LOS ALAMOS NATIONAL LABORATORY ◇ SPRING 2020

NATIONAL ★ SECURITY SCIENCE

THE WARFIGHTER ISSUE

- **Served, still serving:** military veterans leave one mission to find another at Los Alamos
- **A wealth of stealth:** an inside perspective on flying the B-2 Spirit bomber
- **A moment of glory:** testing the Minuteman III intercontinental ballistic missile

+PLUS:

Move over, popcorn! Microwaves can now be used for weapon ignition

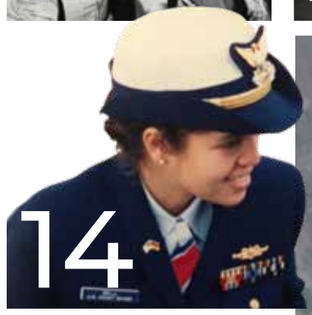
The chief scientist of the Air Force recalls his time at the Laboratory

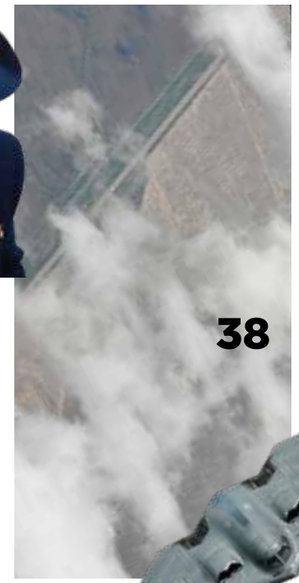
Not just for cows—feedstocks will power the Navy's Tomahawk missiles

PHOTOBOMB

An unarmed Trident II D5LE missile launches from the Ohio-class ballistic missile submarine USS *Maine* off the coast of San Diego, California, on February 12, 2020. "Today's test demonstrates the continued reliability of our sea-based nuclear deterrent, which is made possible by our sailors, civilians, and industry partners, who bring expertise and dedication to the mission," says Vice Admiral Johnny Wolfe, director of the Navy's Strategic Systems Programs. In the event of a real launch, the Trident II could carry the Los Alamos–designed W76 or W88 warheads. ★

Photo: U.S. Navy/Thomas Gooley





IN THIS ISSUE

FEATURES

ABOUT THE COVER

Three active-duty members of the military raise the American flag in front of the Lab's National Security Sciences Building. Every year, airmen, missileers, and soldiers come to the Laboratory to learn more about the partnership between Los Alamos and the military. Read more on pp. 6, 38, and 50.

THE WARFIGHTER ISSUE

SCIENCE AND THE MILITARY HAVE BEEN INTERTWINED SINCE THE MANHATTAN PROJECT.

BY BOB WEBSTER
DEPUTY DIRECTOR, WEAPONS

In the early 1940s, Los Alamos was Project Y of the Manhattan Project. The project was named for the Manhattan borough of New York City, home to the Army Corps of Engineers, which was tasked with the top-secret effort to design and build an atomic bomb to end World War II. In charge of the entire project was Army General Leslie Groves, who oversaw scientific and technical developments, construction, security, military intelligence, and more with a gruff demeanor that kept the difficult work on track.

Although portions of the project were spread across the country, General Groves spent much of his time at Los Alamos, where he was far from the only soldier. The Army's Special Engineering Detachment was brought to Los Alamos because of its experience in technical areas such as engineering and welding. Members of the Women's Army Corps typically filled clerical jobs.

After World War II, Project Y faced an uncertain future. It had a product (nuclear weapons) but lacked a customer until the Navy arrived on the scene in late 1945, needing to know if its ships could survive a nuclear blast. The Navy collected dozens of captured and surplus ships of various types, and Los Alamos prepared nuclear weapons to use against them in an operation code-named Crossroads. Crossroads was conducted at the Marshallese atoll of Bikini in July 1946. The operation's important weapons-effects tests confirmed naval vessels were vulnerable to atomic attack.

In the decades that followed, Los Alamos continued to pioneer weapons technology for the military. During the Cold War in particular, deterrence theory—the idea that nuclear weapons deter attacks—became the dominant military strategy and drove the Laboratory to design and deliver increasingly more powerful and compact nuclear weapons for ever-improved delivery systems. With the development of these weapons came the responsibility to make them safer. Innovative science and engineering were—and still are—necessary in both the development and safety of these complex weapons.

Today, much of our work revolves around maintaining four of the seven types of nuclear weapons in the current U.S. stockpile: the B61 gravity bomb and the W78 ballistic missile warhead deployed with the Air Force and the W76 and W88 ballistic missile warheads deployed with the Navy. (Read more about our modernization efforts of these systems on p. 12.)

Los Alamos not only partners with the military to bolster America's national security, but the Laboratory has also become a way for many veterans to continue their service to the nation. More than 10 percent of our workforce is former military; you can meet just a few of these folks beginning on p. 14. We also have a handful of active duty military at the Lab, including our Air Force Fellows (see pp. 38 and 50) and the men and women enrolled in the Department of Defense's Training with Industry program (see p. 6). We are thankful for their service and grateful that they've chosen to continue their careers at Los Alamos.

This short letter has highlighted only a fraction of the ways Los Alamos and the military have partnered over the years and continue to rely on one another today. Our relationship is storied and robust, and I hope this issue of *National Security Science* helps you see the power of partnerships between these two institutions. ★

MASTHEAD

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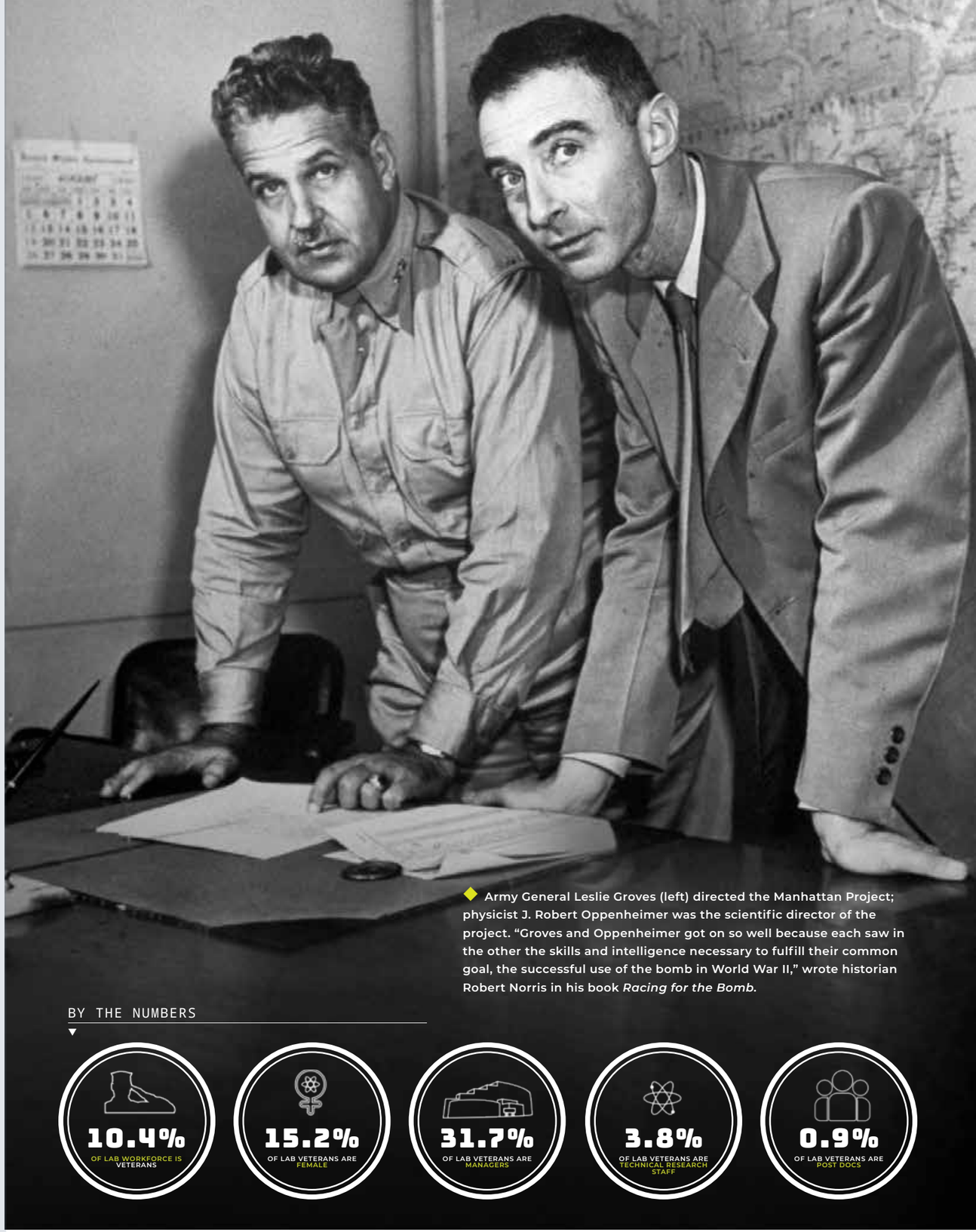
NSS STAFF SPOTLIGHT

Before being hired at Los Alamos, Evan Wells served in the U.S. Marine Corps for nearly four years. During that time, he deployed to Helmand Province, Afghanistan, where he worked in intelligence and combat operations. Wells is now a graphic artist and says the Lab is a great place for veterans to continue their service to the nation. He designed the infographic on p. 3.



Army General Leslie Groves (left) directed the Manhattan Project; physicist J. Robert Oppenheimer was the scientific director of the project. "Groves and Oppenheimer got on so well because each saw in the other the skills and intelligence necessary to fulfill their common goal, the successful use of the bomb in World War II," wrote historian Robert Norris in his book *Racing for the Bomb*.

BY THE NUMBERS

INFOGRAPHIC

THE INTERSECTION

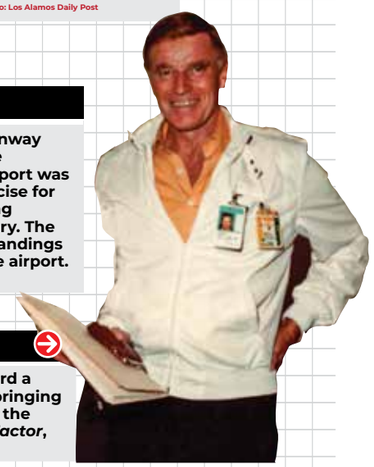
Science and culture converge in Northern New Mexico—and beyond.

Maintained by the Los Alamos Garden Club, the Los Alamos Memorial Rose Garden is the oldest public rose garden in New Mexico. In 2007, on the club's 60th anniversary, a Blue Star Memorial was installed to honor servicemen and women. Photo: Los Alamos County

Because of its short runway and high elevation, the Los Alamos County Airport was used in a training exercise for an HC 130J Combat King military plane in January. The plane conducted two landings and two takeoffs at the airport. Photo: Los Alamos Daily Post

U.S. Navy Captain (retired) Daniel Patrick Mack was the guest speaker at the 2019 Veterans Day event at Ashley Pond Park in Los Alamos. Read more about Mack and other veterans who work at the Lab on p. 14. Photo: Los Alamos Daily Post

More than half of the male residents of Los Alamos County older than 65 are veterans, according to the 2010 census. More than a quarter of Los Alamos County males ages 18–64 are veterans. Photo: Los Alamos County



Before he was a famous actor, Charlton Heston was a gunner aboard a B-25 bomber during World War II. He recognized the Lab's role in bringing the war to an end and in 1983 agreed to narrate documentaries for the Laboratory. Three of these films, *Project Whitehorse*, *The Flavius Factor*, and *Trust, But Verify can be viewed* on YouTube.

CULTURE ↑

SCIENCE →

QUOTED

"LOS ALAMOS THINKS OF ITSELF AS BEING THE HEART AND SOUL OF NUCLEAR DETERRENCE, AND IT IS RIGHT. IF A NATIONAL LABORATORY KNOWS HOW TO AID THE NATION, IT HAS AN OBLIGATION TO STEP FORWARD AND OFFER THAT HELP."

—Chief Scientist of the Air Force Richard Joseph. To learn more about Joseph and his work at Los Alamos and for the Air Force, turn to page 62.

VETERANS

HELPING HANDS

The Veterans Employee Resource Group recruits former military and supports them as they navigate their Laboratory careers.

BY SIERRA SWEENEY

Former Army Captain and Special Forces Officer Ben Bateman says a key part of being in the military is giving and receiving support. "I'm here in front of you today because of the help I asked for and received from others during my nearly nine years of service," he says. "In the military, you are always part of a team." This support system can be difficult to find outside of the military, which is why it's sometimes hard for veterans to transition into jobs after their service. It's also why the Lab established its Veterans Employee Resource Group (VERG).

VERG recruits veterans to work at the Lab and connects them with mentors through its Veteran's Mentoring Program. "We work with veterans and their families to help them adjust so they can hopefully find a place at the Lab," says Bateman, who is now a Laboratory project manager and the current chair of VERG. "When you arrive at the Lab, you have a position, but where do you fit in? That's what we help former military members discover."

VERG also educates and empowers veterans through lectures, military birthday celebrations, and 9/11 and veterans memorial events. In June 2019, for example, Army veteran Josh Mantz visited the Lab as a guest speaker to talk about his brush with death: he was killed by a sniper in Baghdad in 2007 but was miraculously revived 15 minutes later. Events such as that talk, Bateman says, allow vets at the Lab to feel represented. Such events also help all employees better understand the veteran experience.

Bateman grew up in a military family and felt it was his duty to serve his country and stand up for those who couldn't stand up for themselves. Many veterans have similar stories. VERG understands this mentality, Bateman says, and encourages veterans to support each other and find meaningful work at Los Alamos. "The veteran community can enhance the Lab culture of employees helping one another," he says. "As a Los Alamos employee, you are contributing to something greater than any one person." ★

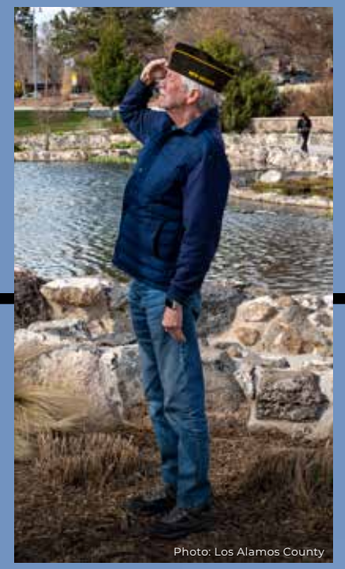


Photo: Los Alamos County

IN MEMORIAM

JAMES NESMITH

Gold Star Vietnam veteran and former chair of the Los Alamos Veteran Committee, James Leslie Nesmith, passed away on December 9, 2019, at the age of 73. Nesmith was a driving force behind the effort to name the U.S. Navy's next Virginia-class fast-attack submarine the USS *Los Alamos* in recognition of the contributions Los Alamos has made to the Navy. ★

Members of the VERG celebrate the Air Force's 72nd birthday in September 2019. Associate Laboratory Director and Air Force Colonel (retired) Mike Hazen was the keynote speaker for the event.

Q&A

ASK A SOLDIER

Explosive Ordnance Disposal Officer Blake Malcom answers three questions about his experience as a guest scientist at Los Alamos.

BY WHITNEY SPIVEY

In 2013, Malcom was deployed to Forward Operating Base Mescal, Afghanistan.
Photo courtesy Blake Malcom

In August 2019, Army Captain Blake Malcom left his position as an explosives ordnance disposal (EOD) company commander and battalion operations officer at Fort Carson in Colorado. Malcom headed south to Los Alamos, where he began a one-year assignment as a guest scientist with the Lab's Explosive Science and Shock Physics group.

The move is made possible by the DoD's Training with Industry (TWI) program, which annually matches 63 military personnel with innovative companies around the country. A maintenance person might spend a year at Caterpillar Inc., for example, or a logistician might go to FedEx. "As an EOD officer," Malcom explains, "I have the opportunity to work at Los Alamos in the Explosive Science and Shock Physics group."

NSS caught up with Malcom to find out exactly what that work entails.

What is a typical day for you at Los Alamos?

Each day is new and exciting. This opportunity has let me see how another organization besides DoD manages explosives safety, inventory, and applications. I also get to observe and participate in cutting-edge explosives experiments. I try to spend as much time as possible at firing points, assisting in setting up experiments. It's exhilarating to capture data at the point of detonation.

What's it like interacting with scientists daily?

I have developed great contacts who are exceptional problem solvers, teachers, and mentors. These people have redefined the way I think about what makes a successful leader and what makes a successful team. My time at Los Alamos will certainly help me create a problem-solving culture within the Army units I will lead in the future.

What's something interesting that you've learned at Los Alamos?

I'm afraid that's classified…but a close second is learning about the weapons complex—across the Laboratory and across the entire Department of Energy. Seeing the moving parts—the tools and talents—in action and having an opportunity to see and participate in projects getting done has really opened my eyes to what a hardworking team can accomplish. This experience has been a highlight of my military service. I wish the assignment was longer than one year. There is way too much to learn here. ★

The Pro Force uses Bearcat armored vehicles and working dogs to protect the Laboratory. Pro Force is a private company that contracts with the Lab through Centerra, another private security company.

SECURITY

THE VET WHO PROTECTS THE LAB

Retired Army Colonel Jesse Galvan once kept our nation's Army bases safe from threat, and now he's continuing that work in Los Alamos.

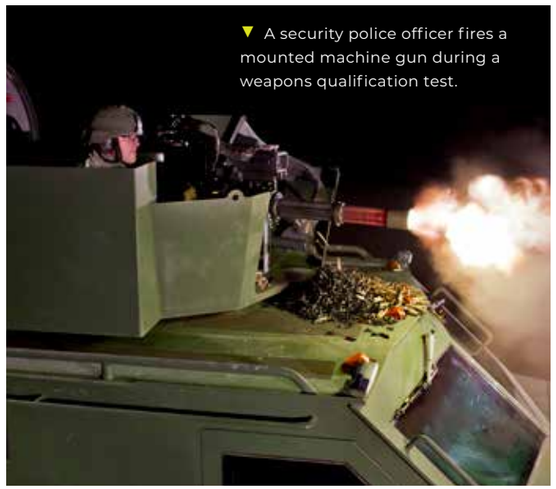
BY J. WESTON PHIPPEN

Around the Lab, we're used to seeing Protective Force (Pro Force) officers checking ID at the front entrance or patrolling the grounds in their white SUVs. But these men and women do a lot more that we don't see, says Pro Force Director Jesse Galvan, a retired U.S. Army colonel.

"You never really see all that we're capable of, and that's the point," Galvan says. "But rest assured we are capable of addressing and defending the Lab against any threat out there."

Galvan grew up as a self-described military brat, moving around a lot. From a young age, he was determined to serve the country like his father, and as a kid in Kansas, Galvan sometimes rode along with the military police at Fort Riley. Their important work left a lasting impression, so after graduating from Kansas State University it was obvious to Galvan what career he'd pursue with the Army.

For the next 30 years, Galvan worked with and led military police units across the country, including at the Joint Force Headquarters National Capital Region in Washington, D.C. He deployed twice for combat missions overseas, both times in support of Operation Iraqi Freedom. And every day through those three decades, he says, he made it a habit to pause for a moment in the morning as he put on his dog tags. It was a ritual Galvan's mentor taught him, to remind himself who he was serving—a practice Galvan refers to as "yoking up," just as a farmer yokes his oxen team before working the field.



A security police officer fires a mounted machine gun during a weapons qualification test.

When it came time to retire this past summer, Galvan says jokingly, "I didn't know what I wanted to do. I was thinking, 'Well, now I guess I have to grow up.'" He hadn't worked in the civilian world since college. But luckily a military friend called about a perfect job opportunity at Los Alamos.

Galvan assumed the role of Pro Force director in August 2019, after moving from the Washington, D.C., area. "My time serving definitely prepared me," Galvan says, "and it's great to be able to provide reassurance and safety to the people working on the Lab's mission."

There was a short transitional period as he adjusted from military culture to the culture already in place at Pro Force, Galvan says. But for the most part, he feels back at home among the 300 people he oversees. It's been all the more of a seamless transfer, he says, because many of the same people who now keep the Lab safe also once served to keep the nation safe. ★

MILITARY

MOVE OVER, POPCORN!

Microwaves can now be used for weapon ignition.

BY KATHARINE COGGESHALL

Cannons have been around since the 13th century (maybe even earlier), and they remain an essential component of modern ground warfare. Traditionally, cannons (artillery) use the mechanism of a firing pin, which must physically strike an igniter material in order to launch a projectile. But now, thanks to work by Lee Perry and Amanda Duque of the Lab's Explosive Science and Shock Physics Division, a cannon can be fired without direct physical contact, using microwaves.

We're not talking about soldiers armed with kitchen appliances here, but rather about the electromagnetic radiation (called microwaves) used by the kitchen appliances to heat our food. "These types of electromagnetic waves are also used for communication and radar and now, for ignition," Perry says.

As in a kitchen appliance, the microwave radiation used in Perry's experiments is sourced from a magnetron, which combines high-voltage electrons with a magnetic field to create microwave radiation. These microwaves are funneled toward a target, such as food in a microwave oven or ignition material in a weapon.

"Microwaves are an unusual energy source for weapon ignition," Perry says, "but there are a number of benefits, even though there were challenges to overcome."

The main challenges for Perry and Duque were working within the confines of existing weapon hardware and matching the impedance of the incoming microwave energy to the energetic material to be ignited. These are complex problems that no one else has ever solved, but Perry and Duque were equipped with years of experience in energetic materials.

With support from the U.S. Army, Perry and Duque solved the unsolvable—achieving microwave ignition to fire a cannon. This achievement eliminated the need for a cannon firing pin and associated mechanical bits. In fact, with microwaves, the cannon was ignited without physical contact; that is, the ignition material was lit directly by the microwaves.

◀ Amanda Duque (pictured) and Lee Perry are developing technology to fire cannons using microwaves.

"A benefit of microwaves," Duque says, "is that we can reach a higher volume of the ignition material. We can even ignite materials that are traditionally very challenging to ignite by conventional means."

When it comes to propulsion, such as propelling a bullet through a gun or a rocket through the sky, the goal is fast movement. This movement is achieved by igniting a certain type of material that generates enough energy to launch something (even very heavy things, such as artillery ammunition). The more material that gets ignited, the more energy that can be harnessed for propulsion. Given that microwaves ignite a greater volume of material, the resulting propulsion distance may also be increased.

But as it turns out, there's room for wider application of microwaves in the field of weapons. Perry and Duque are starting to consider how pre-exposing a high-energy explosive (like that used to detonate a bomb) to microwaves can change the explosive's microstructure and enhance its performance.

"Specifically, we are looking at plastic-bonded explosives (PBX), which are mission-critical materials for the Lab, and we are trying to enhance their performance," Duque says. Exposing PBX to microwaves before detonation may change the material's energetic response to shock. It's a novel concept, and one with a large payoff in terms of potential performance. ★

◀ Soldiers fire a howitzer (a modern-day cannon). Such weapons may soon be fired using microwave technology developed at Los Alamos. Photo: U.S. Army/Angela Chipman

MILITARY

REVOLUTIONIZING TOMAHAWK FUEL

Los Alamos scientists are using feedstocks—such as corn bran—to power the Navy's subsonic cruise missiles.

BY KATHARINE COGGESHALL

The U.S. Navy's Tomahawks, which are long-range, all-weather cruise missiles, can instantly shift course mid-air, striking with GPS-enabled pinpoint accuracy. More than 2,300 Tomahawks have been used in combat, and they remain a critical part of modern U.S. defense. But in contrast to their performance reliability, the sourcing of Tomahawk fuel—called JP-10—is becoming more of a challenge.

Current JP-10 production methods rely on molecules derived from petroleum, which is a fossil fuel. To reduce American dependence on fossil fuels, the Department of Energy asked Los Alamos scientists to find an alternative JP-10 production process. Scientists took that challenge one step further by making the process greener and cleaner.

"We've patented a production process that makes JP-10 from domestic renewable feedstocks, such as corn bran," says biomass conversion chemist Andrew Sutton, "which means we can make our own fuel from start to finish in the United States."

The JP-10 produced from Sutton's process performs the same as the JP-10 from petroleum-derived molecules. It's the same product, but a better process—better because its production doesn't require harsh acids, thereby generating significantly less chemical waste. In addition, the raw materials, because they're biomass, are renewable, and their use in the new process boosts U.S. agriculture.

"Our process supports domestic jobs and simultaneously secures our nation," says synthesis chemist Cameron Moore. "For example, producers of the domestic corn ethanol used in gasoline (up to 10 percent) can now use the byproducts of their process to make JP-10." What was once a low-value byproduct of corn ethanol production can now be a high-value, profitable co-product. Sutton and Moore's JP-10 production process is helping to diversify what was once a niche market.

And at the same time that the domestic economy will be bolstered by this alternative process, the cost of JP-10 may be significantly reduced, by about 50 percent, dropping the current price of $27.50 per gallon down to as low as $10.70 per gallon. So, our supply of Tomahawk fuel will be more reliable and more cost-effective.

Sutton's success directly ties to JP-10's future, in that once the cost per gallon of JP-10 comes down enough, it can be considered for many more aviation applications. "Right now," Sutton says, "JP-10 fuels Tomahawk cruise missiles, but it is being looked at as a potential high-energy-density jet fuel as well."

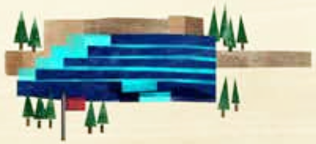
This could be quite the tactical advantage for the U.S. military—energy-dense fuel means more bang for your buck, so jets won't have to designate as much weight to fuel. This can translate to longer flights or more weapons carried. ★

▲ In his lab, Andrew Sutton fine-tunes the chemical reactions needed to produce JP-10.

▼ A Tomahawk missile begins its tip-over phase of flight after being launched from the guided-missile destroyer USS *Sterett*.
Photo: U.S. Navy/Carmichael Yepez

CAREERS

THE VIEW FROM THE OTHER SIDE



Lab employees take on new roles across the country—and around the world.

BY J. WESTON PHIPPEN

Each year about 50 Laboratory employees temporarily say goodbye to Los Alamos to work for a related national or international organization. The Intergovernmental Personnel Act (IPA) and the Change of Station (COS) programs allow federal employees to relocate across the country. Employees also have the option to work abroad with organizations such as the International Atomic Energy Agency (IAEA), in Vienna, Austria.

These external assignments may send an employee away for a year, or sometimes several years. When staffers eventually return, they have gained meaningful outside experience and helped spread the Lab's scientific expertise to policy makers. It's an exchange of ideas that Laboratory Director Thom Mason calls "an institutional priority." Here, a few people share their experiences. ★

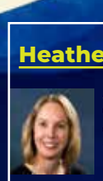
Matt Heavner

FIRST ASSIGNMENT:
Assistant Director for Global Security, Office of Science and Technology Policy, the White House, Washington, D.C.

SECOND ASSIGNMENT:
National Counterproliferation Center, Washington, D.C.

Within weeks of arriving in the nation's capital, Heavner had his picture taken with then-president Barack Obama. This photo and others are included in Heavner's journal. "Keep a record," he tells anyone considering an external assignment. "It's an amazing experience." In addition to providing technical leadership on nuclear proliferation detection policy at the White House, Heavner's experience included working on a team that brainstormed how to deliver humanitarian aid to the people of Allepo during the height of the Syrian civil war. Some ideas were digging an underground tunnel or building autonomous kayaks. Those plans never materialized, but he says "working on this time-sensitive, critical need during a serious global and political conflict humbled me and changed me for the better."

Heather Dion



ASSIGNMENTS:
COS and IPA with NNSA's office of Nuclear Controls in Washington, D.C.

Dion kicked off her first assignment by working on the inaugural Nuclear Security Summit. "The Summit began as an idea that went from obscurity to becoming a household name in the nuclear community," she explains. Held every two years from 2010 to 2016, the Summit increased awareness of nuclear security and established best practices for the global security of nuclear materials. "My time in D.C. was a great way to see the direct impacts the Lab has on the broader nuclear community," Dion says. "And the professional contacts and friendships I established and the education I received through my participation in the summits are invaluable."

Rebecca Stevens

FIRST ASSIGNMENT:
COS with the NNSA's International Nuclear Safeguards Engagement Program, Washington, D.C.

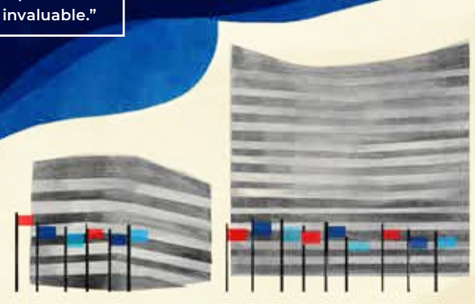
SECOND ASSIGNMENT:
Cost-Free Expert with IAEA's Department of Safeguards, Vienna, Austria

Stevens was away for six years in all. In Vienna, she developed and delivered training courses for IAEA member states on the legal obligations states undertake through their safeguards commitments under the Non-Proliferation Treaty. Stevens says she helped four countries begin nuclear energy programs, which brought her a broader understanding of how safeguard issues work on the international stage. "I think we become wiser when we become more open-minded," she explains. "I'm now more likely to look at my work through a different lens, not just through my default Los Alamos perspective."

Randy Flores

ASSIGNMENT:
IPA in U.S. Representative Ben Ray Lujan's office, Washington, D.C.

Flores has worked at Los Alamos since he graduated high school, so on his assignment to U.S. Representative Ben Ray Lujan's office, he was eager to see how the Lab fit into the bigger picture. He arrived in D.C. with his wife, two kids, two cats, and a chihuahua. For the next 18 months, he worked behind congressional scenes to make sure the Lab was represented in new budgets and to inform politicians of Laboratory capabilities. "This can be the difference between a new project and its funding being sent to Los Alamos or to another site," he explains.



EDUCATION

SARA BECOMES SARRA

The Lab's SARRA program expands to bring service academy and now ROTC students to Los Alamos for summer internships.

For more than a decade, the Laboratory's Service Academies Research Associates (SARA) program brought approximately 30 students annually from the United States Military Academy at West Point, the United States Naval Academy, the Air Force Academy, and the Merchant Marine Academy to Los Alamos for summer internships.

In 2018, Jon Zimak, an Army Reserve Officer Training Corps (ROTC) student at Worcester Polytechnic Institute in Massachusetts was admitted to the program. The chemical engineering major dedicated his summer to developing a Lab database that tracks fire safety issues. "He aced it," says Mike Port, who oversees the program.

Because of Zimak's success, Port, in coordination with leadership from the Defense Threat Reduction Agency (DTRA), decided to make ROTC students a regular part of SARA. Which means that SARA is now SARRA: Service Academies & ROTC Research Associates.

In 2020, as in past years, SARRA students—who are funded by DTRA and have security clearances—will spend four to eight weeks working with Lab mentors on projects that have real national security implications. The program provides these future military officers with their first exposure to innovative-edge scientific, engineering, and computational tools—and to the people who enable the Laboratory to answer the most difficult national security problems.

"We believe it's important for these students to understand the science, engineering, and technology available at the Lab because these are the tools that can help them deal with problems they'll face as military officers," Port says. "Our program also provides each of these cadets and midshipmen with future reach-back capability, if and when they need assistance resolving issues encountered while on active duty."

Potential SARRA students are encouraged to apply at www.lanl.gov/sarra. The majority of SARRA students plan to major in STEM fields, although one or two students every year are pursuing liberal arts degrees. This year's students will begin arriving in early May and cycle in and out until the first week of August. Most service academy students stay for four weeks; ROTC students may be able to stay longer (four to eight weeks). ★

AWARDS

A GREAT PLACE TO WORK

The Lab wins an award for recruiting and hiring veterans.

The Laboratory was recently recognized for "exemplary efforts to recruit, employ, and retain our nation's veterans" with a gold HIRE Vets Medallion Award from the U.S. Department of Labor.

The Honoring Investments in Recruiting and Employing American Military Veterans (HIRE Vets) Medallion Program is the only federal-level veteran hiring award.

"I am constantly hearing about and have experienced first-hand what great employees our veterans and transitioned military personnel are," says C.J. Bacino, of the Lab's Office of Diversity and Strategic Staffing. "We're honored to be recognized for our efforts in this area, but the truth is we're lucky to have such dedicated and talented people select the Lab as their employer of choice."

In a congratulatory correspondence from Eugene Scalia, Secretary of Labor, to Tim Babicke, Human Resources Deputy Division Leader, the Lab is credited with "demonstrated patriotism worthy of praise … and recognition of the value veterans bring to the workplace."

"We've increased our numbers of veterans hired this past year with increased outreach efforts, like attending more military-focused events, visiting bases we've not previously visited, and creating an event with New Mexico Workforce Connection that incorporated local employers," says veteran recruiter Junior Hamilton. "In addition, we provided resumé and cover letter classes in Santa Fe and Española to help veterans navigate the Laboratory's application process. It's definitely been a team effort by the recruiters to share more widely the significance of the Lab's national security mission." ★

THE WEAPONS WILL WORK

The Laboratory ensures U.S. nuclear weapons are safe, secure, and effective by continually assessing and updating them.

BY WHITNEY SPIVEY

Most nuclear weapons in the current U.S. stockpile were designed by Los Alamos and not intended to last indefinitely. These weapons are now more than 30 years old.

Before 1992, when the United States voluntarily ended nuclear testing, these aging nuclear weapons could be tested at the Nevada Test Site (today, the Nevada National Security Site). Now, the Lab has replaced nuclear testing with a science-based approach—a combination of research, nonnuclear tests, computer simulation, and comparison with data from historical nuclear tests. This approach is called the Stockpile Stewardship Program.

Through the Stockpile Stewardship Program, the Lab works in conjunction with other labs and plants in the NNSA complex to assess and ensure the safety, security, and effectiveness of each type of nuclear weapon in the stockpile. Each requires surveillance (a thorough examination of the weapon), routine maintenance, periodic repair, and replacement of limited-life components.

For weapons at the end of their original design life, Los Alamos may increase the weapon's lifespan through a life extension program (LEP), which addresses aging and performance issues, enhances safety features, and improves security. Through an LEP, scientists and engineers comprehensively analyze all of a weapon's components and, based on that analysis, reuse, refurbish, or replace certain components. An LEP helps the United States maintain a credible nuclear deterrent without producing new weapons or conducting underground nuclear tests.

Los Alamos may also conduct alterations (alts), which are changes to a weapon's systems, sub-systems, or components. Not as extensive as an LEP, an alteration is a limited-scope change that affects the assembly, maintenance, and/or storage of a weapon. The alteration may address identified defects and component obsolescence without changing a weapon's operational capabilities.

Weapons may also undergo modifications (mods), which change a weapon's operational capabilities. A modification may enhance the margin against failure, increase safety, improve security, replace limited-life components, or address identified defects and component obsolescence.

Here's a quick overview of the LEPs, alts, and mods that are complete or are currently underway at Los Alamos. ★

B61-12 LEP

The B61 nuclear gravity bomb, deployed to U.S. Air Force and North Atlantic Treaty Organization (NATO) bases, has almost 50 years of service, making it the oldest and most versatile weapon in the enduring U.S. stockpile. Numerous modifications have been made to the B61 since it first entered service in 1968, and four B61 variants remain in the stockpile: the B61-3, -4, -7, and -11. However, the aging weapon system requires a life extension to continue deterring potential adversaries and reassuring our allies and partners of our security commitments to them.

The B61-12 LEP will refurbish, reuse, or replace all of the bomb's nuclear and nonnuclear components, extending the bomb's service life by at least 20 years. The LEP will address all of the bomb's age-related issues and enhance its reliability, ease of field maintenance, safety, and use control. With these upgrades and the addition of a U.S. Air Force–supplied Boeing tail kit assembly, the B61-12 LEP will consolidate and replace four B61 weapon designs (the B61-3, -4, -7, and -10). When fielded, the B61-12 will balance greater accuracy, provided by the modern tail kit, with a substantial reduction in yield, but there will be no overall change in military requirements or characteristics. The B61-12 LEP is critical to sustaining the nation's strategic and nonstrategic air-delivered nuclear deterrent capability.

Los Alamos and Sandia National Laboratories are the design and engineering labs, respectively, for the B61-12 LEP, with Los Alamos also being responsible for producing detonators and other classified components. The B61-12 will be produced in fiscal year 2022. The bomb will be about 12 feet long and weigh about 825 pounds. If it is ever used, it will be ballistically air delivered in either gravity or guided drop modes. It is being certified for delivery by current strategic and dual-capable aircraft, as well as future aircraft platforms.

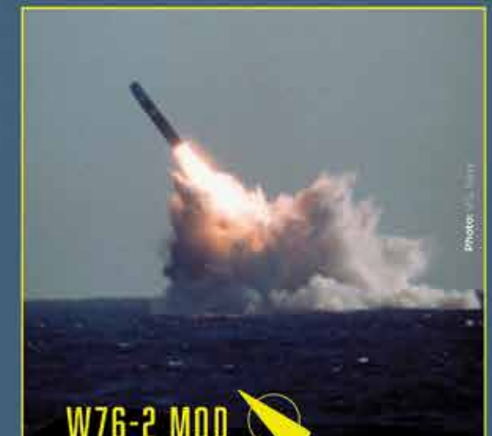
Photo: U.S. Air Force/Ben Bloker

W88 ALT 370

The W88 nuclear warhead entered the stockpile in late 1988 and is deployed on the Navy's Trident II D5, a submarine-launched ballistic missile carried onboard Ohio-class submarines. Deployed now for almost 30 years, the warhead requires several updates to address aging issues and to maintain its current state of readiness.

The W88 Alt 370 program replaces the arming, fuzing, and firing subsystem, adds a lightning arrestor connector, and refreshes the weapon's conventional high explosives to enhance nuclear safety and support future LEP options. The W88 Alt 370 program is scheduled to be completed concurrent with planned exchanges of limited-life, or routinely replaced, components, including the gas-transfer system and neutron generators. These will not change the warhead's military requirements or capabilities.

The W88 Alt 370 program has been in development since 2012. Los Alamos and Sandia National Laboratories are the design and engineering labs for this alt, while multiple nuclear security facilities are responsible for other aspects. Los Alamos produces the detonator assemblies for this alt.



W76-2 MOD

The W76-2 mod, a Los Alamos program, is a modification of the W76-1 warhead, which is used on the U.S. Navy's Trident II D5 submarine-launched ballistic missile. The W76-1, which is still in use, produces a high yield; the W76-2 provides a low-yield, sea-launched ballistic missile warhead capability. The first W76-2 was produced on February 22, 2019, at the Pantex Plant in Amarillo, Texas. Completion of the W76-2 represents NNSA's ability to achieve a significant program milestone in support of a national security initiative requested by the president in the 2018 Nuclear Posture Review.

W76-1 LEP

The W76-1 LEP was a refurbishment of the W76-0 warhead, the warhead for a submarine-launched ballistic missile system first introduced into the stockpile for the Navy in 1978. The LEP extended the warhead's service life from 20 to 60 years. The W76-1 continues to meet all missions and capabilities of the original W76-0 warhead but does not provide new military capabilities. NNSA produced the first W76-1 at the Pantex Plant in December 2018.

Los Alamos and Sandia National Laboratories are the design agencies for the W76-1. The W76-1 LEP also required the capabilities of scientists, engineers, technicians, and support personnel from the Pantex Plant, the Y-12 National Security Complex, the Savannah River Site, the Kansas City National Security Campus, Lawrence Livermore National Laboratory, and the Nevada National Security Site.

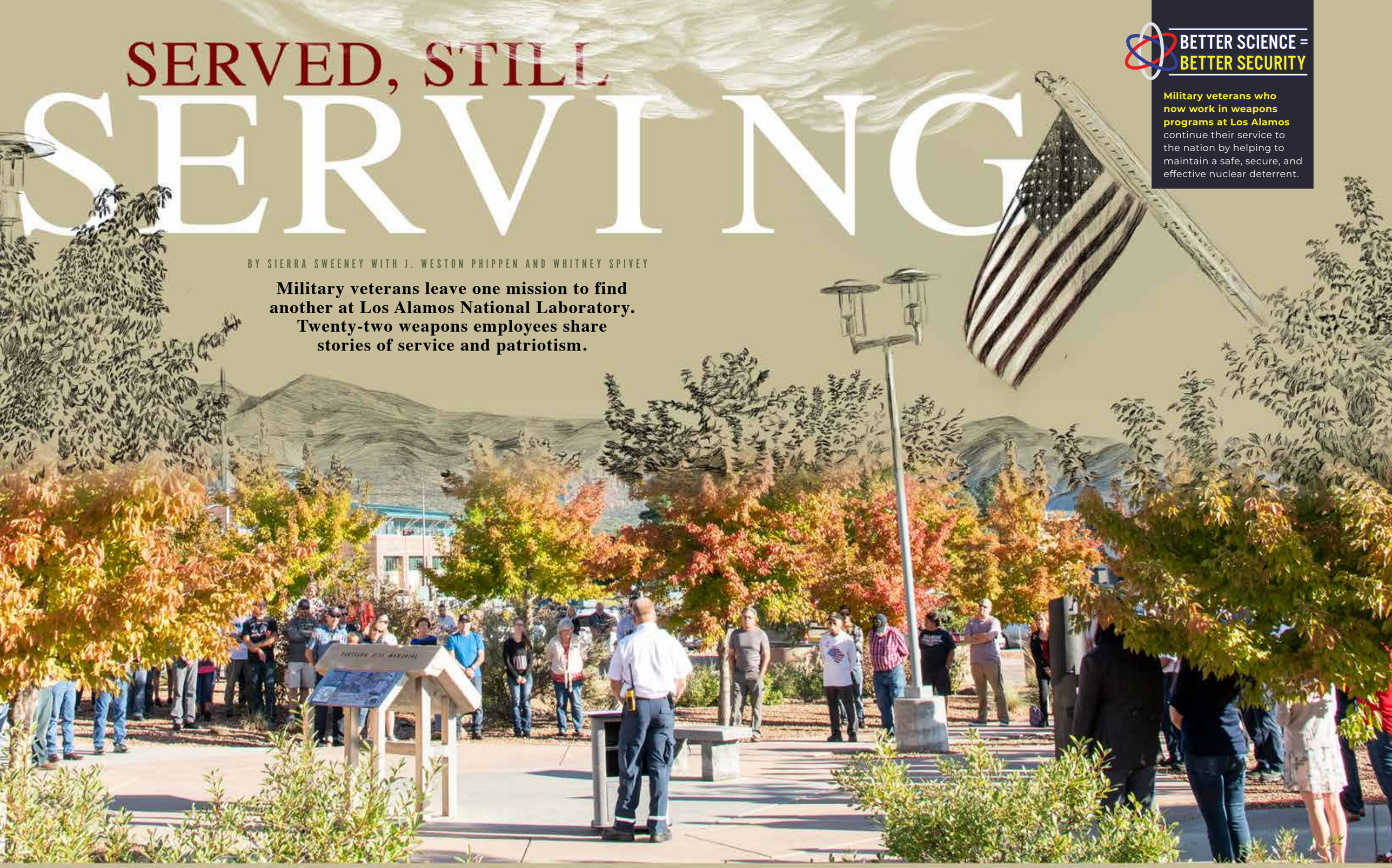
SERVED, STILL SERVING

BY SIERRA SWEENEY WITH J. WESTON PHIPPEN AND WHITNEY SPIVEY

Military veterans leave one mission to find another at Los Alamos National Laboratory. Twenty-two weapons employees share stories of service and patriotism.

BETTER SCIENCE = BETTER SECURITY

Military veterans who now work in weapons programs at Los Alamos continue their service to the nation by helping to maintain a safe, secure, and effective nuclear deterrent.



◆ Los Alamos employees—many of them veterans—gather at the Lab's Pentagon Memorial for a remembrance ceremony on September 11, 2019.

RIZWAN (RIZ) ALI

IN THE MILITARY:

AIR FORCE COLONEL

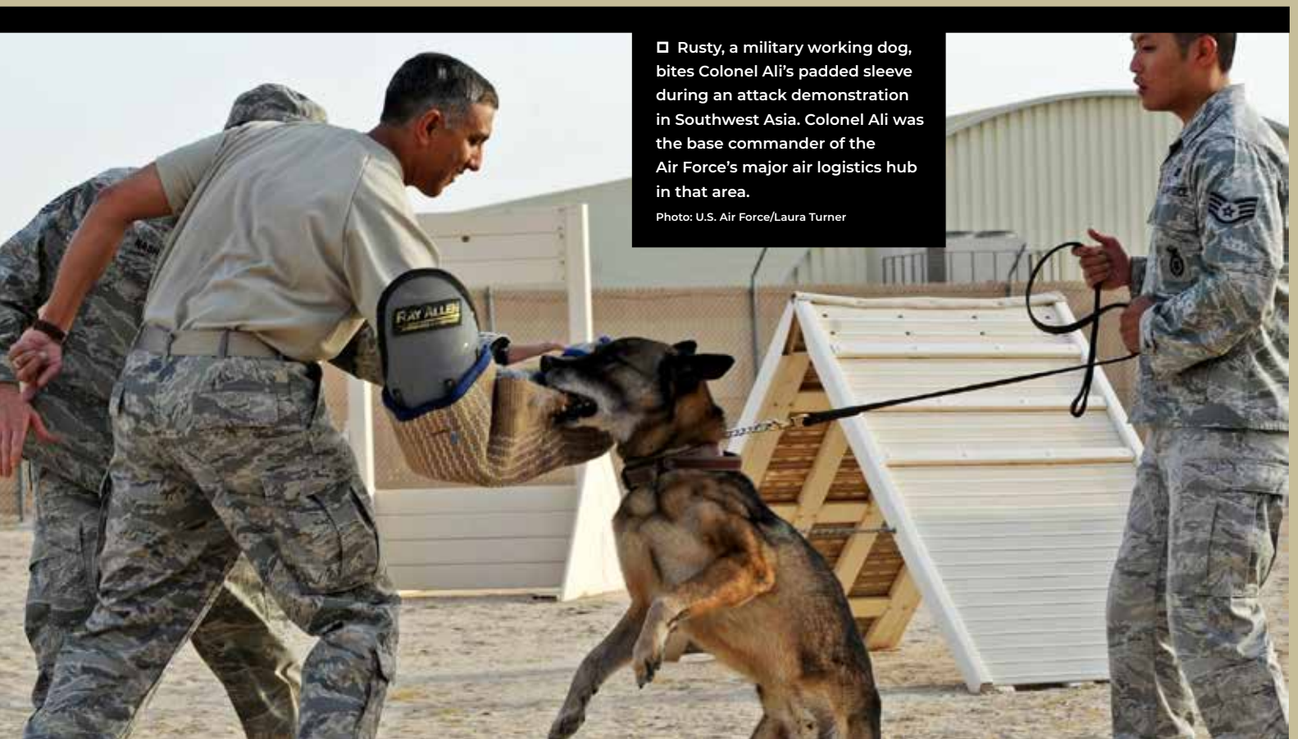
AT THE LAB:

GROUP LEADER FOR SECURE INFORMATION SERVICES AND THE NATIONAL SECURITY RESEARCH CENTER

One of Riz Ali's favorite "war stories" is how he invented the first wireless keyboard. At Illinois' Scott Air Force Base, Ali's 1989 posting, the general he worked under was exceptionally proud of his large conference room's wireless slide-show clicker—supposedly the only one in the world. Unfortunately, the system wasn't what the general thought it was. "It was a Sears garage door opener," Ali recalls now with a chuckle.

Unbeknownst to the general, a previous engineer had made the opener's two buttons trigger a light in another room (a closet really), where an officer would press the forward or backward arrow on a regular keyboard connected to the general's projector. It delighted the general, but it certainly wasn't wireless. So when the general needed another clicker for his smaller conference room, Ali—who'd studied electrical and computer engineering in school—researched infrared and radio signals. After several prototypes, he presented a truly wireless keyboard to the general's assistant. Ali expected excitement, but to his dismay, the assistant complained that all the buttons would confuse the general. So years before the wireless keyboard entered the private sector, Ali was modifying the world's first wireless keyboard into a simple remote control with only two buttons.

During the next three decades, Ali oversaw nuclear incident responses at a classified base, oversaw the air traffic control team that opened Baghdad's airport to U.S. troops after the city's 2003 fall, ran the Air Force's largest cybersecurity engineering center, managed an Air Force museum and archives, and set up NATO's cybersecurity program. Now at Los Alamos, Ali runs the National Security Research Center (the Lab's classified library) and says he enjoys how many fellow veterans he's met here. "I tend to gravitate to other veterans for personal support," he says, "and partly for the opportunity to swap old war stories."



Rusty, a military working dog, bites Colonel Ali's padded sleeve during an attack demonstration in Southwest Asia. Colonel Ali was the base commander of the Air Force's major air logistics hub in that area.

Photo: U.S. Air Force/Laura Turner

During Operation Desert Storm, Anaya was part of a motorized reconnaissance team that drove high-mobility multipurpose wheeled vehicles into Kuwait. Here, he sits in a "hummer" in northern Saudi Arabia in January 1991.

Photo courtesy Roger Anaya

ROGELIO (ROGER) ANAYA

IN THE MILITARY:

MARINE CORPS SERGEANT

AT THE LAB:

IT MANAGER AND DEPUTY GROUP LEADER, ENTERPRISE BUSINESS SOFTWARE, SOFTWARE AND APPLICATIONS ENGINEERING DIVISION

Roger Anaya came to the United States from Mexico when he was eight. By the time he graduated high school, he knew he wanted to go to college and serve his country. "That's why I went reserves," he says. "I had an academic scholarship to the University of New Mexico," he says, "but I felt the United States had given me and my family an opportunity. I wanted to give something back." So he enrolled at UNM in the fall of 1986, then took the spring semester off for boot camp with the Marine Corps.

In 1990, Anaya's reserve unit was activated as part of Operation Desert Storm. Once overseas, he participated in combat missions in northern Saudi Arabia and Kuwait.

For Anaya, the decision to separate from the military in 1994 was a tough one, even though he'd already begun working for Los Alamos in 1992 as a software developer. "I missed the people I served with," he says. "We trained together, lived together, fought together—we did everything together. We all came from so many different backgrounds, but you knew that when you went into a recon mission, you could depend on each other."

As a team leader in the Marines, Anaya says, he was aware that every member of his team was essential, right down to the private who held the radio. He believes the Laboratory also recognizes the value of every employee and emphasizes a similar "we're in this together" mentality. "Everybody at the Lab is here for the same mission," he continues. "Both in the military and at the Lab, you know you're there for a purpose."

In an effort to pay it forward, Anaya is now the commander of the Los Alamos Veterans of Foreign Wars, offering a warm welcome to other vets who are returning home.

CRESTA BATEMAN

IN THE MILITARY:

ARMY CAPTAIN AND MILITARY ACADEMY LIAISON OFFICER

AT THE LAB:

MANUFACTURING MANAGER, HEAT SOURCE TECHNOLOGIES

Cresta Bateman grew up in a family where national security and military history were common dinner-table topics. Her grandfather came to work for the Lab in 1956, and her dad, a Navy vet, started at Los Alamos in 1979. Bateman knew she wanted to continue the family tradition of serving her country, and not long after 9/11, she was selected to attend the United States Military Academy at West Point.

After being commissioned in 2006 with a degree in engineering management, Bateman was deployed during Operation Iraqi Freedom. She says the "best possible culmination" of her training was leading her soldiers into combat as a platoon leader. "Things have really changed and are still changing for women in the military," says Bateman, noting that women haven't always been allowed in combat roles. "As new generations of women enter the military, they take on new opportunities and responsibilities. At the end of the day, we just want equal opportunities to serve."

Today Bateman works for Weapons Production at the Lab while also serving in the Army reserves. She says the Lab's policies, procedures, and real-world mission make Los Alamos a perfect work environment. "I've been part of the national security mission since I was 18 years old. I like that I can continue that service in a way that is interesting and dynamic and that makes a big difference."

Another way Bateman continues to make a difference is through the nonprofit she and her husband (also a former Army officer) started in 2014. Sportsmen for Warriors helps veterans and first responders—aka the Warrior Community—heal through outdoor engagement. The Batemans hope veterans can connect with each other through activities such as big-game hunting, deep-sea fishing, and swimming with sharks, as well as through community engagement. "It's a tribe healing mentality," she says. "Our mission is to help veterans heal by connecting them with somebody who has been there and also made it through."

Captain Bateman attends a graduation ceremony at West Point in May 2010. Photo: Ben Bateman

In September 2007, 1st Lieutenant Best, pictured here at Al-Asad Air Base, prepares for an eight-month combat deployment to Al Qa'im, Iraq. Photo: John Curry

JEREMY BEST

IN THE MILITARY:

MARINE CORPS MAJOR

AT THE LAB:

PROGRAM MANAGER, OFFICE OF NUCLEAR AND MILITARY AFFAIRS

"The United States Marine Corps fit me like an old shoe," says Jeremy Best, who enlisted after high school because he found the structure appealing. "I enjoyed the challenge of having to work from the bottom up, earning every rank from Private to Major," he says. "In the Marines, I knew where I needed to be."

Best ended up spending 20 years in the military. In the early days, he played French horn in the Marine Corps Band and earned a degree in aerospace engineering. As a 1st Lieutenant, he served in Operation Iraqi Freedom in Al Anbar Province, Iraq, from 2007 to 2008. Best then earned a master's degree in nuclear engineering from the Air Force Institute of Technology and completed his military career at the United States Naval Academy as a member of the physics department.

Although Best enjoyed his time in the Marines, the military didn't totally fulfill what he calls his "nerd side." Transitioning to Los Alamos allowed him to combine his defense background with his technical knowledge. Today, Best analyzes weapons effects and helps manage military outreach programs, such as the Service Academies & ROTC Research Associates (SARRA) program, which welcomes young cadets and midshipmen to the Lab each summer. (Read more about SARRA on p. 11.)

Best says the parallels between the military and the Laboratory are what make the Lab a great place for both service academy students and veterans. "Bringing more folks from the military to the Lab will bring more diversity of thought," he says. "The military develops genuine leadership ability in people who are going to make a valuable impact."

"A wide range of people work here at the Lab, and each of them is important to the mission," Best continues. "Everyone from the custodial staff to the Lab director is essential to the Laboratory's national security mission."

From 2015 to 2018, Byers was a military occupational specialty instructor in the Motor Transportation Instruction Company—one of five companies that make up the Marine Corps Detachment at Fort Leonard Wood, Missouri.

Photo courtesy Tim Byers

TIMOTHY (TIM) BYERS

IN THE MILITARY:

MARINE CORPS, MOTOR TRANSPORTATION OPERATOR

AT THE LAB:

RESEARCH TECHNICIAN, INTEGRATED WEAPONS EXPERIMENTS DIVISION

If family history is any indication, Tim Byers was destined to work at the Lab. Byers' father is a current employee, and both of his grandparents worked here. But the Byers family name in Los Alamos dates back even further, back to the Lab's creation when his great-grandfather worked as a machinist during the Manhattan Project. "There have been a lot of us," Byers laughs.

Byers joined the military right out of high school and served in the Marine Corps from 2011 until 2018 as a motor transportation operator. He'd grown up working on cars with his father, and he imagined he'd become a mechanic for the Marines. But he was instead selected to lead transportation convoys and manage vehicle sections. "I'm glad, because it was a better field for me, and it taught me so many things," he says.

Byers eventually became an instructor, overseeing new Marines and a fleet of 60 trucks, altogether worth about $20 million. "When I was an instructor, I learned skills in personnel management. I also learned how to supervise and mentor younger Marines, on top of taking care of all that expensive equipment."

After his military service, Byers took a job at Los Alamos, where he's also responsible for valuable equipment. Specifically, he's charged with the upkeep and management of x-ray systems with energy measured in millions of electonvolts (MeV). These 2.3-MeV-energy x-ray systems are used to analyze small-scale explosions.

The 2.3-MeV-energy x-ray is about 12 feet long and more than four feet in diameter, and it weighs 5,000 pounds. It's also about 60 years old, so Byers maintains the system so that researchers can continue their explosives experiments.

Outside of work, Byers still tinkers with cars. He says his latest project is a Jeep he's turning into a rock crawler.

MARIA CAMPBELL

IN THE MILITARY:

AIR FORCE SENIOR AIRMAN

AT THE LAB:

EXPLOSIVES TECHNICIAN AND FIRING SITE LEADER, EXPLOSIVE APPLICATIONS AND SPECIAL PROJECTS, EXPLOSIVE SCIENCE AND SHOCK PHYSICS DIVISION

Originally from Baja, Mexico, Maria Campbell entered the military after high school and says the Air Force opened her eyes. "When I went into the military, I was young and still had a lot to learn," she says. "I got to see the world, and I got a whole new perspective on the lives of other people. Being in the military teaches you to appreciate the freedoms you have."

For six years, Campbell worked as a mechanic on military and heavy-duty vehicles. When it came time to leave, Campbell had a hard time transitioning from the military to a civilian work environment. Then she found the Lab. She began as an explosives technician doing high-explosives pressing, but her ability to follow directions and learn quickly—skills developed in the military—helped her advance: she now conducts indoor firing activities and is currently one of only two female firing-site leaders at the Lab. She says her favorite thing about the job is getting to blow things up.

Three years into her Lab career, Campbell says some aspects of the military are hard to leave behind; for example, she often calls people ma'am or sir. But Campbell also appreciates the flexibility of her job. "You really have to be more creative with your problem solving around here," she explains. "You can experiment more, but you still have that strong sense of working towards a bigger picture."

That bigger picture is, of course, national security, and that's what makes working at Los Alamos so rewarding for Campbell. "It feels like you're still serving your country," she says. "And for veterans, that's a big deal."

Campbell rides in a chinook helicopter while stationed at U.S. Army Garrison Humphreys in South Korea in 2006.

Photo courtesy Maria Campbell

Eyler smiles 2,000 feet below sea level on research submarine NR-1 in 2003. Photo courtesy Dave Eyler

DAVE EYLER

IN THE MILITARY:

NAVY CAPTAIN

AT THE LAB:

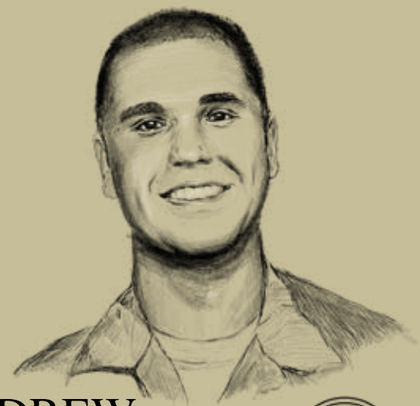
ASSOCIATE LABORATORY DIRECTOR FOR WEAPONS PRODUCTION

Dave Eyler grew up about 40 miles south of Detroit and knew early on that he didn't want a career in the auto industry. So when a high school counselor recommended he consider the U.S. Naval Academy, that's exactly what he did. "I liked the idea of serving the country and getting a good education at the same time," he remembers. "I didn't know anything about submarines, but traveling around the world was definitely going to be different than my hometown of Monroe, Michigan."

Eyler went on to spend 29 years in the Navy doing nuclear-centric work on submarines and naval reactors. "I even finagled my way into grad school a couple times," he says.

After retiring from the Navy, Eyler worked at the Defense Nuclear Facilities Safety Board, an oversight agency for Department of Energy work. That led to a stint at the Savannah River Site, during which he worked as the chief engineer, deputy director of Savannah River National Lab, and chief operating officer for the site. "At that point, I was asked to come to Los Alamos, which was something I couldn't pass up," he says. "I knew that Los Alamos has a certain gravitas and history. Plus, working here has an element of service to the country, which is what had intrigued me about the Navy."

Los Alamos is also the nation's Plutonium Center of Excellence for Research and Production, a designation that Eyler helps maintain in his position as the head of the Weapons Production Directorate. This directorate of more than 1,000 employees develops and produces plutonium pits, detonators, and other weapon components. "You can do things here you can't do anywhere else when it comes to nuclear materials," Eyler explains. "It's a very dynamic and interesting place to work. Is it hard? Yes. Can it be frustrating? Yes. But nothing worthwhile is easy. The people who work here are here because it's a really worthwhile mission."



ANDREW FORD

IN THE MILITARY:

AIR FORCE SENIOR AIRMAN

AT THE LAB:

QUALITY ASSURANCE INSPECTOR FOR PLUTONIUM PRODUCT QUALITY ENGINEERING AND INSPECTION

Following in family footsteps, Andrew Ford enlisted in the Air Force and spent six years maintaining nuclear weapons. When he began working at Los Alamos, he was able to continue this work, but from a new angle. Used to considering only the military point of view, which is focused on handling these weapons, Ford says he found the technical side just as fascinating. "I think it's almost impossible to find a job as interesting, important, and rewarding as the military," Ford says. "Except, of course, for a Los Alamos job."

During his service, however, Ford, like many others, believed that he needed a doctorate to work at Los Alamos. But when Jon Ventura, former director of the Lab's Office of Nuclear and Military Affairs, gave a lecture at Ford's Air Force base, Ford learned that working at Los Alamos was both possible for him and encouraged. From there, the transition was easy, and he embraced the Lab's national security mission. "I need to work at a place with a mission and a sense of pride," he says. "National security is very important to me and to a lot of vets."

In addition to the mission, the Lab's work environment has been a good fit for Ford. "You don't have to enter the Lab understanding everything," he says. "Being able to troubleshoot a problem and learn more as you work is a unique experience available only at a place like Los Alamos."

Along with the good pay, the benefits, and the mission-oriented community, Ford says the opportunity to grow and be essential at the Laboratory is like no other. "Everyone is valuable at the Lab. There's no cookie-cutter way of doing work around here, and all the work feels important. I think that's really what's key to making this a good environment for former military."

From left: Staff Sergeant James Flanigan, Senior Airman Andrew Ford, and Airmen 1st Class Matthew Gish and Jennifer Cook at Malmstrom Air Force Base in Montana in 2014. Photo: U.S. Air Force/Collin Schmidt

CORINA GONZALES

IN THE MILITARY:

ARMY RESERVES MAJOR

AT THE LAB:

FINANCIAL COMPLIANCE SPECIALIST, FINANCE AND ACCOUNTING

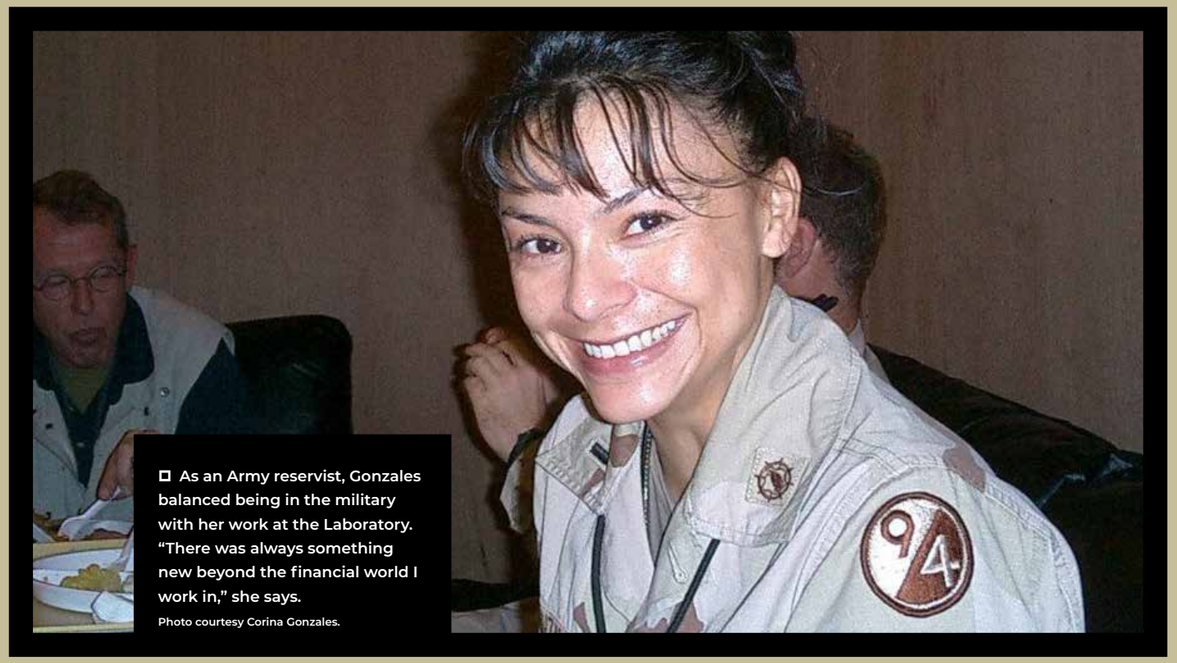
When Taos native Corina Gonzales had served in the Army reserves for 10 years, she challenged herself to stay longer. She ended up serving a total of 27 years, and during that time she also worked at the Laboratory as an accountant. During the week, she'd crunch numbers, and on the weekends, she'd march 15 miles with a 60-pound rucksack. "Showing up to my desk job on a Monday was sometimes difficult," she laughs. "I'm a bit of an oddball. You don't find an accountant–combat veteran combo very often."

Switching between her military and civilian hats was sometimes challenging, "but if anyone has flexibility when it comes to adapting to environments, it's members of the military," Gonzales says.

Though there are accountant positions in the military, Gonzales wanted to do something more hands-on during her service. So, she drove 25-ton Army trucks for combat missions. She also completed an 18-month officer training program and was deployed three times, including to Desert Storm.

According to the Pew Research Center, approximately 14 percent of the U.S. military is female, and 15 percent of female veterans have served in combat. Gonzales says female vets aren't common at Los Alamos, and she thinks that she may not immediately fit people's assumptions. "They may think a female veteran will be an aggressive kind of leader, but I've always tried to lead by example."

The switch from the military to the Laboratory has been a comfortable change for Gonzales because the Army and Laboratory environments complement one another. "One of the Laboratory's core missions is to support military defense and deterrence, much like I was doing in the Army."



As an Army reservist, Gonzales balanced being in the military with her work at the Laboratory. "There was always something new beyond the financial world I work in," she says.
Photo courtesy Corina Gonzales.

Gonzales stands next to his boat, the USS *Boise*. The Los Angeles–class attack submarine underwent preventative and corrective maintenance during this 2017 stop at Naval Station Norfolk in Virginia. Photo: U.S. Navy/Frank Mercurio

A Los Alamos native, Josh Gonzales enlisted in the Navy in 2013 while attending the University of New Mexico. During his service, Gonzales worked as a satellite communications electronics technician on a submarine. Although he misses the teamwork and important technical work on the submarine, Gonzales says there's no place like home, especially when your home has chile.

"I had to have chile shipped out to the sub all the time," Gonzales remembers. "But I do miss the camaraderie. You spend a lot of time with the guys on your crew, and they're a very dependable group." The 140 people onboard Gonzales' boat were trained in everything from technical work to submarine damage control and firefighting. Each crewmember participated in every aspect of life, from working with complex satellite communications to taking out the trash.

Though Gonzales' 100-hour workweeks aboard the submarine were exhausting, knowing that his work directly contributed to national security always helped him get through it. His work at the Laboratory is no different. "In the Navy, I got to see where nuclear weapons are maintained at the ready, as part of the nuclear triad" he says. "Now I work with the accelerators that provide a portion of science-based stockpile stewardship. The experiments we do at DARHT all contribute to that mission." Gonzales also says that working at DARHT, like working on a sub, allows him to interact with a tight-knit crew of people he counts on and who count on him.

But one difference between the military and the Lab is that the Lab is more relaxed. "You go from wearing a uniform every day to seeing people in baseball caps and tennis shoes," Gonzales says. He notes that after five years of enlisted service, wearing T-shirts and eating breakfast burritos on experiment day is a nice change of pace.

JOSH GONZALES

IN THE MILITARY:

NAVY SATELLITE COMMUNICATIONS TECHNICIAN

AT THE LAB:

ENGINEERING SYSTEMS TECHNICIAN, DUAL-AXIS RADIOGRAPHIC HYDRODYNAMIC TEST (DARHT) FACILITY

Logan is a 1994 graduate of the United States Coast Guard Academy in New London, Connecticut. She credits the Academy with helping her develop mental and physical toughness that's served her well later in life.

Photo courtesy Tarah Logan

TARAH LOGAN

IN THE MILITARY:

COAST GUARD LIEUTENANT JUNIOR GRADE

AT THE LAB:

PROGRAM MANAGER IN ADVANCED SYSTEMS DEVELOPMENT, WEAPON STOCKPILE MODERNIZATION DIVISION

"My favorite time of the day was between about 4:00 and 8:00 in the morning," says Tarah Logan, who served five years in the U.S. Coast Guard. "Everyone else was asleep, and I'd look out at the ocean and basically be on top of the world right when the sun was coming up. It was very peaceful and powerful." From her perch on a cutter (a ship more than 300 feet long, with a 150-person crew composed of people from all walks of life), Logan saw almost every marine animal you can imagine.

She also had the responsibility of running the ship, at the age of 22. The Coast Guard Academy prepared Logan for that responsibility—and many others. Logan also inspected fisheries in Alaska, reported drug smuggling techniques (such as false ship hulls) to Coast Guard intelligence, and worked to stop human trafficking of Chinese immigrants.

Logan was proud of the work she did in the Coast Guard, but she knew she couldn't do the same thing for too long. Originally from Española, Logan returned home to Northern New Mexico in 2003 and was recruited to work at Los Alamos by a fellow veteran. She started off as an operations training specialist but now works in the research-based section of the Lab's Weapon Stockpile Modernization Division. She says it's her dream job.

According to Logan, veterans have a lot to offer the Laboratory, including poise under pressure, multitasking ability, focus, and ingrained leadership. In return, Logan says the Lab provides veterans with the opportunity to have multiple careers all in the same place while continuing to be part of a patriotic community and mission. "Where else can you say that you get to work at a place that truly has a worldwide impact?"

DENNIS LUJAN

IN THE MILITARY:

NAVY MACHINIST'S MATE 2ND CLASS PETTY OFFICER

AT THE LAB:

ENGINEERING TECHNOLOGIST

In 1979, after high school, Dennis Lujan was a machinist's mate for four years in the Navy, maintaining propulsion systems, steam turbines, evaporators, and other components on Navy ships. "I saw a portion of the world while learning a trade," he says. When Lujan returned to Northern New Mexico, he joined a Rugby Club and continued to travel, visiting new places until the money ran low. He then decided to do as his father had done and apply for a job at the Lab. His father assured him that Los Alamos was "the best place to work in Northern New Mexico."

In 1984, Lujan began working as a vacuum technician in the Electronics and Instrumentation Division, but when that division was dissolved in 1991, he looked for a new position at the Lab's Technical Area 55. He was hired into the Nuclear Materials Technology Division, and he has remained at TA-55 ever since. Lujan currently works in the Pit Technologies Division, in the Assembly Operations group. Lujan is the subject matter expert on laser welding at TA-55.

As Lujan looks back to the early 1990s, he says a "huge highlight" of his career was "working for PhDs who would teach me anything I wanted to know about our work." Now, 35 years into his Laboratory career, Lujan is mentoring the next generation. His advice to them? "If you want to live in beautiful Northern New Mexico and you want a comfortable life, the Lab is the best choice. I would highly recommend it to other military veterans."

He continues, "The Laboratory not only has provided a career, benefits, and opportunity but also has allowed me to have a fulfilling life away from work." Lujan says this rewarding work-life balance has allowed him to complete house projects, golf, and ski. He also loves to travel with his wife when he's not working. "You'll never see me not happy and smiling," he says. "Life's a bonus."

During a break from Navy operations in the Caribbean, Lujan enjoys a fresh coconut on St. Croix, Virgin Islands, in 1981.

Photo courtesy Dennis Lujan

From March 1989 to June 1990, Lieutenant Daniel Mack (right) was the executive assistant to Rear Admiral Joseph Prueher (left), commandant of the U.S. Naval Academy. Admiral Prueher, who retired as a four-star and later served as the Ambassador to China, remains one of Mack's mentors today.

Photo: U.S. Naval Academy

DANIEL MACK

IN THE MILITARY:

NAVY CAPTAIN

AT THE LAB:

CHIEF OPERATING OFFICER, ASSOCIATE LABORATORY DIRECTORATE FOR WEAPONS PRODUCTION

The sixth of eight children, Daniel Mack saw the United States Naval Academy as his chance for higher education—and a rewarding 28-year career that took him around the world. Alongside highly capable crewmembers, Mack executed covert national security missions on submarines. "We'd go into every mission as if we were going to war," he remembers of his time at sea. "Every crew member pulled their weight."

Mack sees a similar, mission-focused drive among the people he works with at the Laboratory. He enjoys "taking a group of diverse, highly technical people who will challenge your thinking and setting a goal for them, then helping them plan to achieve it."

As the commanding officer of the USS Houston, Mack says he often found himself recruiting while on travel, talking to potential recruits in places as diverse as a Padres baseball game in San Diego, the top of Seattle's Space Needle, and even a Buddhist temple in Japan. Now that he's at the Lab, he sometimes puts those recruiting skills to work for Los Alamos, at military-geared events around the country. He can't help doing that he says, because "just as the military provides an opportunity to receive an education and climb in rank, so does the Laboratory."

"Everyone has different motivations and everyone serves their country in their own way," he says. "At the Laboratory, we want a mix of people who bring their different skills and backgrounds because that's when you get the best results. We're constantly bringing in new and incredibly smart people who will run through a brick wall to get the job done."

DAN McDONALD

IN THE MILITARY:

MARINE CORPS STAFF SERGEANT

AT THE LAB:

EXPLOSIVES TECHNICIAN, HIGH EXPLOSIVES SCIENCE AND TECHNOLOGY

By the age of nine, Daniel McDonald knew he wanted to be a bomb technician. But what he didn't anticipate was that after serving for 12 years in the Marine Corps, he would continue to work with explosives as a technician at Los Alamos National Laboratory.

Instead of detonating thousands of pounds of high explosives, as he did in the Marines, McDonald now works on a much smaller scale—detonating only grams of explosives. He carefully analyzes and collects data on each explosion. "In the Lab's Weapons Program, we are very mission focused and have clear goals for what data collection directly serves," McDonald says.

McDonald says the best years of his life were spent shooting guns and blowing up stuff with his friends in the military. Although the dynamics cannot be exactly replicated at the Lab, he still finds his work at Los Alamos just as interesting, and he guesses that many vets feel the same way. When veterans leave the military, McDonald believes that many struggle to find the same purpose they had in the military. In many ways the Lab bridges this gap by being a workplace with goals, responsible individuals, and meaningful tasks. McDonald advises veterans who wish to work at the Lab to find a way to apply their skills and utilize their ability to learn and be trained as they enter this new science-based environment.

Dan McDonald (left) and fellow Marine Thomas Jones stand together during Range Clearance Operations in 2012 at the Marine Corps Air Ground Combat Center in southern California. Twentynine Palms, as the center is also called, is the largest United States Marine Corps base, covering nearly 600,000 square acres. Photo courtesy Dan McDonald

SARAMOYA MERCER

IN THE MILITARY:

AIR FORCE SENIOR AIRMAN

AT THE LAB:

RADIOGRAPHER, NON-DESTRUCTIVE TESTING AND EVALUATION, ENGINEERING TECHNOLOGY AND DESIGN DIVISION

As a senior airman, Mercer developed leadership skills and completed coursework for a degree. Photo courtesy Saramoya Mercer

Saramoya Mercer followed her brother into the military and became a security forces specialist. Though she values that experience, she believes that her professional career truly began to grow only when she left the military and began working at Los Alamos.

"I like the fact that I served, but I think I'd be further along in life if I hadn't joined," she says. "Or if I at least had been assigned a job more in line with my professional aspirations. The Lab offers me more room for my professional advancement."

After leaving the Air Force but before coming to Los Alamos, Mercer worked as a medical radiation therapist in Santa Fe but still found her career options stifled. Mercer learned about the Lab through her husband, and in May of 2018, she accepted a Lab job as a radiographer and made the switch from radiation oncology to radiography.

Now a part of the Lab's Engineering Technology and Design Division, Mercer says leaving the familiar work of her old job was a big change, but it opened her eyes to how much she could learn in an environment like the Laboratory. "I went from a job where I was proficient and knowledgeable to a job where I understood the fundamentals but was far from an expert. I had a lot to learn."

Now, Mercer can say that she has finally found a place where her work aligns with her interests and motivations. "My job at Los Alamos National Laboratory complements my skills and allows for advancement throughout my professional life. I would recommend Los Alamos for employment to anyone."

In 1996, Otterson, pictured here at Prince Sultan Air Base in Saudi Arabia, helped enforce the no-fly zone over southern Iraq. Photo courtesy Kirk Otterson

KIRK OTTERSON

IN THE MILITARY:

AIR FORCE OFFICER

AT THE LAB:

PROGRAM MANAGER, OFFICE OF NUCLEAR AND MILITARY AFFAIRS

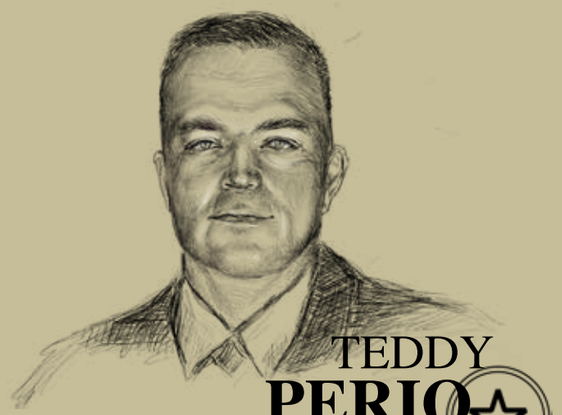
Kirk Otterson's "natural attraction to the military" came from his father, a World War II airborne infantryman. Otterson enlisted in the Army in 1979 and was part of a small security team for overseas weapons before moving on to work intelligence jobs as an Air Force officer. During his military career, Otterson experienced the Cold War, the fall of the Berlin Wall, combat missions over Kosovo, and 9/11.

Otterson has always enjoyed working in small groups of hardworking, dedicated people; when he retired from the military, he taught history at St. Anselm's Abbey School in Washington, D.C. Like being part of the military and working at a high school, he says working at Los Alamos provides a close-knit community, along with "some really bright folks who challenge your thinking daily." In 2019, Otterson was hired into the Lab's Office of Nuclear and Military Affairs, where he builds and maintains the Lab's relationships with the military and its service academies.

According to Otterson, contributing to and learning from a mission-oriented community is an honor that is hard to find outside the military—but he found it at Los Alamos. "I had a beer with a few Lab folks, and it felt like being back on base at the club—just a great sense of being a part of something special," he says of his first visit to Los Alamos. "I feel right at home in a place that values the combination of people and their different perspectives on solving some of the toughest national security challenges."

That mission is a large part of what attracted Otterson to work at the Laboratory. "As a historian and a former intelligence officer, I can see that the Great Power competition has returned and our mission at the Lab is more important than ever. I'm fortunate to be a part of that mission."

Teddy Perio (left) stands with his son, Tyler, who graduated from Coast Guard boot camp. On the right is Perio's grandfather, Corporal Angelo Basso, a World War II veteran. Photo: David Perio



TEDDY PERIO

IN THE MILITARY:

ARMY COMMAND SERGEANT MAJOR

AT THE LAB:

PROGRAM LEAD, NUCLEAR MATERIAL CONTROL AND ACCOUNTABILITY, SAFEGUARDS DIVISION

Teddy Perio has been growing out his beard since 2017, when he retired from 24 years in the military, including four deployments to Iraq. "My wife's cousin didn't even recognize me," he says of his new look.

Facial hair aside, Perio misses working as a drill sergeant in a military unit. He says it can be difficult for some veterans to find a sense of purpose in their work after serving. Luckily, he finds that sense of purpose as a manager for the Laboratory's Safeguards Division, where he is in charge of ensuring the safe management of nuclear materials and mentors a team.

Perio was introduced to Los Alamos through the Hiring Our Heroes Corporate Fellowship, which gives service members work experience and training at institutions like the Laboratory. During his military service, Perio earned three degrees and gained management experience, which was a large part of helping him transition to Los Alamos. "After 24 years, I was done with being away from home, but I still wanted to serve in some capacity—to do something that made me want to go to work every day," he says.

In the military, Perio was taught to adapt and be a problem solver. Finding a job that could challenge him in the same way was an important aspect of what drew him to Los Alamos. "I like the, 'let's fix this together mentality.' And I really enjoy my work as a manager. I wouldn't be satisfied anywhere else."

New Mexico was also a big attraction; his wife grew up 20 minutes from the Laboratory, and Perio knows you cannot find a better climate or better people . "Here, it's family. People look out for each other," he says. "Nobody judges you here. Here, you see me for my work, for what I bring to the table."

MARK PICKRELL

IN THE MILITARY:

MARINE CORPS CAPTAIN

AT THE LAB:

RESEARCH AND DEVELOPMENT GROUP LEADER, DUAL-AXIS RADIOGRAPHIC HYDRODYNAMIC TEST (DARHT) FACILITY

Retired Marine Corps Captain Mark Pickrell has jumped out of almost every moving vehicle (including helicopters), planted claymore mines, and fired every type of weapon imaginable. Pickrell says the military gave him a sense of adventure. "I had a lot of fun," he remembers. "It was like a Disneyland ride, but for adults."

Along with adventure, Pickrell says that it was changing attitudes about military service that attracted him to the Marines. Pickrell was raised by a World War II veteran and remembers a time when everyone stepped up to serve. That culture changed when he was in high school during the Vietnam War. "Suddenly there were student deferments," he remembers, "and I noticed that those who weren't rich were drafted and those who were rich got deferments."

Going against this attitude shift, Pickrell enlisted in the Marine Corps Reserve after earning a doctorate in plasma physics at the Massachusetts Institute of Technology. Then after boot camp and infantry school, he accepted an offer from Los Alamos National Laboratory.

As a Los Alamos scientist, however, Pickrell was still a Marine Corps reservist, and he went on to finish reconnaissance school (an intense eight-week session) and airborne school. In August 1990, Pickrell was activated and served as a platoon commander during the Gulf War.

"The Laboratory has a general sense of appreciation for what the military does," he says. "The common mission is why I like working in the Lab's Weapons Program," he says. Pickrell currently is a group leader at the Lab's DARHT facility and says the people in his group "like working together. We fail or succeed together."

He enjoys hiring former military members into his group. "The Lab is around 10 percent veteran. My group is 25 percent," he continues. "Veterans are mature, reliable people with a diverse way of thinking. And the Lab tends to be a military-friendly environment."

Sitting in his Humvee in Al Jubayl, Kuwait, 1st Lieutenant Pickrell smokes a cigar to commemorate the end of ground operations during the Gulf War in the spring of 1991. Photo: U.S. Marines

In 2016, Port served as the senior Air Force Global Strike Command representative for back-to-back missile test launches at Vandenberg Air Force Base. Read more about these launches on p. 50.

Photo: U.S. Air Force

MIKE PORT

IN THE MILITARY:

AIR FORCE COLONEL

AT THE LAB:

DIRECTOR, OFFICE OF NUCLEAR AND MILITARY AFFAIRS

For Mike Port, being hired as the director of the Lab's Office of Nuclear and Military Affairs was a "Welcome back!" more than a "Welcome aboard." Port had been the senior Air Force Fellow at the Laboratory from 2010 to 2011, while still serving as an Air Force missile launch and nuclear operations officer. An Air Force Fellow spends 10 to 18 months at a government agency learning about national security policies. "The people I met during my fellowship were extremely professional and went out of their way to make me feel part of the Los Alamos team," Port says.

"I joined the military because I wanted to serve our country and be a part of something bigger than myself," Port says. "The same reasons brought me back to Los Alamos." The Laboratory replicated the comradery and teamwork he enjoyed in the military and allowed him to work with "the most sophisticated technology and the brightest minds on the planet."

In transitioning from one nuclear weapons–focused job in the military to another at the Lab, Port reunited with old friends and met many new people, both former military and non-military—a unique combination of people with a unique combination of perspectives. Those varied perspectives, Port believes, are crucial to the Laboratory's ability to solve challenging national security problems. "The melding of different experiences to solve some of the planet's most complex issues is awe-inspiring and makes me excited to come to work every day."

Not everything about working at the Laboratory is similar to working on a military base, Port says, especially the peer-to-peer atmosphere. But the level of professionalism and the dedication to national security are strikingly similar. "Los Alamos is a good fit for me," Port says, "I love working with outstanding professionals who are dedicated to keeping the nation safe."

TERRY PRIESTLEY

IN THE MILITARY:

NAVY LIEUTENANT

AT THE LAB:

OPERATIONS MANAGER (RETIRED), DUAL-AXIS RADIOGRAPHIC HYDRODYNAMIC TEST (DARHT) FACILITY

During his military service—much of it spent underwater in submarines—Terry Priestley contributed directly to America's national security. Working at Los Alamos, he says, is not much different (except for the underwater part). "I joined the Navy and the Lab for many of the same reasons," he says. "I wanted the challenge and found the work with nuclear power important and intriguing. The Lab is another way to serve, and that's what's important."

Priestley is the retired operations manager of DARHT (he's now a senior operations consultant for a Laboratory contractor). DARHT is used to detonate mock nuclear weapons and take radiographs of the resulting implosion. The radiographs are used to better understand the implosion, which then influences the computer simulations that predict how well a real nuclear weapon will perform. "It's pretty cool. It's geeky," Priestley says, "And there is a direct connection between our DARHT work and national security."

Working at DARHT requires a unique skill set (after all, DARHT is the only such facility in the world), which means that no one who applies to work there is fully qualified. According to Priestley, the only place you can go to learn about working at DARHT, is DARHT. "That's why we often like to hire people from the military," he says. "We don't necessarily need an expert—because experts don't exist for a facility like this. We need someone who's willing to learn. And former military have the practical field experience that proves very useful."

"Many former members of the military believe you need a PhD or Nobel Prize to work here, and that's not true," Priestley continues. "The type of people we require is really limitless. We have new people and people who've been here for 20 years. We have mechanics, electricians, high-explosives handlers—really, all kinds of people."

Priestley as a U.S. Navy ensign in 1988. Photo courtesy Terry Priestley

DONNA SCHUTZIUS

IN THE MILITARY:

AIR FORCE LIEUTENANT COLONEL

AT THE LAB:

GROUP LEADER, SECURE NETWORKS AND ASSURANCE, WEAPONS RESEARCH SERVICES DIVISION

"If you want to do something," says retired Air Force officer Donna Schutzius, "you have to be willing to go after it." That's why, after watching Neil Armstrong walk on the moon, she was inspired to join the Air Force and to perhaps one day work in the U.S. Space Program.

In 1982, Schutzius graduated from the United States Air Force Academy, in the third class of women graduates. During her ensuing service, which included Desert Shield and Desert Storm, Schutzius worked with networks information systems, electronics, radar, navigation, and intelligence systems. "I meant to stay for only five years," she says. "But after five years, I was still having so much fun that I stayed and retired after 22 years." She most enjoyed her tactical communications work, which involved being on the ground as part of tactical operations and making missions happen at the "tip of the spear."

Schutzius went on to teach at the Air Force Academy and fostered the first undergraduate information warfare course. She spent the latter part of her military career at the Pentagon in the Special Projects Office. But her life changed when she was called by a friend, Steve Senator, who'd started working at Los Alamos. "He said the work was right up my alley, and he was right," Schutzius remembers. She interviewed and was offered a position that same day.

Veterans are perfect for the Laboratory, says Schutzius, because they are quick on the uptake and responsive to learning new jobs. "They're risk takers—unafraid of new challenges." The Laboratory allows veterans to think innovatively and learn new skills, while using existing skills and continuing their service.

"Service was my No. 1 reason for coming to the Lab," Schutzius says. "I wanted to continue to serve my country, and I thought, 'What better place to do that than Los Alamos National Laboratory?'"

During Operation Desert Storm, temperatures often exceeded 100 degrees Fahrenheit in Saudi Arabia. Schutzius was stationed in Riyadh with the 6975th Electronic Security Squadron (Provisional).
Photo courtesy Donna Schutzius

EVAN SPENCE

IN THE MILITARY:

NAVY LIEUTENANT

AT THE LAB:

OPERATIONS TEAM LEADER, DUAL-AXIS RADIOGRAPHIC HYDRODYNAMIC TEST (DARHT) FACILITY

Despite the months spent away from home—and from dry land—Evan Spence says joining the Navy allowed him to serve his country, develop leadership skills, and travel the world.

During submarine deployments in particular, Spence developed lasting friendships. "It would be hard to find another job where, at 25 years old, you are given the responsibility for a 130-man crew," Spence says. "Sharing experiences in different parts of the world with people from all walks of life helps you form strong bonds and lifelong friendships."

Spence was introduced to the Laboratory at the 2015 Navy Nuclear Power Officer Career Conference, which facilitates networking between Naval officers and the country's leading nuclear science schools and organizations. "As a former Navy Nuke [member of the Navy working in a nuclear field], I found the Lab's science, engineering, and stockpile stewardship programs very appealing," Spence remembers. "At Los Alamos I could do nuclear work not done anywhere else in the world."

When Spence was hired, his group leader was also a former Navy submarine officer, and he helped make Spence's transition almost seamless. "I integrated into the Lab quickly," Spence says. "My military experience allowed me to become a contributing member of the team within days."

Now several years into his Los Alamos career, Spence finds the Lab environment not all that different from the environment he knew during his military service, with two notable exceptions: "Working at Los Alamos and contributing to the safety, security, and success of the armed forces gives me a feeling of satisfaction that doesn't require being on the front lines."

The other exception? Being able to see his family every night and weekend. "The Lab is a challenging and rewarding environment," he says, "and allows me to have a good work-to-family life balance."

Spence returns home to Joint Base Pearl Harbor-Hickam, Hawaii, after a deployment in 2013. Spence was onboard the USS *Olympia*, a Los Angeles–class attack submarine, for seven months. Photo: U.S. Navy

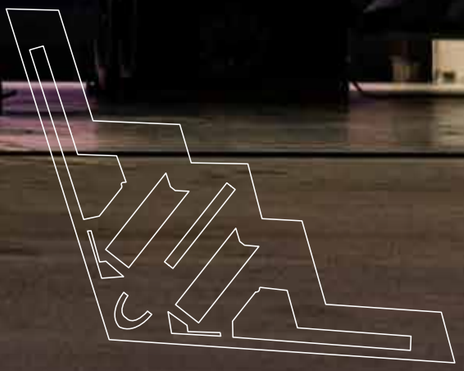
Los Alamos employees: Are you a veteran? *National Security Science* wants to hear your story. Email magazine@lanl.gov.

The B-2 Spirit can deliver the **Los Alamos–designed B61 gravity bomb** across sophisticated defenses to heavily defended targets.

A WEALTH OF STEALTH

BY GEOFFREY STEEVES

The B-2 Spirit can penetrate an enemy's most sophisticated defenses and threaten heavily defended targets. The Lab's senior Air Force Fellow, Lieutenant Colonel Geoffrey Steeves, shares what it's like to fly a 31-year-old, 160,000-pound nuclear-capable bomber.



A B-2 Spirit aircraft is prepped for launch at Whiteman Air Force Base in Missouri.

Photo: U.S. Air Force/Thomas Barley

A B-2 Spirit, deployed from Whiteman Air Force Base, is prepared for a training mission at Joint Base Pearl Harbor-Hickam, in Hawaii. B-2s are part of the Los Alamos–supported nuclear triad that is comprised of land-launched nuclear missiles, nuclear-capable submarines, and nuclear-capable aircraft. Photo: U.S. Air Force/Thomas Barley

REPORT TO AIRCRAFT, REPORT TO AIRCRA

The sirens go off, my eyes snap open, and I bolt upright in my bed.

"Report to aircraft," blares from the command post speakers. "Repeat. Report to aircraft."

The 1980s first-generation pager that is blasting on my hip confirms the message. It's go-time.

It's the middle of the night, and I've barely slept in the past 72 hours, in part because I've spent a great deal of time in the hangar readying the aircraft for combat (what we call "cocking it on"), but also because of the sleeping accommodations themselves. I've been in the confines of this small FEMA trailer with more than a few of my fellow B-2 pilots in very close proximity. Fortunately, this time I wasn't paired up with Bear, whose call sign is fitting for many reasons, including his penchant for snoring like a large mammal.

There's an identical trailer next to ours. Both are filled with rows of uncomfortable beds and heavy, stagnant air. June in Missouri at Whiteman Air Force Base is already oppressively hot and very humid. The temperature seems to exacerbate the smell of the industrial cleaner from the trailer's bathroom, along with the locker room–like scent from so many bodies in the small space. But there's also excitement in the air, and it's palpable.

Despite our fatigue, we do not falter as the sirens blast. We hastily dress in our flight suits and throw on our cumbersome, fire-retardant aviation boots. I make eye contact with my fellow pilot SHIN. His call sign, an acronym for She's Hot I'm Not, is a shout-out to his wife. Mine is Fletch because of the personality similarities I share, or so I'm told, with the Chevy Chase character. As you may have guessed, pilots don't get to pick their own call signs, and as a result, the monikers are sometimes a far cry from Maverick and Iceman. But they were fictional Naval aviators in *Top Gun*, and this is real life in the Air Force.

We run as fast as we can to a row of waiting American-made white minivans (the pilots' requests for Corvettes was denied). No one speaks, and all that can be heard are the sounds of boots hitting the ground and our heavy breathing.

Even with the surge of adrenaline and the gravity of the situation weighing on us, we know exactly what to do, and we do it very fast. Every detail has been planned and rehearsed to a T.

Along with several other pilots, I elect to take the shortcut to my van and leap over one of the concrete Jersey barriers

CALL SIGNS ARE SOMETIMES A FAR CRY FROM MAVERICK AND ICEMAN. BUT THEY WERE FICTIONAL NAVAL AVIATORS IN *TOP GUN*, AND THIS IS REAL LIFE IN THE AIR FORCE.

■ A B-2 prepares to refuel above the Pacific Ocean. Photo: U.S. Air Force/Russ Scalf

WE NEED TO GET THE STEALTH BOMBERS AIRBORNE AS FAST AS POSSIBLE. EXACTLY HOW FAST WE'LL MAKE IT IS CLASSIFIED, BUT IT'S PRETTY DAMN QUICK.

that separate us from our vehicles. For SHIN, though, this shortcut exemplifies "the fog and friction" of war that famous military theorist Carl von Clausewitz spoke of in the 19th century. Not quite clearing the barrier, SHIN face plants on the other side. Scraped and bloodied, he's already peeled himself off the ground and resumed his trajectory toward our van before I can get to him. We've lost only a few seconds, and he's all right, so we'll make fun of him later.

I jump in the front passenger seat and reach through the window to place a red-light siren on the roof of our van. SHIN is in the driver's seat and turns the ignition and stomps on the gas. A wave of "disco lights," as we call them, streaks across the dark tarmac, all headed to the row of hangars and awaiting B-2 stealth bombers. The vans pull up and park close to the hangars, but still far enough away to avoid being a hazard for the bombers' impressive wingspan. We bolt out of the vehicles and sprint the rest of the way, two by two, to our designated aircraft. The Spirit of Washington, tail number 88-0332 is waiting for SHIN and me.

Approaching the aircraft, I hit the alert red slap switch on the nose gear. Immediately, the auxiliary power unit engines spool up, the flush-mounted entry door opens, and the crew's entry ladder folds down to ground level. I scurry up the ladder and into the cockpit. SHIN takes a few seconds on the ground to brief the crew chiefs assigned to our aircraft and then joins me inside.

In short sequence we begin to hear transmissions on the aircraft radio. We continue running our checklist steps to prepare the aircraft for taxi and takeoff, while in parallel, we pull out our grease pencils and code books to authenticate the message and determine our next move. We've been given orders to start the engine, taxi, and take off, as has each set of pilots in the other B-2s alongside us.

One by one, each of the fully fueled approximately 300,000-pound B-2s joins the elephant walk en route to the runway.

We need to get the stealth bombers airborne as fast as possible. Exactly how fast we'll make it is classified, but it's pretty damn quick.

The B-2 is the only known stealth bomber in the world and is capable of dropping both conventional and nuclear payloads. Today, it's the latter that we're focusing on. This mission is a simulation that we call a nuclear generation. And we've got to be fast because in this scenario enemy intercontinental ballistic missiles are headed our way.

We do various simulations twice or more a year, as needed, depending on world events. Our goal is to demonstrate that we're combat-ready for nuclear war.

I lead the line of B-2s, picking up speed on the runway. The nose of my aircraft angles upward and the wheels leave the ground.

Mission accomplished.

> THE B-2 IS THE ONLY AIRCRAFT IN OUR NATION'S INVENTORY CHARGED WITH CARRYING CERTAIN VARIANTS OF THE VENERABLE, LOS ALAMOS–DESIGNED B61 WEAPONS.

Nuclear capable and ready to launch

At $2.2 billion a copy, the B-2 stealth bomber is the world's most expensive aircraft. There are just 20 B-2s total, compared with the fleet of more than 1,000 F-16s, for example. It's also the world's most strategic plane.

As expensive and unique as this aircraft is, what's even more important than the plane itself is the weapons the B-2 can carry. The B-2 is the only aircraft in our nation's inventory charged with carrying certain variants of the venerable, Los Alamos–designed B61 weapons—the Mod 7 and Mod 11 variants. It is also the only aircraft able to deliver the B83 thermonuclear bomb, which is the most powerful in the U.S. stockpile.

The two pilots onboard a B-2 carrying a full load of nuclear weapons are themselves approaching a firepower level on par with some of the world's few nuclear powers. It's a heavy responsibility for an Air Force captain, who is typically 25 to 28 years old when he or she completes the grueling, yearlong initial training course to learn to fly the B-2.

Many years after I graduated and became a B-2 pilot as a young captain, I found myself back at Whiteman Air Force Base in the training squadron again. This time, as a lieutenant colonel, I was the squadron commander responsible for the successful completion of this training. My squadron's job was to create B-2 pilots and nuclear warriors. We did.

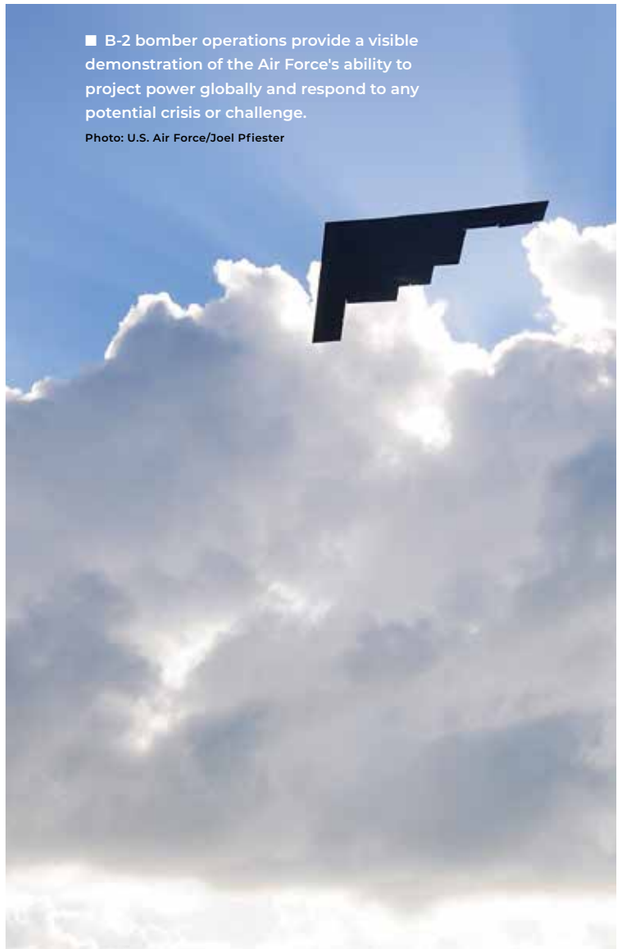
Of course, a nuclear weapon hasn't been delivered in combat since Little Boy and Fat Man helped end World War II—and changed the world forever. But that doesn't mean the B-2 and nuclear weapons aren't being used. These national assets are used every day to both deter our enemies and assure our allies. If B-2 pilots can avoid logging combat hours, we've done our job.

Sometimes, though, the world needs a reminder. The B-2 made its combat debut in Kosovo in 1999 and since then has been a key player delivering conventional munitions in conflicts in Libya, Iraq, and Afghanistan.

We train every day and fly regularly in case we're called upon again.

▲ **Steeves pilots a supersonic T-38 Talon over the Rocky Mountains during a navigation training flight in December 2018. The T-38 is the companion plane to the B-2, ensuring pilots log training hours that would be too costly in the B-2.**
Photo: Geoff Steeves

■ **B-2 bomber operations provide a visible demonstration of the Air Force's ability to project power globally and respond to any potential crisis or challenge.**
Photo: U.S. Air Force/Joel Pfiester



B-2 basics

The B-2 is smooth and stable in flight thanks to its size and mass. It is 69 feet long and 17 feet high and has a 172-foot wingspan, which is slightly more than the width of a football field. Empty, it weighs approximately 160,000 pounds.

Its maximum speed is 630 miles per hour at an altitude of 40,000 feet, which is not much faster or higher than a commercial airplane flies at 460 to 575 miles per hour at a typical altitude of 31,000 to 38,000 feet.

One of the B-2's most unique characteristics is its long-range ability. It can fly 6,000 nautical miles unrefueled and 10,000 nautical miles with just one air refueling. This long-range capability means the B-2 can project air power anywhere in the world. In other words, it provides global strike for America. The B-2's longest continuous sortie to date is just over 44 hours. When the pilots landed after almost two days of nonstop flight, they both had beards.

My longest flight has been 24 hours, though a typical B-2 training sortie is about 5 hours. Needless to say, these long durations are challenging, but they are also very well planned. Aerospace physiology scientists develop plans for pilots to follow on long-duration flights. They consider the flight path, aerial refueling times (both pilots must be awake for these, as well as for takeoffs and landings), positions of the sun, and more to determine when pilots should nap and for how long. It is also recommended to stay well hydrated, as well as to eat protein and healthy snacks to avoid sluggishness from fatty, sugary, or greasy foods. Green chile is typically avoided.

The cockpit is small, with the two pilots sitting side by side. There is just enough room to stand, though not completely upright, and there is a microwave,

■ A B-2 Spirit bomber taxis at sunrise. The plane's unique shape is part of what makes it stealth.
Photo: U.S. Air Force/Joel Pfiester

> I KNEW I COULD EXECUTE THE B-2'S NUCLEAR MISSION—AND SO DID OUR ENEMIES AND ALLIES.

which, out of all technological capabilities in the cockpit, seems to intrigue people the most. That, and the toilet, which is behind one of the seats. It's at the end of a small space intended for a pilot to lie down, though you have the tough choice between resting your head next to a duct blasting out very hot air or next to the pungent chemical toilet.

Sleep on long-duration flights is a necessity for a pilot's performance, but really there is very little downtime. Flying the B-2 is a demanding task, and the associated checklists, aerial refueling, radio calls, and more can, at times, be a lot for two pilots to manage. There is no flipping an auto-pilot switch and listening to music, sending texts, or reading a paperback.

Perhaps the most novel aspect of the B-2 is its stealth. Its unique batwing shape and special coating make it tough on radar operators. Its engines are inside the wing, concealing induction fans at the front of the engines and minimizing engine exhaust. This makes it difficult for thermal sensors to detect the B-2. By the time an enemy on the ground could see the B-2 flying above, it would be too late.

Confidence is key

It all works. We know because we've practiced, through both large-scale, multiday scenarios and half-day sorties.

I still remember one flight in particular. I was a fairly new captain and had only recently graduated from the initial qualification course to become a B-2 pilot when I was chosen to execute a nuclear mission evaluation. My fellow pilot and I were charged to deliver a B83 (minus the physics package) over rural Nevada. We shacked (directly hit) our target.

▼ Steeves returns his first salute from the airmen of the 394th Combat Training Squadron as he assumes command at a ceremony in September 2017. Under his leadership, the squadron produced four graduating classes of B-2 pilots each year (about 16–18 pilots annually).
Photo: Whiteman Air Force Base.

After we landed back at Whiteman Air Force Base and got back into the squadron, the wing commander called us into his office. He congratulated us and explained that our sortie was the most important thing the Air Force had done that day. It took a little time to sink in, but I soon understood he was explaining that I had just played a first-hand role in strategic deterrence.

I knew I could execute the B-2's nuclear mission—and so did our enemies and allies. ★

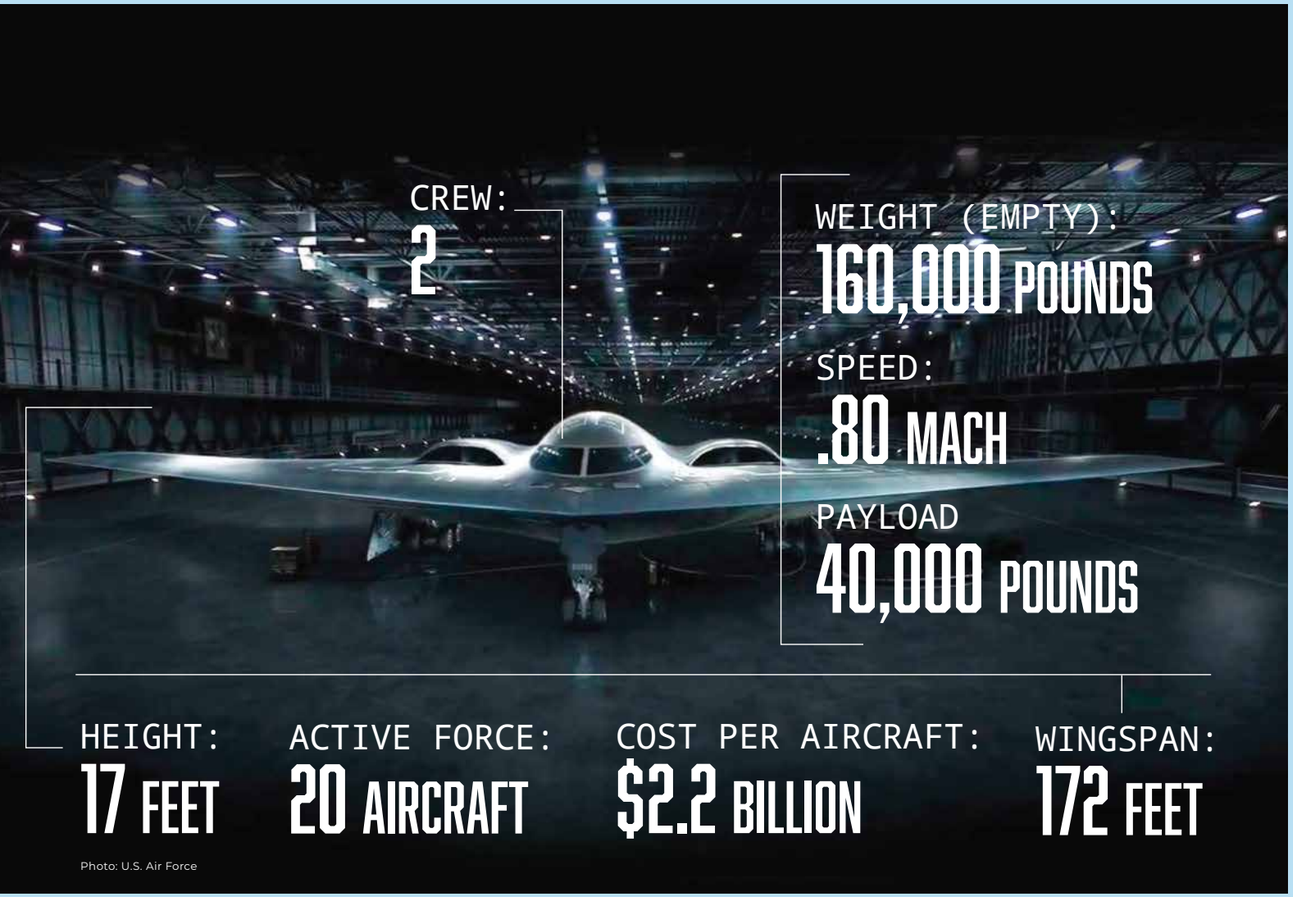

Photo: U.S. Air Force

ABOUT GEOFFREY STEEVES

Lieutenant Colonel Geoffrey "Fletch" Steeves came to Los Alamos National Laboratory in July 2019 on a one-year Air Force Fellowship, which is considered part of his professional military education and a chance to learn more about Laboratory, NNSA, and DOE operations. Before reporting to Los Alamos, Steeves was the commander of the 13th Bomb Squadron at Whiteman Air Force Base, home of the B-2 stealth bomber. Steeves, who earned his commission from the U.S. Air Force Academy in 2001, has more than 2,000 hours flying the B-1 and B-2 bombers. His wife, Brye, is a communications specialist at the Laboratory and helped write this article. They live in Los Alamos with their two children.

■ Steeves is greeted by his children, Eri and Leo, after returning from a routine T-38 training mission in March 2018.
Photo: Brye Steeves

THE B-2 SPIRIT STEALTH BOMBER



CREW: 2

WEIGHT (EMPTY): 160,000 POUNDS

SPEED: .80 MACH

PAYLOAD 40,000 POUNDS

HEIGHT: 17 FEET

ACTIVE FORCE: 20 AIRCRAFT

COST PER AIRCRAFT: $2.2 BILLION

WINGSPAN: 172 FEET

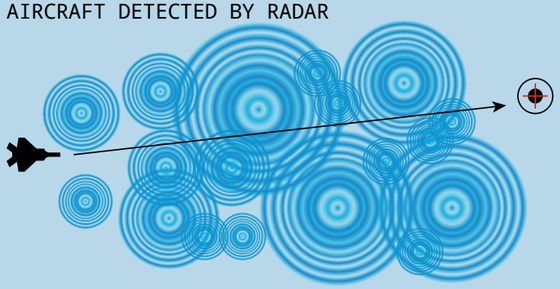
Photo: U.S. Air Force

STEALTH

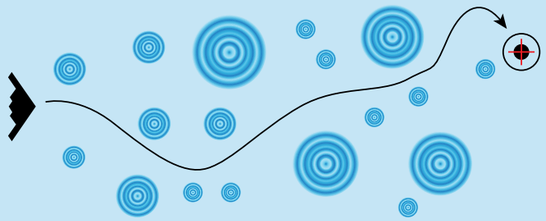
- Anti-reflective paint reduces optical visibility in daylight.
- Curved airframe surfaces and wing design deflects radar beams.
- Engines housed inside the fuselage, to minimize exhaust infrared signature.
- Made from carbon-graphite composite material: stronger than steel, lighter than aluminum.

Stealth comes from a combination of reduced acoustic, infrared, visual, and radar signatures to evade the various detection systems.

AIRCRAFT DETECTED BY RADAR



STEALTH AIRCRAFT LIMITS RADAR DETECTION

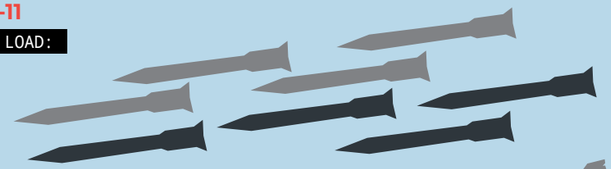


PAYLOAD

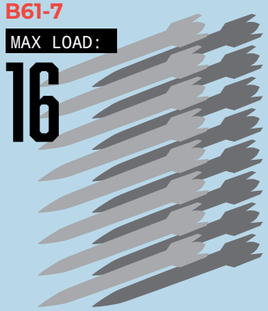
NUCLEAR

Nuclear weapon types may be mixed in any combination up to 16 weapons per aircraft.

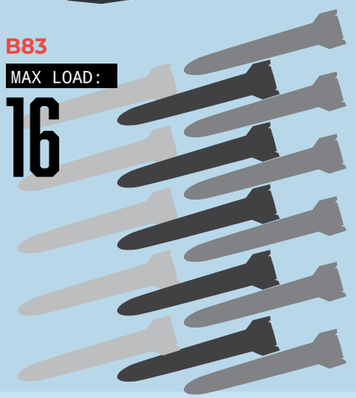
B61-11
MAX LOAD: 8



B61-7
MAX LOAD: 16



B83
MAX LOAD: 16

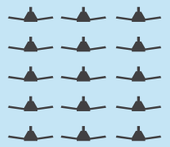


CONVENTIONAL

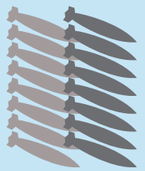
Conventional weapons can be mixed in any combination.

GBU-38 GUIDED BOMBS
MAX LOAD: 80

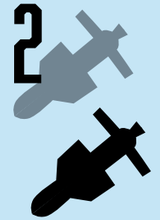
AGM-158 JASSM
MAX LOAD: 16



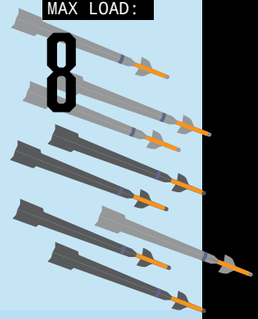
GBU-31 JDAM
MAX LOAD: 16



GBU-57/B MASSIVE ORDNANCE PENETRATOR
MAX LOAD: 2



GBU-28 5,000 POUND PENETRATOR
MAX LOAD: 8



Airpower has come so far since its origins. During two important missions of World War II's Combined Bomber Offensive, nearly 1,000 aircraft were launched—of which 140 bombers were destroyed and more than 900 men were lost. A couple of properly loaded B-2s could likely have done the job of all those planes."

—B-2 PILOT LIEUTENANT COLONEL GEOFF STEEVES, AT A LABORATORY EVENT ON FEBRUARY 25, 2020

A MOMENT OF Glory

J. WESTON PHIPPEN

As the Minuteman III missile nears retirement, the knowledge we gain from testing the system has become more important than ever—even when things don't go as planned.

BETTER SCIENCE = BETTER SECURITY

Minuteman III ICBMs are test-launched at Vandenberg Air Force base to ensure that they will work if they are ever actually deployed—**carrying a Los Alamos–designed warhead.**

An unarmed Minuteman III ICBM launches from California's Vandenberg Air Force Base on February 5, 2020.

Photo: U.S. Air Force/Clayton Wear

Members of the 576th Flight Test Squadron monitor a glory trip at Vandenberg Air Force Base in California. Photo: U.S. Air Force/Michael Peterson

In the summer of 2018, Major Nicholas Edwards paced as his emotions swung from anxious to excited. The control center at Vandenberg Air Force Base on the southern California coast was dark except for the glow of computer monitors, which silhouetted more than a dozen members of the 576th Flight Test Squadron, who spoke last-minute commands and updates into their headsets.

They were communicating with another team in an underground launch control center (LCC) elsewhere on base. That team would soon flip its switches, turn its keys and send a Minuteman III intercontinental ballistic missile (ICBM) bursting into the clear evening sky.

Edwards was the weapons officer for 576th Flight Test Squadron, the sole group charged with test launching the Minuteman III, the military's only ground-based nuclear ICBM. These occasional tests, called glory trips, are always done at Vandenberg Air Force Base and are the most exhilarating moments in any missileer's career. But with so much riding on a successful launch—data, safety, dollars—it's impossible not to feel racked with stress. Months of preparation had gone into this moment. And now as the countdown neared launch, all Edwards could do to ensure Glory Trip 225's success was wait.

A glory trip is similar in every way to a real nuclear missile launch, except that the missile's Los Alamos–designed W78 warhead has been replaced with a joint test assembly (JTA)—also designed and built by the Lab—that replicates a W78 in every way except that it's filled with sensors, not a nuclear device. The JTA endures the freezing limits of outer space as it exits the atmosphere atop the missile, and after it has dislodged from the ICBM, it endures the molten heat of fall to Earth like a meteor, all the while relaying important flight information to the control center at Vandenberg.

Now that the Minuteman III system is 50 years old, nearing the end of its shelf life, these tests have become more important than ever. In fact, the government planned to retire the system in 2020, but Congress extended its service for another 10 years, at which point a replacement system will be deployed. So until then, the United States randomly picks four Minuteman III missiles annually to test from its stockpile, then compiles the data to share with the military and the Lab. "These glory trips give us a lot of information we can't get otherwise, and in that way, they're very useful," says Jay Pepin, the W78 Systems Engineering group leader at Los Alamos.

There's also the national defense angle. "Not only do these tests warn us if there are any issues that need to be addressed with the weapon," says retired Air Force Colonel Michael Port, a former missileer who's now director of the Lab's Office of Nuclear and Military Affairs, "they also show our adversaries that we're still quite capable of using our Minuteman III system, despite its age."

In the case of Glory Trip 225, the missile was pulled months earlier from its silo at Montana's Malmstrom Air Force Base. The maintenance team based there had loaded it onto a truck headed south for the Pantex Plant in Amarillo, Texas, where its warhead was removed. Then the missile traveled west to California. The missileers also made the trip to Vandenberg, and as the countdown for the test commenced, they sat two miles from Edwards, 60 feet underground, in the LCC near the missile, waiting for the signal to turn their keys.

Test launches verify the accuracy and reliability of the ICBM weapon system, providing valuable data to ensure a safe, secure, and effective nuclear deterrent. Under the direction of the 576th Flight Test Squadron, the launch team for this March 2015 test included airmen from the 90th Missile Wing at F.E. Warren Air Force Base.

Photo: U.S. Air Force/Joe Davila

Before any glory trip, the team that accompanies the Minuteman III from its original base will practice for weeks to launch the unarmed missile.
Photo: U.S. Air Force/Christopher Ruano

> **“THERE’S NOTHING COOLER THAN HEARING THE ROAR OF THAT MISSILE. IT SHAKES THE WHOLE BASE.”**
> —NICHOLAS EDWARDS

Normally, the missileers are based near one of the 45 LCCs buried under windswept plains in Wyoming, North Dakota, and Montana. The crews work in 24-hour rotating “on alert” shifts. And because a successful shift means nothing happened, and a successful national nuclear deterrence policy means a missileer will never launch a Minuteman III, a glory trip provides these missileers from up north the rare opportunity to put their training into practice.

A Minuteman III typically requires two “votes,” or coded signals, one each from two separate crews working from two different control consoles. Both must send a launch code to fire a missile, and it’s this redundancy that adds safety to our nuclear strategy because it prevents any rogue launches. But at Vandenberg, for the test, there’s only one launch console. So, with thirty minutes to go until the launch, just as the team had practiced, two of the missileers flipped their launch switches and turned keys on the control panel. Then they reached for screwdrivers. They removed one console, installed a second one, then prepared to turn their keys once more as the countdown resumed.

Back at the control center, every minute in the six-hour launch window was accounted for, colored green or red on the computer monitors overhead and labeled as “go” or “no-go” minutes. The 576th Flight Test Squadron must account for the movements of every satellite, plane, ship, and train from California to the Marshall Islands, halfway between Hawaii and Australia. Add 4,000 miles of weather variables, and a glory trip becomes akin to threading a needle that appears randomly and momentarily.

A hush filled the control center as the countdown neared five… four… three… two… In the LCC, the missileers turned their keys once more, and the ICBM rumbled to life. Edwards watched a screen that showed the silo’s 110-ton cover slide open. The Minuteman III engines burned their solid fuel, fighting gravity with 200,000 pounds of upward thrust. The missile rose and quickly doubled in altitude. It reached 100 feet, then a few hundred. In the dark, all of this appeared as a quickening rooster tail of fire that was suddenly a speck.

“There’s nothing cooler than hearing the roar of that missile. It shakes the whole base,” says Edwards, who is currently working at the Laboratory as an Air Force Fellow.

The control room erupted with cheers. Visiting scientists shook hands with generals and other officers. But Edwards knew better than to relax just yet. A minute later, he says, as everyone watched the ICBM’s progress on the monitors, the room let out a much different noise. “There was a collective, ‘Uh, uh, *ohhhhh*.’ And for a moment, we were all in shock.”

The missile was spinning out of control.

What’d gone wrong? That was the immediate question growing in the room. And in the back of everyone’s mind was a more ominous possibility: Could this be an isolated issue, or could it now be somehow endemic to all the nation’s Minutemen III missiles because of their age? Before Edwards had time to process that thought, though, the lieutenant colonel in charge pointed to him and said, “Come with me.”

For its age, the Minuteman III is still remarkably effective, especially considering that, besides two major model upgrades, it’s practically the same technology developed at the end of the 1950s.

The Minuteman’s story began on October 4, 1957, as hundreds of thousands of Americans craned their necks to watch the sky, in awe of Sputnik, the world’s first satellite. To many people around the world, the Soviet Union’s accomplishment was a marvel. But to some in U.S. government hallways, this triumph was a terrifying manifestation of how far America had fallen behind in the nuclear race.

It wasn’t the satellite that concerned American leaders. It was how the Soviets had placed it into orbit with an ICBM. If the Soviets could use that technology to set a satellite in orbit, it followed that they could deliver a nuclear warhead to the United States. In the days after, *LIFE* magazine ran a headline reading, “Soviet Satellite Sends US into a Tizzy.” The article then quoted a Soviet scientist boasting, “Americans design better

An unarmed Minuteman III ICBM launches from California’s Vandenberg Air Force Base on February 5, 2020. The ICBM’s reentry vehicle traveled approximately 4,200 miles to the Kwajalein Atoll in the Marshall Islands.
Photo: U.S. Air Force/Hanah Abercrombie

Major Nicholas Edwards was a weapons officer with the elite 576th Flight Test Squadron and is now a 2020 Laboratory Air Force Fellow.

> **BECAUSE THE LAB ACCEPTS ONLY ONE INTERMEDIATE-LEVEL AIR FORCE FELLOW EACH YEAR, I HAD A 0.017 PERCENT CHANCE OF GETTING THIS [FELLOWSHIP].”**
>
> **—NICHOLAS EDWARDS**

automobile tailfins, but we design the best intercontinental ballistic missiles.”

And it was true. In the 1950s, the U.S. ICBM program consisted of the Atlas and the Titan. The Atlas was a lighter version of the Germans’ World War II–era V-2 missile. The Titan was slightly more progressive. It dropped its heavy fuselage once in flight giving it longer range. But like the Atlas, it consisted of about 300,000 unique parts, making it time consuming and costly to build. Meanwhile, the Soviets gloated that they could churn out ICBMs “like sausages.”

On top of that, the liquid propellant America used was corrosive, so it couldn’t be stored in the fuselage. Instead, before launch, crews spent two hours fueling the missiles—not an ideal situation if your country is under nuclear attack.

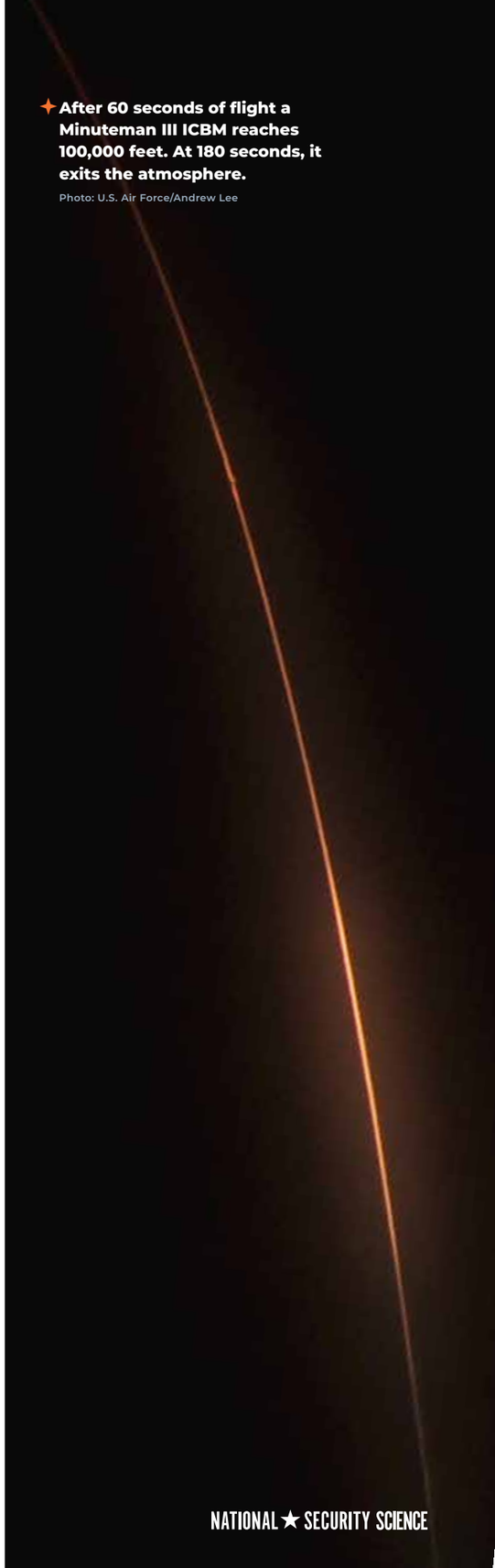
A few days after Sputnik’s orbit, Colonel Edward Hall, who headed propulsion development for the Air Force, visited the Pentagon to implore the government to build a new missile. What he envisioned would be 65 feet tall (half the size of Titan) and weigh 65,000 pounds (Titan was more than 300,000 pounds). It would be powered with the new, noncorrosive solid-state-fuel technology Hall had studied for years, which would allow the fuel to be stored permanently in the missile. That advancement would also allow the United States to store its missiles underground in silos instead of upright on launch pads because the new fuel provided enough thrust for the ICBM to speed out of its barrel-like enclosure before the flames from its own rockets caused it any damage. As part of a defensive strategy, storing the missiles underground would enable the U.S. fleet to withstand an enemy’s nuclear attack and still return a strike.

Hall got his funding. And a little more than a year later, on February 1, 1960, at 11 a.m., he watched at Cape Canaveral, Florida, as the first Minuteman started with a bang and soared skyward, eventually dropping 4,600 miles away in the Atlantic Ocean.

Two years later, the Air Force deployed the first Minuteman ICBM at the height of the Cuban Missile Crisis. Within the next year, the United States placed 1,000 more across the lower 48 states. The first-generation Minuteman had a range of 4,300 miles, flew at 15,000 miles per hour, and could deliver a warhead within less than half a mile of a target. Three years later, the military deployed the upgraded Minuteman II. This version was more accurate and could carry a larger warhead, which also reflected a change in American nuclear policy. At the beginning of the Cold War the United States wanted foremost to be able to endure a nuclear strike and still be able to return one anywhere in the world. Later, the United States moved to a controlled response strategy that depended on some ICBM silos being able to survive a nuclear attack, then deliver a measured retaliation instead of unleashing all its warheads. As the Minuteman III was deployed in 1970, the United States had moved to what it called a flexible response strategy, which required a single ICBM to be capable of taking out multiple targets with multiple warheads, making the threat of a single-strike retaliation more effective and also harder for an enemy nation to defend against.

Throughout these changes, the basics of the Minuteman III have remained constant. After 60 seconds of flight, the missile reaches 100,000 feet and drops its first and largest stage. Its flight path flattens until, at 120 seconds, now 120 miles in the sky, it releases the second stage and shortly after, its third. At its parabolic height, the Minuteman III can reach 750 miles above Earth, twice as high as the International Space Station. It has already shed practically everything but its cone-shaped Mk-12A reentry vehicle, which houses the W78 warhead. From there it’s just a long drop to the target.

The entire process—launch to touchdown—takes about half an hour. That’s why, to emphasize this speed, the blast doors of the Minuteman Missile National Historic Site in South Dakota bare a painting of a Domino’s pizza box with the words, “World-wide delivery in 30 minutes or less—or your next one is free.”



After 60 seconds of flight a Minuteman III ICBM reaches 100,000 feet. At 180 seconds, it exits the atmosphere.

Photo: U.S. Air Force/Andrew Lee

To be a missileer means not

only that you've joined a rather obscure group in the U.S. Air Force, but also that you've become a member of one of the most selective, vetted forces in the military. "It's the highest-classification mission you can possibly do," Edwards says. "You have to be very disciplined."

Edwards knew from a young age, while growing up in Beavercreek, Ohio, that he wanted to join the Air Force. His father had served as a security forces officer during the era of Strategic Air Command, now called Global Strike Command, and he eventually retired at Wright-Patterson Air Force Base. But Edwards also wanted to create his own path. After he enrolled at Purdue University to study mechanical engineering, he enrolled in Air Force ROTC. And as he struggled to choose where he'd serve in the military, he remembered a family friend, a missileer. The more he looked into the career, the more obsessed he became.

Edwards graduated from college in 2008, and after he joined the Air Force, he quickly finished his initial skills training to become a missileer. Then for nine months, he trained in a silo on a rotating 24-hour alert. He tested so well that he was made an instructor early and he discovered a passion for teaching. "There is nothing more rewarding for a young officer than to have someone call you and say, 'I need your help,' and to be able to coach that person through a hard situation."

In 2012, Edwards approached a fork in his career path. He was 28 years old, hoping to advance, and he could either move to the space program and launch satellites, or he could try and join the 576th Flight Test Squadron, the most elite group of missileers. The latter meant attending ICBM weapons school, which is like getting a doctorate, and that meant training for five months, 22 hours a day—twice as long as the Navy's famous Topgun school. Edwards says, "It took me five seconds to realize what I wanted."

Edwards graduated weapons school at a time when the Air Force was reorganizing how it trains missileers, and he became the 576th Flight Test Squadron's first official weapons officer. In that role, he's overseen several glory trips and pioneered the first ICBM tactics tests to identify non-material solutions to enhance the Minuteman III weapon system.

Eventually, the Minuteman will be replaced by a new ICBM system, called the Ground-Based Strategic Deterrent. Few details are available to the public. But as early as 2024, Edwards says, the 576th Flight Test Squadron could be testing this next-generation ICBM.

Each year, the lab accepts two Air Force Fellows—one in a senior career position and the other in an intermediate-level position, as with Edwards. Being accepted is no

small feat, and Edwards has even run the math. "There were approximately 5,600 Air Force majors eligible for the intermediate position," he says. "Of those, 6.25 percent were selected for professional military education, and because the Lab accepts only one intermediate-level Air Force Fellow each year, I had a 0.017 percent chance of getting this."

"I still can't believe I got here," Edwards says.

During his Lab fellowship, both he and the scientists at Los Alamos are making the most of each other. "In Edwards' world," Pepin says, "the W78 is still, in large part, a black box. So being here allows him to see behind that curtain to what we at the Lab think is important and what things we care about. Then he can take that knowledge back to Vandenberg and share it with his squadron." And the cycle of knowledge works vice versa for the Lab.

Scientists at Los Alamos may be the brightest in the world at what they do, but they're essentially building a contained system, then handing it off to become part of another intricate system. Edwards, though, is one of the nation's leading minds when it comes to how the Minuteman III operates and how the United States would design a nuclear counterstrike operation. That kind of strategizing, combined with the information the Lab gets back from the glory trips, has made the work done by Edwards and the 576th Flight Test Squadron invaluable to the research being done in Los Alamos. "It's very hard to simulate all the combined environments of exiting and reentering the atmosphere," Pepin says. "The flight test is really the only way to test all those elements."

And sometimes, more can be learned when something goes wrong than when it goes right.

EDWARDS HAS COME TO THINK OF GLORY TRIP 225 AS A SUCCESS—A TEACHABLE MOMENT.

An unarmed Minuteman III ICBM launches from California's Vandenberg Air Force Base during an operational test.
Photo: U.S. Air Force photo/Lael Huss

THE NORMAL PROCEDURE FOR A glory trip runs something like this: The ICBM launches, and everyone tracks it on the control center monitors. One missileer eyes the yaw and pitch. Another missileer keeps watch downrange for anything that might accidentally cross the flight path. After the first five minutes, when the missile has exited the atmosphere, there's a moment to breathe easier. Then, 30 minutes from the initial launch, it's time to stare at another screen. A white dot flashes in the top corner and just as quickly disappears. As the JTA strikes the ocean, a set of sensors triangulate its impact.

Back in the old days, the local crew on the island near the reentry site would celebrate a successful launch at a local bar, where they'd drink from skinny, yard-long glasses until they'd downed in beer the same distance the JTA had landed away from target. (Edwards can't vouch if this is still current practice.) But at Vandenberg, it's often 3 a.m. or later, so Edwards heads home to his family for a brief rest before he begins preparing for the next day's squadron debrief session. But obviously, that was not how things went on Glory Trip 225.

In the control center, the mission control flight officer sat behind a computer. On the screen before the officer was a digital map with lines that represented the boundary the ICBM had to stay inside. As the ICBM dropped its first stage, the missile began to wobble violently around its center axis, like a spinning top before it falls. No one could predict what the missile would do next, or whether it'd veer suddenly from course into the path of a plane or orbiting satellite. So the flight officer flipped a switch that ignited an explosive cord running the length of the missile. There was a boom, and the ICBM split into its different components—stages one, two, and three, as well as the JTA—and fell from the sky until it splashed into the ocean.

"This was the first time I'd ever seen that," Edwards says, "and it was the first time since 2011 something like that had happened. It was a moment of pure shock."

When the lieutenant colonel told Edwards to follow him, rather than despair, fear, or crippling anxiety, a tinge of excitement filled Edwards' body. In weapons school, Edwards had trained in root-cause analysis, but he'd never used those skills to dissect a failed launch. In the impromptu meeting, the lieutenant colonel, a host of in-house engineers, and Edwards all pieced together a plan. "At first, we were thinking anything could have happened—maybe it'd been a lightning bolt, birds, anything."

During the next six months, Edwards and the investigation team revisited every piece of technology in the Minuteman III system, every action done preceding the launch—from how the missile was extracted from its original silo to how the ICBM was secured in the silo at Vandenberg. They reviewed the missile's history, every place it'd been. Perhaps, Edwards thought, the answer to what'd gone wrong could be found in some environmental experience or where it'd been stored, which could then inform the Air Force and the Lab about other ICBMs kept under similar conditions. It was a plodding process. "Eventually," Edwards says, "we worked it out."

Rather than a disappointment, Edwards has come to think of Glory Trip 225 as a success—a teachable moment, one that imparted more knowledge to the group than if it'd all gone smoothly. And based on what the team discovered, the Minuteman III weapon system is now all that more reliable, ready to live out its final days defending the nation.

But what exactly did go wrong?

That's classified, Edwards says. ★

Edwards at Vandenberg Air Force Base in February 2020. Photo courtesy of Nicholas Edwards

ABOUT NICHOLAS EDWARDS

Air Force Major Nicholas Edwards grew up in Ohio, graduated from Purdue University, and worked as the assistant director of operations for weapons and tactics for the 576th Flight Test Squadron before coming to Los Alamos. In the year he spends at the Laboratory as an Air Force Fellow, he wants to establish a path for more missileers to visit Los Alamos so they can exchange information with scientists about updates to the Minuteman III and its upcoming replacement missile system.

SERVICE, SCIENCE, AND SUCCESS

The chief scientist of the Air Force recalls his time at the Laboratory.

BY WHITNEY SPIVEY

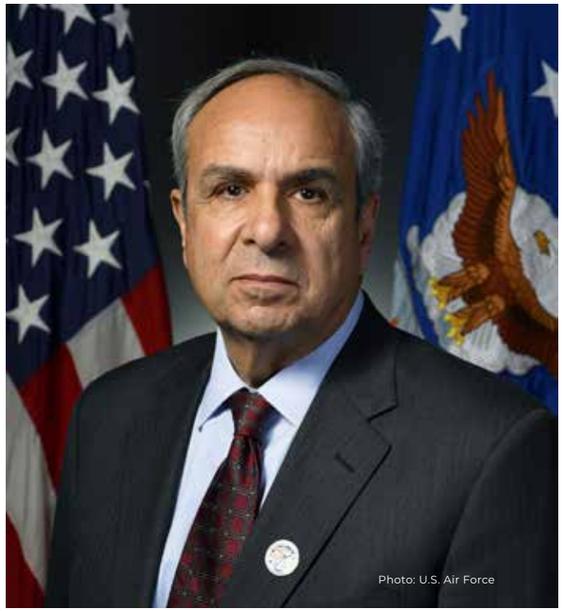


Photo: U.S. Air Force

IN THE SPRING OF 2017, Richard Joseph was feeling pretty content. He'd had a long and successful career working for Los Alamos, for the Air Force, and for himself as a national security consultant. Retirement—back in New Mexico—was just around the corner.

That's when he got a phone call from a former student, Heather Wilson, whom he'd taught at the United States Air Force Academy in the early '80s. Wilson had just been named Secretary of the Air Force, and she wanted to have lunch with her former professor and longtime friend.

So Joseph made the trip to the Pentagon, and that's when Wilson asked Joseph to become the 36th chief scientist of the Air Force. "I said 'no,'" Joseph remembers. "I said, Heather, I've perfected my life. I'm crazy about my wife, I have hobbies, I have grandchildren, and I do just the right amount of work every month."

But deep-down Joseph knew he would reconsider. "I couldn't pass up the opportunity of public service that involved working again for the Air Force and for one of my former students," he says. "It doesn't get any better than that."

Nearly two years into the chief scientist job, Joseph stopped by Los Alamos to chat with *NSS* about his work, his time at the Laboratory, and why dealing with an adversary is a lot like playing ice hockey.

You first came to Los Alamos as a grad student in 1978. What were your first impressions of the Lab?

When I came here, I'd heard all about Los Alamos because I'd worked for a man, Bob Carter, who'd worked for [Nobel Laureate Enrico] Fermi during the Manhattan Project. Bob told me all about the Lab and all about Los Alamos the town and the area, so when I came here as a grad student, I came primed, and I sure wasn't disappointed. It was an exciting place, and I couldn't believe that anyone would actually get paid to work in a place like this.

The Laboratory was, to me, the perfect place to be. I was doing basic nuclear physics. I would sometimes find myself leaving the computing center late at night and just chuckling to myself like I'd made off with the crown jewels because this was not work—this was just fun.

The entire Lab seemed to be set up for scientists to do their work. I seemed to be able to learn from everybody. Experts were everywhere in this system, and they all were leaning forward to help make things happen.

After a few years teaching at the Air Force Academy, you returned to Los Alamos as a nuclear weapons development liaison officer with the Defense Nuclear Agency. What did you work on in this role?

I hit the ground here running because I already knew something about the Lab. I defined some experiments that had to do with neutral particle beams. It was 1981, and I sweet-talked beam time [experiment time on the accelerator]. In those days, that's how you got programs started. You went around and you signed people up to take part. You didn't have to have money or a charge code. A program manager gave me $10,000 to spend on experiments, and I spent almost all of it buying lead bricks for shielding.

In the 1990s—in support of Operation Desert Storm—you were part of a research program that developed light detection and ranging (LIDAR) for detecting biological agents. LIDAR is a remote sensing method that uses light in the form of a pulsed laser to measure distance. How did that program evolve?

A general showed up at the Lab, a brand new one-star whose name was John Jumper (he eventually became chief of staff of the Air Force). We showed him what our idea was, which was essentially to build a vehicle that could go out and look for clouds of bioagents using LIDAR.

Later, I drove John to the airport, and he said "Rich, I'm a fighter pilot, and here's how I'd do this: put your system on an airplane and have a range of about 100 kilometers." And then he said he'd like us to do this in 30 days.

We didn't really know what we were getting into. We started by writing down all the reasons why this was impossible. One person would present some impossible thing, and another person would say, "Well, that's not impossible. I know how to do that." What motivates people at Los Alamos more than anything is the thought of doing something that nobody else has done before.

After three weeks, we moved out to the Yuma Proving Ground. For a week, we mounted the laser on an airplane and tested it. The Army accepted it. At the end of 28 days, we had completed the whole project from start to finish. They were very long days, but the transformation in our people was just amazing. On the last day, an airplane picked us up,

> **What motivates people at Los Alamos more than anything is the thought of doing something that nobody else has done before.**

and I said to the flight attendant, "You wouldn't believe that these people, for the past month, have been working 18- to 20-hour days." She said "Oh my god, they're so energetic."

I described it later as "feeling the power of the machine." I remember the first time I rode on a superbike motorcycle. A friend of mine had bought one of the first of the Kawasaki 500s. I got on it, and I almost went off the back of the bike, it accelerated so fast. I felt the power of the machine. This experience was feeling what this Laboratory could do. I thought, I'm never going to be satisfied with anything but that kind of performance.

How did working at Los Alamos prepare you for your current role as chief scientist of the Air Force?

I learned that when it comes to managing science, less is more. Scientists are generally motivated by curiosity. Part of every dollar that is spent in a place like this has to go for the satisfaction of spontaneous curiosity. And if we ever get to the point where we don't allow that in laboratories, they are not laboratories anymore.

I learned the power of inspiration. Scientists may feel like they are hard-bitten rationalists, but the fact of the matter is they can be inspired, and they can be led. When General Jumper came here, one of our senior physicists said, "I think I would step off the roof of this building if he asked me to do it." There was something about this guy that made you trust him right away. It's a leadership quality.

I learned not everybody in a scientific institution is motivated by the same thing. Some people never want to be told what to do. Some people always want to be told what to do. You need to find the right place for people to thrive and to contribute.

I learned that support organizations can support. Instead of complaining about them, we need to find ways to bring them in. I learned that people who are supporting programs do better the closer they are to the program because they know why they are doing what they are doing.

In your current role, you've developed a bold science and technology strategy for the Air Force. What does it say?

The science and technology community does better when it knows what the problems are. So, we wrote our strategy in terms of the capabilities we believe the Air Force needs. We want to be able to sense anything, anywhere we need to sense it, whenever we need to sense it. We need to be able to make sense of what we sense. We need to be able to analyze the data we take and understand it. And then we need to be able to communicate the data secretly wherever it needs to go, and we need to be able to deliver force where it needs to be delivered, when it needs to be delivered.

We want to be able to control time and complexity. We would like to be able to control the pace before a conflict and in a conflict—whether we want it to move faster to the detriment of an adversary or move more slowly to the detriment of an adversary's plans. And in peacetime, we want to present the adversary with a complex set of things to worry about. We want to be where the adversary is going. We want to be where the adversary can't be.

Years ago, I coached youth ice hockey in Los Alamos. And what I learned down at the rink in the canyon on cold winter nights was that youngsters who are still learning the game shoot at the goalie. But you shouldn't shoot at the goalie; you should shoot where the goalie isn't. Better yet, you shoot where the goalie can't be. That's the approach our strategy takes with the adversary: Shoot where the adversary can't be. That's the complexity part.

In addition to your technical work, you do a lot of mentoring. Why?

I believe that one of the roles of people in my stage of life and career is to help those who are coming up behind us. I spend a fair amount of time talking to people about their roles in their organizations and how to be more effective. I'm not the model of effectiveness, but if I can encourage people not to give up and instead to seek ways of getting things done, then that's a contribution. ★

■ **Top:** Richard Joseph, chief scientist of the Air Force, uses a laser during a visit to Travis Air Force Base in California. Joseph serves as the chief scientific adviser to the Chief of Staff and Secretary of the Air Force, and he provides assessments on scientific and technical issues affecting the Air Force mission.

■ **Bottom:** U.S. Air Force Senior Airman Michael Samuel (right) briefs Richard Joseph at Travis Air Force Base.

Photos: U.S. Air Force/Louis Briscese

CREATING COMMUNITY

Materials scientist and aerobics instructor Rajendra Vaidya thrives in what he calls his "global public square." **BY OCTAVIO RAMOS**

Beat-driven dance music fills a room at The Family YMCA in downtown Los Alamos. About 15 people dressed in workout clothes stroll in, each taking his or her place before a raised platform known as step.

Leading the class is certified step-aerobics instructor Rajendra Vaidya of the Lab's Strategic Development Office. Vaidya takes the students through a warm-up, explaining and demonstrating each move with ease. Once the warm-up is finished, Vaidya launches into an intense routine designed to boost heart rate, challenge breathing, and strengthen the body's muscles.

"I've been teaching these classes for about 27 years," Vaidya says. "I'm trying to remember how many people have participated in these classes over the years, but I do know I've taught more than 4,000 step classes to date."

What keeps Vaidya going in such a challenging role that demands both physical stamina and the ability to motivate? For Vaidya, it comes down to his students.

"Teaching these classes has been very rewarding," Vaidya notes. "I love to interact with so many different types of people, each of whom brings varying viewpoints and opinions that stimulate my intellectual curiosity. I've worked hard to make my classes feel more like fun social clubs."

✦ **Vaidya teaches a class at The Family YMCA.**

TACKLING STRATEGIC DEVELOPMENT

After earning a doctorate in materials science and engineering, Vaidya joined Los Alamos as a postdoc in 1992. He then joined the Materials Science and Technology Division, where he worked as a staff member and a team leader. For 15 years he also worked as a group leader for various other organizations. Vaidya then joined the Strategic Development Office at the Laboratory's Plutonium Facility.

"I currently serve as a technical project manager working on process-improvement activities," Vaidya explains. "I also help prepare the next generation of engineers and scientists to improve upon current process knowledge so the Laboratory can more easily meet deliverables for the national security mission."

As Vaidya explains it, process improvement consists of using science and engineering to improve current processes at the Plutonium Facility. "One example is designing a nondestructive methodology to perform real-time corrosion monitoring of nuclear material storage containers. The goal is to identify defects before they can compromise safety so we do not waste time and money."

To help the next generation of engineers and scientists at the Plutonium Facility, Vaidya is leading an effort to create an industrial engineering capability. "We've never had such a capability, and I believe it's crucial as the Lab ramps up pit production," explains Vaidya, referencing the Lab's mission to start delivering a minimum of 30 plutonium pits (the cores of nuclear weapons) per year by 2026. "These pits must be flawless to ensure the national security mission of the United States."

IT'S MORE THAN JUST AEROBICS

Vaidya fell into aerobics quite by accident. "I played badminton while in graduate school," he says. "One day, an aerobics instructor came up to me and explained they needed a male instructor to teach classes as part of a study to determine if an instructor's gender influenced class size and participation. I agreed to try it out and learned the routines."

Once Vaidya started teaching, he found that he really enjoyed it. "I never did find out that study's results," he says with a laugh. "I just started teaching, really liked it, and eventually became certified. I haven't stopped since."

Vaidya teaches aerobics four times a week. He holds a morning class on Sunday, evening classes on Tuesdays and Thursdays, and a lunchtime class on Wednesdays.

"I don't look at my classes as just exercise classes," Vaidya says. "I treat each class as a 'global public square,' the reason being that while we're exercising we touch upon a variety of topics, from facets of the Laboratory's culture and community life to entertainment news and sometimes even politics." Vaidya flashes a smile. "Well, not too much about politics, because it can be a little sensitive."

For Vaidya, his knack for cultivating diverse interchanges in his aerobics classes has made it easier to interact with the many personalities and viewpoints at his job at the Lab.

"I really enjoy the diversity of people here at work," Vaidya explains. "I joke about it, but I keep myself young by working with so many different personalities here. For example, the young scientists and engineers, they bring a certain energy and vitality to their jobs. It's fascinating for me to participate in this global public square, one that continues to craft such an exciting and diverse scientific culture." ★

✦ **Vaidya inspects a modular integrated nondestructive test setup used to interrogate nuclear material storage containers at the Lab's Plutonium Facility.**

> "I treat each class as a 'global public square,' the reason being that while we're exercising we touch upon a variety of topics, from facets of the Laboratory's culture and community life to entertainment news and sometimes even politics."
>
> —RAJENDRA VAIDYA

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.**

Shea Mosby received a Presidential Early Career Award for Scientists and Engineers. The award is the highest honor bestowed by the U.S. government on outstanding scientists and engineers in the early stages of their independent research careers. Mosby's research at Los Alamos has focused on nuclear reactions relevant for applications using a variety of detector systems at the Los Alamos Neutron Science Center. He started at the Laboratory studying neutron capture using the Detector for Advanced Neutron Capture Experiments. Mosby recently began investigating novel approaches to measuring neutron-induced reactions for radioactive isotopes, which preclude traditional measurement techniques.

Laboratory scientists Brian Albright (Primary Physics), Patrick Chain (Biosecurity and Public Health), Dana Dattelbaum (Explosive Science and Shock Physics), Michael Hamada (Statistical Science), Anna Hayes-Sterbenz (Nuclear and Particle Physics), Michael Prime (Advanced Engineering Analysis), and Laura Smilowitz (Physical Chemistry and Applied Spectroscopy) were honored as 2019 Laboratory Fellows. "Los Alamos National Laboratory Fellows are the best of our scientists and engineers," explains Lab Director Thom Mason. "This year's fellows are leaders in their fields who have made exceptional contributions not only to the Laboratory's national security mission, but also to the broader scientific community."

Sowjanya Gollapinni, of Subatomic Physics, was granted a five-year Department of Energy (DOE) Office of Science 2019 Early Career Research Award. The Office of High Energy Physics selected her research for funding because she is focused on developing a laser-based calibration system for the Deep Underground Neutrino Experiment (DUNE). DUNE is an international collaboration seeking to answer the question of why we live in a matter-dominated universe. DUNE is comprised of more than 1,000 scientists and researchers from more than 30 countries.

Chemist Jennifer Hollingsworth is being honored as a Fellow in the American Association for the Advancement of Science for her work in materials chemistry. Hollingsworth is being honored specifically for her discovery and development of non-blinking giant quantum dots, spanning pioneering contributions to materials chemistry, photophysics of excited-state processes in nanomaterials, and applications in optoelectronics.

John Sarrao, deputy director of Science, Technology, and Engineering (STE), was named to the 2020 New Mexico Technology Research Collaborative (TRC) board. The TRC promotes tech commercialization in New Mexico—investing in early-stage science and technology that will diversify the economy. Sarrao's participation in TRC supports the Laboratory's commitment to promoting STE and a viable local economy.

Five scientists were recently elected fellows of the American Physical Society (APS). Scott Hsu, Alan Hurd, Katherine Prestridge, Richard Van de Water, and Hans Herrmann were chosen for their "exceptional contributions to the physics enterprise." Fewer than one half of one percent of APS members are elected as fellows each year. These five scientists represent the breadth of physics contributions made at the Laboratory. Van de Water said of the award, "The thrill of doing science is an award itself, an APS Fellowship honor makes it that much better."

Mike Steinzig was elected fellow in the American Society of Mechanical Engineers, an honor bestowed on less than three percent of the society's membership. Steinzig was recognized for his pioneering work in Electronic Speckle Pattern Interferometry for residual stress measurement. At Los Alamos, Steinzig is part of the W88 Alteration and Refresh Program.

The University of New Mexico School of Engineering's Nuclear Engineering Department's 2019 Distinguished Alumni Award went to Associate Laboratory Director for Facilities and Operations Bret Simpkins. Simpkins received a bachelor's degree and master's degree in nuclear engineering from UNM in 1983 and 1988, respectively. He was honored at a special event on November 7 in Albuquerque. ★

IN MEMORIAM

ROSE BETHE

Rose Bethe, former Manhattan Project staffer and widow of Nobel Prize-winning physicist Hans Bethe, passed away on December 24, 2019, at the age of 102. Hans led the Manhattan Project's Theoretical Division, while Rose worked in the Project's housing office, assigning homes to incoming scientists and their families. Later, she assisted with production of electronic boards alongside renowned physicist Bruno Rossi. ★

68 YEARS AGO

On April 22, 1952, Charlie, a 31-kiloton nuclear test, was detonated 3,447 feet above Yucca Flats at the Nevada Test Site. The Los Alamos–designed test was part of the Tumbler-Snapper operation and also part of the military's Desert Rock IV exercises, during which thousands of military personnel trained to simulate activity on a nuclear battlefield. Here, members of the Army's 82nd Airborne Division parachute toward a drop zone just north of ground zero. ★

Photo: Nuclear Testing Archives

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THEN + NOW

On October 16, 1945, in a ceremony at Fuller Lodge in Los Alamos, the Army and Navy presented the E Flag Production Award to the team of scientists, engineers, military personnel, academics, and others who worked at the secret Project Y site in Northern New Mexico, helping end World War II.

The flag dates to the early 20th century, when it was a Navy award. During World War II, the award was combined with awards presented by the Army and the Army-Navy Munitions Board. The E Flag recognized exceptional performance in the production of war equipment, and the combined award was given only between 1942 and 1945.

Pictured at left, then–Lab Director J. Robert Oppenheimer, Army General Leslie Groves (head of the Manhattan Project), University of California President Robert Sproul, and Navy Commodore William "Deak" Parsons stand with the flag. Above, current Lab Director Thom Mason stands beside the same flag, now hanging in the Los Alamos Weapons Conference Center in the Lab's National Security Sciences Building. The flag is a tribute to the Laboratory's exemplary wartime service and is also a reminder of the rich history of collaboration between Los Alamos and the armed services. After more than 75 years, this partnership continues to ensure the security of the nation. ★