



SAN DIA

LAB NEWS

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Hispanic
Heritage: A
first-generation
story **Page 7**

Hydrogen sea change	8
Mileposts	11
Cyber Defenders	12
Making STEM waves	14

Labs researchers capture six R&D 100 Awards

By **Neal Singer**



META OPTICS STUDIO — This software package enables the rapid design and optimization of large-scale meta-optics for integration into optical imaging systems. [Watch video.](#) Courtesy of Sandia Creative Services

Sandia researchers took home six R&D 100 Awards, one joint with Los Alamos National Laboratory, and one special award for 2023 in the annual international technical competition that includes researchers from universities, corporations and government labs.

These awards bring Sandia’s total to 150 since 1976.

“These excellent achievements further Sandia’s mission and demonstrate the impact that innovative research and development like your endeavors have produced,” said Chief Research Officer Doug Kothe, associate laboratories

— CONTINUED ON PAGE 3

Sandia chases two big new goals

Labs leaders empower staff to pursue innovation, modern engineering

By **Myles Copeland**

At a town hall Laboratories Director James Peery unveiled the Labs’ two new big goals — accelerate innovation and lead in modern engineering — by recounting a personal story.

As a fresh college graduate starting out at the nation’s premiere engineering laboratory, James was approached by senior team members with many questions. They wanted to know what computers he was using in college, what algorithms and languages.

“These were current and future distinguished-level staff members asking me,” James said during the Sept. 6 town hall at the Steve Schiff Auditorium. “They were interested in what I could bring to the laboratory.”

Years later, James and Labs leadership are hoping for

— CONTINUED ON PAGE 6



“IT’S ABOUT ALL OF US” — Labs Director James Peery, center, speaks along with Deputy Labs Directors Laura McGill and David Gibson at the town hall meeting about the Labs’ strategy to accelerate innovation and lead in modern engineering Sept. 6 at the Steve Schiff Auditorium. **Photo by Craig Fritz**

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TABLE of CONTENTS

- 1 | Labs researchers capture six R&D 100 Awards *continued on page 3*
- 1 | Sandia chases two big new goals *continued on page 6*
- 2 | Celebrating 25 years of economic development
- 6 | Computer model of atmosphere finalist for prestigious new prize
- 7 | From Sesame Street to Sandia: A first-generation journey to college graduation
- 8 | Invention at forefront of hydrogen sea change
- 10 | Magnetic beads key to better handheld lab
- 11 | Mileposts and recent retirees
- 12 | Cyber Defenders: Interns take on national security challenges
- 14 | Making waves at Meet a Scientist Day

EDITOR'S NOTE: Please send your comments and suggestions for stories or for improving the paper. If you have a column (500-800 words) or an idea to submit, contact the Lab News editor at labnews@sandia.gov.

Celebrating 25 years of economic development

Sandia Science and Technology Park marks major milestone

By **Kim Vallez Quintana**

Many of the people and companies that helped launch an innovative idea a quarter century ago came together to celebrate what that idea has become: a catalyst for economic development and technological advances.

This year marks the 25th anniversary of the Sandia Science and Technology Park, which sits on 340 acres just outside Kirtland Air Force Base. “Looking back, we had to start this park on this vacant dirt. At a time when the Eubank gate was the back gate to Kirtland. It was three lanes of asphalt with no curb or gutter,” said Sherman McCorkle, chairman of the SS&TP Development Corp. “As naive as we were, we had no idea what it would take.”



AN INNOVATIVE IDEA — In 1998, leaders from Sandia, the city of Albuquerque and the state of New Mexico broke ground on the new Emcore building, the first tenant of the Sandia Science and Technology Park.

Photo courtesy of the Sandia Science and Technology Park

Twenty-five years later, the park is home to 40 businesses, schools and Sandia organizations that employ 1,800 people and pump millions of dollars of revenue into the state each year. Since its start, the park is credited with contributing nearly \$7.2 billion in wages and salaries, \$166 million in gross receipts tax revenue to the state of New Mexico and \$36.6 million in gross receipts tax revenue to the city of Albuquerque.

McCorkle was one of the original partners who joined the anniversary celebration on Sept. 12 at the National Museum of Nuclear Science & History. Another was Linda von Boetticher, the technology park program leader. “I am blown away; we are blown away with how many of you came to celebrate with us. This is a tremendous



THE ORIGINALS — Original Sandia Science and Technology Park tenants Scott McWilliams, Dennis Blake and Debbie Amsbaugh with Rocket Lab share their technology during the 25th anniversary celebration. **Photo by Craig Fritz**

synergy and opportunity to come together.”

“It’s an amazing milestone of 25 years,” said Dan Sanchez, DOE Technology Partnerships manager, NNSA Sandia Field Office. “It came to our attention in the 1990s that world dynamics were changing our national security posture, and the defense programs were beginning to decline because of world conditions. It was through the leadership of the Department of Energy and with the innovation at Sandia National Labs that we came together as a community to stand up this new ecosystem of technology transfer partnerships and economic competitiveness beyond our expectations.”

Some of the companies who signed on at the beginning remain in the park, including SolAero by Rocket Lab, which started as Emcore back in 1998. Its mission has remained the same: making solar cells and panels used in space. Production manager Dennis Blake said there are a lot of benefits being in the park. “We have a direct pipeline to many of our customers. It also gives us a more technical setup with the individuals we have among us at the park and can collaborate.”

Eric Miller is another park tenant. He owns PADT Inc., which sells the tools engineers use to design products, including those at Sandia. “The No. 1 benefit is access to the staff at Sandia. After 9/11, we couldn’t just go visit them, so they could



LEADING THE WAY — Sherman McCorkle, chairman of the Sandia Science and Technology Park Development Corp., shares stories of the park’s early beginnings. **Photo by Craig Fritz**

come and visit us. We can visit their engineers outside the gate. Some stop by on the way home and do a little mentoring or sit in on a demo.”

The hope is that the park will continue to grow and energize the tech industry while fulfilling Sandia’s mission. “It brings together companies that can provide services and technology to the labs. It also gives them the ability to access researchers’ facilities. It’s just right there,” said Mary Monson, senior manager of Technology Partnerships and Business Development at Sandia. [f](#)

R&D 100

CONTINUED FROM PAGE 1

director for Advanced Science and Technology.

The R&D 100 Awards, in its 61st year, is a globally prestigious recognition of invention and innovation. It claims entries this year from 15 countries and regions and is sponsored by R&D World Magazine.

Honors go to researchers deemed to have developed the year’s 100 most outstanding advances in applied technologies, in the judgment of the magazine’s editors and expert panels.

The awards focus on practical impact rather than pure research and reward entrants on their products’ design, development, testing and production.

The winning applications were announced in late August.

The Sandia winners are:

Analytical/Test: Detecting epileptic seizures before they manifest

Pre-Symptomatic Volatile Organic Compounds Detector of Seizure Events

Philip Rocco Miller, principal investigator;
Gary Arnold (external collaborator)

This invention improves the lives



PRE-SYMPTOMATIC CHEMICAL DETECTION OF SEIZURE EVENTS — The Pre-Symptomatic VOC Detector of Seizure Events is a portable instrument that can alert the wearer to an imminent seizure more than 20 minutes before it occurs. [Watch video.](#)

Courtesy of Sandia Creative Services

of people with epilepsy. The wearable detector identifies skin-emitted gasses that indicate an episode is imminent. A feat never before accomplished by technology — some dogs do it naturally, with the drawback they have to be present at the right time — the detector's pre-symptomatic warning enables the wearer to seek shelter and to communicate with family and health care providers before the seizure occurs. This dramatically lessens the stress of those formerly at the mercy of these unpredictable events.

The device when commercialized will function by constantly sampling gasses emitted from the wearer's skin and analyzing them automatically without the wearer's input or engagement. Upon detection of volatile organic compounds specific to seizures, the device will alert both the wearer and their care circle.

The instrument comprises several system devices made in Sandia's silicon microfabrication facility. A chemical pre-concentrator collects and stores the volatile organic compounds. Chemical separation takes place in a two-dimensional micro gas chromatography device. Detection is performed with a miniature ion mobility spectrometer. When these components are combined at a system level, their total volume — about that of a midsize novel — and weight — 1.5 pounds with battery — are amenable to being worn on the body.

This project has roots in MicroChemLab, Sandia's first Laboratory Directed Research and Development Grand Challenge.

Software/Services

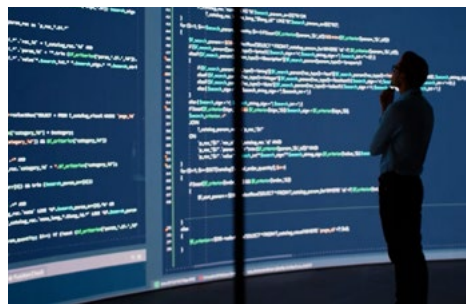
META Optics Studio

Ihab El-Kady, principal investigator; Denis Ridzal; Timothy Wilde; Edgar Bustamante; David Fitzpatrick (external collaborator); Ryan Chilton (external collaborator); Mehmet F. Su (external collaborator)

META Optics is a software package built for the design, simulation and optimization of flat meta-surfaces, which are artificial structures used to engineer the light wavefront for enhanced focusing, phase correction and removal of aberrations. If

designed correctly, a metalen can perform the function of a highly focusing, high-speed traditional lens while being a fraction of its weight and absolutely flat. This has revolutionized the field of optical imaging and extended its possibilities by severely reducing size, weight and power requirements while extending the imaging resolution to well below the subwavelength limit. META Optics Studio is the only known software capable of simulating a centimeter-sized meta-surface at nanometer resolution within a few hours.

The project developed out of the Metamaterial Science and Technology Laboratory Directed Research and Development Grand Challenge from 2009-2011, and funding from Defense Advanced Research Projects Agency.



MATERIALS LEARNING ALGORITHMS — This software framework uses machine learning to predict the electronic structure of materials faster and at greater scales than what was previously feasible. [Watch video.](#) Courtesy of Sandia Creative Services

Materials Learning Algorithms

Sivasankaran Rajamanickam, principal investigator; Attila Cangi, principal investigator (external collaborator); Normand Modine; Aidan Thompson; Jon Vogel; Adam Stephens; Lenz Fiedler (external collaborator)

The Materials Learning Algorithms is a software framework that uses machine learning to predict the electronic structure of materials. Electronic structure is fundamental for understanding virtually all molecular and material properties. The software enables these calculations at length and time scales that were previously unfeasible.

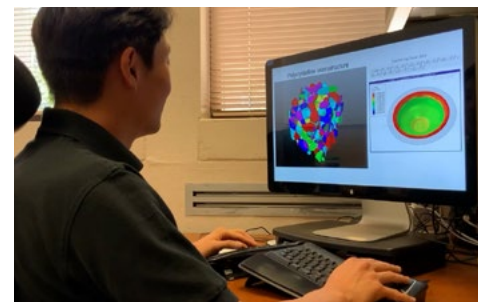
Density functional theory, for which the Nobel Prize was awarded in 1998 is the most heavily used approach for electronic

structure calculations. However, the method is complex, expensive and limited to small scales because the computation cost increases cubically with the system size. Machine Learning Algorithms is focused on solving the limitations of density functional theory using machine learning.

The key questions that the software addresses are, “Can machine learning help accelerate these first-principle electronic structure calculations?” and “Can this approach be more scalable with respect to system size?” The methods developed in the framework answer both these questions in the affirmative, demonstrating a 5,000-time speedup on systems feasible with DFT.

Materials Learning Algorithms was primarily funded out of a Computing and Information Sciences LDRD project, “Accelerating Multiscale Materials Modeling with Machine Learning,” which ended in 2022.

Materials Data-Driven Design



MATERIALS DATA-DRIVEN DESIGN — This project enables manufacturers to account for the internal structure of materials when shaping and forming a part for the first time by leveraging a proprietary deep learning model. [Watch video.](#) Courtesy of Sandia Creative Services

David Montes de Oca Zapiain, principal investigator; Hojun Lim, principal investigator; Benjamin Greene; Taejo on Park (external collaborator)

MAD3 is an innovative software that leverages the power of machine learning to modernize the forming and stamping processes of sheet metals. It predicts the parameters that characterize the directional mechanical behavior of a metal alloy 1,000 times faster than existing solutions. As a result, the software significantly reduces expensive and time-consuming forming and stamping trials.

More explicitly, metal alloys such as

aluminum or steel used in various manufacturing processes like stamping and forming exhibit directional strength and formability that cause the metal to distort. The reaction, called plastic anisotropy, determines whether the material is capable of being shaped to the desired component fit and finish, and whether it will withstand the applied performance load. As a result, accurate predictions of the metal's plastic anisotropy are crucial in major manufacturing and supported by automotive and aerospace metal manufacturers as well as suppliers.

However, the cost of characterizing plastic anisotropy has skyrocketed because characterization requires specialized equipment and significant technical expertise. The software uses state-of-the-art data-driven and machine-learning techniques to first extract a unique fingerprint descriptor of the metal alloy's internal structure, then subsequently uses these descriptors to predict the plastic anisotropy parameters in an accurate and efficient manner.

These anisotropy parameters can be used to perform forming and stamping simulations with unprecedented accuracy since they incorporate the effect of the polycrystalline grain structure.

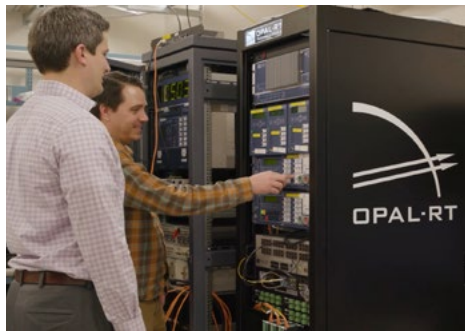
Additional special recognition (Silver medal): Market Disruptor — Services

PowerModelsONM: Optimizing Operations of Networked Microgrids for Resilience

Matthew Reno, principal investigator; Trupal Patel; Adam Summers; Ronald Matthews; Dan Kelly

PowerModelsONM software optimizes networked microgrids for power restoration during blackouts and other extreme events. It is the only physics-based optimization software package featuring networked microgrids for modeling restoration of electric power distribution feeders.

Utilities can use PowerModelsONM to plan for networked microgrids to support rapid recovery during extreme-event-induced grid outages. Superior validation is achieved using utility data sets for software simulation and hardware-in-the-loop



PowerModelsONM: OPTIMIZING OPERATIONS OF NETWORKED MICROGRIDS FOR RESILIENCE — Utilities can use PowerModelsONM to plan for networked microgrids to support rapid recovery during extreme-event-induced grid outages model. [Watch video.](#)

Courtesy of Sandia Creative Services

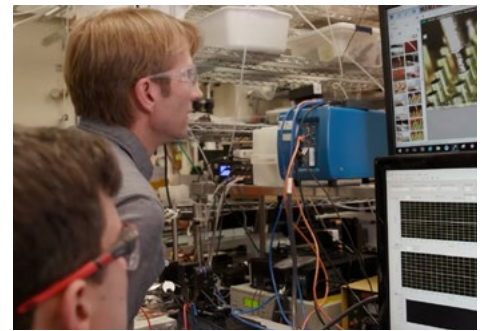
experiments. Sandia is a partner on PowerModelsONM with Los Alamos National Laboratory, National Renewable Energy Laboratory and National Rural Electric Cooperative Association.

Process/Prototype Electro3D

Karl Walczak, principal investigator; Brian Perdue; Adam Cook; Jonathan Height; Jon Coleman; Jesse Duran (former Sandia intern); Jakob Graham Bates (former Sandia intern); Garrett Williams (former Sandia intern)

Electro3D is an additive process that leverages fluidics with electrochemistry to produce high-quality materials and parts rapidly. The technology could serve many sectors, especially printed electronics, because materials such as copper can be printed at the room temperatures and pressures at which Electro3D performs.

The process also can be used to analyze and even build materials through an electrodeposition printhead that reduces mass transport losses. The printhead attached to commercial robots or 3D printing stages has the potential to be a more energy-efficient and economical pathway to generate materials and parts than currently available methods. The technology is scalable, deployable and has the potential to print multimaterials (metals, semiconductor, polymers) with rapid transition.



ELECTRO3D — Electro3D allows for new and exciting possibilities in the world of electrochemical metal 3D printing. Not only does it allow users to print materials into less extreme environments, but it eliminates cost and transport limitations that no other technology can offer. With Electro3D, 3D metal printing can enable endless new possibilities for users. [Watch video.](#) Courtesy of Sandia Creative Services

The custom printhead dramatically increases the replenishment rate of the electrolyte in the deposition area, which improves the uniformity and rate of the material deposited. The deposition is controlled by tuning the fluidics, current and voltage that drive the electrodeposition reaction. This information is fed into a feedback loop that moves the printhead based on real-time feedback of deposition conditions, which is critical to achieve the desired material properties and geometry of the part.

This work is rooted in “Advanced Manufacturing Techniques of Thermoelectric Modules,” a recent Laboratory Directed Research and Development project. [f](#)



Open Enrollment is coming.

ACTIVE EMPLOYEES
Oct. 18 – Nov. 6

RETIREES

Pre-Medicare:	Oct. 15 – Nov. 10
Medicare:	Oct. 15 – Dec. 7

Computer model of atmosphere finalist for prestigious new prize

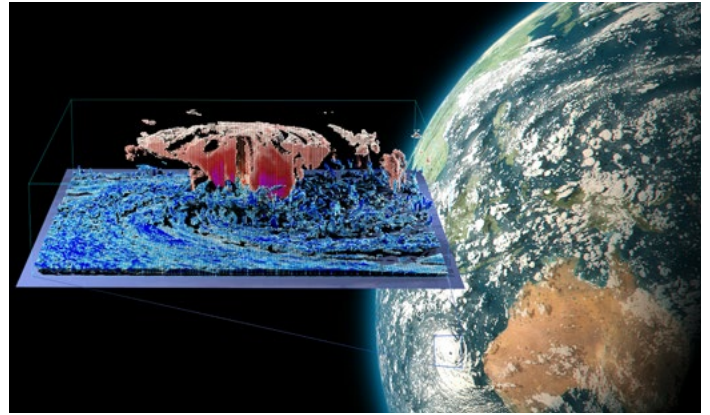
By **Neal Singer**

A team from Sandia and seven other DOE national laboratories is a finalist for the new Association for Computing Machinery Gordon Bell Prize for Climate Modeling for running an unprecedented high-resolution global atmosphere model on the world's first exascale supercomputer.

The Gordon Bell submission, led by Energy Exascale Earth System Model, or E3SM, chief computational scientist and Sandia researcher Mark Taylor, details the team's record-setting demonstration of the **Simple Cloud Resolving E3SM Atmosphere Model**, SCREAM, on Oak Ridge National Laboratory's 1.2 exaFLOP — 1.2 quintillion computing operations per second — Frontier machine. Incorporating state-of-the-art parameterizations for fluid dynamics,

microphysics, moist turbulence and radiation, SCREAM is a full-featured atmospheric general-circulation model developed for very fine-resolution simulations on exascale machines.


The Gordon Bell Prize for Climate Modeling “aims to recognize innovative parallel computing contributions toward solving the global climate crisis,” according to the Association for Computing Machinery. It will be awarded for the first time in November at the International Conference for High-Performance Computing, Networking,



A NEW FRONTIER — The record-setting global atmosphere Simple Cloud Resolving E3SM Atmosphere Model demonstration is a finalist for the new Association for Computing Machinery Gordon Bell Prize for Climate Modeling.

Image by Brad Carvey

Storage and Analysis in Denver and accompanied by a \$10,000 award provided by Gordon Bell. Winners will be selected based on their potential to impact climate modeling and related fields.

For more on E3SM, visit e3sm.org. 

Big goals

CONTINUED FROM PAGE 1

similarly broad contributions in pursuit of the two big goals of Sandia's Labs strategy.

“We're looking to everyone,” said James, who identified business and human resources practices as potential areas of innovation, along with science and engineering. “It's not just about our R&D family at the laboratory — it's about all of us.”

Throughout its history, **Sandia has evolved** to be responsive to the country's national security needs. These two goals are driven by emerging challenges.

“We've got to be more agile to deliver capability faster,” Deputy Laboratories Director for Nuclear Deterrence and Chief Technology Officer Laura McGill told the crowd. “There are going to be new threats that we have to address with



ACCELERATING CONVERSATION — Tom Klitsner, a senior manager in computer systems and technology integration, speaks during a brainstorming session as part of the town hall.

Photo by Craig Fritz

diverse and innovative solutions.”

While there are executive-owned, Labs-level milestones for their achievement, the goals are intended as a north star that staff can use in their work and planning. Labs leaders aimed to make them short and memorable.

“I think it’s really cool that we’re doing something simple,” Deputy Laboratories Director and Chief Operations Officer David Gibson said.

“Sandia does a lot of amazing things, and it’s always as a result of everyone coming together and working hard collectively to achieve those goals.”

Town hall attendees seemed to appreciate this clear, practical approach.

“It is great to have unifying goals that the majority can relate to and work toward,” said Sylvia Saltzstein, a senior manager in integrated security solutions

who attended the event.

“We have a great opportunity to create and deliver inventive value as staff members,” said Irbis Gallegos, a cyber security professional and attendee. “We can all benefit from a unifying, strategic implementation that seeds and incubates ideas and then makes them real. The future looks brilliant.” 



INSIDE SANDIA
PODCAST

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Sandia's big goals

Goal No. 1: Accelerate innovation

By FY 27, Sandia will be a leader in scientific, engineering and operational innovation and an employer of choice for highly innovative and creative talent.

The Labs strategy defines innovation as “developing and applying an idea, expert knowledge or technology in a novel way to address a specific challenge and achieve value for the laboratories or our partners.”

Goal No. 2: Lead in modern engineering

Modern engineering approaches will be used by a majority of teams by FY 26, and by all teams by FY 29.

As highlighted in the Labs strategy, modern engineering approaches include:

- A continuous digital thread from concept through development that eliminates paper artifacts and manual transactions.
- Integrated model-based systems engineering.
- Physics-based modeling and simulation with artificial intelligence and machine learning to reduce physical testing.
- Automated integration of security at every phase of the software development lifecycle.

From Sesame Street to Sandia: A first-generation journey to college graduation

By **Maggie Krajewski**

In 1998 Catalina Acosta was about to be the first in her family to graduate high school.

She’d also be the first to attend college. But she needed a letter of recommendation. So, she did what many seniors do and asked her high school counselor.

He said no.

“He asked why I was even thinking about college when people like me are just meant to pop out babies,” Catalina, a Sandia analyst, recalls. “I knew what he meant, insinuating that because I was a Hispanic woman, my only job was to have kids. I told him that I would prove him wrong and get that degree.”

She did.

The more you know

Catalina’s parents came to New Mexico from Chihuahua, Mexico, in the late 1970s. She was born and raised in Albuquerque and lived most of her life across the street from the elementary school where she would attend and later volunteer in high school, working with the school secretary.

Growing up, she watched her parents work hard to support the family. Her mother often worked several jobs, and the work could be physically demanding.

“My dad was a press operator and made boxes. My mom worked mostly in the custodial field and doing laundry, washing linens, ironing, jobs like that,” Catalina said. “My parents wanted more for me; they wanted me to have a career

where I could be self-sufficient. They always encouraged me to further my education. They would say, ‘the more you know, the better off you’ll be.’”

She was eager to learn and equally determined to take full advantage of the opportunities she had living in America.

Finding her path

When Catalina was four years old, she started teaching herself English by watching Sesame Street. But Big Bird and Elmo only took her so far.

“When I started elementary school they put me in special education classes,” Catalina said. “There was a language barrier and at that time, I don’t think schools knew what to do with kids like me. I did need some extra help, but the special ed classes were too easy.”



HER BETTER LIFE — Catalina Acosta stands in front of the San Ignacio Catholic Church in Albuquerque. Catalina was the first in her family to graduate both high school and college.

Photo by Craig Fritz

It was a middle school teacher who first recognized Catalina's potential and started pushing her to think about the future.

"Mrs. Molina-Dodge would ask us, 'What do you like to do? Where do you see yourself when you think about your career?'" Catalina remembers. "She was the first educator to put that little buzz in my ear."

And then Catalina discovered the business world.

"I had a typing teacher in high school who encouraged me to join the Business Professionals of America student group," Catalina said. "And that's where I found my career path."

At the time, Sandia offered a scholarship to graduating seniors looking to major in office administration and she was awarded one. Catalina attended a two-year program at Albuquerque's Technical Vocational Institute, now known as Central New Mexico Community College.

She completed the program and transferred to the University of New Mexico's Anderson School of Management where she graduated with a degree in business administration.

A fruitful comeback

"I was never focused on the money; I just knew I wanted to get a degree," Catalina said.

Shortly after graduation, she returned to the high school where her former counselor was still working.

"I went to his office and said, 'here's my popped-out baby,'" Catalina said. "And I handed him my degree."

The degree represented a birth of new opportunities for Catalina.

"I'm grateful that I can show my kids the rewards of pursuing an education. I can give them guidance I didn't have," Catalina said. "I want them to know that


Hispanic Heritage Month signature event: A better life

Sandia employees are invited to hear more stories like Catalina's as part of Hispanic Heritage Month Signature Event: A Better Life Tuesday, Oct. 3, noon-1 p.m. MDT, in Steve Schiff Auditorium. The event will feature first-generation stories from Sandians who were the first in their family to graduate from college or a skilled trade school.

they can always go farther; they can always do more."

And do more is something Catalina has done plenty of in her 25 years at Sandia.

In that time, she has worked as an intern, office administrative assistant and administrative support associate, where she has supported various groups including information technology, the Technical Library and research and development. Today she is a governance, risk and compliance analyst in the Labs' assurance systems and reporting department.

When asked what it means to be a first-generation American, Catalina says, "I'm proud to live the American dream as a Mexican American. I'm here where I can learn about different cultures, enjoy more opportunities and have a better education. I'm here. And I belong." 

Invention at forefront of hydrogen sea change

Safety feature available for licensing to manufacturers

By **Michael Ellis Langley**

Sandia continues to innovate the use of hydrogen as a fuel source in vehicles and vessels with a newly developed safety feature that is ready for licensing to manufacturers.

The Flow Assist Vent Mast was developed to replace the simple metal-pipe

vent mast that is ubiquitous at hydrogen stations and other facilities handling lighter-than-air gases. The new approach introduces two active functions to venting such gases: dilution and dispersion, which make sure potentially flammable vapors are kept away from people and structures.

Physical chemist Lennie Klebanoff and fluid dynamicist Myra Blaylock investigated the design for seagoing vessels that takes planned or accidental hydrogen releases up and away, dispersing the flammable vapors away from passengers and the ship's superstructure.

"Hydrogen-powered vessels could store high-pressure hydrogen in a composite tank that resembles a SCUBA tank, or the hydrogen could be liquified in cryogenic tanks," Lennie said. "For either case, we want to be ready for planned and unplanned hydrogen releases. You might get releases in routine maintenance when you need to empty a section of pipe to service it. But there can also be emergency cases where you have to empty the hydrogen tanks rapidly."

But venting hydrogen is not as simple as just installing an empty tube to the air well above the ship's superstructure.

A breath of fresh air

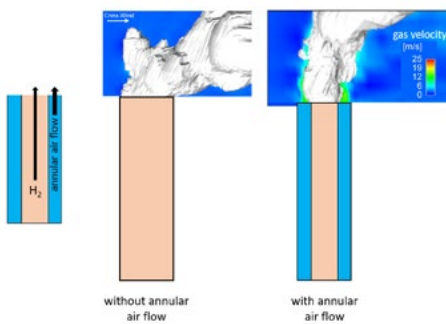
“What this invention does is force peripheral air from around the side of this pipe into the vent mast exit so that the released hydrogen is mixed with a lot of air, diluting the hydrogen to below the 4% flammability threshold in the exiting plume, reducing the risk of combustion. That’s the first active improvement made over having an empty pipe,” Lennie said.

Hydrogen is the lightest gas, which helps it disperse as it rises in heavier air, improving safety. However, that weight also introduces a problem.

“Hydrogen molecules are very light, so they get pushed around by heavier air molecules,” Lennie said. “This is a problem if the hydrogen exiting the vent mast encounters downward pointing winds, which can push the hydrogen down towards passengers, crew or vessel structures. Having a peripheral flow helps the hydrogen plume overcome any downward-pointing wind, pushing the hydrogen up and away, while also diluting it.”

Myra quantified this idea by modeling how the Flow Assist Vent Mast would function in a windy environment, confirming the peripheral air flow would work to increase the vertical momentum of the hydrogen molecules while also diluting their concentration in the air flow.

“The Flow Assist Vent Mast would be both shorter and safer,” Myra said. “I used Sandia’s state-of-the-art Sierra Toolkit for computational fluid dynamics to analyze the very complicated flow in this system.”



GO WITH THE FLOW — A cross-section of the hydrogen vent mast technology shows how the device can safely disburse potentially flammable hydrogen fumes away from vessels and people.

Illustration by Lennie Klebanoff

Sandia to the fore

Hydrogen vessels are not just future tech. Former Sandian Joe Pratt who, along with Lennie, discovered the technical feasibility of hydrogen fuel cell vessels, founded the company Zero Emission Industries, or ZEI. With \$3 million in funding from the California Air Resources Board, Pratt launched the hydrogen-powered ferry Sea Change in 2022. The Sea Change will begin to ferry the public around the San Francisco Bay this summer.

“It’s the first hydrogen-powered vessel that’s gone all the way through the U.S. Coast Guard gauntlet of regulatory approval, and its hydrogen propulsion approach is based on our work together at Sandia,” Lennie said. “The Sea Change is the first commercial hydrogen fuel-cell ferry in the Western Hemisphere.”

Lennie said that Pratt’s confidence to take entrepreneurial leave to establish ZEI — along with Sandia’s established partnerships with the U.S. Coast Guard, the Department of Transportation’s [Maritime Administration](#), or MARAD, naval architects, and hydrogen fuel suppliers — tremendously shortened the commercialization time from the feasibility study to having a vessel on the water.

Since 2016, Sandia has performed feasibility studies on hydrogen-powered vessels, most recently with Scripps Institution of Oceanography, which wanted to [launch the world’s first hydrogen-powered research vessel](#). That concept received approval from California lawmakers who awarded the project \$35 million to design and build a liquid hydrogen hybrid research vessel based on a design created in a MARAD-funded Sandia project involving Scripps and naval architect Glostern Marine.

“The Sandia feasibility work gave Scripps the confidence such a vessel was possible, and the relationships we had already established with the Coast Guard, naval architects and the gas suppliers created the calm seas needed for the State of California to want to fund it,” Lennie said.

Sandia’s history with hydrogen

Myra said that work was also made



UP, UP AND AWAY — The hydrogen vent mast installed near the aft of the hydrogen-powered ferry “Sea Change” funnels potentially dangerous fumes away from people on board the vessel. The vessel was built by Zero Emission Industries, founded by former Sandian Joe Pratt.

Photo courtesy California Air Resources Board

easier because the Labs have logged decades of study in alternative fuel systems, including hydrogen.

“The nation is already moving toward a green economy, and I see our project, and this invention itself, as part of Sandia’s work to make alternative fuels safer and easier to use,” she said. “By using a Flow Assist Vent Mast, the venting structure can be shorter, lighter, and safer, which makes it easier to have a hydrogen fueled boat be attractive and more widely accepted. It will be exciting to have more hydrogen fuel cell vessels because they are quieter, reduce air pollution, and completely prevent polluting fuel spills because hydrogen cannot be trapped by water. It will be a benefit for everyone, everywhere.”

“It’s just not for boats either. Hydrogen filling stations can have these Flow Assist Vent Masts too, as could some vehicles,” Lennie said.

“Add on to that storage facilities for hydrogen, possibly even hydrogen trains that are being considered. This improved vent mast would make all of those hydrogen applications safer,” Myra added.

The Flow Assist Vent Mast is ready for a corporate partner to produce it, and Sandia’s Business Development team is currently [promoting the technology](#). [Learn more](#) about transitioning Sandia projects and intellectual property into successful products that benefit the nation. [f](#)

Magnetic beads key to better handheld lab

By **Michael Ellis Langley**

Bioengineers have developed a new way to use magnetics to expand upon the capabilities originally developed with the SpinDx handheld medical diagnostic tool and quickly diagnose even more diseases and illnesses.

Building upon success

Developed 11 years ago, SpinDx was able to determine a patient's white blood cell count, analyze important protein markers and process dozens of assays — or measurements of biochemical markers — from a single sample, all in a matter of minutes.

"I had a certain idea in mind for how we might build upon, but also simplify, what had been done with SpinDx," chemical engineer Robert Meagher said. "In the case of medical diagnostics, you want a rapid response in places where there might be need to analyze a sample quickly — a remote base or a clinic or something like that — and detect the biomarkers of infection so that you can get an early indication of whatever your patient is infected with. If it's a bacteria or a virus or something else, that can guide very early treatment decisions like administering antibiotics or antivirals."

Robert hoped to increase the number of tests that can be done by the device.

"The ideas that I had turned out to be pretty hard to implement," he said, "and that was around the time that Josh was coming on board the project and came up with some really creative new directions."



PASSING THE TEST — A new type of handheld testing device for biofluids developed at Sandia is now ready for commercialization.

Photo by Josh Choi

Innovation gets personal

Electrical engineer Gihoon "Josh" Choi wanted to work in bioengineering because a family member was hospitalized for months with a disease, in part because testing was so slow.

"I wanted to pursue electrical engineering to develop a portable diagnostic system that can be used in a practical setting," he said. "And I thought a creative approach to handle multisteps of sample process with minimal user intervention is crucial for the advancement of point-of-care technology. So, we came up with the programmable electromagnetic actuator that automates the sample steps."

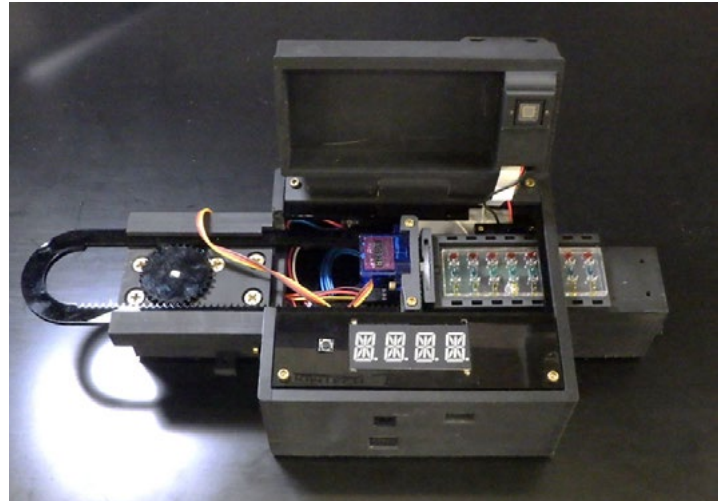
Tiny magnetic beads, between 1-5 microns, are used to collect the samples of bodily fluids. The sample clings to the bead, creating a sphere of material that can be tested multiple times.

"In conventional biology methods, it's very common to just have a little test tube that has the beads, and you just literally put a magnet next to that, the beads collect next to the magnet and then you go in with a pipette," Robert explained. "The beauty of it is that you can capture something from solution on the bead, hold the bead in place and then change the solution conditions around it to accomplish multistep assay."

One sample, multiple test steps

Josh figured out a way to use electromagnetism to actuate the tiny beads inside a microfluidic device, where it can be tested in multiple ways with multiple reagents.

"You don't necessarily want that person who's running the test to have to stand there looking at their wristwatch or setting a timer for five minutes to add the next



POLE POSITION — Magnetic fields inside a new handheld biochemistry lab make it possible to run multiple tests of blood and other fluids far from a hospital or traditional lab.

Photo by Josh Choi

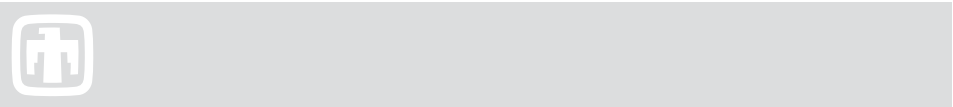
reagent. Now, in another five minutes, run a wash step and wait another five minutes," Robert said. "You really want something where the operator can just add the sample and press go."

Ten to 15 minutes later, the health care provider can get the result one would get in a home COVID test. Building upon the technology developed with SpinDx, which could only be used for single-step assays, the new platform allows users to wash samples and other intermediate processes, automating more complex testing and higher fidelity results.

"You can repeat that for multiple cycles," he added. "Instead of a person putting the tube of beads next to a magnet, using a machine that takes up a lot of laboratory space and has \$100,000 or more worth of robotics, you can perform the test where the care is actually needed."

Through funding from the [Laboratory Directed Research and Development](#) office, Josh built a prototype. [Sandia is now seeking commercial partners](#) to share the technology with. Robert and his team are working on adding to the toolkit of what Sandia can implement with the electromagnetic array, including temperature-controlled incubations. [i](#)

Mileposts



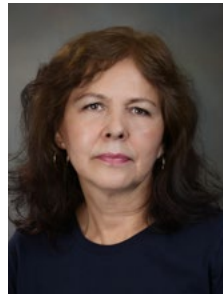
Allen Robinson 40



Robert Brown 35



Merlin Decker 35



Marjorie Hernandez 30



Bill Moffatt 30



Greg Guidarelli 25



Craig Lawton 25



Jim McElhanon 25



Stephen Zenker 25



James Dykes 20



David King 20



Michal Kuca 20



Mike Pooler 20



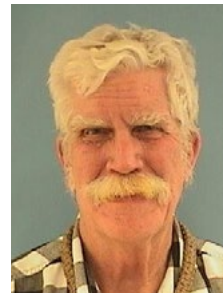
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Richie Spangler 20



DeAnna Campbell 15



Mark Halliburton 15



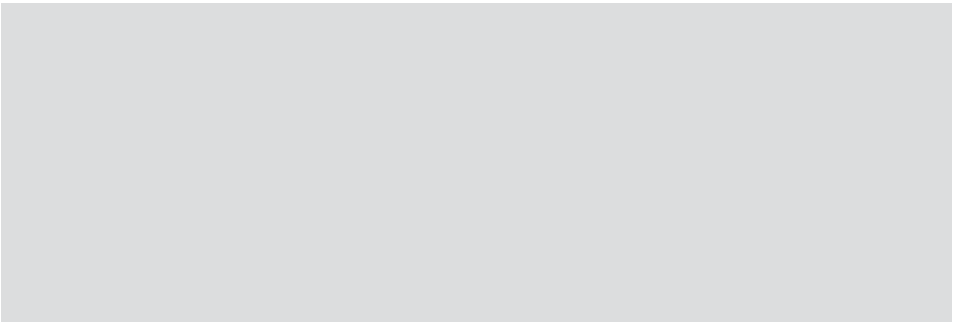
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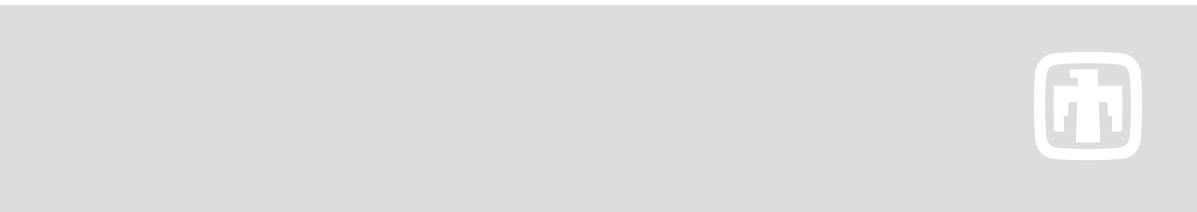
Roshan Quadros 15



Lynette Ramirez 15



Recent Retirees



Ed Duckett 37

Cyber Defenders: Interns take on national security challenges

By **Mollie Rappe**

Nearly every day, a cyberattack or newly discovered zero-day exploit hits the headlines, which makes providing the best training for the next generation of cybersecurity professionals of vital importance.

Sandia's internship institute in cybersecurity, called the **Center for Cyber Defenders**, has been introducing college students from across the U.S. to important national security challenges since 2001. Over the past two decades, nearly 500 undergraduates and graduate students in cybersecurity, computer science, computer engineering and related fields have worked on research projects, attended training courses and technical tours while receiving mentorship and unparalleled networking opportunities.

"We want to expose the students to Sandia across the board, and we want them to be able to contribute to meaningful work on a national security project," said Tiawna Cayton, the team lead for the internship program. "Hopefully, we can really get them to understand the passion behind our missions and why people want to work here."



NETWORKING CENTRAL — Sandia intern Grace Kenny works in the Center for Cyber Defenders office. The colorful, collaborative workspace includes the center's own take on the Linux penguin.

Photo by Craig Fritz

The students, who have ranged from those who just completed their freshman year of college to doctoral students, start out as full-time summer interns. Some of these interns become part-time, year-round interns while continuing their education, based on the fit of the student with the project and the availability of funding. Last year, about 60% of the interns transitioned, which was quite high, Tiawna said.

Approximately one-third of past interns have been hired as full-time employees upon completion of their degree, though not necessarily into the same center as the one they worked for during their internship, Tiawna said. Of the interns who were hired, 70% are still at Sandia, a remarkable statistic in the age of the Great Resignation.

"Getting to work with these teams is really rewarding, especially as one of the teams I got to work on a research project that was pretty open-ended," said Akul Goyal, a year-round intern in the Center for Cyber Defenders and a graduate student at the University of Illinois, Urbana-Champaign, who was a summer intern last year. "The problem wasn't well-defined, so that gave me a lot of freedom, which made it a very smooth transition from academia. What we were solving, it seemed



DEFENDER AT WORK — Sandia intern Grace Kenny works on a project in the Center for Cyber Defenders office. The cybersecurity internship program provides hands-on training and networking opportunities to college students.

Photo by Craig Fritz

that there were downstream applications for it, so that was cool."

A valuable opportunity for students

Some of the events that Colette Bristol, the coordinator for the Center for Cyber Defenders, arranges for the interns include tours of notable Sandia facilities such as the **National Solar Thermal Test Facility**, the **Ion Beam Lab** and the virtual reality lab at Sandia's **Cyber Engineering Research Laboratory**.

Colette also arranges short technical talks by Sandia experts. One talk by Sandia cybersecurity researchers Shelley Leger and Doug Ghormley is about how trust is abused in cybersecurity and a way to "gamify" trust, said Shelley, who has mentored interns from the program since 2009.

"All in all, I think I've scheduled about 30 tours and tech talks for this summer," Colette said. "My goal is to make everybody feel welcome."

The interns are also exposed to short courses such as a two-day course on how to break down a reverse-engineering problem and use an open-source software

package called **Ghidra**, taught by Chris Leger and Bryan Kennedy, Shelley said.

But don't think that the interns only work and study. Colette also arranges social events such as picnic lunches, and the interns get to explore Albuquerque and the surrounding area over the summer.

To encourage networking and learning from one another, the interns are all co-located in the same office space, Tiawna said.

"I think it's really invigorating for them," she said. "They're able to bounce ideas off of one another; they're able to get help. They get to see the variety of problems all the other interns are working on as well. Cybersecurity is a very broad topic; there are tons and tons of things that go into that. They get to see a broad spectrum of what is available."

Shelley agreed about the value of the interns' office space and culture.

"In the Center for Cyber Defenders, they're in this open room with cubicles," she said. "When somebody has a problem, they'll ask for help, and gradually the people around the area will hear the problem and start congregating, shouting out ways to make a solution better."

The program organizers said that because of these opportunities and the environment, it's great that they've been able to host interns on-site again after only having remote interns during the summers of 2020 and 2021.

National security results, too

The Center for Cyber Defenders interns also make an impact on Sandia's vital national security missions, Tiawna said.

"A lot of really great work comes out of interns," Tiawna said. "They have different perspectives, the diversity of thought is really great. Someone told me one time, 'the best thing about grad students is they don't know what's impossible yet,' and I think that's totally true."

Shelley agreed about the value of interns; she has mentored up to seven interns at once.

"From the interns, I get energy, knowledge, sometimes excellent execution, even research direction — I've had some interns that actually change the direction


of my Laboratory Directed Research and Development

research by being on the project — and an ability to engage my desire to create and enable connections between people," she said. "In general, the interns are super excited to be here and love finding out what we do.

They love understanding the nuances of our mission and the breadth of our mission space. And they are in school, which means they are up to date on the technologies and the research that I need to understand to be able to execute my mission properly."

About six years ago, a summer intern spent a quarter of his time working on one of Shelley's LDRD projects. He knew the right questions to ask and how to approach systems-level problems, and his influence can still be felt on later research, Shelley said.

Over the school year and this summer, Akul has been working on **Tracer FIRE**, a Sandia-developed cybersecurity training scenario that provides university students, not just Sandia interns, with a realistic cybersecurity incident response scenario. Each year the details of the scenario change, but the students spend three days trying to identify the bad guys and figure out how they got into the network. Akul has been working on data parsers and labeling various events in the Tracer FIRE dataset so that the data is more useful for cybersecurity researchers.

"There's a lot of great things about the Center for Cyber Defenders program," Akul said. "It's the closest you'll get to academia without being in academia. I think working at a major tech company, research is a lot more boxed in. At Sandia, there does seem to be more of a need for a downstream application than in academia, which was interesting." 



CYBER INTERN — Colette Bristol, right, the coordinator for Sandia's Center for Cyber Defenders program, talks with intern Joel Schott in the Center for Cyber Defenders office. Colette arranges tours of interesting facilities and short technical talks so that the interns can get the most out of their summer.

Photo by Craig Fritz

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Making waves at Meet a Scientist Day

By **Spring Booth**

Small hands moved the washer higher up on the wooden dowel. Then, with the help of a Sandia intern, they returned the makeshift “boat” to the water and watched as it tipped over. Four-year-old Maddie might not fully understand the concept of metacentric height (aka, why you shouldn’t stand up in a canoe) demonstrated by the hands-on display, but she saw how the ship became unstable the farther away the weights moved from the boat’s center.

Metacentric height was one of the marine energy concepts children learned about at Explora’s Meet a Scientist Day. A group of Sandia summer interns, under the guidance of Kelley Ruehl, designed and created two portable kits to teach kids about marine energy at [Explora Science Center and Children’s Museum](#) in Albuquerque.

The Saturday event drew dozens of children. In addition to tipping the boat, participants were able to generate electricity with



EARLY INSPIRATION — Four-year-old Maddie being shown how to tip the ship on a metacentric height kit at Meet a Scientist Day.

Photo by Spring Booth

a small-wave energy converter by moving a paddle up and down to make waves. The faster they moved the paddle, the bigger the waves and the higher the reading on the attached voltmeter. Sandia researchers and interns helped the kids use the kits and answered questions about how waves and

currents can be converted to energy.

This project was funded by the [Water Power Technologies Office](#) and was supported by Sandia’s Community Involvement team. “Outreach events like these,” said Rafael Baez, a Sandia intern on the [Water Power](#) team who helped develop the kits, “are important to the community as they give more exposure to STEM-related fields. It gives kids the opportunity to discover different topics at a young age, encourage curiosity and open new doors for future careers.”

The marine energy kits were designed to use common items, so they can be easily reproduced. Instructions for making the kits and activity cards explaining the marine energy concepts behind them are available in both English and Spanish. The kits will become part of Explora’s traveling outreach events making their way to numerous science nights at New Mexico schools, parks and community centers. Hundreds of children will have the opportunity to tip the ship, make waves and see science in action. [i](#)

SATURDAY, SEPT. 30
IS
Sandia Gives Day
Find the project list on Community Involvement's internal website