to the rich cultural heritage of the region, according to Carr. "When we hear people use cultural terms, what does that mean? What is involved? I think that naming and understanding names can be a part of that positive culture that we all want to try to build," he says.

Other names evolved out of necessity. More than a decade ago, the Los Alamos County 911 emergency system required that all Lab roads and streets be named. "Every single road, no matter how short it was, had to have a name," Carr says.

Lab historian Ellen McGehee was among those who helped with this effort. "We first identified historical names associated with the technical areas where the streets were located and then used Los Alamos nuclear test names as infill." Because the United States conducted nearly 1,000 tests before the current testing moratorium went into effect in 1992, there were lots of names to choose from. Among them: Crossroads, Able, Castle, Greenhouse, and Ice Cap.

Both McGehee and Carr say that although the 911 naming was time consuming, it was also important. "One of the main things that brings us together is our shared history," Carr says. "There is a lot of inspiration in history, and it's important for an organization to be able to have that shared history and culture. That comes out in the naming of things."

Carr also emphasizes the need to preserve the reasoning behind the names given. "Names can become almost meaningless within just a generation. It's funny how quickly things get lost. If you name a conference room after someone, but no one knows who the guy is, does it really honor him?" Carr asks. "Hang a plaque in the conference room so the history doesn't get lost. Naming something after somebody or something is about inspiring hopefully positive emotions in people. And, when you lose the story, you lose your ability to do that."

But not every name at the Lab inspires reverence. In fact, many were meant to be funny and were based on comics or private jokes. "Los Alamos has always had a number of practical jokers and people who have great senses of humor, who are clever, and I think that's part of our DNA historically," Carr says. Take for instance, Lower Slobbovia, a test site located in a remote part of the Lab. The name comes from the hillbilly comic strip *Li'l Abner*, which ran from 1934 to 1977 and featured a frigid, faraway, backward country called Slobbovia, ruled by King Stubbornovsky the Last.

"My understanding is that Lower Slobbovia and some of the other firing sites in the far reaches of the Lab were named during the 1950s, when inside jokes were more a part of the culture," McGehee says.

According to retired Los Alamos scientist Richard Malenfant, a machine built to study uranium and plutonium was named Flattop after a character from *Dick Tracy*. Malenfant says presumably the name was chosen because the machine was flat on top—as was the cartoon character's head.

Another example is the road named Godiva, which honors the Lab's 1950s-era Godiva uranium reactor, an unreflected, or bare, reactor named after Lady Godiva, famous for the ride where she bared it all through the streets of Coventry in the 11th century.

"I love that aspect of the Lab's personality," Carr says. "Who doesn't want to laugh?"

Humorous interpretations of names have also emerged throughout the decades. D was one of the Lab's early buildings, and when it was replaced, the new building was called D-Prime, or DP. Over the years, employees have offered conjectures that DP stands for Dogpatch, another fictional town from *Li'l Abner*, and even "Displaced Persons" because the site is fairly remote.

But what about Eenie, Meenie, Minie (all firing sites) and Moe (a magazine site)? Did you think we had forgotten to reveal where these sites got their names? We haven't forgotten, but it seems everyone else has. "There's a story behind that," Carr says. "I'll have to find someone who remembers." A few Lab employees claim that these nursery rhyme names (like many other Los Alamos names) have some connection to *Li'l Abner*. Malenfant, on the other hand, believes the names are meaningless. He says, "Sounds better than one, two, three, and four." ★

Do you know the history behind any unusual Los Alamos place names that we failed to mention? Email magazine@lanl.gov.

Clockwise from top left: In the mid-1940s, DP West was dedicated to plutonium operations and storage; up to 4,500 pounds can be dropped from the Meenie site tower; an explosives test is executed at the Minie firing site in December 2020; members of the Asian Pacific Islander employee resource group hold an Enewetak street sign that was installed in 2022.

■ R&D engineer Tyler Brunstein-Ellenbogen, of the Materials Recovery and Recycle group, collects radioactive rock specimens. Some of them contain uranium, which is naturally occurring in soil, rock, and water. "Learning more about the geology and engineering behind shielding the specimens led me to seek a job in the nuclear field, so the plate is an homage to how I got here," he says.

DRIVEN BY SCIENCE

Scientists' creativity extends to their vehicles.

BY WHITNEY SPIVEY

New Mexico license plates are simple, colorful, and award-winning. In 2017, the chile plate won America's Best License Plate Award from the Automobile License Plate Collectors Association. And in 2024, the turquoise plate was recognized by the Discoverer blog, which stated: "Congratulations to all New Mexicans out there because we believe that your license plate is the best in the country. This is due in no small part to the design's incredible colors, with its turquoise background and vibrant yellow lettering."

Most Los Alamos National Laboratory employees, of course, have New Mexico plates. But only some choose to personalize the text. Here is a collection of science-themed plates spotted around the Laboratory. ★

◀ In New Mexico, residents can submit up to three ideas for a personalized plate. "I filled out a paper form, and one of the ideas I wrote down was SCIENCE," remembers geophysicist Mike Cleveland. "In a state with two national labs, I didn't think it'd be available, but a few weeks later, it

▲ "I have been studying isotopes for more than 20 years," says Anthony Pollington of the Nuclear and Radiochemistry group. "I've long been fascinated by the things you can learn from them." Because New Mexico no longer allows the letter I on plates, Pollington used a 1 instead.

▲ Although communication specialist Maureen Lunn's plate refers to tortilla chips smothered in cheesy goodness, it could be interpreted as a scientific acronym. Researchers in the Lab's Intelligence and Space Research division developed NACHOS, the Nano-satellite Atmospheric Chemistry Hyperspectral Observation System. The collection of tiny satellites monitors harmful gases, such as pollution from power plants, from space.

◀ Dynamic Imaging and Radiography group leader Keith Rielage started his career as a particle astrophysicist and has worked on several dark matter detectors. "Unlike normal, everyday matter, dark matter does not absorb, reflect, or emit light and can only be detected by its gravitational and weak interactions with normal matter," Rielage explains. "The composition of dark matter is still unknown, and the universe seems to hold six times as much dark matter as normal matter."

▲ A while back, retired physicist and history buff Glen McDuff watched a television show about a man who painted nose art from World War II bombers on Harley Davidson motorcycles. "I thought this was a really cool idea," McDuff remembers. "Then, it occurred to me that the best nose art for my Harley would be from the *Enola Gay* and *Bockscar*." Because these planes dropped the atomic bombs, "why not have a plate that says A-bomb?" McDuff says. "So I had two good ideas in the same decade, which is very rare."

▲ When a colleague pointed out that McDuff's Chevy truck with the 500-horsepower, 502 cubic-inch engine is significantly more powerful and louder than his Harley with the A BOMB plate, outfitting the truck with a hydrogen bomb license plate "just made sense."

▲ Physicist Jim Hill came to the Lab in 1996 as a post-master's student and was thrown into the world of nuclear safety. He became particularly involved with one-point safety, a weapons design mandate that requires a low probability of nuclear yield in the event of an accidental detonation of a weapon's high explosives. "It has been a topic near-and-dear to me since I got here," Hill says. "I thought it would make a nice plate, and it has been a conversation-starter on more than one occasion."

▲ Mike James drives an electric vehicle, but that's not what the EV on his license plate represents. "I was educated as a nuclear engineer," explains James, who is part of the Lab's Nuclear Chemistry and Spectrometry team. "My plate refers to a specific fact one memorizes very early on: the energy of neutrons at room temperature: 0.0253 electron-volts."

RED, GREEN, OR CHRISTMAS?

In a poll of 1,966 Lab employees, 38 percent said Christmas (red + green) is their favorite chile option. Green was close behind with 35 percent, and red had 27 percent of the vote. ★

	Red	Green	Christmas
Thom Mason Director	✓	✓	
Frances Chadwick Staff Director			✓
Bob Webster Deputy Director for Weapons	✓	✓	✓
Kim Scott Executive Officer for Weapons		✓	
John Benner Associate Laboratory Director for Weapons Production		✓	
James Owen Associate Laboratory Director for Weapons Engineering			✓
Mark Anthony Associate Laboratory Director for Plutonium Infrastructure	✓		
Nancy Jo Nicholas Associate Laboratory Director for Global Security			✓
Tri Tran Stockpile and Enterprise Analytics Office Director		✓	

▲ "After years of offroading abuse and weathering, my old Land Rover has become noticeably rusty," explains Reg Rocha, Nuclear and Radiochemistry deputy group leader. "And when I see it, I naturally think Fe_2O_3, a main chemical product of iron oxidation into rust." Rocha says that despite his "somewhat nerdy car-naming logic," most people in Los Alamos get the reference.

▲ "My license plate references the fact that my car is turbocharged—it boosts the oxygen in the engine intake," explains Analytics, Intelligence, and Technology division leader Keith Bradley. "But more importantly, it is an ersatz reference to some physical phenomena that are extremely important to the Laboratory's mission."

▲ Delta P is a measurement of the atom ratio of plutonium-238 to plutonium-239 after a nuclear test, relative to its value prior to the event. This change, or delta, is an important diagnostic and has been reported in radiochemistry experiments since the very early days of nuclear testing. "As a long-time member of the Radiochemistry Assessment team, I knew I had to give my truck a suitably radchem-nerdy license plate," says team leader Hugh Selby. "Delta P seemed like the right choice."

Preservation is underway at V-Site.

RESTORING PROJECT Y

Manhattan Project National Park preserves historic sites at Los Alamos National Laboratory.

BY JILL GIBSON

The Manhattan Project National Park (MAPR) consists of sites in three locations—Hanford, Washington; Los Alamos, New Mexico; and Oak Ridge, Tennessee—that served as the primary centers of operations during the Manhattan Project, the United States' top-secret effort to develop atomic weapons to help end World War II.

"The Manhattan Project changed the geopolitical landscape of the world," says Jonathan Creel, Los Alamos National Laboratory MAPR program manager. "What happened then affects us to this very day, and that is important to share with people."

But to share these historic stories, the buildings where the work took place must be preserved. A small team of professionals from Los Alamos National Laboratory, the National Park Service, the National Nuclear Security Administration Los Alamos Field Office, and the Department of Energy Office of Legacy Management, is focused on sites across Los Alamos National Laboratory, where much of the building and small-scale testing of the first atomic weapons took place.

Dating to the early 1940s, the Los Alamos Manhattan Project facilities were built hastily, many constructed simply of drywall, and expected to last no more than one or two years. "This was a mission that had to be done very quickly, and that's reflected in the architecture and the infrastructure," says Laboratory Historian of Science Elliot Schultz.

Now, preservationists are hard at work restoring the facilities. Their location within a secure part of the Laboratory presents an added set of security and logistical concerns. "The unique part of Los Alamos being part of a National Historic Park is that this is an active laboratory," Creel says. "In some places, work is being done right next door."

Here's a look at three of the preservation projects going on now:

V-Site

The first building constructed at V-Site in 1944 was a small triangular-shaped structure surrounded by an earthen berm. Here, scientists conducted early tests of the first implosion weapon prototypes to ensure that key components could withstand cold temperatures and the vibration of an airplane bomb bay.

A high bay assembly building and covered storage area were added in late 1944 to support the assembly of the Trinity device. Assembly of the device's high-explosives package took place here in early July 1945.

At one time, V-Site consisted of six buildings, but four of the buildings were destroyed during the May 2000 Cerro Grande Fire. One of the most significant preservation efforts at V-Site included replacing the deteriorating roofs of the two remaining buildings in 2023. Preservationists say the modern sheet roof material will prevent leaks and possible damage to the building and exhibits inside.

Slotin Building

After World War II, work continued at Los Alamos under the operational control of the Manhattan Project, and scientists continued to explore fundamental weapons and plutonium research. On May 21, 1946, scientist Louis Slotin was conducting an experiment involving a subcritical mass of plutonium and beryllium when his hand slipped, leading to a critical reaction and a sudden burst of radiation. Slotin died nine days later from exposure.

Over the years, as the building was remodeled and interior walls were added, the location of the Slotin accident ended up in the center of a hallway. Current preservation efforts at this site are focused on restoring the interior of the building to its original condition by removing walls and components that were added when the building was converted to a workshop after the accident. These additions have made giving tours of the facility difficult. When the building interior is back in its historic configuration, the goal is to replicate what the facility looked like when the accident took place.

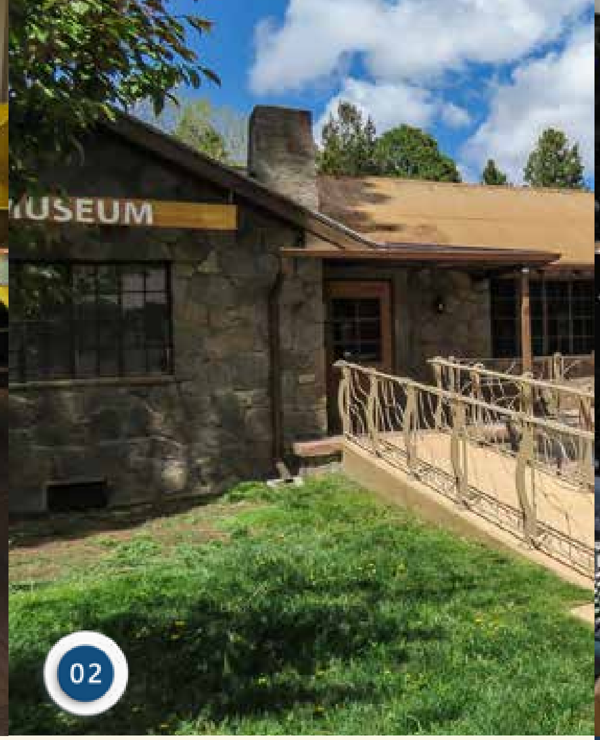
Guard shacks

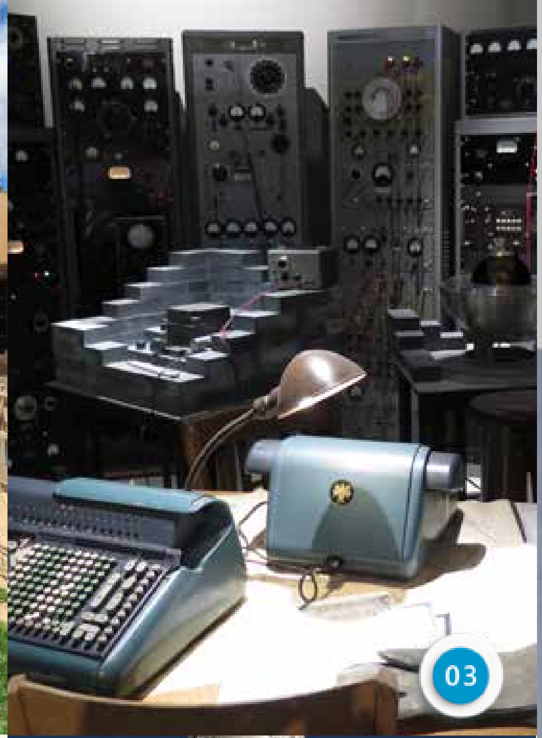
During the Manhattan Project, Los Alamos was a restricted top-secret community, and all personnel had to enter through guard stations, known locally as guard shacks. Two of these shacks recently traveled to Vancouver, Washington, where they are being restored at the National Center for Preservation Technology and Training, a historic preservation research and education center that will help document the preservation process.

"The guard shacks will not only return to the Laboratory in excellent condition, but they will return with excellent documentation of the architectural features of the buildings as well as the entire preservation process, which will help to inform future preservation work on the buildings," says MAPR cultural resources specialist Jeremy Brunette.

"I'm thrilled to see these buildings are finally getting the care and attention that are due to them," Schultz says. "It's exciting as a historian to see that people are really appreciating what these facilities did and how they contribute to the broader story of not only the Manhattan Project, but where we've gone as a nation since 1945." ★

Two guard shacks are loaded onto a trailer for transport to Vancouver, Washington, where they will be restored. "It can be argued that the Manhattan Project was the most significant event of the last century, and its effect continues to reverberate today," says MAPR cultural resources specialist Jeremy Brunette. "It is a privilege to be able to contribute to the preservation of the remaining buildings and structures that supported the Manhattan Project. Working with the Manhattan Project provides opportunities to solve preservation questions and problems regularly, all while continuing to develop a greater understanding of its history."





MORE WAYS TO EXPLORE

In addition to Manhattan Project National Park, these six sites and museums offer various perspectives on New Mexico's nuclear history.

BY JILL GIBSON

01 The Bradbury Science Museum

Los Alamos - As Los Alamos National Laboratory's public museum, the Bradbury's goal is to help people understand and appreciate the history and work of the Lab from its Manhattan Project origin to its modern day mission. First established in 1954, opened to the public in 1963, and renamed after Norris Bradbury (the Laboratory's second director, see p. 32) in 1970, the Bradbury moved to its current location in 1993. Today, the museum continues to highlight diverse aspects of the Lab's work.

02 The Los Alamos History Museum

Los Alamos - Featuring information about the Los Alamos homestead era, the Los Alamos Ranch School, the Manhattan Project, and the Cold War, the Los Alamos History Museum includes historic buildings (including a Cold War section housed in the former home of Nobel Laureate Hans Bethe), exhibits, and artifacts from the city's past. Eventually, the museum will include the J. Robert Oppenheimer home.

03 The National Museum of Nuclear Science & History

Albuquerque - Established in 1969, the exhibits at this Smithsonian Affiliate museum document nuclear history and science. A 9-acre outdoor area behind the 30,000-square-foot museum building features the largest publicly accessible aircraft collection in the state—in addition to rockets, missiles, cannons, and a submarine sail.

04 The New Mexico Museum of Space History

Alamogordo - Dedicated in 1976 as the International Space Hall of Fame, the New Mexico Museum of Space History—a Smithsonian Affiliate—emphasizes the significant role that the state of New Mexico has played in the development of the U.S. space program. The museum includes an exhibit showcasing Los Alamos National Laboratory technology developed for the exploration of Mars.

05 The Trinity site

White Sands Missile Range - The location of the world's first nuclear detonation is a national historic landmark. Near ground zero, visitors can see Jumbo, a large steel container built (but never used) to contain the explosion, and the McDonald ranch house, where the plutonium core of the bomb was assembled. Public open houses are held twice a year.

06 The White Sands Missile Range Museum

White Sands Missile Range - The White Sands Missile Range Museum's mission is "to collect, preserve, and interpret the history of the greater White Sands area—its peoples, lands, and technological contributions in support of the United States Armed Forces—from the prehistoric era to the present." The museum includes exhibits about the Trinity test, missiles, early rocketry, and the U.S. space program. ★

LOS ALAMOS PRE-LINKEDIN

Location has always played a prominent role in Laboratory recruiting.

This job recruiting advertisement for the Laboratory appeared in a 1956 edition of *Scientific American* magazine. Today, the Lab's job postings continue to highlight the natural beauty of northern New Mexico, the access to outdoor recreation, and the welcoming small-town feel of Los Alamos. To learn more about what the Lab was like during the 1950s under the leadership of Norris Bradbury, the Lab's second director, see page 32. ★

Engineer Alex Wass (right) shows Bob Webster, deputy Laboratory director for Weapons, some of the parts that will make up the Scorpius accelerator cell modules.

SCORPIUS TAKES SHAPE

A new machine will enhance scientists' understanding of nuclear weapons.

BY JILL GIBSON

Assembly is underway at Los Alamos National Laboratory on components of a groundbreaking machine that will allow scientists to use real plutonium in experiments while studying specific aspects of a nuclear weapon's function. The machine, called Scorpius, will prove instrumental in the Laboratory's stockpile stewardship mission, which ensures the safety, security, and reliability of the nation's nuclear weapons through computational tools and engineering test facilities rather than full-scale nuclear testing.

Although the plutonium used will never reach criticality—the condition that forms a self-sustaining nuclear reaction—the tests performed as part of the Scorpius Advanced Sources and Detection (ASD) project will provide essential knowledge about how the key element in nuclear weapons behaves.

Assembly began on March 7, 2024, on the first two accelerator cell modules for Scorpius. "This means we have officially started building, and I am so looking forward to seeing this experiment in my lifetime," says Bob Webster, deputy Laboratory director for Weapons. Completion of the modules is expected by the end of the year.

'It will be transformational'

The accelerator cell modules are key components of the 400-foot-long linear accelerator that will create radiographic images of subcritical plutonium experiments. When completed, Scorpius will be housed in a tunnel nearly 1,000 feet underground in the Principal Underground Laboratory for Subcritical Experimentation (PULSE, formerly the U1a complex) at the Nevada National Security Sites, north of Las Vegas.

ASD Senior Director Mike Furlanetto says the machine will provide information on plutonium aging, behavior, and safety, and that it will provide more accurate data for computer simulations that model weapons behavior. "Just knowing the impact this will have on how we do our work as a design lab is pretty amazing," he says. "It will provide so much data to assess and certify the nuclear stockpile—it will be transformational."

The project is a collaboration between researchers from Los Alamos, Sandia, and Lawrence Livermore national laboratories, and the Nevada National Security Sites. Los Alamos leads the design team, which has been working since 2014 on the project.

No easy assembly

Building the cells is a complicated and lengthy process, Furlanetto says, but he points out that Los Alamos has extensive experience building similar complex accelerator cells for the Dual-Axis Radiographic Hydrodynamic Test (DARHT) facility, which takes high-speed images of mock nuclear devices imploding at speeds greater than 10,000 miles an hour. While Lab scientists say DARHT provides extremely useful data, they agree that conducting experiments with actual plutonium, instead of plutonium surrogates, will open new research avenues.

"We are drawing on our expertise with a very advanced predecessor," Furlanetto explains. "Each of these cell modules is a physical vacuum chamber with magnets, power connection, vacuum pumps, cooling water, and controls that must be precision aligned to the next one in line within microns. Getting everything together at that level of accuracy and precision does take some time."

Each module will consist of three cells. Each cell will be roughly 3 feet in diameter and each module will be about 5 feet wide, 10 feet long, and 10 feet tall.

"I've written more than 200 pages of assembly procedures," says engineer Alex Wass, who heads the assembly team. Those 200 pages cover the assembly of one cell. Then there's a separate—and equally long—set of procedures for the remaining module assembly.

Once completed, the Los Alamos–built modules will travel by truck to Nevada, where they will be united with the other pieces of Scorpius for testing aboveground. Once that testing process is complete, a vendor will be selected to assemble the remaining cells and modules at the Nevada National Security Sites.

Furlanetto explains that 102 is the number of cells necessary to achieve the best performance in the accelerator. "That number of cells was an extremely intentional choice," he says.

Finally, the 102 cells, assembled into 34 modules (plus one backup module), and Scorpius' remaining parts will travel by elevator nearly 1,000 feet down into the PULSE tunnel for final assembly underground. "That's another challenge," Furlanetto says. "One of our main design constraints was building something to get in that elevator. The pieces will go down in 20,000-pound chunks."

When complete, Scorpius will weigh 2.44 million pounds and be longer than a football field. Scientists expect the machine will be fully operational by 2030.

How Scorpius works

When Scorpius operates, solid-state pulsed-power systems created by Livermore will energize an injected electron beam and provide power for the accelerator modules. The electron-beam injector, built by Sandia, will send high-energy electron beams, broken into four or more pulses separated by as little as 200 nanoseconds, speeding down the accelerator.

As the pulses travel the length of the accelerator, the 102 accelerator cells will increase the pulses' energy to more than 20 mega electron volts. Near the end of the machine, each pulse will collide with a metal target and generate x-rays that will pass through a simultaneously occurring plutonium experiment contained inside a steel vessel.

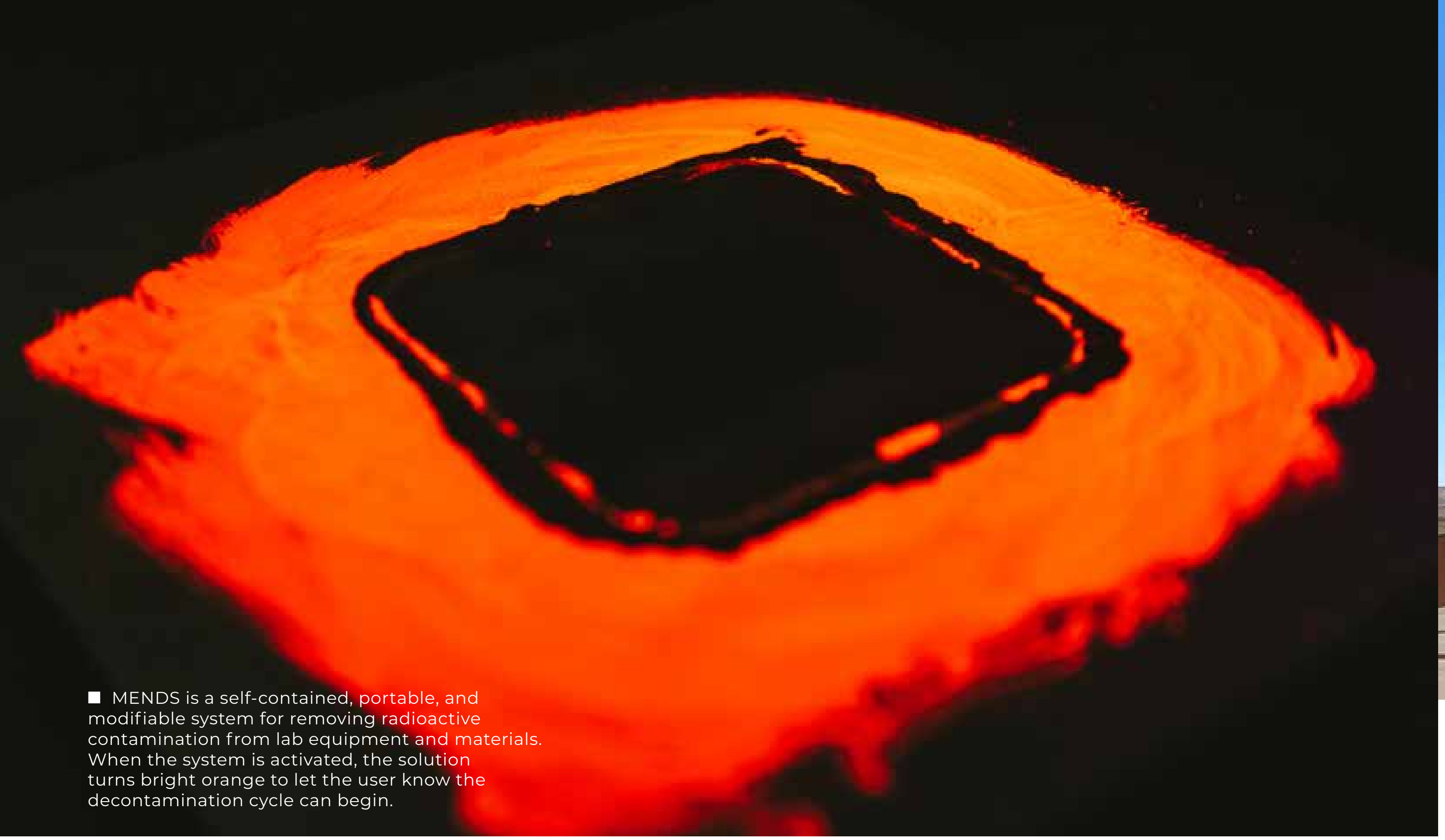
Finally, a detector will convert the x-rays into images recorded by a sensitive, high-speed camera. This ability to produce multiple images of plutonium experiments will provide significant insights for scientists.

"Scorpius will be an extremely important part of our tool set," says Don Haynes, Los Alamos senior director of the Nevada Programs Office. "It will answer or solve a lot of problems or questions that we're currently wrestling with."

Being able to radiograph plutonium under extreme conditions and pressure will provide more accurate data for computer simulations modeling. The experiments will give researchers an extremely sophisticated and detailed understanding of plutonium and weapons behavior.

"We're extremely confident in the reliability of the nation's current nuclear stockpile, but with this tool in our toolbox we will have the ability to explore everything from new materials, to new designs, to new delivery systems," Furlanetto says. "Scorpius will allow us to do that." ★

Kimberly Scott, executive officer for Weapons, views parts for the accelerator cell modules being constructed at Los Alamos.



MENDS is a self-contained, portable, and modifiable system for removing radioactive contamination from lab equipment and materials. When the system is activated, the solution turns bright orange to let the user know the decontamination cycle can begin.

MENDING GAPS IN WASTE PROCESSING

A new decontamination system prioritizes worker safety and environmental responsibility.

BY BRITTANY ST. JACQUES

Because of its national security mission—which includes manufacturing plutonium pits for nuclear weapons—Los Alamos National Laboratory produces a considerable amount of transuranic waste, including equipment and materials contaminated with radioactive elements. For the past 24 years, that solid waste has been packaged, shipped, and stored at the Waste Isolation Pilot Plant (WIPP, see p. 10) in southern New Mexico.

With an eye toward the future, Los Alamos scientists and engineers are considering ways to prevent overloading the waste repository. In 2022, a Los Alamos team developed a novel instrument for decontaminating transuranic waste. This new technology is safe, efficient, and generates low-level radioactive waste, which is cheaper to dispose of than transuranic waste and doesn't require disposal at WIPP.

The Modular Electrochemical Nuclear Decontamination System (MENDS) is a self-contained, portable, and modifiable system for removing radioactive contamination from lab equipment and materials. The system relies on a decontamination solution that dissolves radioactive contamination bound to a surface and carries it away with the solution back to an internal reservoir. (If you're picturing a carpet cleaner, that's the right idea.)

MENDS recycles and reactivates the decontamination solution, allowing for a single decontamination cycle to continue using a small, fixed volume of solution. Depending on the configuration of the MENDS system, this volume can be even less than a pint.

However, MENDS doesn't just reduce the amount of waste generated during decontamination; it's also fast, effective, and reduces worker exposure compared to current decontamination methods. In fewer than 30 minutes, MENDS can decontaminate equipment and materials to low-level waste limits, allowing this waste to be disposed of like regular trash or lab equipment, thus dramatically reducing waste streams intended for WIPP.

Operating MENDS is very simple and requires only basic personal protective equipment, such as safety glasses, gloves, and coveralls. Once the system is activated, the solution turns bright orange, signaling the user to start the decontamination cycle. With custom components and attachments tailored for each application, users can set up the MENDS system and walk away while it runs. Instead of being stuck scrubbing a surface, users are free to accomplish other tasks while MENDS takes care of the cleaning. Once the MENDS cycle is complete, the small volume of contaminated solution is sent to a radioactive liquid waste treatment facility. The decontaminated equipment can then be safely disposed of as low-level waste.

MENDS technology dramatically increases the efficiency of decontamination, decreases generated waste, and increases worker safety by limiting radiation exposure during cleaning. "Our work is modernizing plutonium processing at Los Alamos, increasing the efficiency," says scientist Rami Batrice of the Lab's Biochemistry and Biotechnology group. "But most importantly—and at the heart of our research—is improving worker safety; our MENDS system reduces the need for direct handling of radioactive material, reducing the radioactive exposure experienced by the workforce." ★

A plume rises at the New Mexico Fire Training Academy in Socorro, New Mexico.

BLAZING PARTNERSHIPS

Los Alamos scientists work with the New Mexico Fire Training Academy to better understand how fires behave.

BY IAN LAIRD

In the event of a nuclear detonation, fires caused by thermal radiation will flare up around the blast site. Jon Reisner, an atmospheric scientist at Los Alamos National Laboratory, has spent more than three decades modeling what those fires might look like and what their downstream effects might be.

But how do you model a fire? Some of the data that Reisner uses comes from crib fires—essentially, small experimental fires. The problem with crib fires, however, is that they typically resemble wildfires, which are fueled by organic material. This is very different from fires in urban environments. In cities, Reisner explains, modern construction materials, such as glass, steel, and concrete, burn differently than materials such as wood and plant matter. Oxygen levels also play a role in how fires behave: buildings have limited ventilation compared to the open environments of wildfires.

Just over a year ago, Kip Carrico, a professor at the New Mexico Institute of Mining and Technology, and Ryan Himes, a New Mexico Tech graduate student, introduced Reisner to the New Mexico Fire Training Academy, located west of Socorro.

"To be honest with you, I wish we knew about this facility probably 20 or 30 years ago," Reisner says. "We went down there, and they just had fun burning things."

At the academy, firefighters are presented with fires in mock buildings and rooms that are similar to what they might encounter on the job in an urban environment—and perfect for Reisner to study. Now, Carrico gathers data for Reisner by flying drones through the smoke plumes of training fires to collect aerosol samples.

"This is a way for us to transition from crib fires to actually looking at more realistic fuels," Reisner says.

The facility also allows Reisner and his team to study ventilation parameters, such as the number and size of the gaps in an enclosed space, which affect how particles escape and oxygen enters the space. For example, Reisner can study a fire in a room with multiple windows and doors versus a room with only a door. The data can be extrapolated and applied to large-scale urban fires.

"Small ventilation parameters sort of quench the fire," Reisner explains. "Then, as you increase the parameters, as you add more oxygen, you get a steady state between burning and oxygen coming into the fire."

Reisner says the data collected through the collaboration with the New Mexico Fire Training Academy is helping build a foundation for future research. "When we do calculations, now they're based on additional data that's very good," he says. "This helps validate our models, and so hopefully the next generation of scientists can piggyback on these efforts and really start understanding the complexity of these combustion scenarios." ★

Drones are used to collect aerosol samples.

TECH TRANSFER

Los Alamos National Laboratory works with private industry to develop technologies for public use.

BY J. WESTON PHIPPEN

Written into Los Alamos National Laboratory's agenda of operation is a promise to transfer "new and emerging technologies" to private industry as well as "technologies to stimulate new business startups, attract entrepreneurs, create alternative job opportunities, and attract businesses and capital to the region."

Laboratory Staff Director Frances Chadwick explains that the concept of being a "force for good" within northern New Mexico and beyond "means raising the entire economic wellbeing of the state and the region we work in."

Here are a few of the ways the Laboratory works with private industry:

- The **Los Alamos Licensing Program** licenses Lab-developed technologies for commercial, research, and U.S. government use so that institutions can bring Laboratory technologies to the public, often creating jobs in the process.
- The **Lab-Embedded Entrepreneur Program** grants innovators in clean energy a two-year fellowship at a national laboratory to build a green technology into a business.
- **Cooperative Research and Development Agreements** (CRADAs) allow Los Alamos scientists and businesses to work alongside each other to develop a technology. Sometimes, the Lab has expertise in a field that companies would like to lean on. Or, perhaps, Los Alamos has the facilities and the federal government licenses needed to work with certain materials.
- The **Technology Readiness Gross Receipts (TRGR) Initiative** provides New Mexico businesses the opportunity to work directly with scientists and engineers at Los Alamos to advance technologies licensed from or developed through CRADAs with Los Alamos. The goal of this partnership with the state of New Mexico is to move technologies past the invention stage to the market-ready stage.
- The **New Mexico Small Business Assistance Program** helps for-profit small businesses in New Mexico access cutting-edge technologies, solve technical issues, and gain knowledge from technical experts at Los Alamos. The assistance is provided at no cost.
- The **Community Technical Assistance** program makes Los Alamos scientists and engineers available to provide short-term, limited assistance to entities facing technical hurdles that overlap with Laboratory capabilities as long as the assistance does not duplicate services or compete with the private sector. This help is provided at no cost to the organization seeking assistance, and the scope of work provided varies based on individual project needs.

Here are five—of many—companies that have blossomed thanks to these tech transfer relationships:

Mercury Bio

Los Alamos is helping Santa Fe, New Mexico–based Mercury Bio through a TRGR that was set up in July 2023. "What we're doing is trying to enable a technology that does not exist," says Mercury Bio CEO Bruce McCormick, explaining the company's goal of developing a novel drug delivery method that could target specific cells within the body. "Roughly 85 percent of diseases are untreatable, and that's simply because we don't have a way to access the cells causing the disease."

One focus of the TRGR has been using Laboratory supercomputers and artificial intelligence to design and model synthetic proteins that do not exist in nature. These novel proteins might be the key to reaching and destroying cancer cells. "A company like Mercury Bio, and most companies for that matter, won't typically have access to equipment like supercomputers," says Sandrasegaram Gnanakaran of the Lab's Theoretical Biology and Biophysics group, who is also the principal investigator on the TRGR partnership. "This is the first case I'm aware of where, at the Lab, we are using artificial intelligence to design completely new proteins."

Kairos Power

Albuquerque-based Kairos Power is developing a fluoride salt–cooled, high-temperature nuclear reactor that promises to be safer and more cost efficient than conventional reactors. Such a reactor would deliver clean energy that competes with the cost of natural gas. Kairos, however, needs a fuel source for the reactor. Rather than traditional fuel rods, the Kairos reactor will use tri-structural isotropic particle fuel. These so-called "TRISO pebbles" contain uranium, a radioactive element that can only be handled in very specific conditions and amounts, which is why the pebbles will be produced at the Lab's Low-Enriched Fuel Fabrication Facility, set to begin operation in 2025.

"This is where Los Alamos is critical to our mission—this collaboration allows us to leverage their infrastructure," says Micah Hacket, Kairos' senior director of fuels and materials. "The team at Los Alamos has been fantastic to work with; we've come to think of them as part of our own team, frankly, because we're aligned in the same goal."

Pajarito Powder

Founded in 2012, Pajarito Powder produces catalysts for hydrogen fuel cells—small devices that convert chemical energy into enough electricity to power vehicles. In a hydrogen fuel cell, a catalyst is necessary to split electrons and protons from hydrogen molecules and combine them with oxygen molecules to form water and heat. Traditionally, fuel cell catalysts have consisted of expensive noble metals such as platinum deposited on carbon. Improving these catalysts could bring down fuel cells' cost and help spur adoption of the technology.

Pajarito Powder's catalyst is made through a "bottom-up synthesis" process that allows more control over how and where the carbon and platinum bond. Through TRGR and CRADA programs, the company has worked with the Lab to fine-tune its product. "We've run accelerated stress tests that have characterized the efficiency and durability of the catalyst,"

■ Mikaela Dicome, an analytical chemist for Pajarito Powder, pours liquid nitrogen into a vessel. Photo: Pajarito Powder

says Siddharth Komini Babu of the Lab's Materials Synthesis and Integrated Devices group. "Companies want to know that these fuel cells work well and that they will last a long time. So, we've developed ways to reproduce driving a hydrogen car for 8,000, even 30,000 hours without ever leaving the Lab."

xLight

In 2024, xLight was granted a CRADA to work with Los Alamos on the design of a small accelerator—about the size of two buses. The accelerator's high-energy beam would be used to imprint patterns on semiconductor chips. "Los Alamos is really a perfect place because they've worked with accelerators nearly as long as the Lab has existed," says Bruce Dunham, vice president of accelerator systems at xLight.

If successful, this partnership could bring about the first automated accelerator program in the world and the first new development in semiconductor technology in decades. Given the wide usage of semiconductor chips and issues in the semiconductor supply chain, "we're very interested in their technology because of what it would mean for the nation," says Steve Russell, the Lab's deputy division leader for the Accelerator Operations and Technology group. He notes that xLight has also been accepted by the Lab's TRGR program. "We want to do anything we can to help them, and we're cheering them on."

UbiQD

Quantum dots are nanocrystals that can convert light into energy and, when given electrical charge, also emit light. In 2014,

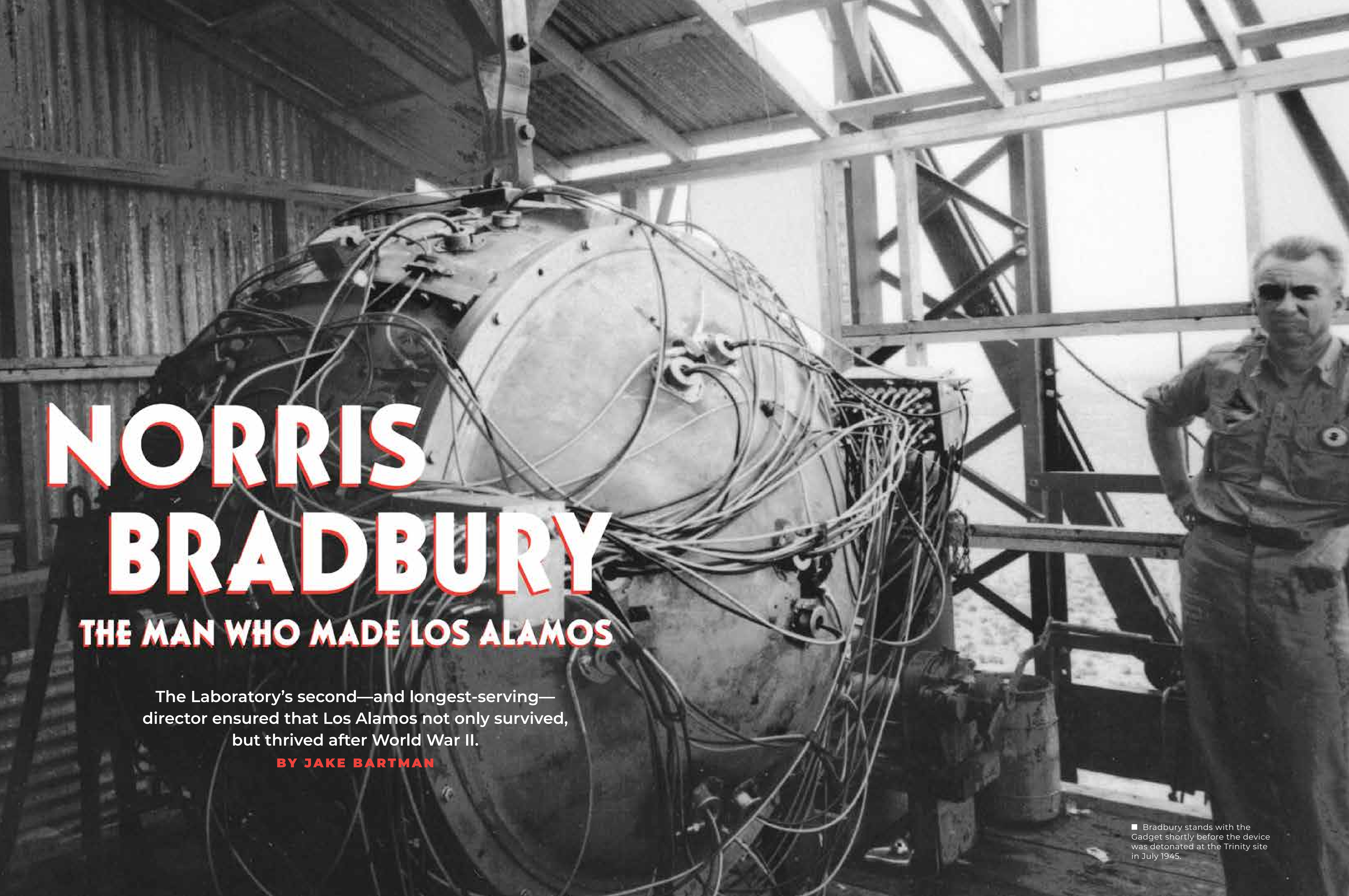
■ In 2023, the UbiQD headquarters in Los Alamos was outfitted with quantum dot solar windows. Photo: UbiQD

Los Alamos postdoctoral researcher Hunter McDaniel left the Lab to found UbiQD (pronounced "ubiquity") with the idea of licensing the Lab's nanocrystal technology. McDaniel saw promise in the solar energy realm, where the small size of quantum dots meant they could be manufactured into a thin film, turning any window or piece of glass into a source of solar power generation.

"The sun generates an enormous amount of energy," McDaniel explains, adding that an area the size of Santa Fe County, near Los Alamos, receives sufficient energy from the sun to power the entire planet's electrical demand. "Quantum dots can be added to solar panels to increase their efficiency or included in windows to harvest the light's energy without blocking the view."

Recently, UbiQD has applied its quantum dot technology to greenhouses. "We can manipulate the size of the quantum dots in a way that captures specific wavelengths of light," McDaniel says, "so we developed a line of greenhouse films that shift the light spectrum and enhance photosynthesis."

For these applications, among others, UbiQD's quantum dot technology has received widespread praise, including grants from the U.S. Department of Energy and the state of New Mexico Advanced Energy Award. ★



NORRIS BRADBURY

THE MAN WHO MADE LOS ALAMOS

The Laboratory's second—and longest-serving—director ensured that Los Alamos not only survived, but thrived after World War II.

BY JAKE BARTMAN

■ Bradbury stands with the Gadget shortly before the device was detonated at the Trinity site in July 1945.

On his rare breaks from work, Norris Bradbury—who, in 1945, succeeded J. Robert Oppenheimer as director of Los Alamos Scientific Laboratory (now Los Alamos National Laboratory)—liked to take road trips to remote corners of Latin America.

As Bradbury's daughter-in-law, Ellen Bradbury-Reid, who took part in a number of these odysseys, sees it, Bradbury was seeking a reprieve from the burdens that came with serving as director of the nation's preeminent nuclear science laboratory. "I think he wanted to get away and be around people who didn't treat him like a celebrity," Bradbury-Reid says.

But any respite Bradbury might have attained on these trips was precarious. Bradbury-Reid recalls one trip to rural Mexico, when the family was in search of a bottle of Bacanora, the famed bootleg agave liquor.

"We were in this tiny town, and a police car comes up behind us," Bradbury-Reid says. "And Norris says, 'Either we're going the wrong way on a one-way street, or something's gone wrong at Los Alamos.'" On more than one occasion, Bradbury-Reid says, her father-in-law had to leave his vacations early—sometimes by helicopter—to deal with pressing Laboratory business.

Bradbury's commitment to his work might be even more remarkable for the fact that he was reluctant to become director in the first place. At the end of World War II, Bradbury wasn't at all certain that he wanted to stay at Los Alamos, where, during the Manhattan Project, he helped to build the world's first nuclear weapons. Persuaded to accept a 6-month term as director, Bradbury wound up remaining in the role for 25 years—a tenure that makes him, by a comfortable margin, the Laboratory's longest-serving director to date. (The second longest-serving, Siegfried Hecker, led the Laboratory for 11 years.)

Bradbury's directorship wasn't remarkable just for its duration, however. As Los Alamos' leader, Bradbury helped transform the Laboratory from a hasty wartime project into an enduring institution tasked with safeguarding the nation's security. Leading the Laboratory during the first decades of the Cold War, Bradbury shepherded Los Alamos through challenges that included the development of the world's first thermonuclear weapons, an arms race with the Soviet Union, international agreements that established new limits on nuclear testing, and the Laboratory's diversification into many areas beyond nuclear weapon design.

In a 1983 retrospective on Bradbury's career in *Los Alamos Science*, physicist Louis Rosen summarized Bradbury's legacy succinctly: "Oppenheimer was the founder of this Laboratory. Bradbury was its savior."

A scientist and a soldier

Born in Santa Barbara, California, in 1909, to a mother who was a schoolteacher and a father who was a jack-of-all-trades (a landscape architect, rancher, and machinist), Bradbury excelled as a student, graduating from Chaffey High School in Ontario, California, at age 16. He went on to earn a bachelor's degree in chemistry from Pomona College in Claremont, California, and then a doctorate in physics from the University of California, Berkeley, in 1932. Three years later, he accepted a position as assistant professor of physics at Stanford University. At the time, Bradbury was just 26 years old.

In 1933, Bradbury married Lois Platt, who he'd met as an undergraduate student. In a 1970 profile (in Los Alamos' *The Atom* magazine), Bradbury summarized their courtship with his typical lack of sentimentality: "Lois was the sister of my roommate in college. She was engaged to someone else. The engagement fell apart, and I moved in." The couple remained together for 64 years, until Bradbury's death in 1997.

While a graduate student, Bradbury followed one of his academic mentors' examples in joining the U.S. Naval Reserve. In 1941, before the United States entered the Second World War, Bradbury received a commission and was told to report to the Naval Proving Ground in Dahlgren, Virginia. There, Bradbury worked in ballistics—specifically, on engineering the outer casing of bullets and other projectiles.

In 1943, Bradbury's supervisor, William "Deak" Parsons, disappeared from Dahlgren. It wasn't until 1944 that Bradbury learned where his supervisor had gone.

"I was suddenly directed to report to Albuquerque," Bradbury recalled to an interviewer in 1985. "I did so, and there was my old pal, Captain Commodore Parsons." Parsons took Bradbury to Los Alamos, and—"probably in defiance of all the security regulations"—explained the work underway in Los Alamos (which was known as Project Y of the Manhattan Project). Parsons, who was responsible for Los Alamos' Ordnance Division, asked, but didn't order, Bradbury to join the project.

Bradbury recalled experiencing mixed emotions about accepting Parsons' request. "I was happy at Dahlgren," he said. "I had sort of a dismal premonition that once I got [to Los Alamos], I would never get away, and that turned out to be right."

In the end, Bradbury's sense of duty got the better of him. "I got to thinking about the blue uniform I was wearing, and who was I to argue about where I was assigned?" Bradbury remembered. "I called Parsons and told him I'd take the job."

> "Oppenheimer was the founder of this Laboratory. Bradbury was its savior."
>
> —LOUIS ROSEN

The Bradburys—Norris, Lois (who was pregnant with their son David), and sons Jim and John—set out by car for New Mexico. "We started out with six well-worn tires and discarded them as they wore out on the trip," Bradbury recalled. The family arrived at Los Alamos in the summer of 1944.

Bradbury wasn't the only soldier-scientist at the Laboratory. At its height, around 40 percent of Los Alamos' workforce were members of the Army. Many of these employees worked alongside civilians, helping to design the first nuclear weapons. But Alan Carr, the Laboratory's senior historian, says that Bradbury's status as both a physicist and a naval officer likely gave him a distinct sense of the Manhattan Project's urgency.

"He was duty-oriented," Carr says. "As a soldier, I think he recognized the weight that went with the work they were doing."

Bradbury ended up playing a key role in the Manhattan Project. At Project Y, researchers worked on two nuclear weapon designs. The first was a uranium gun-type weapon, in which two pieces of uranium were fired together to initiate a nuclear chain reaction. The second design was more complicated: a plutonium implosion device, in which a plutonium core, or pit, was compressed to create nuclear energy, or yield.

Scientists worried that this latter design might not work, necessitating a full-scale test of a plutonium implosion device—what came to be known as the Trinity test. Bradbury was responsible for assembling all the nonnuclear parts of the device, which was code-named the Gadget.

The test was conducted at the Alamogordo Bombing and Gunnery Range, near Socorro, New Mexico, on July 16, 1945. As the first-ever nuclear explosion, Trinity ushered the world into the atomic age. In contrast to Oppenheimer, who famously claimed to have reacted to the successful test by recalling lines from the *Bhagavad Gita*, Bradbury's reaction was straightforward.

"For me to say I had any deep emotional thoughts about Trinity… I didn't," he said. "I was just damned pleased that it went off."

Taking the helm

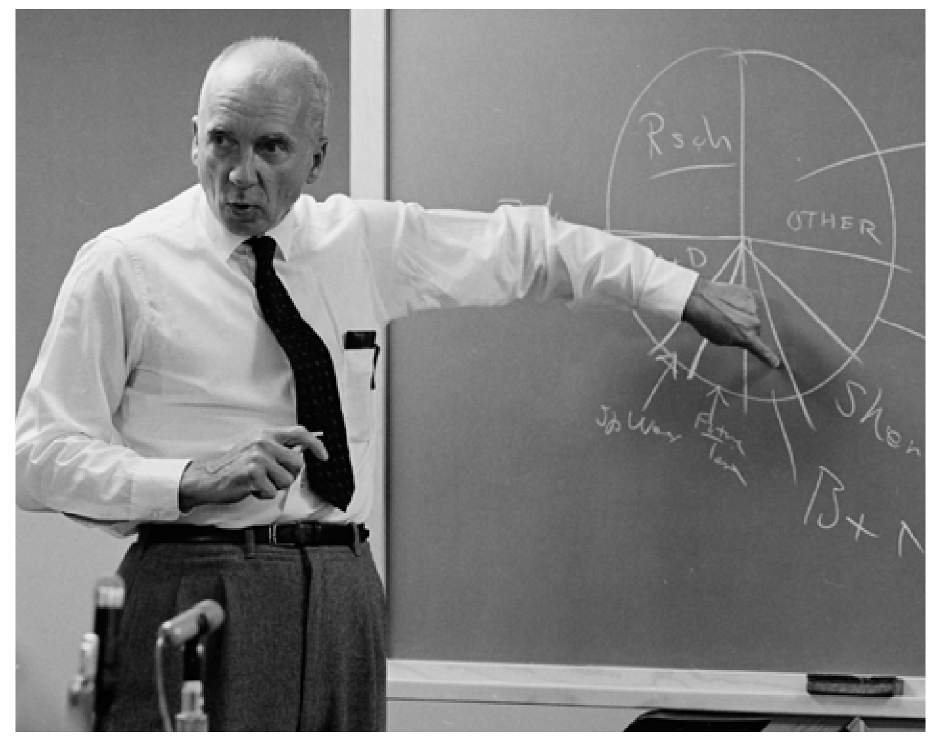
After two U.S. nuclear weapons were detonated over the Japanese cities of Hiroshima and Nagasaki in August 1945, Japan surrendered, bringing the Second World War to a close. Suddenly, Los Alamos was known the world over as the place where researchers had designed those weapons.

In the war's aftermath, rumors swirled in the community of Los Alamos, which by that point numbered a few thousand people, that the Laboratory might close. Many of the Laboratory's scientists—including Oppenheimer—were eager to leave New Mexico and return to the universities from which they'd come.

According to Laboratory historian Nicholas Lewis, however, General Leslie Groves—who led the Manhattan Project—never considered shuttering Los Alamos.

"Groves didn't believe that the scientists should all go back to their universities," Lewis says. "He wanted the Laboratory to continue stockpiling weapons, and he wanted the weapons developed during the war to be improved upon."

Even before the war's end, Groves had begun considering who might assume the Laboratory's helm after



■ Bradbury sustained the Laboratory after World War II and later supported its diversification into areas that weren't directly related to nuclear weapons. Here, he stands beside a diagram representing possible future research areas for the Laboratory.

Bradbury (first row, left) attended the Nuclear Physics Conference at Los Alamos in August 1946.

Oppenheimer departed. Groves conferred with Oppenheimer, and the two agreed on a replacement. One afternoon in mid-September 1945, 36-year-old Bradbury was summoned to Oppenheimer's office and given a job offer.

Bradbury's eldest son, Jim, was 10 years old when his father was offered Los Alamos' top job. Jim remembers his father carefully weighing the question of whether to assume the directorship. "He and my mother talked about it a whole lot," Jim says. For one thing, Bradbury was still a professor at Stanford University, where, before the war began, the family had built a house.

But among other reasons the Bradbury family decided to stay was their affinity for the place in which they'd come to live. "They loved New Mexico," Jim says.

In the end, Bradbury agreed to take the job of director, but only for six months or until Congress could pass legislation that determined the Laboratory's future. A tempest followed when the University of California, which operated the Laboratory, discovered that Groves and Oppenheimer had appointed Bradbury without the University's input.

"They were madder than hell," Bradbury recalled. Ultimately, though, the University decided, in Bradbury's words, "'We'll give the poor bastard a little while to see what he does.' So they politely left me alone." In years to come, Bradbury would earn the University's approval, befriending Robert Underhill, who for many years served as secretary-treasurer of the University's board of regents.

In his inaugural months as director, Bradbury faced significant challenges. The first had to do with staffing.

During the Manhattan Project, Project Y had swelled to some 3,000 employees (far more than the 100 that Oppenheimer initially thought necessary). With the war over, some of the Laboratory's leaders and scientists left immediately, eager to return to their academic laboratories, as Bradbury had been tempted to do. Others were members of the military who would soon be discharged. And some employees, according to Bradbury, were simply waiting for better opportunities and "not doing a stroke of work."

To deal with these staffing woes, Bradbury made two decisions. The first was to commit himself fully to the Laboratory. "I decided I couldn't run a laboratory that would have a future unless I was willing to put my own future on it," Bradbury said. "It needed a man who believed in it himself before others could believe in it."

Bradbury's second decision was to "shake the tree," as he put it. Although the government had promised to pay the moving expenses of anyone who wanted to leave Los Alamos, Bradbury decided to give this offer an expiration date—September 1946—to encourage indecisive employees to make up their minds.

Altogether, some 1,400 employees stayed at the Laboratory. "They stayed," Bradbury said, "because, to some extent, they shared my opinions of what the Laboratory was supposed to do."

What did Bradbury think that the Laboratory was supposed to do? In the aftermath of the war, Bradbury charted a course that sought a balance between short-, intermediate-, and long-term goals. In a 1948 speech at Pomona College (his undergraduate alma mater), Bradbury explained the importance of focusing on a breadth of endeavors. "If war is imminent, production is important; if in the middle future, development must be emphasized; but the long-range strength lies in research," he said.

Bradbury's vision for the Laboratory—as a facility that would balance production, development, and research—was guided by his sense of the postwar world's uncertainty. In the first year after the war's end, the Soviet Union's sphere of influence expanded in Eastern Europe. Indeed, while the United States and many of its allies were demobilizing, the Soviet Union seemed focused on consolidating its wartime gains.

Nuclear weapons, Bradbury felt, would play a key role in hedging against Soviet expansionism. As the only facility in the country capable of developing and producing nuclear weapons, Los Alamos had an obligation to continue supplying the nation with the tools to achieve its postwar aims.

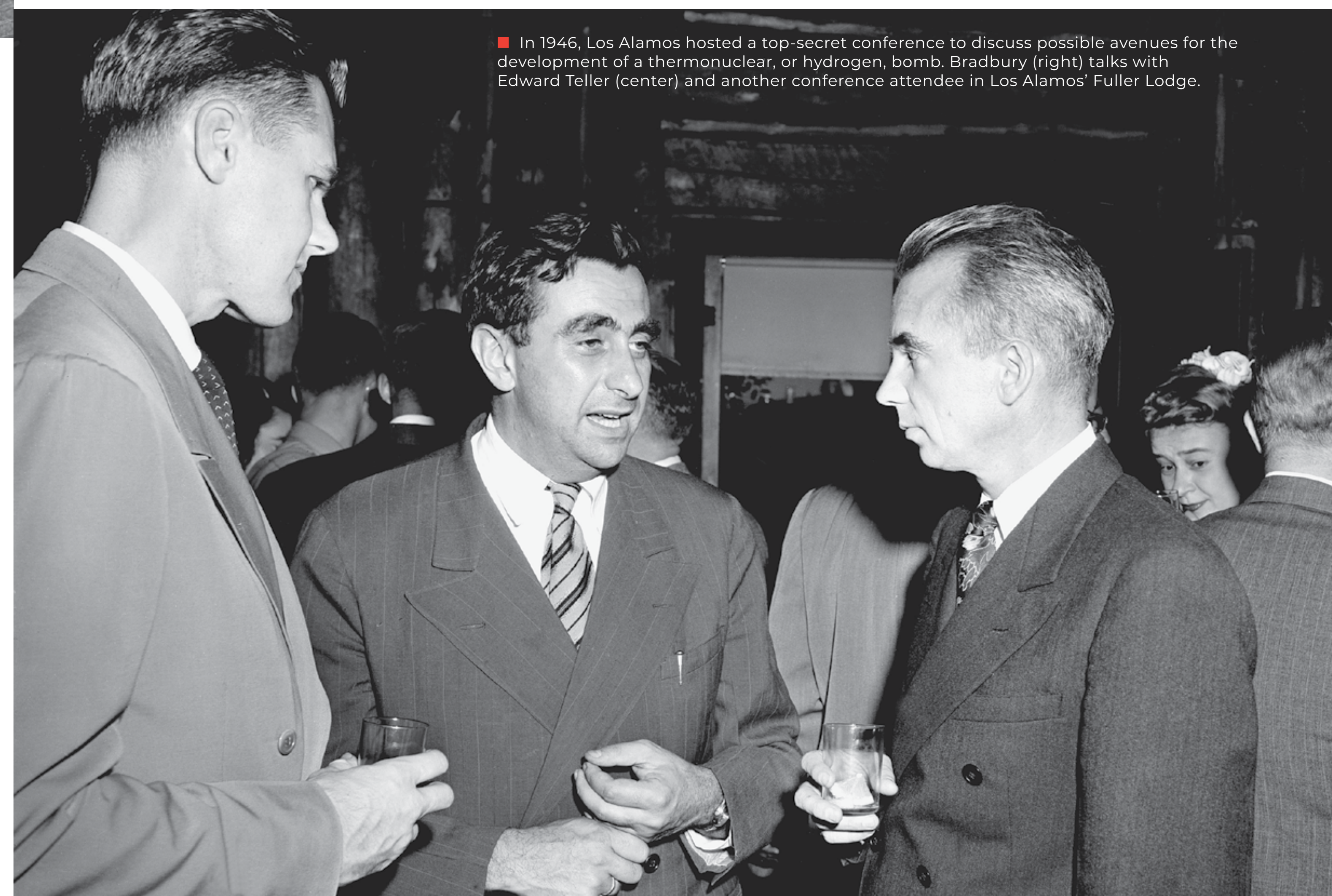
"Bradbury saw that the United States was going to be negotiating new power structures," Lewis says. "He thought that the U.S. should negotiate from as strong a position as possible."

Early struggles

In the first months after the war, Bradbury had his hands full with other challenges, too. In February 1946, the pipes that carried water to Los Alamos froze for several weeks. Tanker trucks carried water from the Rio Grande into Los Alamos for distribution throughout the town. These and other privations (including the town's muddy streets, hastily built housing, and isolation from the outside world) proved too much for some residents. Among those who chose to leave that winter was physicist (and future Nobel Prize winner) Hans Bethe, who had led the Laboratory's Theoretical Division during the war.

Groves, recognizing that better living conditions would be necessary for the Laboratory to attract the personnel it needed, greenlighted major investments in housing and infrastructure in the Los Alamos townsite. (The town of Los Alamos remained property of the Atomic Energy Commission [AEC] and closed to the public until 1957, when the fence that separated it from the outside world was removed.)

Project Y's muddy roads were paved during the early years of Bradbury's directorship.



In 1946, Los Alamos hosted a top-secret conference to discuss possible avenues for the development of a thermonuclear, or hydrogen, bomb. Bradbury (right) talks with Edward Teller (center) and another conference attendee in Los Alamos' Fuller Lodge.

> "I decided I couldn't run a laboratory that would have a future unless I was willing to put my own future on it."
>
> —NORRIS BRADBURY

At the same time that Bradbury worked to manage staff and deal with frozen water pipes, the Laboratory was also tasked with planning the first nuclear tests to take place after Trinity. These tests, called Operation Crossroads, were to be conducted at the Marshall Islands' Bikini Atoll in the summer of 1946.

John Hopkins, who began working at the Laboratory as a student in 1955—and who, over the course of some four decades at the Lab, would come to direct its testing and weapons programs—says that Bradbury's feelings about Crossroads were decidedly mixed. Crossroads was conducted to test the effects of nuclear weapons like the ones detonated at the end of World War II. "Bradbury felt that was a waste of time," Hopkins says. "His thinking was that if you dropped a nuclear weapon on a ship, it was going to sink."

Whatever Bradbury's personal feelings about Crossroads, he recognized that the test series had the potential to galvanize the Laboratory's remaining staff by giving its post-Manhattan Project workforce a common goal. "It gave me something to put people on, and I needed all the good people I could get," Bradbury said. The Crossroads tests took place in July 1946 and provided the U.S. Navy with valuable information on the effects of a nuclear blast on or near their ships (some of which did, in fact, sink).

In the first years of the Cold War, Los Alamos worked to improve the weapons designed during the Manhattan Project. When these weapons were used in Japan, they were so complex that scientists from the Laboratory had to help assemble the bombs just before they were dropped.

Accordingly, one of the Laboratory's priorities was to refine its weapon designs, turning its devices into bombs that could be easily handled and deployed by the military.

Some of this work would take place elsewhere. By the time World War II ended, much of the work to prepare the weapons for combat use had moved south from Los Alamos to an airbase in Albuquerque, New Mexico, forming the basis of what is today Sandia National Laboratories. Outsourcing certain weapons production processes helped ensure that the nation retained its ability to make nuclear weapons should there be an accident at the Laboratory. However, a shortage of space in mountainous Los Alamos played the biggest role in the decision to move certain functions elsewhere.

"It was simply impossible to keep on increasing the activities at Los Alamos," Groves recalled of the decision. "Relief was essential."

Other Laboratory functions soon moved offsite, too. In 1951, the Pantex Plant opened in Amarillo, Texas, becoming the facility tasked with assembling and dismantling the nation's nuclear weapons. Two years later, in 1953, the Rocky Flats Plant near Denver, Colorado, became the nation's primary producer of the plutonium pits that are the cores of nuclear weapons.

These facilities, and others across the country, helped ensure that by the early 1950s, Los Alamos' focus had settled squarely on designing, rather than producing, the United States' nuclear weapons.

Bradbury as leader

As director, Bradbury was known for his humility. "He had little patience for the perks of top management," wrote physicists Harold Agnew (who succeeded Bradbury as director) and Raemer Schreiber (who eventually served as the Laboratory's associate director) in a 1998 biographical memoir of Bradbury.

"His office was strictly functional; no carpeting, no lounge chairs, simply GI office furniture," Agnew and Schreiber wrote. "His usual attire was casual; in fact, if he appeared for work in a business suit, it meant he was expecting VIPs or that he was about to leave on official business. His office door was open all day, except when he was in conference. He answered his phone himself unless he was already on the line."

Although Bradbury had a soldier's self-discipline, he wasn't interested in enforcing the kind of rank-based hierarchy that he'd experienced in the Navy.

"He treated everybody exactly the same," Hopkins says, noting that Bradbury's democratic spirit made him popular with the Laboratory's workforce. "The feeling at the Lab was, 'He really cares about us.'"

Bradbury's unpretentious attitude extended to his life outside the Laboratory. For years, he drove a battered Ford Model A to and from work. With his sons, he enjoyed disassembling and reassembling the car on weekends, and when the vehicle finally grew too decrepit to use, he donated it to the auto shop at Los Alamos High School.

Stories abound about Bradbury's down-to-earth demeanor. One anecdote involves the wife of a new Los Alamos employee who called the Zia Company (which at that time carried out maintenance in Los Alamos' government-owned housing) to help fix a broken thermostat.

By chance, Bradbury had been dispatched by his wife, Lois, to this new employee's house to deliver a message. Bradbury arrived at the house before the Zia Company repairman and, when prompted by the new employee's wife, fixed the thermostat. Having mistaken Bradbury for the repairman, the wife was chagrined when the real repairman arrived shortly thereafter.

The Laboratory's first director, J. Robert Oppenheimer (right), visited Los Alamos for the last time in 1964. Here, Oppenheimer is pictured with Bradbury at the Los Alamos Scientific Laboratory Museum. A photograph of the Trinity test hangs in the background.

Because the town of Los Alamos existed to support the Laboratory, the town's social life was inevitably shaped by the Laboratory, too. This meant that the Bradbury household naturally played an important role in the greater Los Alamos community.

Having inhabited a hastily built apartment during the war, the Bradburys later moved into a house in Los Alamos' Bathtub Row neighborhood (so named because the homes were the only ones in wartime Los Alamos that had bathtubs). In the late 1940s, the Bradburys moved into a spacious new home that commanded an impressive view of the woods and mountains around Los Alamos. Norris and Lois lived in the house for the rest of their lives.

Jim Bradbury recalls that his mother was regularly tasked with organizing social functions. He says that every other month or so, the Bradburys would host a party to welcome new hires to the Laboratory—parties that were enduringly popular with Los Alamos' workforce.

"When I'd talk to people years later, that party was one of the things they'd always mention," Jim says.

The hydrogen bomb controversy

The first four years of Bradbury's directorship were largely taken up with establishing the Laboratory on a firm footing, ensuring that the town of Los Alamos was an appealing place to live, and improving on the designs of the nuclear weapons deployed at the end of World War II. In support of the latter goal, in 1948, Los Alamos led Operation Sandstone, a series of three nuclear tests in the Marshall Islands. But the Laboratory's priorities shifted suddenly after the Cold War began in earnest.

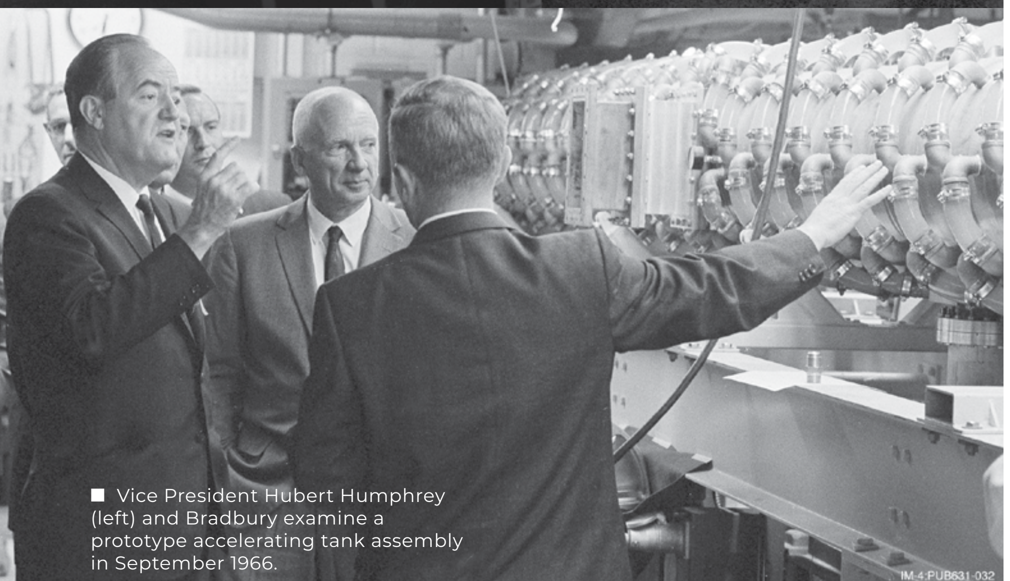
On September 24, 1954, Bradbury gave a press conference in which his tone was unusually defensive.

The occasion was the publication of a book, entitled *The Hydrogen Bomb: The Men, The Menace, The Mechanism*, by *Time* magazine journalists James Shepley and Clay Blair Jr. According to the book, Los Alamos had dragged its heels in developing the world's first thermonuclear, or hydrogen, bomb. (Unlike the fission weapons developed during the Manhattan Project, thermonuclear weapons use fission followed by fusion to produce far greater explosive power.)

The hydrogen bomb debate began in the aftermath of the first Soviet nuclear test, Joe-1, in August 1949. After the test, the General Advisory Committee (GAC) to the AEC, which was led by Oppenheimer, debated whether the United States should develop thermonuclear weapons.

In October 1949, the GAC released a report recommending that the United States not develop thermonuclear weapons. In January 1950, however, President Truman overrode this recommendation and expressed his support for the hydrogen

■ On December 7, 1962, President John F. Kennedy visited Los Alamos, where Bradbury briefed him on Project Rover—the Laboratory's effort to develop a nuclear-powered rocket. U.S. Senator Clinton P. Anderson of New Mexico is at right.



■ Vice President Hubert Humphrey (left) and Bradbury examine a prototype accelerating tank assembly in September 1966.

■ In April 1976, Bradbury welcomed California Governor Ronald Reagan to Los Alamos. At the time, the Lab was managed by the University of California system.

bomb's development. Thermonuclear research, which had always been part of Los Alamos' work, soon assumed pride of place at the Laboratory.

Physicist and Project Y veteran Edward Teller had returned to the Laboratory in 1949. Teller had been fascinated by the possibility of developing a thermonuclear weapon since before the Manhattan Project began. However, he soon clashed with Bradbury, whom he felt had given him insufficient authority over the thermonuclear program.

Frustrated with Bradbury and the Laboratory, Teller left Los Alamos again in 1951. He set about helping to found a new national laboratory, which today is known as Lawrence Livermore National Laboratory. Teller also became a key source for Shepley and Blair's book.

On November 1, 1952, Los Alamos conducted the world's first test of a thermonuclear device, code-named Ivy Mike, in the Marshall Islands. The device used a design that Teller had developed in collaboration with mathematician Stanislaw Ulam at Los Alamos.

Shepley and Blair's book, however, suggested that the hydrogen bomb could have been developed much sooner.

"Shepley and Blair's book came very close to accusing the Laboratory of sabotaging the hydrogen bomb effort," Lewis says. "The book imputed that Teller alone was responsible for the bomb and implied that Livermore had invented it."

Bradbury resented Shepley and Blair's suggestion that a thermonuclear weapon might have been developed any faster. At the 1954 press conference, Bradbury explained that thermonuclear weapons had been researched both during the Manhattan Project and after the war. He further noted that after the Soviet Union's first nuclear detonation, the Laboratory voluntarily adopted a six-day work week in order to develop a thermonuclear weapon sooner.

"THERMONUCLEAR WORK NEVER STOPPED," reads Bradbury's prepared remarks for the press conference (the capitalization is his). He added that if the Laboratory had ceased developing fission weapons to focus only on developing thermonuclear weapons, "The fission weapons stockpile would have been but a fraction of its present size. The essential fission techniques required for practical thermonuclear weapons would not have been developed. Discouragement would have nagged at those who worked in the field without the means for practical accomplishment, and the [thermonuclear] program—and the Laboratory—might have died."

Lewis says that Bradbury's frustration owed to the fact that even before the book's publication, Bradbury had dealt with pressure from leaders in Washington for years, many of whom believed Teller's claims that Los Alamos had failed to pursue the hydrogen bomb with due haste.

That pressure was visible in April 1954, when Bradbury testified at the hearing that famously led to the revocation of Oppenheimer's security clearance. At the hearing, the AEC's lawyers criticized Oppenheimer's reluctance to support full-scale development of thermonuclear weapons. But Bradbury sided with Oppenheimer, stating that while Oppenheimer had been at Los Alamos, Oppenheimer had always supported thermonuclear research (even though the Laboratory didn't yet have the means to develop a thermonuclear weapon).

Bradbury was relieved when, after he delivered this testimony, the AEC's chairman, Lewis Strauss, issued a statement affirming that Los Alamos had done its duty in developing the hydrogen bomb. Bradbury took this statement to have refuted, once and for all, any claim that Los Alamos had failed to adequately pursue thermonuclear weapons development. So, he was piqued when later that year Shepley and Blair insinuated that the Laboratory had failed to develop the bomb as quickly as possible.

"By the time the Shepley and Blair book came out, Bradbury was done with the controversy," Lewis says. "He was frustrated that everyone had come to believe that Teller was the hero and he was the villain."

Carr agrees that Teller's version of events distorts the Laboratory's history. "Going back to World War II, Teller claimed a hydrogen bomb test might be as little as a year away," Carr says. "These were overly simplistic timelines that were completely unrealistic. But Shepley and Blair uncritically accepted the baseless narrative that Bradbury had been dragging his heels."

Carr adds that while Teller's contributions to the hydrogen bomb's development were real, they were inflated in accounts like Shepley and Blair's.

"Teller was a remarkably creative theoretician, but a large team of talented people is needed to manufacture a hydrogen bomb," Carr says. "Teller later acknowledged this, penning an article titled 'The Work of Many People.' Unfortunately, however, the wholly inaccurate appraisal of Norris Bradbury and his Laboratory lingered for decades."

> "I think Bradbury really would have been happier if nuclear weapons had turned out not to be possible."
>
> —JOHN HOPKINS

The Laboratory diversifies

Over the course of Bradbury's 25-year directorship, the nation's nuclear stockpile expanded precipitously. During World War II, the United States produced only two types of nuclear weapons: a uranium gun-type weapon (Little Boy, detonated over Hiroshima) and a plutonium implosion device (Fat Man, detonated over Nagasaki). At its numerical peak in 1967, the nation's nuclear stockpile swelled to 31,255 weapons. By the time Bradbury retired in 1970, Los Alamos had designed more than 60 types of nuclear weapons.

While Los Alamos continued to develop and test nuclear weapons, its mission also broadened. Beginning in the mid-1950s, Bradbury began securing congressional support to expand Los Alamos' mission into other areas.

"In its first decade, Los Alamos was almost purely a weapons laboratory. Everything the Laboratory did was connected to nuclear weapons design or testing," Carr says. "But in the second decade, Bradbury started lobbying to make the Laboratory more technologically diverse. Los Alamos shifted from being a nuclear weapons laboratory to a nuclear science laboratory."

Among other initiatives inaugurated during Bradbury's tenure, the Laboratory carried out pioneering work in nuclear technologies. Project Rover explored the possibility of developing nuclear-powered rockets, and Project Vela saw the development of satellites that could detect nuclear explosions around the world and in outer space. Bradbury supported the creation of the Los Alamos Meson Physics Facility, known today as the Los Alamos Neutron Science Center (LANSCE), which made possible new research into basic nuclear and non-nuclear physics. And beginning in the 1960s, Los Alamos began developing safeguard technologies to help ensure that the development of nuclear power wouldn't lead to the spread of weapons-grade nuclear materials.

"I don't think there is any overall trend in the Laboratory toward either applied or basic research," Bradbury reflected in 1970. "What's obvious is a trend toward diversification. We have many more projects than we did 20 years ago. Many of them are quite small, and many more of them are unclassified. In that sense, we're becoming more like a national laboratory."

Why did Bradbury support diversifying the Laboratory's work? Carr says that Bradbury's attitude toward nuclear weapons—his lifelong hope that the world might someday find a way to ban or eliminate them—may have played a part.

"Bradbury looked forward to the day when weapons might not be necessary," Carr says, noting that Bradbury once said, "Nobody likes nuclear weapons; I hate them. But it has to be done."

Hopkins clearly recalls Bradbury's attitude toward nuclear weapons. "I think Bradbury really would have been happier if nuclear weapons had turned out not to be possible," Hopkins says. "But he also felt that 'These weapons are possible. You can thank nature for that. And since they're possible, we have an obligation to make them as effective and as safe as possible.'"

Bradbury's hope for a world without nuclear weapons received a boost in 1958, when the United States, Great Britain, and the Soviet Union agreed to a moratorium on nuclear testing. For nearly three years, no nation conducted a nuclear test, and a comprehensive test-ban treaty seemed possible.

Lewis says that Bradbury's support for diversifying the Laboratory was in part a response to these developments. Bradbury felt that a greater diversity of work would make it easier to sustain the Laboratory and to retain the scientists who would be needed if testing should resume.

"Bradbury believed that by diversifying, the Laboratory could hold people in reserve," Lewis says. "That way, if testing ended, a moratorium happened, or something interrupted the weapons program, once testing resumed, you could put all those people back onto weapons."

Prospects for a comprehensive test-ban treaty soon dimmed, partly because the first years of the 1960s proved a fraught time for relations between the United States and the Soviet Union. However, in the aftermath of the Cuban Missile Crisis, tensions eased, which led the Soviet Union, Great Britain, and the United States to negotiate the Limited Test Ban Treaty of 1963. This treaty forbade nuclear testing in the atmosphere, in space, or underwater (underground testing was still permitted).

In July 1963, the U.S. Senate's Foreign Relations, Armed Services, and Joint Atomic Energy committees held 11 days of hearings to debate ratifying the Limited Test Ban Treaty. Prominent figures, including Teller and Senator Barry Goldwater, opposed the treaty. But Bradbury testified in favor of ratification.

"I think, in this instance, I may speak for most of my colleagues at Los Alamos," Bradbury said during the hearing. "We have never believed that nuclear weapons were an end in themselves; they are merely tools to an end ... the abandonment of war and most of all, a nuclear war."

Bradbury went on to describe the treaty as a "small but positive step" in the direction of world peace, and to praise the treaty as "the first faint sign of hope that international nuclear understanding is possible."

"I, myself, with considerable knowledge of nuclear things, with some knowledge of their military use, but with only a plain citizen's feelings about people and nations and hopes and fears, would prefer to try to follow the path of hope," Bradbury said. In September, the Senate ratified the Limited Test Ban Treaty by a vote of 80:19.

Later years

In a 1952 magazine article about Bradbury, the director's secretary described his diligence in answering correspondence. "You never saw a man go through a basketful of papers so fast," she said, "and you'd swear he wasn't reading even a fraction of the stuff. Yet, six months later, he'll remember every detail."

In the late 1960s, Bradbury's relentless work ethic began to run up against a shifting political and bureaucratic landscape. By that point, Lawrence Livermore had begun to distinguish itself by developing nuclear weapons that were small but powerful, and to vie with Los Alamos for status as the nation's preeminent nuclear weapons laboratory.

Los Alamos' dominance was also challenged by Livermore's close relationship with the military. Whereas Livermore was willing to work in tandem with the armed forces to design weapons that met military specifications, Bradbury felt that the military should accommodate itself to Los Alamos' work.

"Bradbury's attitude was that we should build the best weapons we could, and then the military could use them," Hopkins says. "Whereas Agnew"—Harold Agnew, the Laboratory's third director, who assumed the role after Bradbury retired—"was willing to work a lot more closely with the military, to find out what it was that the military needed."

Lewis agrees with this assessment, noting that Livermore's close relationship with military leaders gave it an advantage when, in the late 1950s, the laboratories began developing warheads for intercontinental ballistic missiles (ICBMs).

"Los Alamos started falling behind," Lewis says. "The Laboratory was still in the pre-ICBM world, and Bradbury wasn't ready to adapt to that."

Bradbury faced other challenges in the later years of his directorship. Conflicts with Congress led to time-consuming battles over funding and the Laboratory's direction. At the same time, even as Los Alamos expanded—the Laboratory's workforce had swelled to nearly 4,000 people by 1970—

> "If it hadn't been fun, I wouldn't have stayed as long as I have."
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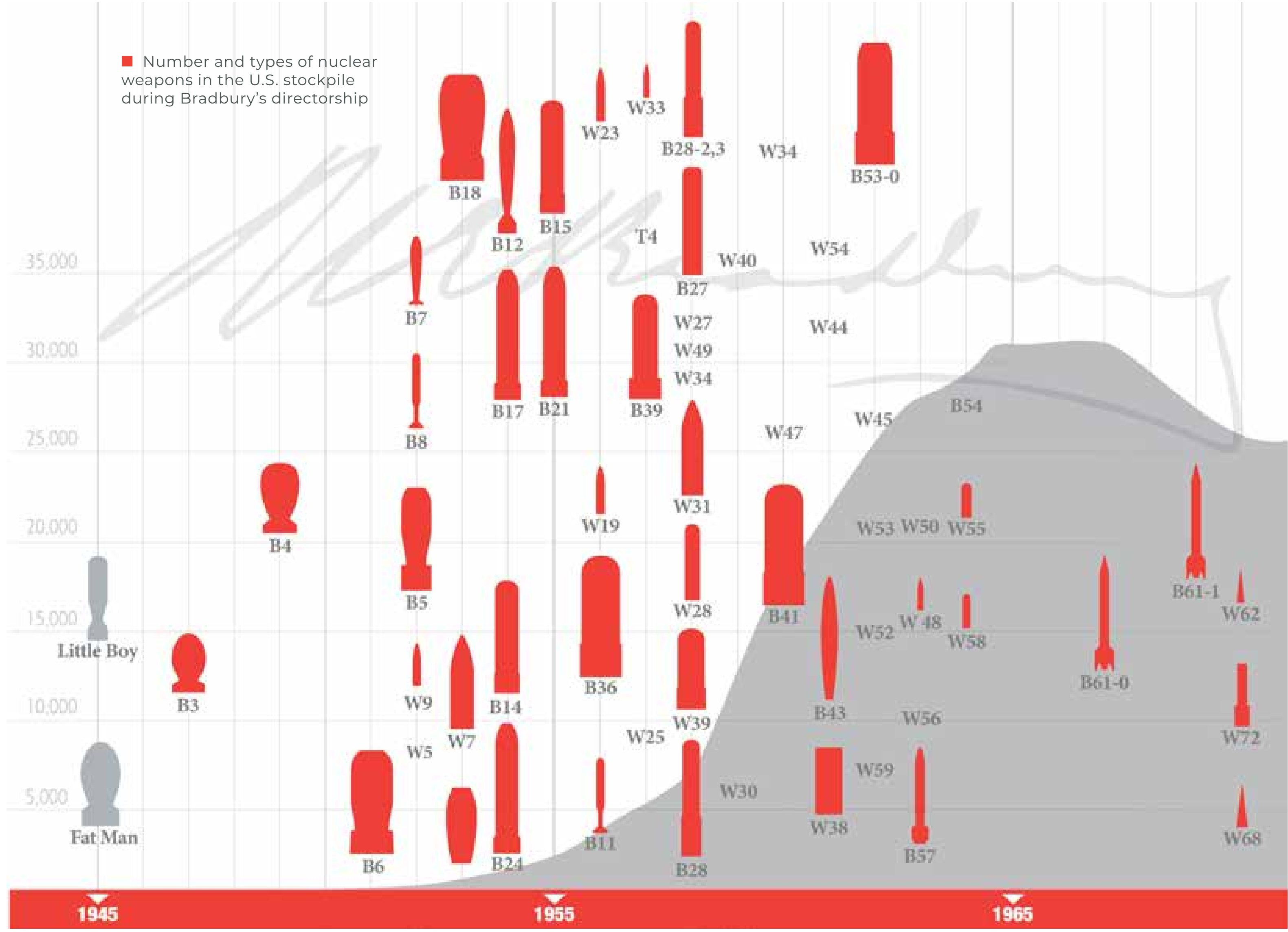


Bradbury retained much of the Manhattan Project's structure, with some 20 division leaders reporting to him directly.

"It really reflects Bradbury's abilities, and his self-sacrifice, that the Lab maintained that structure as long as it did," Lewis says.

Both Hopkins and Jim Bradbury remember that despite—or because of—Bradbury's many responsibilities, Bradbury remained passionate about the Laboratory's mission and engaged with its work. In Jim's recollection, his father's decision to retire owed more to a general conviction that it was time to turn over the reins than to burnout or fatigue.

"I think he said that once he got to 25 years, that would be enough," Jim says.

Like Oppenheimer—who had ended his time at Los Alamos with a speech acknowledging receipt of the Army-Navy "E" Production Award on behalf of the Laboratory—Bradbury's time as director ended with an award.

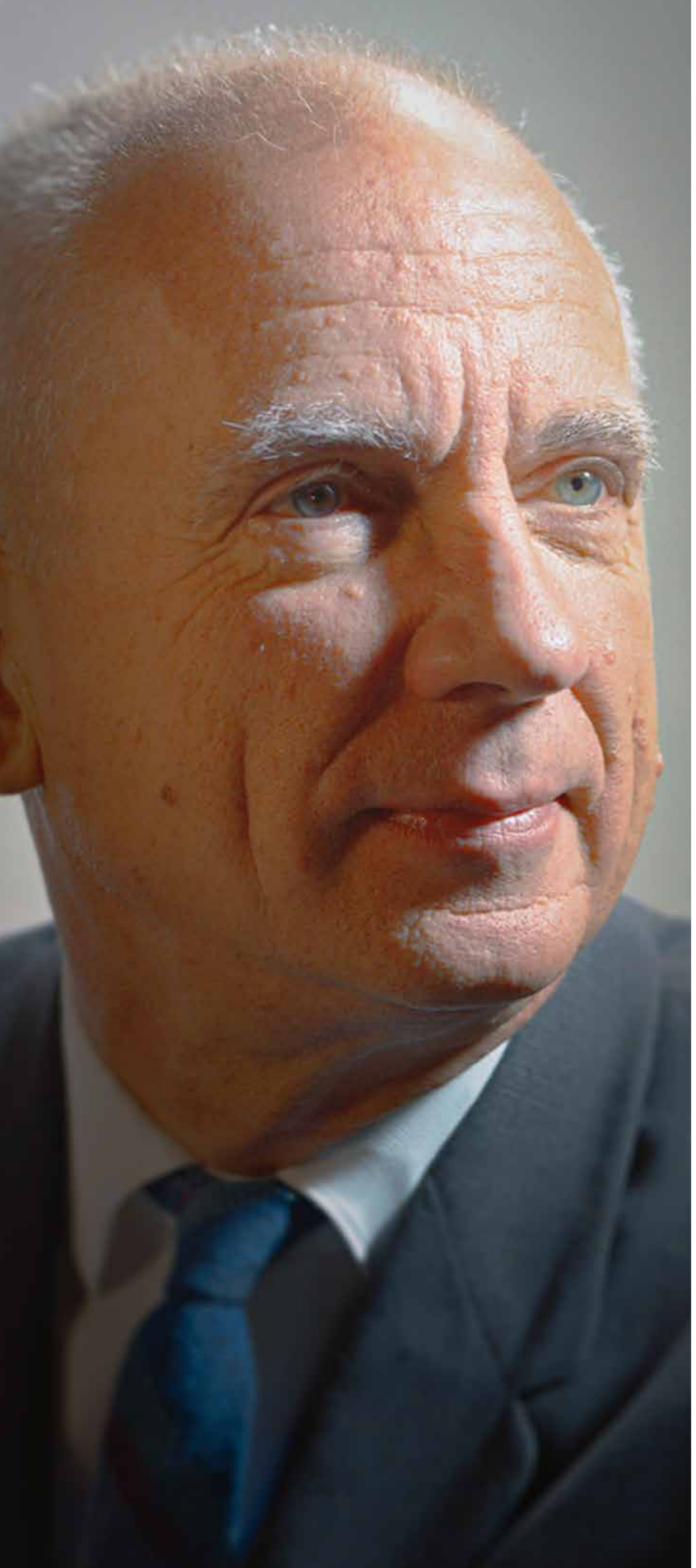
The Enrico Fermi Award—which brought with it a gold medal, a commendation, and a $25,000 prize—was conferred on Bradbury by the AEC. The award's commendation read, "For his inspiring leadership and superb direction of the Los Alamos Scientific Laboratory throughout one quarter of a century, and for his great contributions to the national security and to the peacetime applications of atomic energy."

Bradbury received another recognition in 1970, when the Laboratory's science museum was renamed the Norris E. Bradbury Science Museum. Originally housing classified exhibits, the museum had begun exhibiting documents and artifacts to the public in 1963, hosting some 14,000 visitors in its first year. The museum's name was later shortened to the Bradbury Science Museum and is now located in downtown Los Alamos.

"It's been fun," Bradbury reflected on the occasion of his retirement. "If it hadn't been fun, I wouldn't have stayed as long as I have."

Life after the Laboratory

By his own account, Bradbury wasn't ready to slow down after leaving the Laboratory in 1970.



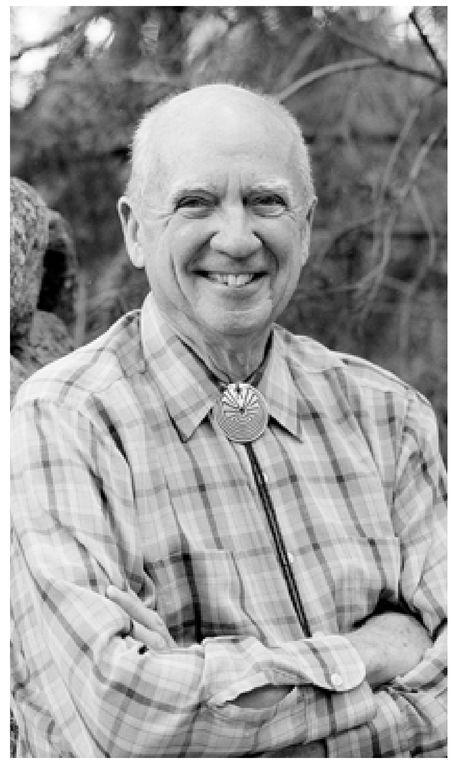
"When a man says he's going to retire, you immediately start thinking about a rocking chair. I'm not ready for one," he said.

Bradbury declined Agnew's offer to serve as a senior consultant at the Laboratory, preferring to devote himself to other pursuits in his adopted home state and beyond. He was fascinated by the art and culture of the Southwest's Native American communities (one of his favorite accessories was a bolo tie bearing a sacred symbol of the O'odham peoples of southern Arizona). As an amateur archaeologist, Bradbury enjoyed traveling on weekends to archaeological sites throughout New Mexico, and in retirement, he served for a time as president of the New Mexico Archaeological Society.

In 1969, Bradbury was appointed to the University of New Mexico Board of Regents. He remained on the board until 1971, and in the years that followed (Bradbury would live for 27 years after he left the Laboratory), he was involved in a variety of other organizations. Among other things, he served on the boards of the Los Alamos YMCA, the Los Alamos Medical Center, the First National Bank of Santa Fe, and the Santa Fe Neurological Society. He was also a consultant to the National Academy of Sciences—a role that necessitated frequent trips to Washington, D.C. With Lois and other family members, he traveled to Scandinavia, India, and Australia—and on trips to Latin America that could no longer be interrupted by Laboratory business.

Bradbury served in various capacities at Trinity on the Hill Episcopal Church in Los Alamos, including as junior warden. In that role, his duties included landscaping—he pulled weeds and took care of flowers in the spring and summer, and he shoveled snow in the winter—along with other unglamorous tasks, like fixing leaky pipes. At home, Bradbury was a passionate woodworker who delighted in making beds, chairs, and furniture for his children and grandchildren.

Bradbury had an abiding interest in the history and culture of the American Southwest. Above, he and Lois display Native American artifacts in their Los Alamos home. Below, he wears a bolo tie featuring the I'itoi, or "Man in the Maze"—a sacred symbol of the O'odham peoples of southern Arizona.



In the early 1990s, Bradbury injured his leg while chopping wood. The injury turned gangrenous, necessitating a leg amputation that confined him to a wheelchair. Bradbury accepted this setback without complaint. He continued to contribute to the Los Alamos community, too, if on a smaller scale. The Bradburys enlisted a nurse to assist them, and, while on daily walks through the neighborhood, Bradbury would sometimes ask the nurse to stop his wheelchair so that he could pull a weed or two from the sidewalk.

Bradbury died in Los Alamos on August 20, 1997, at the age of 88. His funeral, three days later, drew a sizable crowd. In an obituary, Siegfried Hecker, who was then the Laboratory's director, lauded Bradbury for his contributions to the United States' national security and scientific endeavors.

"Norris had the vision and the foresight to recognize that the national security job of the Laboratory wasn't over, but only beginning," Hecker said. "He had the wisdom to recognize the value of laboratories like Los Alamos to the nation in areas broader than national security—helping to strengthen the nation's world position in basic science, plus contributing to civilian challenges such as nuclear energy, magnetic fusion, and the Rover nuclear rocket program. The nation's laboratory system of today owes in no small measure its foundation to Norris Bradbury." ★

FLYING HIGH

over the Land of Enchantment

Location helps Los Alamos scientists test new technology.

BY JILL GIBSON

“We’re doing some things that can only be done in New Mexico.”

—STEPHEN JUDD

Location, location, location—it’s the key to home sales, but location matters to national security experts, too.

Los Alamos National Laboratory’s New Mexico location has led to numerous advantages and collaborations. These benefits are particularly evident when it comes to finding faster, more affordable ways to test new weapons technology and components. “We’re doing some things that can only be done in New Mexico,” says Stephen Judd, manager of the Lab’s Stockpile Responsiveness program (SRP).

Judd explains that the SRP began in 2018 with a Congressional mandate to the U.S. Department of Energy (of which Los Alamos is a part) to “exercise all aspects of the nuclear weapons life cycle” while speeding up the pace of accomplishments and lowering costs. The program’s ambitious goals include rapidly prototyping, producing, and testing technology and systems; shortening the design, certification, and manufacturing process; minimizing both time and cost involved; and transferring knowledge from one generation to the next.

Thanks to an ideal location in the Land of Enchantment, the Lab is meeting those lofty goals in record time. “We’re proving we can do this,” Judd says. “Building new technologies, launching systems out of the atmosphere to test them, and moving at speeds we haven’t achieved in years. The world is changing rapidly, and keeping up with our adversaries requires responsiveness.”

Sending science soaring

For Los Alamos scientists, a key aspect of stockpile responsiveness involves flight testing: launching payloads—a combination of newly developed weapons systems, components, and technology—on rockets. Flight testing provides information on how systems behave in real environments, such as the vacuum of space or extremely high or low temperatures, and at varying accelerations, velocities, and pressures. Compared to computer simulations or ground testing, flight tests determine how things work (or not) out in nature, in environments similar to those experienced in an intercontinental ballistic missile launch.

■ Mechanical engineers Logan Ott (left) and Justin McGlown make final adjustments to the titanium flight vehicle that was specially manufactured for an upcoming flight test.

During these flight tests, the rocket enters space but does not complete an orbit of Earth. Instead, the rockets take a suborbital flight: a brief jaunt above New Mexico.

Throughout the flight, the onboard telemetry system transmits data from the rocket to a nearby satellite. This data provides scientists with real-time information about the performance of the payload, revealing how their experiments and technology function during flight. As the rocket reaches the apogee of its flight (the farthest point in its orbit from Earth), it releases the research payload, which is monitored by scientists during its return fall.

Descending at supersonic speeds, the payload hits the ground in White Sands Missile Range (WSMR), where it is retrieved by scientists. Then it’s back to the lab to analyze data and the post-flight status of the payload.

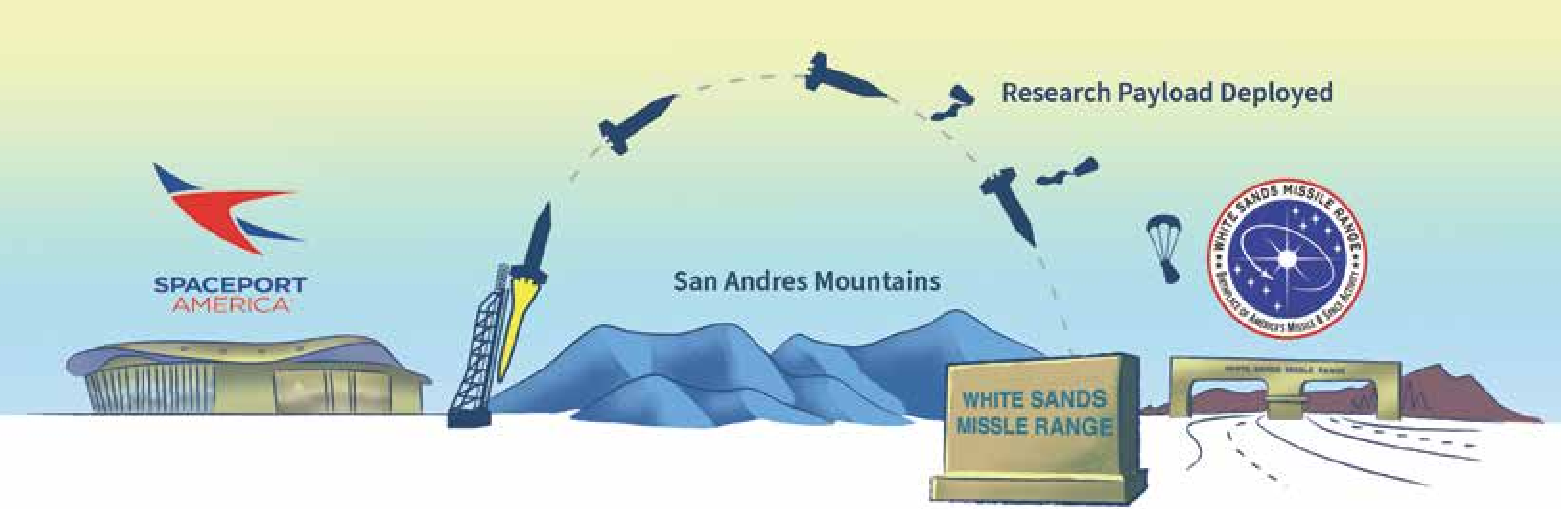
Since 2021, the SRP team has conducted three test flights and is preparing for five more launches in late 2024 through fall 2025. Along the way, Judd and his colleagues have learned to make the most of their resources, many of which are tied to location.

The land of advantages

Judd points out that New Mexico has a lot to offer, including a commercial space launch provider, an Army missile range, and vast, largely unoccupied stretches of desert.

“New Mexico is an ideal place for flight testing—it’s very controlled,” he says. “Flying over an ocean involves a lot of logistics and can be very expensive and time consuming, and limits what we can test.” The New Mexico desert provides a complementary capability that simplifies many aspects of flight testing and dramatically lowers the cost. During the Cold War years, the United States often conducted flight testing in New Mexico. “The SRP is reestablishing that capability,” Judd says. “We’re getting the band back together, so to speak.”

Flying over that desert wouldn’t be possible without the U.S. Army-operated WSMR, the largest (3,200 square miles) fully instrumented open-air test range in the Department of Defense. Markus Hehlen, the Lab’s senior project leader for agile space, says White Sands sometimes serves as a launch site and always provides expertise in tracking payloads, collecting data, and other important monitoring and measurement tasks. “White Sands adds technical capabilities



that allow our team to make measurements that you can't make anywhere else in the world," he says.

The third crucial New Mexico advantage became clear when commercial space flight came to the state. Several companies began holding launches in New Mexico using Spaceport America, a Federal Aviation Association (FAA)-licensed launch complex built and owned by the State of New Mexico. Spaceport America provides launch space and services to companies in the commercial aerospace industry, including Richard Branson's Virgin Galactic. "We thought, if commercial companies like SpaceX and RocketLab can do orbital launches at low cost and high cadence, why can't we partner with industry and use Spaceport America or White Sands to do something similar for suborbital launch?" Judd says.

The SRP currently works with two private companies, Up Aerospace and X-Bow (pronounced "crossbow") Systems. Other flight companies have expressed interest in partnering with the Lab. "The more tools in our toolbox, the better" is Judd's response, though he won't say if more partnerships are in the works.

"The world is changing rapidly, and keeping up with our adversaries requires responsiveness."

—STEPHEN JUDD

Judd says that partnering with commercial flight companies allows the Lab to conduct tests at a much lower cost than typical tests over the Pacific Ocean. Those flights can run \$50–100 million each, whereas current tests can be conducted at \$5–10 million, a full order of magnitude cheaper (and faster). "The nuclear enterprise is wrestling with the need to become competitive with our adversaries," Judd says. That's where the revolution in commercial space flight and the number of companies competing to serve new aerospace customers has been a boon for the United States, according to Judd. "Our advantage is that we have a huge, distributed industrial base."

A match made in New Mexico

New Mexico–based X-Bow Systems is one of the private aerospace companies Los Alamos uses to leverage the advantages of commercial space flight. Jason Hundley, X-Bow CEO, describes his company's collaboration with Los Alamos as "the perfect private-public partnership." Hundley says X-Bow and the Lab have worked together on two flights so far. "At each launch, their guys are working with our guys, and it has created a really good learning system. It allows us to bring a very evolvable approach to the flight-testing needs."

Hundley notes that one of the key factors behind the successful partnership is his company's New Mexico location—X-Bow's headquarters are in Albuquerque, and it has the ability to launch rockets from Spaceport America or White Sands. "It's a unique place. We do the launch vehicle design; Los Alamos brings the payload; we drive four hours to White Sands to conduct the physical launch; and we can be home for dinner. New Mexico has the infrastructure and capabilities both X-Bow and the Lab need."

Despite the many advantages, partnering with private industry has also created new challenges. "For instance, how do you put a classified part on a private rocket?" Judd says. But the SRP team is accustomed to solving problems. "There are a lot of things to think through and many groups that have to be involved—security, classification, even the FAA. How do you ship and store a classified part? How do you recover it? There are zillions of details that have to be worked out."

One thing that has helped the SRP team tackle those details is the Laboratory's proximity to the flight locations. "The fact that we can hop in the car and drive to White Sands is incredibly helpful," Hehlen says.

Judd says when SRP began, the relatively close location of Spaceport America made it possible for the Lab's security officers to visit the launch site and get an in-person look at how security issues would be handled. "That made a huge difference in our ability to address security concerns." As it turns out, launching classified experiments on commercial rockets is possible with considerable help from the Lab's security groups, and without having to get security clearances for everyone involved. "To us, it's just a payload," Hundley says.

Putting the 'new' in New Mexico

For the planned 2024 launches, the SRP team is taking things one step further. Los Alamos scientists are working with both X-Bow and Up Aerospace companies to build new rockets that are specially tailored to the Lab's testing needs. "For the first time in decades, we're using entirely new rockets to conduct testing," Judd says. "It's state of the art."

The new rocket family from Up Aerospace is called Spyder, while X-Bow is developing a new XL rocket family for modular launch. Whereas decommissioned Department of Defense rockets are commonly used for flight testing, these new rockets will not be made of any parts that are repurposed from older rockets or reused technology. People in the industry often use the term "frankenrockets" to describe rockets assembled out of a variety of used parts.

Judd says everything about the new rocket will be based on the Lab's specifications. "We get to guide the development of these rockets, so they meet our testing needs," he says.

"This is a national lab's job—high risk, high payoff; doing something no one has ever done before."

—STEPHEN JUDD

The rocket isn't the only thing that will be new. "We usually take something we already know works and change one thing—but this time everything is new," Hehlen says. "We will use a new telemetry system, new satellite, new guidance package, new flight vehicle, new designs, and a new thermal protection system. We developed all of these at Los Alamos."

The team turned to another New Mexico partner to construct a flight vehicle, the cone on the end of a rocket that holds the payload. The flight vehicle holds the components and technology the Lab is testing. Kansas City National Security Campus' New Mexico branch, located in Albuquerque, built the flight vehicle using a unique process and material.

"We collaborated with the Kansas City team to develop an additively manufactured titanium vehicle," Judd says. In the past, flight vehicles were built using a forge, which

Dylan King, a visitor touring the Lab, lifts the lightweight flight vehicle.

In June 2023, Los Alamos partnered with X-Bow Systems to launch a rocket from White Sands Missile Range.

> "The fact that we can hop in the car and drive to White Sands is incredibly helpful."
>
> —MARKUS HEHLEN

was expensive and did not allow for easy modifications. Judd says the new process represents a dramatic change. "Titanium is light, strong, and has a high melting point. The additive manufacturing process allows us to make rapid modifications. The flight vehicle is 5 feet tall and weighs just 40 pounds. You can pick it up."

For now, the shiny metallic flight vehicle sits upright in the corner of a small room at Los Alamos National Laboratory, waiting for the day it will soar over New Mexico. Logan Ott, a mechanical engineer, leans over the titanium frame, making final adjustments. "See, the whole thing goes together like this," he says with one last turn of the screwdriver. "Inside, we'll put the experiments and equipment we are testing. Then we will take it to the launch site and connect the flight vehicle to the rocket."

The flight vehicle looks like a simple cone, but construction of this crucial component required innovation. "The Kansas City New Mexico team uses electron beam additive manufacturing," explains Los Alamos mechanical engineer Justin McGlown, one of the researchers on the project. "It's similar to building a piece of coiled clay pottery," he says, lifting the large piece to demonstrate how light it is.

Building the first titanium flight vehicle took a year and a half and required close collaboration between the Kansas City and Los Alamos teams. Along the way, the scientists learned many lessons. "Did you know that you can't weld titanium in open air?" Judd asks. To address this problem, the Kansas City New Mexico engineers came up with a new approach during the welding process. They have perfected and sped up the titanium flight vehicle manufacturing process and are exploring ways to apply that technology to other projects. "This just demonstrates we can build new things… big things. This faster, more affordable process is a key enabler of responsiveness that wasn't available 30 years ago," Judd says.

He adds that the convenience of the Kansas City team's New Mexico location helped streamline the process. "It was all done by working together. Many, many meetings in person. Changes on the fly in real time… a radical approach of talking to each other—that's responsiveness too."

Collaboration within and beyond state lines

Bringing people together lies at the heart of the SRP. Hehlen points out that the project's size demands collaboration. "We have approximately 100 people working together across 10 to 15 divisions of the Lab."

Los Alamos collaborated with Kansas City New Mexico to manufacture this titanium flight vehicle. For more on Kansas City New Mexico, see p. 6.

Jordan Shoemaker, a research and development engineer for one of the upcoming flight tests, says that the SRP helps make connections on all levels. "We are developing teams and exercising the responsiveness part of our mission. It takes a lot of conversations to get the final design—weekly team meetings with physicists and engineers sitting in the same room working to develop something that works and that can be built."

"The SRP team isn't just building connections within New Mexico—they're reaching overseas. One of the upcoming flight tests will be a joint venture with the United Kingdom (UK) Ministry of Defence. Collaborating with British scientists is not new for Los Alamos. The Lab has worked closely with the UK since the beginning of the Atomic Age, and the two countries signed a bilateral treaty in 1958 providing for the exchange of defense information related to nuclear weapons.

Alan Novak, the Lab's project manager for the UK flight tests, explains that working with British scientists will further develop both nations' flight testing capabilities. "The Los Alamos SRP team is proud to continue the long partnership with the UK," he says. "Working with an allied nation in establishing low cost, high cadence flight test capabilities is mutually beneficial. We have a lot of work ahead of us, but we have great teams."

It grows as it goes

Crescit eundo or "it grows as it goes" is the New Mexico state motto, a statement designed to express hope for the state's future. This motto also applies to the SRP, given the team's optimistic attitude and acceptance of failure and risk. "We want to give people the opportunity to try new things and learn by doing," Judd says, noting the program's emphasis on training early-career scientists by allowing them to take risks.

When Rayni Jules, an engineer working in the SRP, graduated from Vanderbilt University four years ago, he didn't plan to join a team that flight tests new nuclear weapons technology, but he says he finds the field exciting. "I'm learning as I go," Jules says. "It's high-stakes learning, but it works."

"We set out to try a new way of doing things," Judd says. "This is a national lab's job—high risk, high payoff; doing something no one has ever done before."

Judd points out that the SRP mission fits in with the Lab's Manhattan Project legacy. "When this Lab built the atomic bomb—nobody knew how to do that. It was all new."

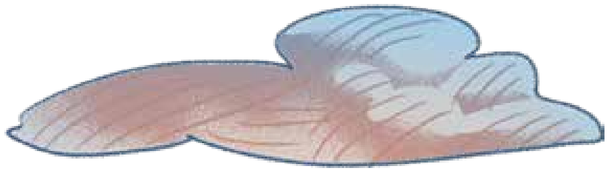
Hehlen says managing risk is a balancing act. "Since SRP's inception, we have been trying to do things at a much faster pace than ever. To do things faster, you must be cognizant of risk and push hard enough to learn as much as possible. We don't want to be too safe. We are open to expect failures, but we want to fail upward."

One way the team manages risk is by building redundant data collection systems that include using radio links, satellites, and onboard sensors. "Part of learning from failures is figuring out how to discover when something goes wrong during spaceflight," Hehlen says.

There have been setbacks and challenges in multiple areas, but Judd points out, "Failure is how you learn."

With several launches coming up in the next few months, Judd says he's looking forward to future failures. "Both confidence and humility come from experience. Our question is always, 'Will it work?' If it doesn't work, 'Why not?' Failure is a positive result."

Plus, Judd notes, the program has already achieved some successes. "Just looking at the benefits we've realized from working with our many New Mexico partners is exciting," he says. Soon, the SRP team will watch another rocket carry Los Alamos experiments high into the turquoise sky over the Land of Enchantment. "Each flight pushes harder, and with every flight we learn." ★

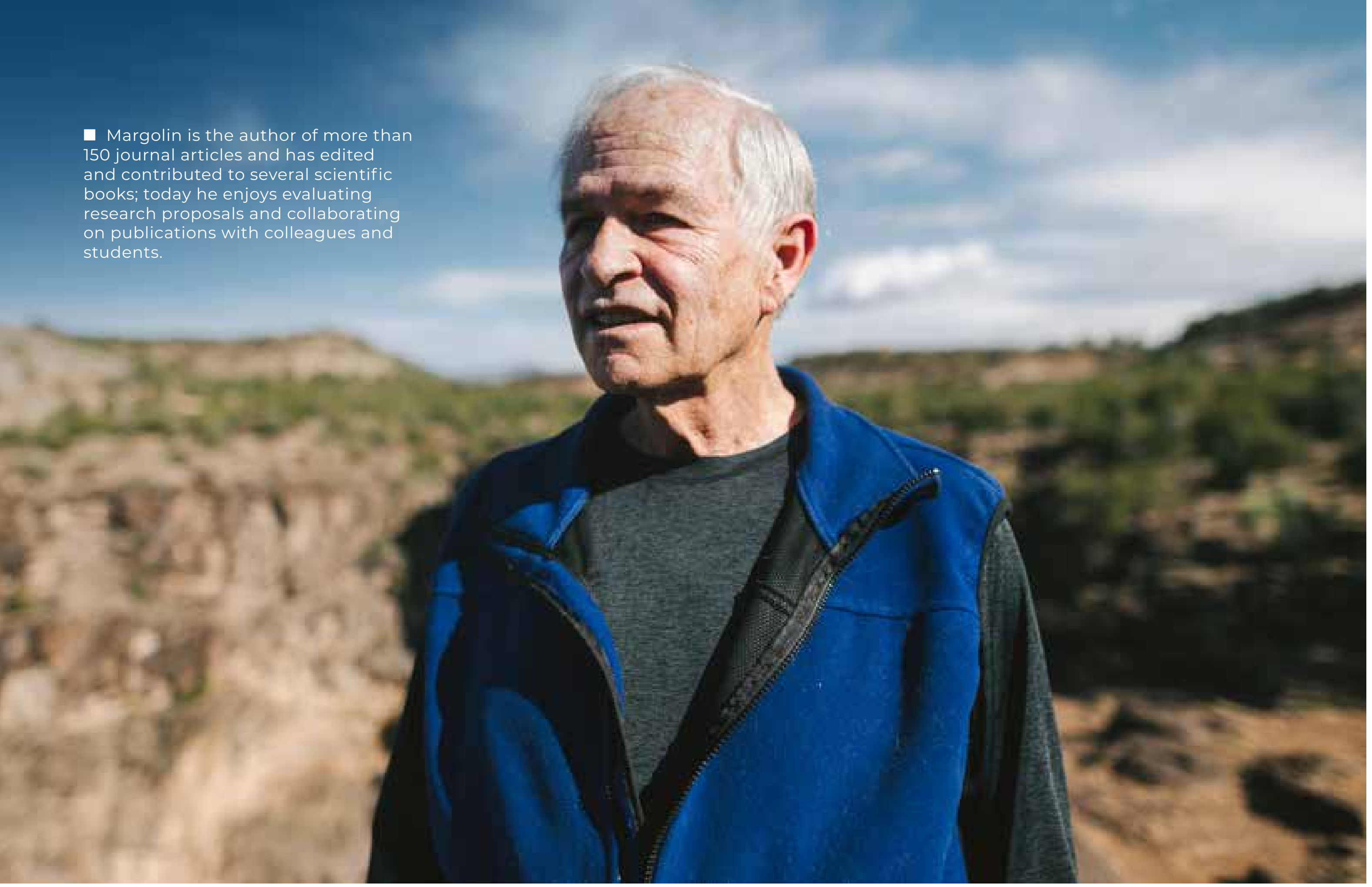


■ Rock climbers explore the cliffs of White Rock Canyon, near Los Alamos. The top climber navigates Len's Roof, an overhang named after Len Margolin, an avid climber, mountaineer, and Los Alamos physicist.
Photo: Jason Halladay

Mentor of Methods & Mountains

Physicist and mountaineer Len Margolin celebrates more than half a century of science and adventure at Los Alamos National Laboratory.

BY JILL GIBSON



■ Margolin is the author of more than 150 journal articles and has edited and contributed to several scientific books; today he enjoys evaluating research proposals and collaborating on publications with colleagues and students.

22-year-old Len Margolin knew something was wrong when he saw the Los Alamos Scientific Laboratory security fence. He was on the wrong side of the fence—the inside—without his Lab credentials. Even as a brand-new employee, on the job less than a week, Margolin recognized a major security violation. Then, with lights flashing, the Lab security officers pulled up.

Margolin remembers the incident, which occurred in July 1969, like it was yesterday. "I had finished work and was headed out for a run by the east gate of town, when I spotted a rock cliff leading into the canyon below. So, I decided to climb down." As he faced the security officers, he realized that his desire to explore had landed him in a difficult situation.

The officers took Margolin into custody. "They called my boss. He wasn't too happy with me," Margolin says. Nevertheless, the young physicist wasn't about to stop climbing, hiking, and exploring. Today, as he celebrates 55 years as a Los Alamos National Laboratory employee, Margolin still spends his time hiking the mountains of northern New Mexico and Colorado. He can say with a smile that it all worked out.

The climb from New Jersey

Margolin graduated from high school in Jersey City, New Jersey, and went on to The Cooper Union in New York to earn dual degrees in physics and math. He continued his education at the University of Michigan, pursuing a PhD in physics during the Vietnam War.

After graduating, "I had to find a useful job or join the Army," Margolin remembers. In school, he had studied quantum field theory, a mathematical and conceptual framework for particle physics and other areas of theoretical physics, but he was also interested in the early use of computers.

Computational physicists use high-speed computing to investigate complex physical systems and solve scientific problems requiring large data sets that can only be dealt with through highly automated high-speed processing and storing.

"In the late '60s, the physics community at large didn't believe in computational physics," Margolin says. "They thought the computer was a very good way to solve equations quickly, but they did not view it as a discovery tool."

But Los Alamos was different. In addition to crisp mountain air, soaring ponderosa pines, and proximity to uncharted places to hike and climb, "people here knew about computational physics and took it seriously," Margolin explains. "We had some of the fastest computers available, and it was exciting to come to work with people who understood their value."

Over the years, Margolin has pioneered creating methodologies used in the Lab's computer modeling and simulation codes. These codes produce three-dimensional models that allow scientists to understand the performance and reliability of the nuclear weapons in the nation's stockpile. Since 1992, when the United States began a moratorium on underground testing, scientists have used computer simulations instead of conducting live tests of nuclear weapons. Margolin's work serves a crucial role in national security.

"I'm still here because I enjoy what I do, and I can immodestly say I'm very good at it," explains Margolin. "I'm working on things right now that I think are very important for science. Think how lucky we are to go to work every day and say, 'Boy I'm glad I'm here.'"

Margolin's group leader, Abigail Hunter, says Margolin's positive attitude is contagious. "Len has had a huge career at the Lab and has been here for so many decades, but the fact that he's still so excited about and engaged with his technical work makes me feel like I have something to look forward to in my own career," she says. "Just to have that passion and excitement in your work after 55 years is both rare and inspiring."

The cliffs of technology

When Margolin first started work at Los Alamos, the Lab had some of the world's fastest computers, but "fast" was relative.

"When I got here, we were still working on the IBM Stretch machines," Margolin says. IBM built Stretch, a large-scale (mainframe) computer considered the world's first supercomputer, to meet the rigorous computing requirements of government laboratories conducting nuclear weapons research. Scientists often needed to carry out more than 100 billion arithmetical operations to evaluate a weapon's design. Before Stretch, the world's fastest computers needed six months to solve one of these problems. Stretch was much faster, but remember, that's fast in late '60s terms.

"Maybe once a day you would get an answer," Margolin says. "The rest of the time, you'd wait."

Back then, data was stored on punched cards, pieces of stiff cardboard with tiny rectangular holes. Computer operators fed the cards by hand into the machine. Margolin remembers bringing long trays of cards, called decks, to the operator and waiting for hard copy printouts of the results. "Some scientists weren't nice to the operators, and sometimes their card decks would mysteriously be lost," Margolin recalls with a laugh.

As technology at the Lab evolved, Margolin was always at the forefront of the newest developments. "In 1973, I became the first person at the Lab to get a computer terminal with a screen," he says. "Harold Agnew, who was the Lab director at the time, stopped by my office to see it. He liked it so much that he bought a bunch."

Today, Margolin says he's grateful for the Lab's high-speed computing power. Even his laptop far exceeds the abilities of those early machines. "Now I hit the button, and my Mac is so fast that I have an answer before my hand comes down—that's how great things are."

> **"I'm working on things right now that I think are very important for science."**
>
> —Len Margolin

Margolin appreciates modern technology, but he says he is still learning about the newest technological gamechanger, artificial intelligence (AI). "Many of the younger scientists in my area are focused on AI," Margolin says. "Although I don't believe AI will replace human creativity and intuition in the near future, it can be a valuable tool for a multitude of applications at the Lab."

"When I mentor people," Margolin continues, "I don't try to teach them the answer. I ask them, 'What are the questions?' When you find the right questions, you'll find the right answers. One of the questions we should be asking is: 'How can we use AI to help reach our goals?'"

The heights of history

The evolution of computers is just one of many dramatic changes Margolin has seen during his time at the Laboratory. "When I first came here, Norris Bradbury (see p. 32) was still the Laboratory director. In those days, we were about 3,000 people, 16 technical divisions, each with a division leader, and then the Lab director—that was all the management there was." Today, the Lab has approximately 18,000 employees across countless divisions, groups, teams, programs, and levels of management that didn't exist when Margolin started his career.

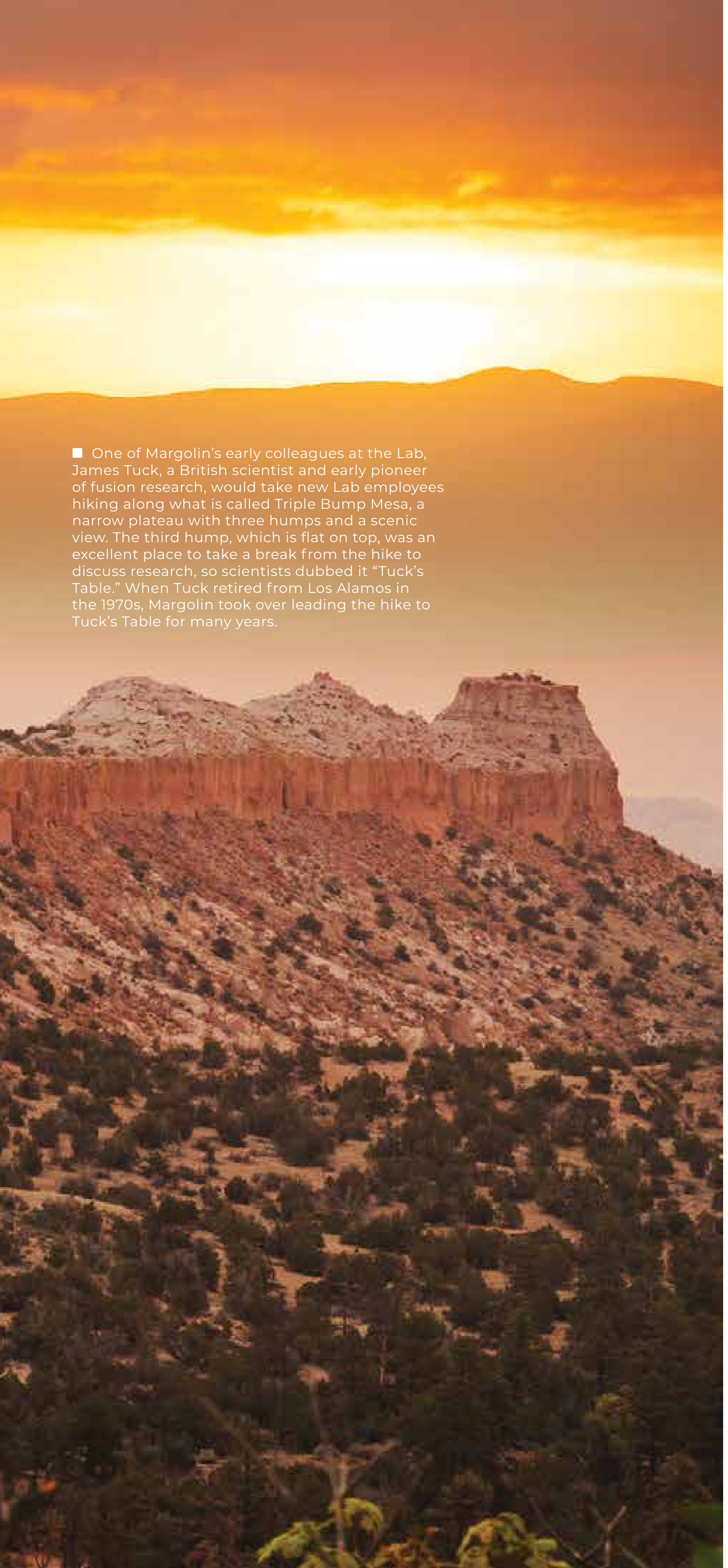
Hunter describes Margolin's lengthy tenure at Los Alamos as invaluable. "He has seen the Lab change over decades and is one of the few people who understands the history of the decisions that have led to where we are now." She says she's glad Margolin has no plans to retire soon, but she worries that when he finally leaves Los Alamos, a wealth of information will leave with him.

Recently, following a visiting scientist's presentation about coding, Lab employees gathered around Margolin to get his perspective on the talk. Dressed in worn jeans and a plaid shirt, the gray-haired man commanded an audience. "People seek Len out," says Nathaniel Morgan, one of Margolin's colleagues. "He knows the background and the history behind the codes we work with every day."

Morgan describes Margolin as "an invaluable resource," saying, "Len has a unique eye from a theoretical physics background." Morgan adds that Margolin often questions and challenges early-career scientists, pushing them to examine underlying physics, rethink any assumptions, and revisit historical methods. "Everyone tends to circle around Len because he's the only one left with this indispensable understanding of the past that is so necessary to help us move into the future," Morgan says.

The mountains of mentorship

Fortunately for Morgan and others, Margolin is passionate about helping graduate students,



One of Margolin's early colleagues at the Lab, James Tuck, a British scientist and early pioneer of fusion research, would take new Lab employees hiking along what is called Triple Bump Mesa, a narrow plateau with three humps and a scenic view. The third hump, which is flat on top, was an excellent place to take a break from the hike to discuss research, so scientists dubbed it "Tuck's Table." When Tuck retired from Los Alamos in the 1970s, Margolin took over leading the hike to Tuck's Table for many years.

postdocs, and early-career colleagues. "My idea of mentoring is to do something together—not to lecture someone—to work together and help someone learn," Margolin says. "I find enjoyment from watching people learn and grow."

Scientist Jesse Canfield has benefited from Margolin's guidance. "Len is a good role model," Canfield says. "He has worked on everything in weapons physics at the Lab and has a good background and perspective."

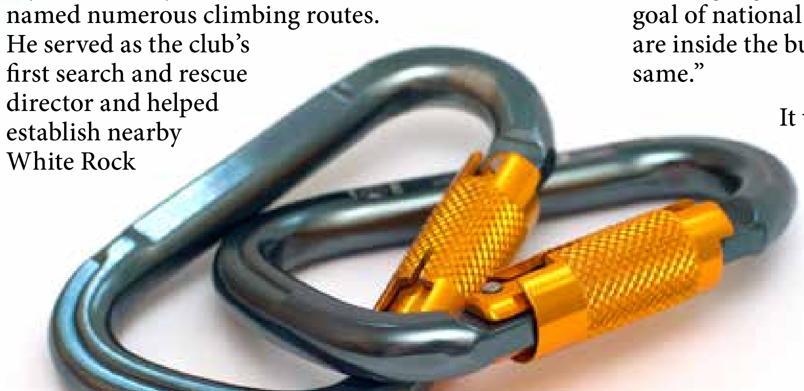
Hunter describes Margolin as generous with his time when it comes to mentoring. "He does a good job pulling in early-career staff and never works in a vacuum," she says. "He's very good at working with people and helping his colleagues become technical leaders on their own."

Margolin himself was mentored by two of the Laboratory's most distinguished scientists, Bob Thorn and Frank Harlow. "Those two brilliant men made a huge difference for me," he says. Thorn was the supervisor who hired Margolin, and Harlow was Margolin's thesis advisor, a Laboratory Fellow, and known by some as the "father of computational fluid dynamics."

Ascending new peaks

One of the constants throughout Margolin's 55 years at the Laboratory has been hiking and rock climbing. "I spend all my time doing science, and I think that being creative takes a lot of energy," he says. "You need to be able to go somewhere where you can really regenerate yourself. The mountains are that for me."

Margolin's interest in the outdoors helped him form friendships. He joined the Los Alamos Mountaineers and became one of the more active members of the group. "For many years, I kept my climbing gear in the trunk of my car for whenever someone called to say, 'Let's go climbing tonight,'" Margolin says. Over the years, he discovered and named numerous climbing routes. He served as the club's first search and rescue director and helped establish nearby White Rock Canyon as a key place for top rope climbing, a form of rock climbing where an anchor holds the climbing rope from above.



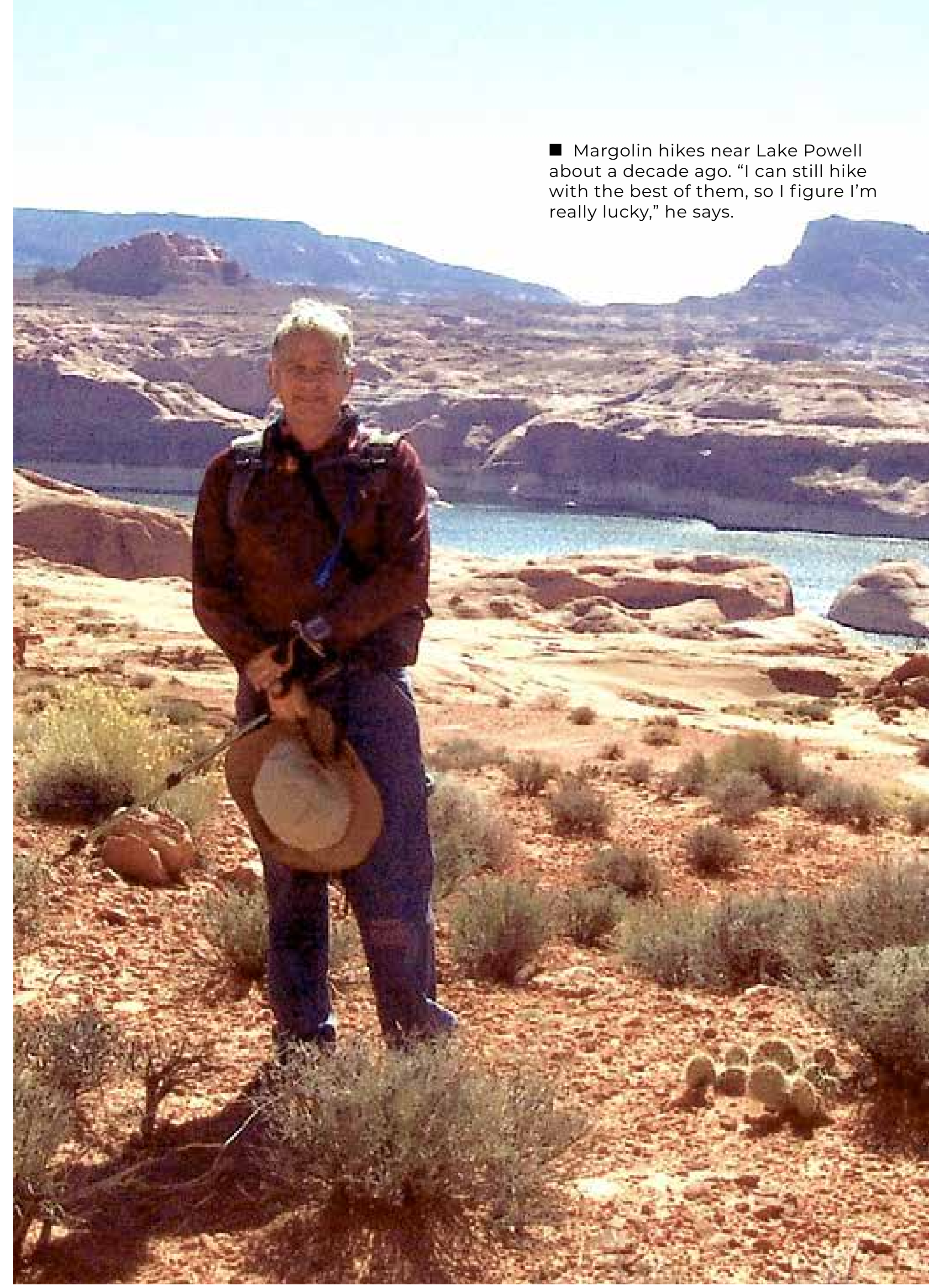
Margolin also spent many years climbing the Brazos Cliffs near Tierra Amarilla in northern New Mexico. The approximately 3,000-foot-high escarpment offered endless climbing opportunities. Margolin and several of his Lab coworkers spent numerous weekends exploring the challenging cliffs.

In 1975, Margolin had the chance to explore a new set of mountains when the Laboratory sent him and three geologists to take measurements at Mount Baker, a volcano in Washington state that had just become active. Margolin recalls that their expedition was prolonged by a 5-foot snowfall and whiteout conditions that stranded them near the top of the mountain for an extra two days. Despite (or perhaps because of) those challenges, his love of the mountains continued to climb.

After ascending many of New Mexico's highest peaks, Margolin began summiting "fourteeners," mountain peaks with elevations of at least 14,000 feet above sea level. Although New Mexico has no fourteeners, there are more than 50 such peaks in Colorado and 1 in Washington State. He climbed all of those and then learned that there were about a dozen more fourteeners in California.

"California is also the home of Los Alamos' sister laboratory, Lawrence Livermore National Laboratory," says Margolin. "So, in 1985, I moved there to work for Livermore, climbed all those fourteeners, and then I came back to Los Alamos." Because the University of California operated both labs at the time, Margolin's employment at Livermore counts toward his 55-year service anniversary. "At Los Alamos, we joke about competing with Livermore," he says, "but the truth is we are all working together toward the same goal of national security. When you are inside the buildings, it's exactly the same."

It was what rose just beyond some of those buildings—the mountains of northern New Mexico—that drew Margolin back to Los Alamos only five years after he left. He has lived in New Mexico, hiking those mountains, ever since. Margolin admits that at 77 years old, climbing mountains is a bit harder than it once was, but says, "I have good health and I can still hike with the best of them, so I figure I'm really lucky."



Margolin hikes near Lake Powell about a decade ago. "I can still hike with the best of them, so I figure I'm really lucky," he says.

Margolin's other interests are evident in his favorite Star Trek episode ("Darmok" from *Star Trek: the Next Generation*), his favorite movie (*I, Robot*), and his favorite author and philosopher (Isaac Asimov). He enjoys taking photographs while hiking and is considering writing a science fiction novel… if he ever decides to retire.

Margolin says that when he looks back at his career, he can't point to specific accomplishments. "There have been some very significant things I've worked on, but no one thing stands out." Then again, Margolin is still climbing—both literally and through his scientific research. "Through the years, I've had many colleagues and students, and together we've made many important contributions to the field of computational physics," he says. "I still have important work to do." ★

FROM COAL TO CLEAN

The Los Alamos-led Four Corners Rapid Response Team helps facilitate a regional shift away from fossil fuels.

BY JAKE BARTMAN

■ The coal-fired Navajo Generating Station and the affiliated Kayenta coal mine provided hundreds of jobs before closing. The Four Corners Rapid Response Team, led by Los Alamos National Laboratory, is helping the area transition.
Photo: Dreamstime

For decades, the fossil-fuel industry provided the Navajo Nation with lucrative jobs and revenue for the tribe's government. The closure of coal-fired power plants across the Four Corners region is bringing about an energy transition. Photo: Dreamstime

The Navajo Nation is spread across more than 27,000 square miles in the Four Corners region—the only place in the United States where the borders of four states (Arizona, Colorado, New Mexico, and Utah) converge. In the latter half of the 20th century, non-Navajo utility companies built seven coal-fired power plants in and around the Navajo Nation, which is roughly the size of West Virginia. Fueled by the region's ample coal deposits, these plants helped provide power for the Southwest's rapidly expanding population.

The plants brought lucrative job opportunities to the region. In 2012, employees at the Navajo Generating Station (NGS) earned an average of $35 per hour—more than twice the average wage for residents of Arizona's Coconino County, where the plant was located. Employees of the nearby Kayenta Mine, which was on the Navajo Nation, averaged some $117,000 per year in pay, while the average annual income in the Navajo Nation hovered at around $36,000 per year.

"A lot of the Navajo Nation's middle class really got started with work at the power plants and in the mines," explains Arvin Trujillo, who until recently served as executive administrator and senior advisor to the president of the Navajo Nation.

In the past five years, however, many coal-fired power plants in the region have gone dark, and others are slated to shut down within the next decade. The closures are due largely to a nationwide shift toward cleaner and less expensive sources of energy, including natural gas and renewable sources.

Decommissioning coal-fired power plants also helps move the nation toward a carbon dioxide-emission-free power sector, which the Biden administration aims to achieve by 2035.

In 2019, NGS and the Kayenta Mine closed. Nine months later, then-Navajo Nation president Jonathan Nez told the United States House of Representatives' Committee on Energy and Commerce that the closures had resulted in the loss of 1,000 jobs for Navajo workers and $40 million in annual revenue for the tribe's government. "The NGS owners provided short notice, leaving the Navajo Nation little time to mitigate the large negative impacts," Nez said.

Helping to mitigate these negative impacts is where Los Alamos National Laboratory comes in. In 2020, the federal government created the Interagency Working Group on Coal and Power Plant Communities and Economic Revitalization (IWG). The IWG has established 6 rapid response teams, each located in one of the IWG's top-25 "priority communities"—communities that are facing, or will soon face, transitions away from fossil fuel-based economies.

Each rapid response team (RRT) helps connect regional stakeholders with representatives from 11 federal agencies, including the departments of Agriculture, Commerce, Education, Energy, and Labor. Los Alamos leads the Four Corners RRT, which is helping navigate barriers that keep regional communities from accessing funds earmarked to support infrastructure projects, business development, workforce training, and more.

"There are some very well organized and very passionate environmental groups in northwest New Mexico, and they're quite excited about the energy transition—about being able to look out their windows and see blue skies from the closure of these coal-burning power plants," says Kevin John, a scientist at Los Alamos and director of the Four Corners RRT. "But I think you have to balance that with the challenges facing community leaders who are working through the real-time problems of economic diversification."

"The Rapid Response Team has been a great liaison to the federal government, especially at higher levels of the federal government," says Trujillo, adding that although the federal Bipartisan Infrastructure Law (2021) and Inflation Reduction Act (2022) made billions of dollars available to support communities transitioning away from fossil fuel economies, these funds aren't always easy to access.

"Most of the dollars that are available are through grants," Trujillo says. "And a lot of times, federal grant processes are quite complex and pretty time consuming."

The onerous process of applying for grants is further complicated by the fact that federal agencies sometimes struggle to understand the unique challenges facing communities in the Four Corners. John recalls a moment at the Four Corners Energy & Water Innovation Student Symposium, which the RRT helped organize in 2023, bringing together federal agency representatives, tribal leadership, national laboratory researchers, and students from regional colleges and universities.

"Somebody asked the question, 'How many of you have to haul water in order to get your daily and weekly water supply?'" John says. "And the number of hands that went up in the room was stunning. I think that sometimes, people who come to the region don't appreciate how different the Four Corners are from coal communities they might be more familiar with—in Appalachia, for example."

The Four Corners region is the only place in the United States where the borders of four states converge.

> At Los Alamos, we have technology to support the deployment of all carbon-related projects in the Four Corners region."
>
> —Bailian Chen

WHY LOS ALAMOS?

The Four Corners RRT is the only RRT led by a U.S. national laboratory. Federal agencies, such as the U.S. Department of Agriculture or the U.S. Environmental Protection Agency, lead the other five teams.

Why is Los Alamos, which is perhaps best known for its nuclear weapons work, directing an initiative like the Four Corners RRT? The answer has to do with the Laboratory's long history of energy research, which includes nuclear, fusion, geothermal, hydrogen, and more. Over the years, the Laboratory's energy research has expanded into biofuels, direct air capture (which involves removing carbon dioxide from the atmosphere), and carbon capture and storage (CCS) (which involves capturing carbon dioxide emitted from industrial sources).

CCS encompasses a range of technologies, but one application involves capturing the carbon dioxide emitted from a coal-fired power plant's smokestack. This carbon dioxide can then be transported through a pipeline or truck, used in fossil fuel production or industrial processes, or stored in underground salt caverns or depleted oil wells.

In 2017, PNM Resources, which operated the San Juan Generating Station, announced that it intended to close the plant in 2022. The City of Farmington then set out to acquire the plant, intending to install CCS technologies there, with the goal of keeping the generating station in service longer.

Los Alamos reviewed a prefeasibility study of the CCS retrofit and suggested that the project was practical. Although complications ultimately led to the San Juan Generating Station's closure, the Laboratory's assessment of the plant helped create relationships with stakeholders in the Four Corners region. Those relationships in turn led researchers at Los Alamos to think in new ways about how the Laboratory's work could benefit communities in the Four Corners and beyond, setting the stage for the Laboratory-led Intermountain West Energy Sustainability and Transitions (I-WEST) initiative.

I-WEST brought together universities, national laboratories, private companies, and other groups to develop a roadmap for achieving net zero carbon dioxide emissions in a six-state region called the Intermountain West (comprising Arizona, Colorado, Montana, New Mexico, Utah, and Wyoming).

Key to I-WEST was a "place-based approach" to evaluating the implementation of energy technologies—including hydrogen, carbon capture, biofuels, wind and solar, and more. In addition to evaluating technological pathways to carbon neutrality, I-WEST also explored the economic, workforce, policy, and energy justice implications of implementing diverse energy technologies in the region, culminating in a report that was released in 2022.

Andrea Maestas, a program manager in the Laboratory's Applied Energy Program Office, says that the Laboratory's leadership of I-WEST helped make Los Alamos the right choice to head the Four Corners RRT. "Leading these regional initiatives has been a stretch for Los Alamos," Maestas says. "Even though we had a history doing research in the Permian Basin, it's very different to do community-engaged research and advocacy for a region. This has been a huge and impressive shift for a lot of our technical staff members."

> "I think that sometimes, people who come to the region don't appreciate how different the Four Corners are from coal communities they might be more familiar with—in Appalachia, for example."
>
> —Kevin John

The Kayenta Mine operated from 1973 to 2019.
Photo: U.S. Department of the Interior

GREEN OPPORTUNITIES

Although the energy transition poses challenges for the Navajo Nation, Trujillo says that the transition brings opportunities, too. The Navajo Nation's ample sunshine and wind can be harnessed to produce electricity, which, along with regional stores of natural gas, could be used to make hydrogen. The Four Corners region has many underground salt beds and depleted oil reservoirs, which might be used to store carbon dioxide captured from power plants or other sources.

Trujillo says that the Navajo Nation is interested in exploring a range of energy technologies to help bolster the tribe's economy. Among other projects, Navajo leaders hope to see CCS technology, of the kind once planned for the San Juan Generating Station, implemented at nearby Four Corners Generating Station.

Four Corners Generating Station is a coal-fired power plant on Navajo land about 12 miles south of the former San Juan Generating Station. Although the Four Corners plant is slated to close in 2031, Trujillo says that if CCS technology were implemented there, it might be possible to keep the generating station running longer. "It will be difficult to get anyone to invest in a power plant that can't reduce emissions," he says.

Trujillo says that the Navajo Nation is also exploring opportunities to use the region's ample solar resources for power and hydrogen production. In tandem with these projects, Navajo leaders are interested in developing pumped storage hydroelectric power, which would allow utility providers to store energy from renewable sources for use at times when renewable energy isn't available (when the sun stops shining or the wind isn't blowing).

"We're hoping that these developments will help us attract new manufacturing and new industrial companies to the region," Trujillo says. "We hope that companies will look at the fact that we're using renewable or non-carbon-based energy to supply their industries."

REGIONALLY RELEVANT RESEARCH

Entrepreneurs and stakeholders in the Navajo Nation are seeking federal funds to kickstart energy-related projects. To make federal grants and programs more accessible to these stakeholders and others in the Four Corners, the Four Corners RRT helped organize events in New Mexico and Arizona where representatives of federal agencies met with entrepreneurs and community leaders interested in garnering federal support for a breadth of economic, workforce, and community-development projects.

"At first, we were really trying to understand what the 11 different federal agencies that are involved with the IWG could bring to communities," John says. "I think that one role that Rapid Response is playing now is matchmaking communities with the right agency resources."

Kevin John

Maestas says that the Laboratory's involvement in the Four Corners' energy economy goes beyond acting as a facilitator between federal agencies and local communities. "Even when we have our Rapid Response hat on, we're still Los Alamos," Maestas says. "Our technical expertise means we have the opportunity to provide technical assistance to regional stakeholders."

Bailian Chen, a scientist at Los Alamos who is an expert in CCS and hydrogen, is one researcher whose work has the potential to support the Four Corners' energy transition. Chen and other researchers, in collaboration with several regional consortiums, are working to better characterize carbon dioxide sources (including power plants) in the Four Corners, and to research other aspects of carbon capture, technology, transportation, utilization, and storage.

"There are plenty of carbon dioxide storage formations underground in the San Juan Basin," Chen says. "But transportation is a challenge."

That's because transporting carbon dioxide at scale requires building pipelines that cross land belonging to a breadth of public and private owners. Pipelines can also leak, releasing the captured carbon dioxide.

One of Chen's recent projects includes working to expand an open-source software platform called SimCCS, which was developed at Los Alamos. SimCCS incorporates data on carbon dioxide capture locations, storage sites, and geographic information, such as topography, land ownership, and population density. The software allows users to holistically consider the different aspects of CCS deployment in a region.

Originally, SimCCS was developed to optimize cost: Using the platform, a user could determine the least expensive way to build CCS infrastructure. Chen and other researchers have modified SimCCS to allow users to optimize for other goals, such as minimizing the environmental or social impacts of pipelines and other CCS infrastructure.

Researchers at Los Alamos have also collaborated with universities and other national laboratories to develop technologies that support CCS risk assessment, including by evaluating underground storage formations for potential leaks. They've also helped develop tools that can quantify the risk of induced seismicity—that is, earthquakes that might be caused by injecting carbon dioxide belowground.

"At Los Alamos, we have technology to support the deployment of all carbon-related projects in the Four Corners region," Chen says.

HYDROGEN

Researchers at Los Alamos are also working to adapt CCS technologies to an energy technology that has the potential to become an important alternative to fossil fuels: hydrogen.

In some contexts, hydrogen can serve as a lower-emission alternative to natural gas. Used inside a fuel cell—a device that converts chemical energy into electricity—hydrogen can also power motors inside semitrucks, passenger cars, or other vehicles, yielding only heat and water vapor as byproducts.

Throughout the Four Corners region, stakeholders are interested in hydrogen as an alternative energy technology. Some regional groups are advocating for the expansion of hydrogen production and use in the region, and businesses such as Navajo Agriculture Products Industry, which intends to use hydrogen to power its farming equipment, hope to lead the way.

Researchers at Los Alamos are developing a tool called Optimization, Evaluation, and Risk-Assessment Techniques for Hydrogen Energy (OPERATE-H2) that is based on SimCCS. This tool will allow users to evaluate geologic reservoirs, such as salt beds and depleted oil wells, for potential hydrogen storage, and to consider the different aspects of an economy of hydrogen production, transportation, and storage, in much the same way that SimCCS does for carbon dioxide.

Los Alamos scientist Prashant Sharan is a part of the team developing OPERATE-H2. He is also working on a project that involves using something called "produced water" to make hydrogen.

Produced water, a byproduct of crude oil production, is a mix of groundwater and water that has been pumped belowground to help force oil and gas out of the earth. "New Mexico is a water-stressed region, and much of the water that is available is brackish," Sharan says. "But the region does have massive produced-water resources."

Produced water contains salts and other substances that reduce its purity. Sharan's team has found that by using a process called supercritical water desalination and oxidation, it is possible to make produced water

The Navajo Generating Station.
Photo: SRP

In August 2022, U.S. Secretary of the Interior Deb Haaland spoke at an event that announced the creation of the Four Corners Rapid Response Team.
Photo: IWG

clean enough to use in hydrogen production, and to do so efficiently and economically—an innovation that might help conserve regional water resources and bring down the cost of hydrogen production.

"The work we're doing at Los Alamos can play a major role in helping increase industry's confidence in these technologies," Sharan says.

John emphasizes that although Los Alamos stands to bring its technical know-how to bear in the Four Corners region, the Laboratory's role isn't to dictate policy or promote one energy technology or another. Instead, the Laboratory can serve as a "trusted information broker" in the Four Corners region.

"We are technologically agnostic," John says. "We don't have skin in the game in terms of if the region picks one technology over another. We'll simply be a resource to help a community understand, for example, how much water one technology consumes relative to another. But we aren't advocating for one thing over another at all."

A CULTURE SHIFT

The Four Corners RRT has contributed to a larger culture shift for the Laboratory's staff. Maestas says that increasingly, researchers at Los Alamos are thinking about the ways in which the Laboratory's energy work might affect local communities.

This shift is consistent with the Department of Energy's (DOE's) growing emphasis on community engagement. For example, project proposals submitted under the Bipartisan Infrastructure Law and the Inflation Reduction Act require a "community benefits plan" that explores how the project might affect communities, and how the project might advance diversity, equity, inclusion, and accessibility, among other considerations.

Maestas says that the Four Corners RRT has helped the Laboratory take those factors into account.

"Our researchers have adopted a frame of mind where they think about community impacts, societal readiness, and technology acceptance as part of their R&D projects," Maestas says. "This is how DOE thinks about projects, and we have been at the forefront of it with initiatives like the RRT."

Although the Four Corners RRT has expanded the Laboratory's involvement with communities across New Mexico and beyond, for John, the Four Corners RRT's mission hits close to home. John was raised in a coal-producing region in western Pennsylvania, where his father worked at a coal-fired power plant that closed in the 1990s. He says that it has been rewarding to advocate for the Four Corners as the region's energy workers reckon with a transition like the one his father faced a quarter century ago.

"Seeing my father go through that, and having to redefine who he was—I think a lot of this journey has been somewhat personal for me," John says. "The Rapid Response Team is something I've been really excited to be a part of." ★

■ Los Alamos interns Joel Yazzie, Nylana Murphy, Jasmine Charley, and Jonathon Chinana worked with the NTU partnership program. Los Alamos scientist Tommy Rockward is at right.

CONNECTING WITH COLLEGES AND UNIVERSITIES

The Four Corners Rapid Response Team helps Los Alamos form new partnerships with regional schools.

BY JAKE BARTMAN

Los Alamos National Laboratory is partnering with schools in the Four Corners region (an area the size of West Virginia where Arizona, Colorado, New Mexico, and Utah share a border) to help carry out regionally relevant research and train a new generation of scientists.

Building on relationships inaugurated as a part of the Los Alamos-led Four Corners Rapid Response Team (RRT)—which seeks to help mitigate the barriers that keep communities from accessing funds earmarked to support transitions away from fossil fuel-based economies—the Laboratory is strengthening relationships with schools such as Navajo Technical University (NTU) in Crownpoint, New Mexico, and San Juan College (SJC) in Farmington, New Mexico.

Los Alamos scientist Prashant Sharan, who recently collaborated with NTU on a hydrogen-related project proposal, says that schools can be valuable research partners as the Laboratory provides technical support to Four Corners communities.

"Los Alamos is situated very far from some of these communities, so we don't understand the problems they're facing," Sharan says. "Universities can play a massive role in helping us to understand and also in educating communities on energy issues and opportunities."

With an enrollment of more than 1,300 students, NTU is the largest tribal university in the United States. Initially focused on providing workforce training in business and office work, culinary arts, computer science, and construction trades, NTU's academic programs have proliferated since its founding as the Navajo Skills Center in 1979. Today, NTU offers 20 certificate programs, 25 associate degrees, 19 bachelor's degrees, 3 master's degrees, and 1 doctorate.

"Our degree program offerings are primarily based upon what the needs of the Navajo Nation are," says Colleen W. Bowman, NTU's provost. "As we create new programs, we must consider where the jobs will be for our graduates."

Bowman explains that NTU and other tribal colleges and universities (TCUs) face unique challenges in seeking to expand. For one thing, federal grants are often structured in ways that make it difficult for TCUs to use the grants to hire needed faculty. Moreover, tribal governments can't issue bonds that could fund the construction of academic buildings, student housing, and other key infrastructure at TCUs.

"We have a lot of strong STEM programs, but we have limited space for learning or for laboratories," Bowman says. "That's one of the biggest concerns we have when we talk about expanding our partnerships."

Andrea Maestas, a program manager in the Laboratory's Applied Energy Program Office, says that although NTU students were already coming to Los Alamos for internships, one benefit of the RRT has been the increasing visibility of the Laboratory's collaboration with schools such as NTU.

"Laboratory outreach is typically focused on surrounding communities. But with Rapid Response, we've broadened the scope," Maestas says.

With a goal to create career opportunities in hydrogen fuel cell technology, in 2023, the Department of Energy's Hydrogen and Fuel Cell Technologies Office sponsored the Native American Fellowship, a pilot program exclusive to NTU. (The fellowship expands on the National Nuclear Security Administration's Minority Serving Institutions Partnership Program and will also support equipment purchases for NTU's Center for Advanced Manufacturing, a state-of-the-art research and development facility.) At Los Alamos, interns are studying different aspects of hydrogen fuel cell design, including materials engineering and additive manufacturing.

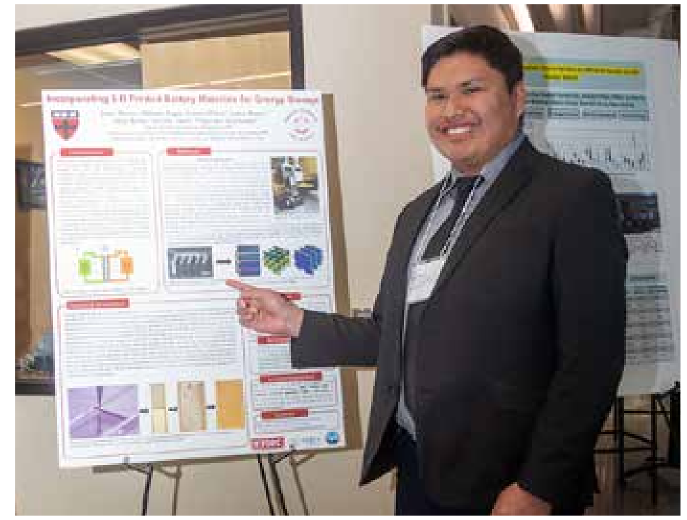
Bowman says that she hopes to see NTU's relationship with Los Alamos expand into areas that go beyond the sciences to encompass work in the trades and administrative work as well. She says that although NTU, like other tribal colleges and universities, is still working to anticipate future energy needs in the region, the school is eager to train students to meet those needs.

"How can we prepare students to be experts in technologies like hydrogen? And how can we do that with Indigenous knowledge at the table?" Bowman says. "I think a lot about questions like these."

SJC, which was founded in 1956, is a two-year institution that educates more than 8,700 students each year, the majority of whom are from historically underrepresented groups. For decades, SJC's School of Energy has helped prepare students for energy careers in the Four Corners' fossil fuel economy.

Alicia Corbell, dean of SJC's School of Energy, says that one challenge the Four Corners is facing is the departure of former fossil fuel workers from the region. "When it was first announced that the San Juan Generating Station would be closing, a lot of workers sought jobs outside the area," Corbell says. "We continue to see that out-migration of workers."

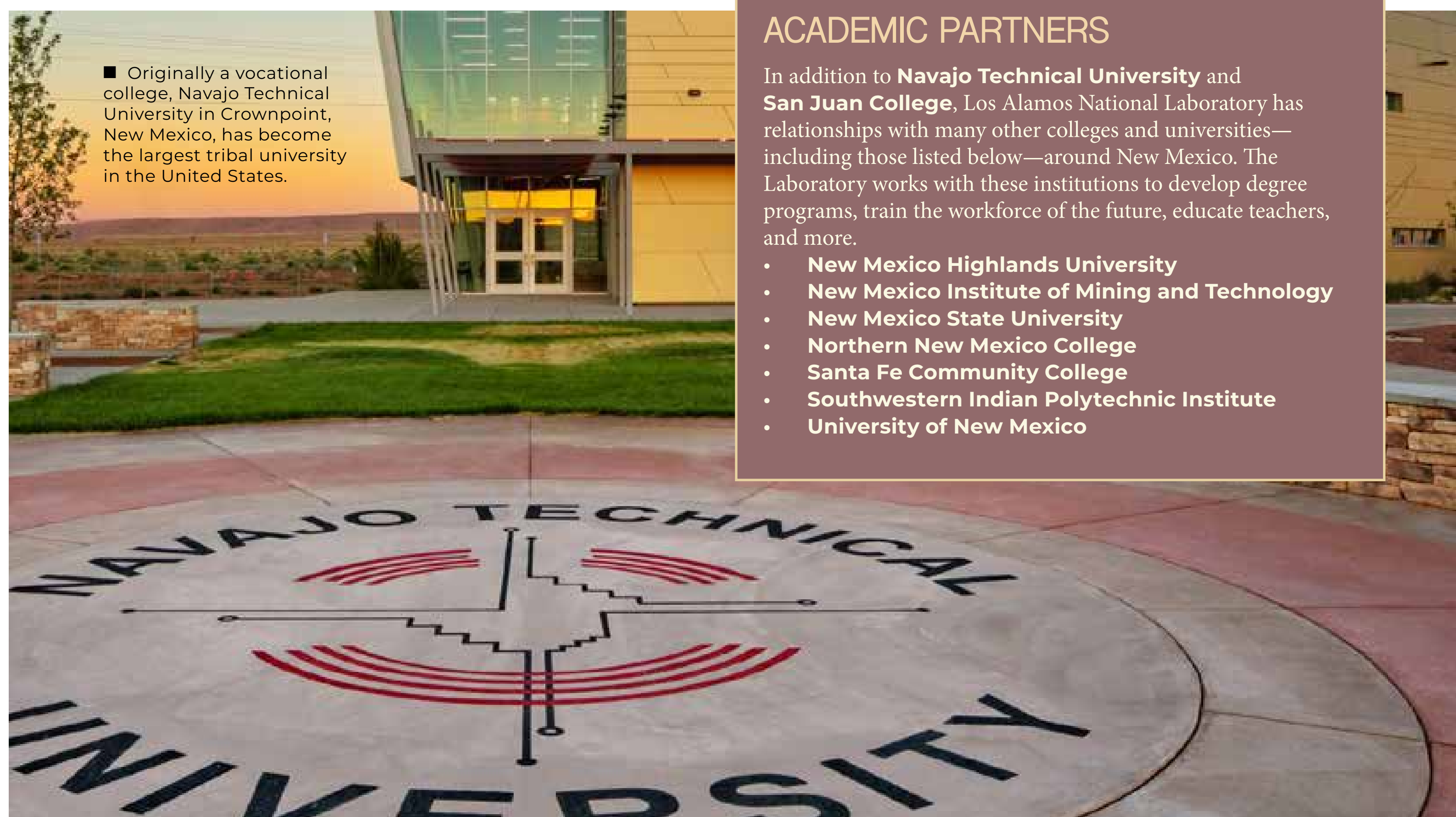
SJC is helping retain, and retrain, former fossil fuel workers for new kinds of energy careers. In 2019, New Mexico's legislature identified SJC as the state's Center of Excellence of Renewable Energy and Sustainability. The school has used the funds that came with this designation to develop programs in electric vehicle maintenance, lithium-ion batteries, hydrogen power, and water security and sustainability.



■ Students from Navajo Technical University and other regional schools presented their applied-energy research during an Energy-Water Nexus event at San Juan College in 2023.

In addition to building connections between the Laboratory's energy researchers and SJC's energy programs, the RRT has also increased students' awareness of national security–related opportunities at the Laboratory. "As part of our Rapid Response effort, we have brought San Juan College and NTU faculty to Los Alamos for lab tours and to learn about our student programs and other workforce development opportunities," Maestas says. "Now the Laboratory is more than just something they've heard about—it's a place they have visited and can encourage their students to explore."

Corbell says that she's glad to see the relationship between SJC and the Laboratory grow. "They have just welcomed us with open arms," she says of Los Alamos. ★



■ Originally a vocational college, Navajo Technical University in Crownpoint, New Mexico, has become the largest tribal university in the United States.

ACADEMIC PARTNERS

In addition to **Navajo Technical University** and **San Juan College**, Los Alamos National Laboratory has relationships with many other colleges and universities—including those listed below—around New Mexico. The Laboratory works with these institutions to develop degree programs, train the workforce of the future, educate teachers, and more.

- **New Mexico Highlands University**
- **New Mexico Institute of Mining and Technology**
- **New Mexico State University**
- **Northern New Mexico College**
- **Santa Fe Community College**
- **Southwestern Indian Polytechnic Institute**
- **University of New Mexico**

THE TOWN THAT RAISED ME

Growing up in Los Alamos ignited my passion for learning.

BY TERRY WALLACE JR., DIRECTOR EMERITUS

My father, Terry Wallace Sr., began his career at Los Alamos Scientific Laboratory in 1956 as a uranium chemist with a newly minted PhD from Iowa State. He had gone to Arizona State on an ROTC scholarship and was given the option to complete his ROTC [Reserve Officers' Training Corps] service at Los Alamos after completing his doctoral work. Looking back, what a stroke of luck that was for me.

As a kid growing up in Los Alamos, I didn't realize what a unique place it was until much later—after I left for college, first to go to New Mexico Tech in Socorro and then to go to Caltech in Pasadena. It was then that I experienced the broader world and saw just how unusual—and special—this town that raised me was.

As a kid, Terry Wallace Jr. wanted to build a mineral museum to house the rocks and minerals he collected. "Rather than laughing me off, my father suggested the backyard," Wallace remembers. "There I am with a trowel building a wall. The museum was never finished but was a reminder of who my father was."

Lab director emeritus Terry Wallace says growing up in Los Alamos ignited his passion for learning.

FAMILY DAYS AT THE LAB

Some of my earliest memories of the Laboratory are from Family Days. Today, we have the Family Picnic, but back then, employees could bring their children and spouses into their labs and offices.

I loved Family Days. It was an incredible privilege to be able to go into those facilities and see things that so few people in the world were allowed to see. For part of his career, my father worked in the old Chemistry and Metallurgy building (CMR). CMR housed radioactive materials, but we were still allowed to go in—even as children.

I'll never forget when I got to see an RTG (radioisotope thermoelectric generator) made out of neptunium, and I could feel the heat coming off of it. We didn't wear any protective gear at all. Can you imagine that today?

Terry Wallace Sr.

UNUSUAL TEACHABLE MOMENTS

My dad was very quiet (hard to believe for those who know me, I'm sure) and didn't talk a lot about work. But there were a few events in his career that I remember well.

When I was in high school—around 1973—the Jackpile-Paguante uranium mine near Grants, New Mexico, found ore that they couldn't identify. They sent it to Los Alamos for analysis, which went to my father. So, my dad decided this was a "teachable moment" for me to learn how to do x-ray diffraction.

He brought me with him to the Laboratory to do it. I can't really recall how I could possibly come into a lab (at that time my father worked at DP East), but it was the first of thousands of x-ray diffraction analyses I did in my career.

The sample from Jackpile ended up being coffinite, which is a radioactive mineral. I remember being surprised at the name when I looked up the diffraction peaks, and wondered if I would just die. Alas, coffinite is named after a geologist, Reuben Coffin.

When I was in college and had my first mineralogy class, I was surprised to learn that none of my other classmates had ever done a diffraction analysis! Los Alamos was a very special place.

Also, my dad would come home with truckloads of discarded stuff from the Laboratory's salvage yard.

I grew up in Pajarito Acres in White Rock, in the second house to be built in that development. We had a barn. Half of the barn was for my mom's animals, but the other half was for all the stuff my dad picked up from salvage—like fume hoods. So, again, there was all this rare stuff that most people never got to see, and here it was, at our house. I learned tremendous things just by living in close proximity to this wonderful environment.

THE POWER OF THE LABORATORY

It wasn't really until I started graduate school at Caltech that I started to have real conversations with my dad about his work at Los Alamos. I recall well a conversation about trying to balance the uranium budget for the planet.

At that time, the general theory was that uranium was highly siderophobic—meaning it could not coexist with iron—and thus, had to be in the Earth's crust. (*Sideros* is the Greek word for iron.)

But my father had worked on uranium at high temperatures and suggested that there would be total miscibility between uranium dioxide and steel, meaning the two substances would be able to fully mix with each other. Thus, perhaps the iron in the Earth's core could behave similarly. In fact, my father and his colleagues decided to test this and published a frequently cited paper stating that there was considerable uranium in the core, and it was the key component of driving the geodynamo (Earth's magnetic field).

Having these long discussions with my father on topics like how much uranium existed on the planet taught me that scientific breadth is perhaps the most important trait for problem solving. That really shows the power of the Laboratory in the world of science. There were such bright people here who spent their time and energy figuring out why things behaved the way they do—and making discoveries that changed the way we see the world. That's still true today.

So much of my career was shaped by the people I grew up with around here—not just my dad. I often talk about how we need to foster in children the importance of asking "why"—encouraging them to ask it even when it's annoying. When I was a kid, we'd go on camping trips with our friends and someone would find a rock and then this long argument would ensue about what kind of rock it was and what its color meant. Everyone was fully involved and had an opinion.

I didn't realize until much later that wasn't everyone's experience growing up—to be surrounded by people who were so passionate about discovery. It really ignited in me a passion for learning. I'm eternally grateful for that. ★

Terry Wallace Sr. died on October 7, 2011.

Dominic Roybal collects natural materials, such as plants and soils, to produce powdered pigments, which can be used to form colored paints.

ADVANCING AN ANCIENT ART FORM

Classification analyst Dominic Roybal creates art from nature.

BY IAN LAIRD

Some people connect with their roots through the food they cook, the clothing they wear, or the names and languages they use. For Dominic Roybal, a classification analyst in the Office of Classification and Controlled Information at Los Alamos National Laboratory, this connection is nurtured by engaging directly with the earth; he combines a variety of soils and plants to create pigments and paints. It's how he bridges time to connect with his ancestors, who first came to northern New Mexico 400 years ago.

"The Roybal roots date back to the Spaniard, Ignacio Roybal, who settled here after the Pueblo Revolt, around 1680 or 1690," Roybal says. "I grew up in Española, about 20 miles northeast of the Laboratory, and I live in Española. My roots are here."

RECONNECTING WITH HIS ROOTS

Roybal is a member of a small community of artists who work in straw appliqué, a traditional northern New Mexico art form that draws inspiration from the Moorish damascene style in Spain. "It's sometimes called 'el oro de los pobres,' or 'the gold of the poor,'" Roybal says. "This tradition arose from the use of inlaid gold to decorate objects, but when missionaries arrived in northern New Mexico, there was an absence of gold—so they used straw instead."

Straw appliqué traditionally involves taking carved wooden objects, applying a base layer of paint derived from gypsum, adding color through ground-up soils and plants, inlaying or applying straw to emulate gold, and then finishing with a pine resin to seal the colored straw in place.

From start to finish, Roybal estimates that it takes four or five days to create each piece of art. The timeline varies, though, based on what he's making and what form he uses. Straw appliqué comes in two primary forms—traditional depictions of religious imagery and a more expressive form focused on mosaics and patterns.

"When you do more of the traditional side, you're working with a design that has been passed down and is established and often quicker to work with," Roybal says. "When you're doing your own design, that's where my creative side comes out, but it can take longer because you want to do something different."

Although Roybal says he believes in the importance of understanding the traditions and history behind straw appliqué art, he also notes that it's important for each artist to leave behind something unique in their work.

"As an artist, you do the traditional things and then you expand from that. I've incorporated other art forms or mediums. I've used ceramics in my work, and I've used sculpture with straw appliqué," says Roybal, noting that his work has sold at the Traditional Spanish Market in Santa Fe.

BEYOND ART

Roybal's connection to northern New Mexico extends beyond art and ancestral ties. His now 96-year-old father, Theodore Roybal, joined the Lab in 1949 and worked there for nearly four decades as a surveyor. "Through my dad, I've always known what the Lab does," says the younger Roybal, who began working at the Lab during the summer of 1985, between his junior and senior years of high school. As a student, he inspected the lightning rods and grounding equipment on buildings and planted trees as part of forestry efforts.

After graduating from New Mexico State with an engineering degree, Roybal briefly worked with the New Mexico Department of Transportation before taking a job as a production engineer at the Pantex Plant in Amarillo, Texas. There, Roybal became a derivative classifier, or DC; DCs are employees who assess the classification level of information in their respective fields. "I understood what to protect as far as our nuclear stockpile is concerned," Roybal says. "Working at Pantex, a pure production agency, you get to understand the full scope of our stockpile."

Five years later, Roybal took a job closer to home—in the Detonator Production division at Los Alamos. (Detonators are the small devices that trigger explosives inside nuclear weapons, see p. 6.) In his new role, Roybal continued to work as a DC, and before long, he was offered a permanent position in the Office of Classification.

Roybal started working in the Office of Classification in 2017 and says it's been a rewarding experience. Much of his work involves determining what information and products—such as this magazine!—are releasable to the public. Through this process, Roybal is able to learn about and appreciate the entire scope of work at the Lab.

"I feel a large sense of pride working in the Lab," Roybal says. "Over decades, it has helped build up the surrounding communities, and now I feel that—through my work and through my art—I have contributed to this community as well."

NEW MEXICO THROUGH AND THROUGH

Reflecting on his artistic journey, Roybal is proud of the work he has done and how it has shaped him.

"It's made me a broader person that I never would have been before," he says. "I'm an engineer, I'm into science, I love to work with math. When art was introduced to me, it was a different way of looking at things and a different way of saying 'I can create something from almost nothing.'"

Roybal sees a lot of similarities between the paint production process and a chemistry problem, like when a green plant suddenly turns into hues of blue when crushed. To him, the mixing and production of paints is a form of engineering but with the added freedom of expression that comes with any artistic medium.

With such a small community of artists who produce straw appliqué, Roybal is always looking for ways to share the art and tradition with people. He says he hopes that others take an interest in connecting with the natural world and northern New Mexican history so that traditions like straw appliqué stay alive.

"To go and collect pigments from the soil and the earth, there's probably not a large percentage of people willing to do that," Roybal says. "It's easy to go and buy paint, but making it from scratch, carving wood, pushing your chisel through it, painting—you learn that by doing." ★

Spanish settlers inlayed straw in materials to create the appearance of gold in their art; Roybal uses this same technique today.

Roybal finds in nature the materials he needs to produce colored paints.

THE DISTINGUISHED ACHIEVEMENTS OF LOS ALAMOS EMPLOYEES

BETTER SCIENCE = BETTER SECURITY

Hardworking people—the Laboratory's most important asset—enable Los Alamos to perform its national security mission.

National Security Science won three awards in the summer 2024 New Mexico Press Women's Communication Contest. The summer 2023 Oppenheimer issue won first place for graphics and design and moved on to the National Federation of Press Women's contest. "Harnessing the power of the sun," about the Laboratory's fusion research, won first place in the science and technology category. This article, which was written by Jill Gibson and appears in the winter 2023 energy issue, also moved on to the national contest, where it won first place in the science and technology specialty articles category. Gibson's story "A blast from the past," from the spring 2023 enterprise issue, won third place in the magazine feature story category in the New Mexico contest.

J. Patrick Fitch is the Laboratory's new deputy director for Science, Technology and Engineering. Fitch previously served as the associate director for Chemistry, Earth and Life Sciences at Los Alamos.

Chemistry deputy division leader Kevin John is now a fellow of the American Association for the Advancement of Science, the world's largest general scientific society. John recently served as the deputy director for the Laboratory's Applied Energy Program Office, where he led the Four Corners Rapid Response Team (see p. 60).

Theoretical physicist Wojciech Hubert Zurek was elected to the National Academy of Sciences. Zurek is an authority on the foundations of quantum theory and on the dynamics of both classical and quantum phase transitions. He has also studied astrophysics and the physics of information.

Bjørn Clausen was named a 2024 Neutron Scattering Society of America fellow for his experiments and modeling that use neutrons to determine how a material's structure affects its performance while subjected to extreme conditions. As the instrument scientist for the Spectrometer for Materials Research at Temperature and Stress at the Los Alamos Neutron Science Center, Clausen is an expert in engineering-related neutron diffraction and materials modeling.

Wendy Caldwell, of the Computational Physics division, and Cathy Plesko, of the Theoretical Design division, were honored with a Defense Programs Award of Excellence for their contributions to NASA's Double Asteroid Redirection Test.

Sean Finnegan is the new program director for the Office of Experimental Sciences (OES) within the Laboratory's Weapons Physics associate directorate. OES uses the application of cutting-edge science and modern experimental capabilities to maintain and develop the nation's nuclear stockpile.

More than 230 staff members on 8 different teams were recognized with Honor Awards from the Department of Energy secretary—the highest honor a DOE employee or contractor can receive. The Laboratory projects that were recognized are the Actinium-225 Tri-Lab Research team, Atmospheric-Test Film Scanning and Analysis Project team, German FRM-II Low-Enriched Uranium Conversion team, Joint Los Alamos National Laboratory/Savannah River Site Pit Manufacturing Classification Guide team, National Ignition Facility Fusion Ignition team, Transforming Los Alamos National Laboratory's Transuranic Waste Disposition Process team, U.S. Department of Energy Fleet Management team, and the U.S. Department of Energy Leadership in Climate Action team.

Five Los Alamos employees who also serve in the National Guard and Reserve Forces received Patriot Awards—a recognition for efforts of individual supervisors supporting citizen warriors through a range of measures, including flexible schedules, time off before and after deployment, time to care for families, and granting leaves of absence if needed. The employees are nuclear facilities engineering manager Landry Milnes, nuclear facilities engineering manager Laila Badran, nuclear facilities engineer Victoria Baca, emergency operations manager Kevin Brake, and emergency operations manager Christian Rittner.

Equal Opportunity Publications Inc. announced Los Alamos National Laboratory among the Top 20 Government Employers of Choice in the winter 2023–24 edition of the *Careers & the disAbled* magazine. The Lab was ranked seventh and is the highest-ranking national laboratory. The Lab has received this recognition annually since 2018.

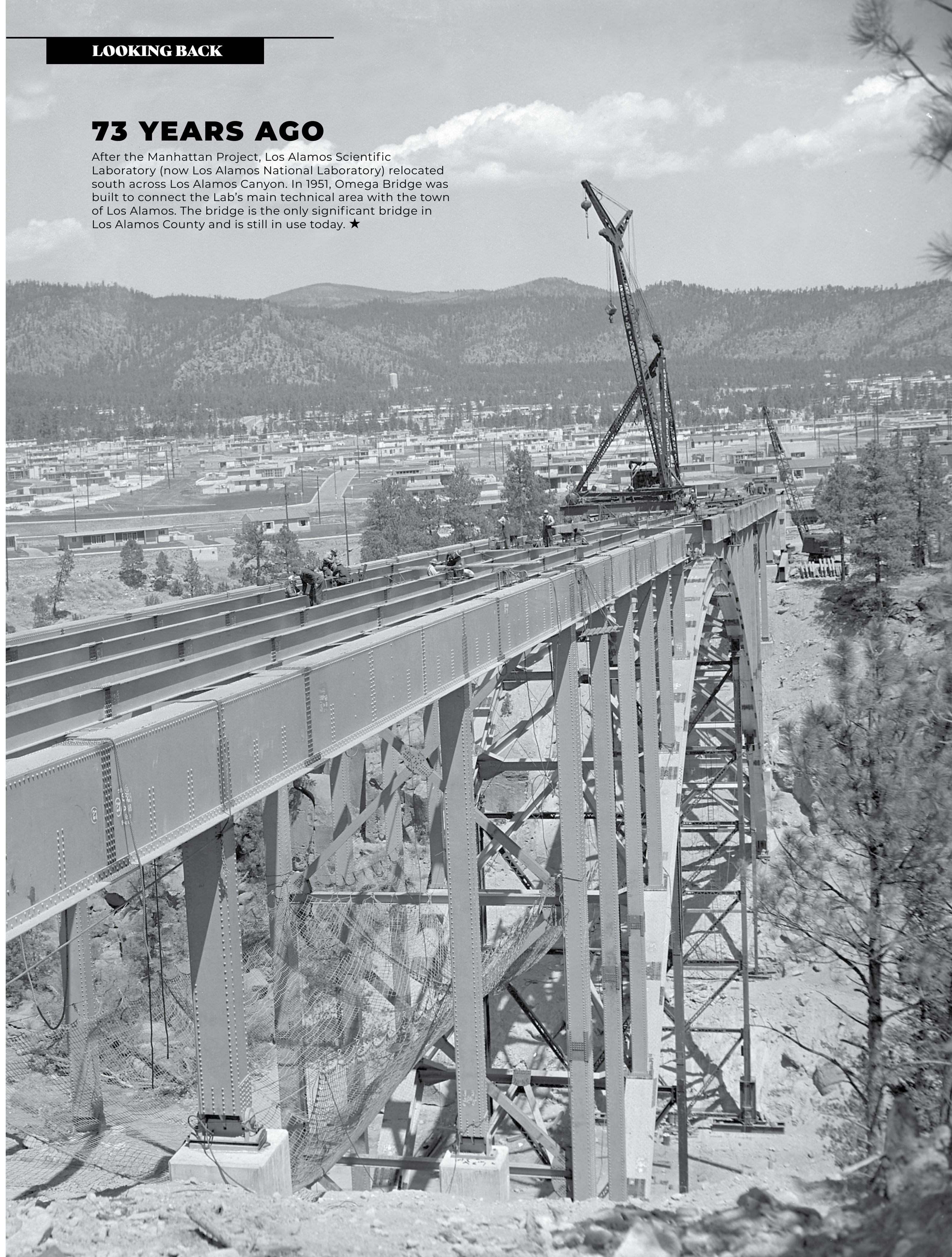
Every year since 1982, the National Nuclear Security Administration's Office of Defense Programs has recognized teams that realize significant achievements in quality, productivity, cost savings, safety, or creativity in support of the nuclear weapons program. Los Alamos recipients of the 2022 Defense Programs Award of Excellence were recognized during a ceremony on April 30. Executive principal assistant deputy administrator for Defense Programs David Hoagland presented awards to the Elevating RLUOB to a Hazard Category-3 Nuclear Facility team, the TA-55 Dynamic Pyrometry team, the Small Pit Tube Non-Nuclear Components Manufacturing team, Project Berkshire, the PBX 9751 Development team, and the 3X Acorn Product Realization team. ★

IN MEMORIAM

Explosives scientist Philip Leonard came to the High Explosives Science and Technology group at Los Alamos as a postdoctoral researcher in 2009; he became a staff member in 2011. He most recently worked as a program manager in the Weapon Stockpile Modernization division. "Phil was brilliant, a talented scientist, skilled teacher, and had an innate curiosity for the world around him," read his obituary. "These objective truths about Phil, however, cannot convey the leadership he provided, and the guiding beacon he was to his coworkers, friends, and family." Leonard died tragically in a car accident on February 27, 2024. ★

73 YEARS AGO

After the Manhattan Project, Los Alamos Scientific Laboratory (now Los Alamos National Laboratory) relocated south across Los Alamos Canyon. In 1951, Omega Bridge was built to connect the Lab's main technical area with the town of Los Alamos. The bridge is the only significant bridge in Los Alamos County and is still in use today. ★



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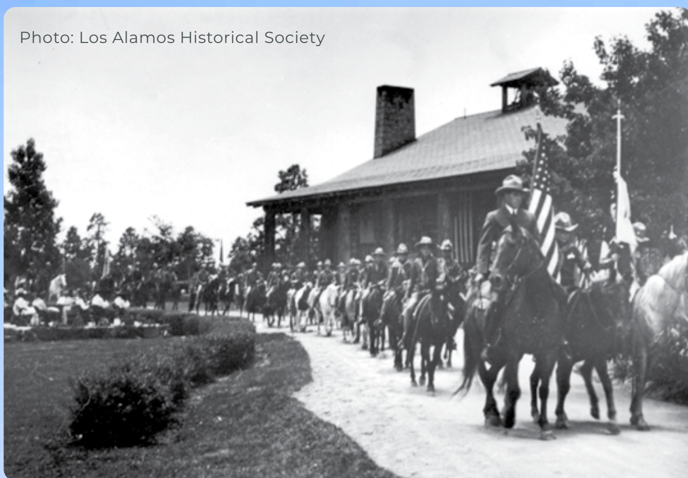

Photo: Los Alamos Historical Society

THEN & NOW

Nearly 100 years separate these photographs of patriotic Los Alamos residents on horseback. In the small photo, students at the Los Alamos Ranch School parade in front of Fuller Lodge. In the large photo, Rodeo Queen Brittany Hollowell rides her horse, Blue Star Moon, in the opening ceremony of the annual Los Alamos County Rodeo as the national anthem plays.

Photo: Los Alamos County/Leslie Bucklin