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Membrane to make fresh water **Page 2**

Kauai Test Facility launches its largest missile

REMEMBER ME — Sandia's Kauai Test Facility, shown here in 2019, celebrated the largest launch in its nearly 60-year history in May. **Photo by Mike Bejarano and Mark Olona**

Record flight supports missile defense research

By ***Troy Rummler***

The largest missile ever to launch from Sandia's Kauai Test Facility in Hawaii has shown the storied test range is still growing to meet the testing needs of advanced weapons systems.

Sandia used the four years leading up to the launch to ensure the test facility could safely accommodate the new vehicle.

"Sandia's flight safety analysis takes into account hundreds of failure modes and real-time wind profiles to ensure risks are within acceptable safety limits for personnel and assets," said Steve Lautenschleger, Sandia's manager for the mission.

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A goal for everyone

Sandia's new 10-year target objective goes to the heart of why the Labs exists

By ***Nancy Salem***

As a national security laboratory, Sandia must look ahead to anticipate threats and be ready to quickly respond to challenges. A long history of strategic thinking has led the Labs to a new target objective designed to strengthen its mission, operations and culture in the decade to come.

"Where are we going and what do we need to become? We wanted to answer those questions," said Labs Director James Peery, who spearheaded development of the target objective. "Having a strategic vision is critical to Sandia. Our role is unique and vital in a rapidly changing geopolitical world with numerous evolving threats. We must stay ahead of adversaries who are making technical advances that endanger our national security. In this dynamic

— CONTINUED ON PAGE 5

10-YEAR VISION — Labs Director James Peery led the effort to develop Sandia's 10-year target objective. "We worked very hard on this and I'm happy with the result," he said. "Strategy reflects the expertise of our rich and diverse portfolio of technical and operational activities." **Photo by Lonnie Anderson**

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Mimicking mother nature:
New membrane to make freshwater

Sandia electrodialysis membrane inspired by algae protein

By ***Mollie Rappe***

Scientists at Sandia and their collaborators have developed a new membrane, whose structure was inspired by a protein from algae, for electrodialysis that could be used to provide freshwater for farming and energy production.

The team shared their membrane design in a paper published recently in the scientific journal Soft Matter.

Electrodialysis uses electrical power to remove dissolved salts from water. Currently it is used to capture salt from seawater to produce table salt and remove salt from brackish water to make freshwater, but it could also

CRYSTAL CLEAN WATER — Susan Rempe, right, a Sandia bioengineer, and Stephen Percival, a material scientist, examine their biologically inspired electrodialysis membrane for producing fresh water. By mimicking an algae protein, the membrane can remove salt from seawater and wastewater to make fresh water while using less electricity. **Photo by Randy Montoya**

be used to remove salt from wastewater to provide a new source of freshwater.

The researchers found that the addition of a common amino acid, called phenylalanine, to an electrodialysis membrane enabled it to better capture and remove positive ions, such as sodium.

"Adding phenylalanine to the electrodialysis membrane increased the selectivity for positive ions by a significant amount, to our pleasant surprise," Susan Rempe, the lead bioengineer on the project, said.

Ensuring an adequate supply of freshwater is a national security problem, she said. Freshwater is essential for everything from drinking and farming to producing energy from nuclear-, coal- and natural-gas-based power plants.

Clean water, with less electricity

Currently, a method called reverse osmosis is used commercially to remove salt from seawater or brackish water to produce freshwater, but it has several limitations. One limitation is the need for high pressure to push freshwater out of an increasingly salty solution. The high-pressure driving force is costly and leads to the membrane getting clogged or fouled by undissolved material in the water easily, Susan said.

The more concentrated the salty solution, the bigger the problem. As a result, there are few options for cleaning up salty wastewater. As an example, water produced by hydraulic fracturing to recover natural gas, which can be ten times as salty as seawater, generally gets buried underground instead of being returned to the environment, Susan said.

Sodium and chloride are the two most common ions in seawater and table salt. Of course, there are a variety of other positively and negatively charged ions in seawater and wastewater, too.

Electrodialysis is a potentially better method than reverse osmosis because it uses electrical current to draw out the salt ions, leaving behind freshwater. This requires less energy and makes the membrane less likely to get clogged, Susan said. Electrodialysis needs a pair of membranes to produce freshwater, one that captures positively charged ions, such as sodium, and one that catches negatively charged ions, such as chloride.

Looking to biology for inspiration

Susan and her team sought inspiration from biology in the form of a specific protein that transports ions called channelrhodopsin. Channelrhodopsin originally comes from algae and is commonly used in optogenetics — a technique in which biologists have targeted control of specific living cells using light.

This ion-transport protein allows many different positively charged ions through, including sodium ions, potassium ions, calcium ions and protons, but no negatively charged ions. This kind of selectivity is important for an electrodialysis membrane.

Susan and former postdoctoral researcher, Chad Priest, saw that there was a lot of a certain kind of amino acid, called phenylalanine — one of the 20 building blocks that proteins are made from — along the protein's ion-transport pathway.

"We've been working on the channelrhodopsin protein for quite a while, trying to understand its properties and how it is selective for specific ions," Susan said. "We noticed several phenylalanine side chains lining its ion-transport pathway and we wondered 'What are phenylalanines doing in there?' We usually think of phenylalanine as a molecule that repels water and ions in biological transport proteins."

Susan and Priest's computational calculations showed that the phenyl side chain of phenylalanine forms a component of several binding sites along the transport pathway of the channelrhodopsin protein. Their calculations showed that those phenylalanine binding sites interacted with sodium ions enough so that the positive ions were stable, but not so stable that they would stop moving through the channel.

Layer-by-layer construction

Susan talked with Stephen Percival, Leo Small and Erik Spoerke, Sandia material scientists, about this biological oddity. The team thought incorporating the tiny molecule phenylalanine into an electrodialysis membrane might make it easier to separate positively charged ions from water during electrodialysis.

The process of making the electrodialysis membrane is somewhat like old-fashioned candle making. First, Stephen dipped a commercially available porous support membrane in a positively charged solution, rinsed off the membrane and then dipped it into a negatively charged solution. Because the solutions have opposite charges, they can self-assemble into a coating on both sides of the membrane, said Stephen, who started working on the project as a postdoctoral researcher.

He did this with and without the phenylalanine to test how the addition of the amino acid affected the membrane.

Each two-solution cycle added a very thin layer of membrane that can capture positive ions. For this project, Stephen primarily made membranes that were five or 10 two-dip layers thick. A five-layer membrane coating with or without phenylalanine was about 50 times thinner than a human hair. A 10-layer membrane was 25 times thinner than a human hair. The thickness of electrodialysis films is important because thicker films require more electricity to pull ions through.

"We found that by simply adding phenylalanine to the dip solutions, we were able to incorporate it into the finished electrodialysis membrane," Stephen said. "Furthermore, we were able to increase the membrane's selectivity for sodium ions over chloride ions, when compared to the standard membrane without phenylalanine."

Specifically, they found that the five-layer film with phenylalanine had selectivity similar to that of the 10-layer film without phenylalanine, but without the increased resistance associated with thicker coatings. This means that the phenylalanine film can effectively purify water while using less electricity, thus making it more efficient, Stephen said.

However, the amino acid was just mixed in the solution, so the team doesn't know if it interacts with the positive sodium ions in the exact same manner as in the biological protein Susan modeled.

"Between the bio-inspired nature of the project, working with experts across different disciplines and mentoring

undergraduate interns, this is one of the papers that I am most proud of," said Stephen. "The paper's findings were also very important. We were able to demonstrate that ion selectivity can be increased independently of the membrane resistance, which is quite advantageous."

Partnerships and paths forward

The Sandia team also collaborated with Shane Walker, a civil engineering professor at the University of Texas at El Paso, to further test the membrane. Walker and his team compared Sandia's electrodialysis membrane to commercially available membranes in a complex, lab-scale electrodialysis system. They looked at a number of parameters including salinity reduction, electricity consumption and water permeance.

"Our UT El Paso partners analyzed our membrane in a real electrodialysis system," Susan said. "They put membrane samples into their lab-scale system, ran a whole bunch of tests and compared our membrane to commercial membranes. Our membrane did quite well."

Walker's team found that Sandia's bio-inspired membrane was competitive with commercial electrodialysis membranes. Specifically, Sandia's membrane was above average in terms of current density. Water permeance, which is related to the movement of water from the salty-input water to the freshwater, was higher than average. Sandia's membrane was slightly below average in terms of salinity reduction after an hour of runtime and consumed more electricity than most of the six membrane pairs tested.

These results were published in a paper in the scientific journal Membranes on March 19. In the paper, the researchers concluded that while the Sandia's bio-inspired membrane was competitive with commercial membranes, there is still room for improvement. Hopefully, companies can learn from this bio-inspired membrane to improve the efficiencies of their electrodialysis membranes.

In the future, Susan would like to design an electrodialysis membrane that can separate out specific economically valuable ions, such as rare earth metal ions. Rare earth metals are used in automotive catalytic converters, powerful magnets, rechargeable batteries and cell phones and are mostly mined in China.

"The natural next step of the project is to use biology, again, as inspiration to design a membrane that will specifically move rare earth ions across a membrane," Susan said. "Rare earth metals are valuable, and the lack of domestic supply is a national security issue. Together, taking care of our water supply and recycling our valuable minerals are important for environmental security and climate mitigation."

This project was funded by Sandia's Laboratory Directed Research and Development program and the channelrhodopsin research was conducted at the Center for Integrated Nanotechnologies.

Kauai missle

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The missile sailed over the Pacific Ocean on May 29 as a medium-range ballistic missile-like target for Flight Test Aegis Weapon System 31 Event 1, a test coordinated by the Missile Defense Agency and the U.S. Navy. It stood 60 feet tall with a 6-foot base diameter.

Johnathon Huff, Sandia's acting associate labs director over National Security Programs said, "The launch of the largest guided rocket ever flown from the Kauai test facility represents a great achievement for a nationwide team during challenging operational conditions. The team showed excellent focus on the mission in the face of extended assignments. I am honored to be part of a team at Sandia that meets the challenge of executing new, technically challenging capabilities."

Sandia operates the Kauai Test Facility, located on the U.S. Navy Pacific Missile Range Facility, the world's largest test range, for the DOE. Operational since 1961, the facility has supported more than 465 launches, including research and development, operational training and test and evaluation.

Launch team adapts to oversize vehicle

This latest, record-setting shot was so large that the missile service tower had to be physically modified. New floors were adapted to the larger missile diameter, and a new, 10-foot-tall launch stool was built for the launch. The tower gives workers access to the missile while it is sitting on the launch pad.

The modifications to the tower give Sandia flexibility to accommodate vehicles of different sizes for future launches. Several launches of a similar size to the one in May are now in planning stages.

As a test range service provider, Sandia provides assembly facilities for customer-provided flight vehicles, runs pre-flight diagnostics and ground testing, conducts launch operations, and collects and delivers data for various government agencies and partners.

Specialists normally rotate in from New Mexico to run these tests or manage progress on-site. But to minimize the spread of coronavirus, many of the team members consolidated travel and quarantined for 10 days after arriving in Hawaii. As a result, work trips typically measured in days or weeks in some cases stretched on for months.

"It's difficult for personnel to field a mission at a remote site for that long. People on our team have families and other responsibilities back home. It takes an incredibly dedicated staff to execute this type of flight test." Steve said.

Sandia 10-year goal

CONTINUED FROM PAGE 1

environment, it is imperative that Sandia stewards its work into the future with a thoughtful and impactful strategy focused on breakthrough ideas."

The target objective is deceptively simple — "In 10 years we will have unleashed innovation and high-velocity engineering to counter global threats" — but a lot went into it. Over the past nine months, the Senior Leadership Team worked on every word using input from numerous feedback sessions. "There is a lot of commitment to the words in the target objective," said executive strategy professional Elizabeth Roll. "The whole SLT got behind it."

"It's important to identify where we're going so everyone is pointed in the same direction."

—James Peery

Eye on the future

The 10-year target objective is the ultimate, larger-than-life goal that everyone at the Labs works toward. "It should be specific and measurable and ignite passion, excitement and energy from every person in the organization," Elizabeth said.

It sits under Sandia's purpose, vision and mission, enduring statements that spell out who we are and what we do. It is supported by four 5-year goals to be achieved through specific milestones, all developed through extensive research and analysis, workshops, crowdsourcing and leadership meetings. "This is a solid framework of a single objective supported by goals and milestones to reach critical results: sustained U.S. technical advantage, an unstoppable team, breakthrough innovations, timelines cut in half and our DNA, exceptional service in the national interest," James said. "The importance of these outcomes cannot be overstated."

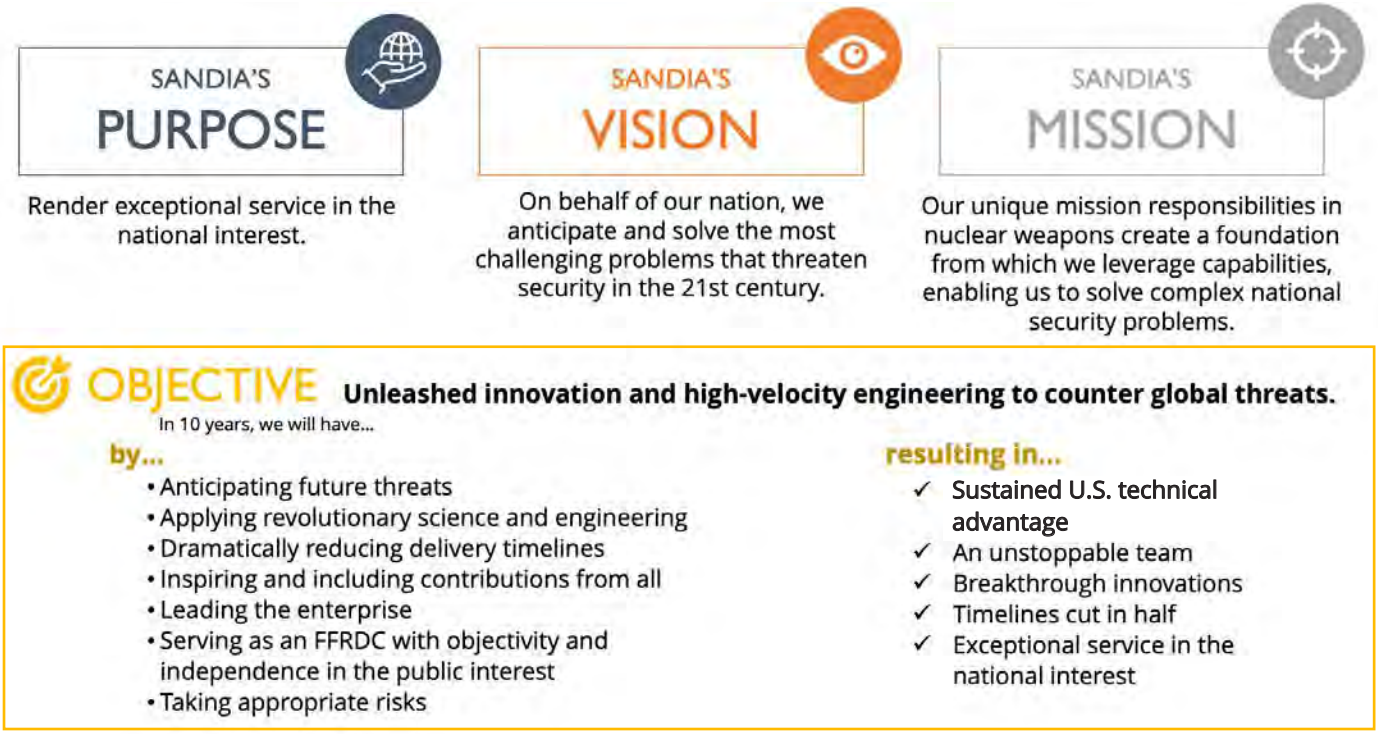
The first of the 5-year goals is to provide unmatched value to Sandia's sponsor, clients and National Security Enterprise partners by understanding the needs of the nation, delivering on commitments and cultivating and enhancing relationships and collaborations. The second goal is to radically improve mission delivery by advancing the way Sandia does science and engineering and unleashing innovation. "This is about changing how we do things in order to go faster and reduce timelines," said executive strategy professional Cally Maloney.

The third goal is to drive an exemplary culture of inclusion, agility and delivery to build the power of Sandians. "We have awesome people and need to unleash their potential through a great culture, inclusion and diversity, better processes and less bureaucracy," Cally said. "We won't reach our objective without Sandia being a great place to work that attracts and retains the best people."

The fourth goal is to transform the user experience by adopting best practices and modernizing operations. "This addresses what it's like to do work at

See the milestones and get involved

Your help in strategic planning is welcome. Please visit strategicplan.sandia.gov and email strategy@sandia.gov to get involved. The latest Sandia Strategic Outlook blog includes a look at the FY22 goals and milestones.



ROAD TO SUCCESS — This strategy framework shows how the 10-year target objective supports Sandia's purpose, mission and vision and produces breakthrough results.

Sandia," Cally said. "We can't change the way we work and move quickly if processes are slow and systems and operations aren't efficient."

Crucial steps to success

The nitty-gritty work toward achieving the goals and, ultimately, the objective is in the FY22 milestones. These are measurable yearly steps outlined by the Senior Leadership Team that are crucial to achieving the goals and include such areas as benefits and compensation, risk-taking, product realization, modeling and simulation, information technology and community engagement.

Each member, including James, is the champion of a particular milestone and works on tasks with directors and staff members. Teams report back at the Quarterly Strategic Review, when progress is recorded and adjustments made. So far, $2.5 million has been budgeted to achieve FY22 milestones.

James said the objective, goals and milestones apply to every Sandian. "No matter which organization you represent, we want you to bring ideas and innovation to your work to achieve our shared goals," he said. "We need innovation from HR, finance, facilities, science, engineering — from everywhere in the Labs — to improve how we deliver on mission and to make Sandia an even better place to work. Think about how you can contribute to this 10-year vision. Strategy touches us all, and we move toward this future together. In everything we do we must keep an eye on the horizon and take the Labs closer to the tomorrow we envision."

Sandia helps set up future of ocean research with hydrogen fuel cells

By ***Michael Ellis Langley***

Lennie Klebanoff has received considerable acknowledgment for his groundbreaking work to understand the wider applicability of zero-emission hydrogen fuel cells.

But Lennie didn't expect that his work would inspire students at one of the oldest and most respected schools of ocean and Earth research on the planet: The Scripps Institution of Oceanography at U.C. San Diego. These students petitioned Scripps to commit to a zero-emission fleet of research vessels following an analysis of hydrogen fuel-cell power on ships.

"It's completely out of the blue," Lennie said of the petitions and personal appeals to school administrators. "We didn't talk with these students. They are trying to motivate the university to take action. It's great that our work inspired these young people."

Partnering with Scripps Institution of Oceanography

Lennie began working with Scripps Institution of Oceanography more than four years ago following the success of an influential 2016 analysis he and former Sandian Joe Pratt wrote on the feasibility of high-speed hydrogen-powered ferries on San Francisco Bay. That report led to the State of California funding construction of the first commercial hydrogen ferry in the Western Hemisphere and a Tech Transfer Award from the Federal Labs Consortium.

FUEL CELL FUTURE — An artist conception of a new Scripps Oceanographic Institute research vessel shows a hydrogen fuel cell (labeled LH_2) that was conceived at Sandia and will provide propulsion and energy for the ship's systems. **Photo courtesy of Glosten**

Scripps, in a project funded by the Department of Transportation's Maritime Administration, asked for Sandia's help with their research fleet.

"Scripps wanted to know if it would be possible to use hydrogen fuel cells to power research vessels, since they needed to replace three ships in their aging fleet," Lennie recalled. "So, we were able to get more funding from MARAD. In collaboration with Scripps and the naval architect Glosten, we looked into that question. Turns out, the answer is yes, as we reported in 2018."

The impact of that 2018 study was immediate and profound, according to Bruce Appelgate, Scripps' associate director of Ship Operations & Marine Technical Support.

"Our imagination really took off. They were showing that non-polluting hydrogen

fuel cells could be used in a maritime environment," Appelgate recounted. "Our mission at Scripps is to explore the planet from the ocean depths to the top of the atmosphere. While we do this, we also want to go the extra yard to care for the environment."

But hydrogen fuel-cell vessels would also help data collection.

"For research purposes, a hydrogen-powered boat can actually work better," Appelgate explained. "Emissions from diesel engines can corrupt our samples, and noise from diesel engines degrades the sensitivity of our underwater hydrophones. We can collect better samples and observations from hydrogen-electric ships."

From study to design

Lennie became committed to helping Scripps achieve their aim: clean power for their research.

"Partnering again with Scripps and Glosten, we did a follow-on feasibility study looking at using fuels cells as part of a hybrid power train, in other words a hydrogen hybrid vessel," Lennie said. "What if you had a diesel engine coupled with a hydrogen fuel cell to provide partial power? What would that vessel look like? A hydrogen hybrid vessel would be a nice way to introduce hydrogen technology onto a research vessel."

But it wouldn't be easy, recalled Glosten's senior marine engineer Sean Caughlan.

"When made from green sources, hydrogen can provide amazing environmental benefits but compared to diesel it has low energy by volume. Therefore, the challenge is carrying enough to provide a meaningful benefit," Caughlan said. "The other challenge is that the design rules constrain where on the vessel the hydrogen can be stored, and it can be difficult to find space while still providing room for normal vessel operations. Safety is the highest priority in vessel design and with hydrogen's inherent volatility there are a number of systems that must be added, all with a space and weight cost to the vessel."

Taking the first steps with hydrogen

In the meantime, Scripps was gaining practical experience with hydrogen fuel-cell technology via a separate and parallel Maritime Administration-DOE project to use a land-based containerized 100-kilowatt fuel-cell generator to provide power for research vessels while in port at the Scripps' Nimitz Marine Facility in San Diego.

"I think this land-based project helped to make fuel-cell technology more real to Scripps. They saw what a fuel cell looks like, how they operate, and what hydrogen tanks look like and how they are refilled. This shore power demonstration project helped take the mystery out of the technology, in a good way," Lennie said.

But the project found other proponents — a group no one expected.

"The students found out about all this work we've been doing and are now using it to promote their own ecological agenda to Scripps," explained Appelgate.

"Every time I went out on a stump speech for zero emissions, people got really excited," he added. "The students just glommed on to this. The students started the petition asking the administration — me — to make a research vessel with hydrogen fuel cells happen. I've never been petitioned like this. There is a lot of activism right now. A lot of issues bubbling to the surface. This is a big issue that isn't acrimonious."

Designing a hydrogen hybrid vessel

Thanks to the students and Scripps' dedication to their vision, the university and Sandia weren't done imagining the future.

As part of the 2020 feasibility study of a hydrogen hybrid vessel, Lennie and his Glosten and Scripps collaborators designed a hydrogen vessel that met the 14 science mission needs that Scripps had to have in new research vessel, all the while satisfying the speed, stability and other vessel performance requirements of a high-performance research vessel.

"Our design showed the basic feasibility — but to actually build a vessel you need very detailed designs and engineering drawings, far beyond the scope of our project," Lennie said.

But the work was enough for Scripps to finalize their plans for replacing their fleet, starting with the research vessel the Robert Gordon Sproul. In 2021, Appelgate and his Scripps colleagues put in a proposal to the State of California to fully design and build the hydrogen hybrid to replace the 40-year-old Sproul.

Scripps sets sail in a new direction

On July 23, U.C. San Diego announced that the California Legislature decided to fund the project with $35 million, enabling the construction of a hydrogen hybrid research vessel to replace the Sproul, setting the stage for a new beginning. Appelgate said having hydrogen as a component made the proposal successful and that he believes the lawmakers would not have funded a diesel-only vessel.

"This is so exciting," Lennie said. "I went out in the hallway and did a cartwheel. I'm just happy that our work has been found useful by others and will help reduce emissions in the maritime setting."

Caughlan sees a future full of potential.

"Hydrogen can store many times more energy by weight or volume than batteries. It may not be practical for crossing oceans, but for coastal vessels, there's a lot of promise," the marine engineer said. "It is important for institutions like Scripps, Sandia and Glosten to take a leading role in establishing the science, design practices and standard operating procedures to make sure the technology is successful in the vessel application."

Lennie said he's just proud to have been a part of this revolutionary project.

"Bruce at Scripps as well as Sean Caughlan and Robin Madsen from Glosten have been incredible partners," he said.

Appelgate was effusive about how Sandia helped set a new standard for ocean research.

"The great outcome of this work was learning that it was all technically possible using commercially available gear," Appelgate said. "The magic sauce now is in the integration of it all into a working vessel, which had not been shown previously to be possible. The vision that Lennie has brought to this — he's way out in front in terms of how hydrogen can really be transformative. I am so proud to be involved in this with Lennie and Sandia and Glosten."

Sandia 3D-imaging workflow has benefits for medicine, electric cars and nuclear deterrence

New computer simulation method can equip engineers, doctors with more, better information

By **Michael J. Baker**

Sandia researchers have created a method of processing 3D images for computer simulations that could have beneficial implications for several industries, including health care, manufacturing and electric vehicles.

At Sandia, the method could prove vital in certifying the credibility of high-performance computer simulations used in determining the effectiveness of various materials for weapons programs and other efforts, said Scott A. Roberts, Sandia's principal investigator on the project. Sandia can also use the new 3D-imaging workflow to test and optimize batteries used for large-scale energy storage and in vehicles.

"It's really consistent with Sandia's mission to do credible, high-consequence computer simulation," he said. "We don't want to just give you an answer and say, 'trust us.' We're going to say, 'here's our answer and here's how confident we are in that answer,' so that you can make informed decisions."

The researchers shared the new workflow, dubbed by the team as EQUIPS for Efficient Quantification of Uncertainty in Image-based Physics Simulation, in a paper published today in the journal Nature Communications.

"This workflow leads to more reliable results by exploring the effect that ambiguous object boundaries in a scanned image have in simulations," said Michael Krygier, a Sandia postdoctoral appointee and lead author on the paper. "Instead of using one interpretation of that boundary, we're suggesting you need to perform simulations using different interpretations of the boundary to reach a more informed decision."

EQUIPS can use machine learning to quantify the uncertainty in how an image is drawn for 3D computer simulations. By giving a range of uncertainty, the workflow allows decision-makers to consider best- and worst-case outcomes, Scott said.

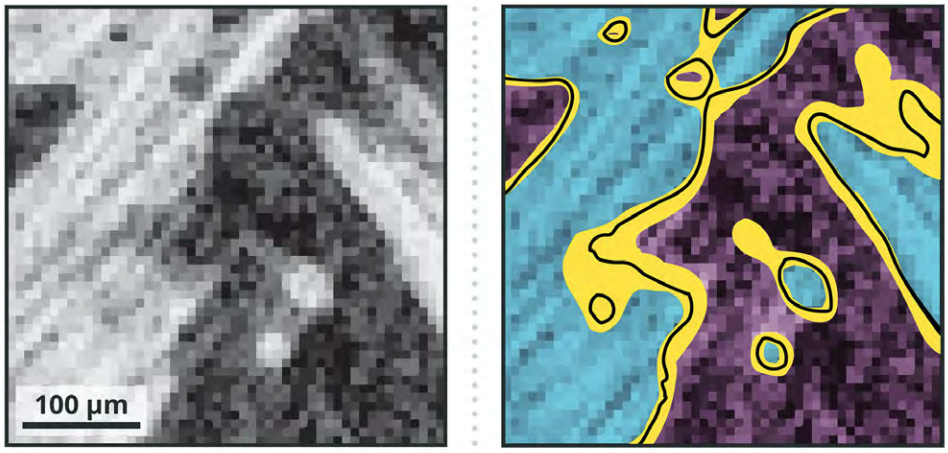


IMAGE SEGMENTED — An illustration used by Sandia researchers to show the uncertainty of drawing boundaries in scanned images used for high-consequence computer simulations. The gray-scale image on the left is a scan of material used as a thermal barrier. The illustrated image on the right shows the material segmented into two classes (blue and purple). The black lines show one possible interface boundary between the two classes of material. The yellow region depicts the segmentation uncertainty, meaning the black lines could be drawn anywhere within that area and still be valid. **Graphic by Sandia**

Workflow EQUIPS decision-makers with better information

Think of a doctor examining a CT scan to create a cancer treatment plan. That scan can be rendered into a 3D image, which can then be used in a computer simulation to create a radiation dose that will efficiently treat a tumor without unnecessarily damaging surrounding tissue. Normally, the simulation would produce one result because the 3D image was rendered once, said Carianne Martinez, a Sandia computer scientist.

But, drawing object boundaries in a scan can be difficult and there is more than one sensible way to do so, she said. "CT scans aren't perfect images. It can be hard to see boundaries in some of these images."

Humans and machines will draw different but reasonable interpretations of the tumor's size and shape from those blurry images, Michael said.

Using the EQUIPS workflow, which can use machine learning to automate the drawing process, the 3D image is rendered into many viable variations showing size and location of a potential tumor. Those different renderings will produce a range of different simulation outcomes, Carianne said. Instead of one answer, the doctor will have a range of prognoses to consider that can affect risk assessments and treatment decisions, be they chemotherapy or surgery.

"When you're working with real-world data there is not a single-point solution," Scott said. "If I want to be really confident in an answer, I need to understand that the value can be anywhere between two points, and I'm going to make decisions based on knowing it's somewhere in this range not just thinking it's at one point."

It's a question of segmentation

The first step of image-based simulation is the image segmentation, or put simply, deciding which pixel (voxel in a 3D image) to assign to each object and therefore drawing the boundary between two objects. From there, scientists can begin to build models for computational simulation. But pixels and voxels will blend with gradual gradient changes, so it is not always clear where to draw the boundary line — the gray areas in a black and white CT scan or X-ray, Michael said.

The inherent problem with segmenting a scanned image is that whether it's done by a person using the best software tools available or with the latest in machine learning capabilities there are many plausible ways to assign the pixels to the objects, he said.

Two people performing segmentation on the same image are likely to choose a different combination of filtering and techniques leading to different but still valid segmentations. There is no reason to favor one image segmentation over another. It's the same with advanced machine learning techniques. While it can be quicker, more consistent and more accurate than manual segmentation, different computer neural networks use varying inputs and work on different parameters. Therefore, they can produce different but still valid segmentations, Carianne said.

Sandia's EQUIPS workflow does not eliminate such segmentation uncertainty, but it improves the credibility of the final simulations by making the previously unrecognized uncertainty visible to the decision-maker, Michael said.

EQUIPS can employ two types of machine learning techniques — **Monte Carlo Dropout Networks** and **Bayesian Convolutional Neural Networks** — to perform image segmentation, with both approaches creating a set of image segmentation samples. These samples are combined to map the probability that a certain pixel or voxel is in the segmented material. To explore the impact of segmentation uncertainty, EQUIPS creates a probability map to obtain segmentations, which are then used to perform multiple simulations and calculate uncertainty distributions.

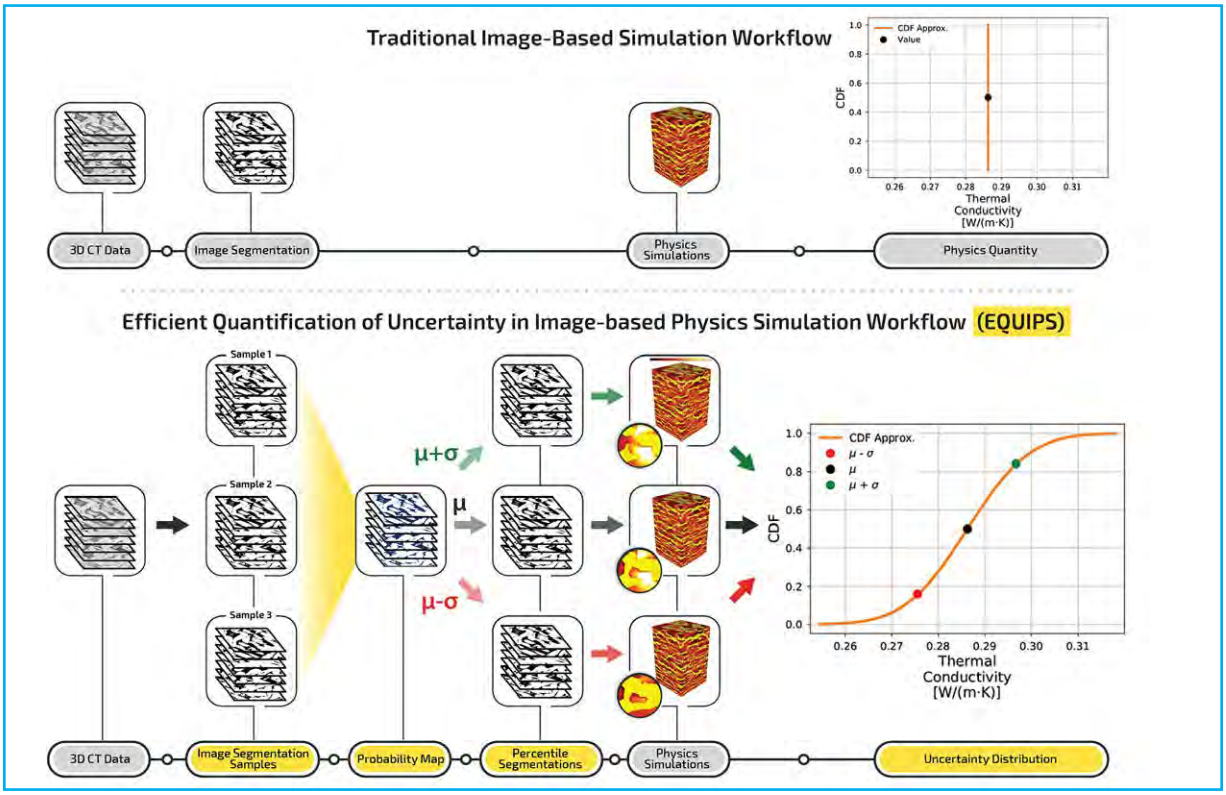
Funded by Sandia's **Laboratory Directed Research and Development** program, the research was conducted with partners at Indiana-based Purdue University, a member of the **Sandia Academic Alliance Program**. Researchers have made the source code and an EQUIPS workflow example available online.

To illustrate the diverse applications that can benefit from the EQUIPS workflow, the researchers demonstrated in the Nature Communications paper several uses for the new method: CT scans of graphite electrodes in lithium-ion batteries, most commonly found in electric vehicles, computers, medical equipment and aircraft; a scan of a woven composite being tested for thermal protection on atmospheric reentry vehicles, such as a rocket or a missile; and scans of both the human aorta and spine.

"What we really have done is say that you can take machine learning segmentation and not only just drop that in and get a single answer out, but you can objectively probe that machine learning segmentation to look at that ambiguity or uncertainty," Scott said. "Coming up with the uncertainty makes it more credible and gives more information to those needing to make decisions, whether in engineering, health care or other fields where high-consequence computer simulations are needed."

Tools available online

The EQUIPS team has made the source code and a working example of the new workflow available online for other researchers and programmers. Bayesian Convolutional Neural Network source code is available **here** and the Monte Carlo Dropout Network source code **here**. Both are on GitHub. A python Jupyter notebook demonstrating the entire EQUIPS workflow on a simple manufactured image is available **here**.



EQUIPPED SOLUTION — A traditional image-based simulation workflow converts 3D images into image segmentations using manual or convolutional neural network-based algorithms, then performs a simulation on the reconstructed segmented image. With EQUIPS, developed by Sandia researchers, segmentation uncertainty is calculated by creating many image segmentation samples and combining them into a probability map for simulations. **Graphic by Sandia**

Better together

Sandians donate to programs that train dogs to assist their owners and communities

SANDIA GIVES

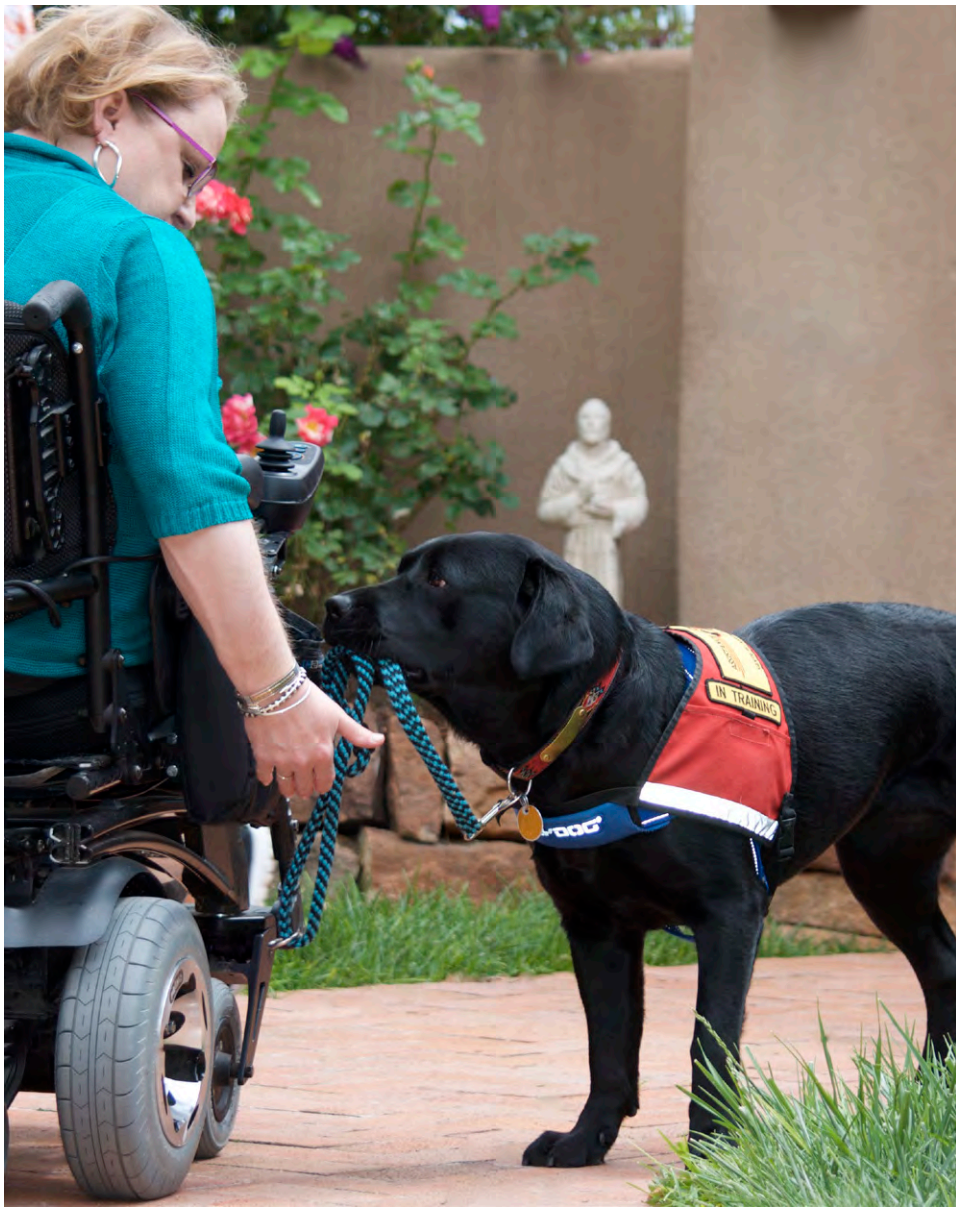
By **Katrina Wagner**

Sandians love animals. This is evident every year during ANGLE's Homeward Bound Drive when the workforce donates hundreds of pounds of pet food, toys and puppy pads to various agencies that help animals in need in the Albuquerque area. Dogs are cute and cuddly, they provide protection and they've even become co-workers while we telework, occasionally offering a hearty bark right in the middle of an important Teams meeting. But they can be more than a pet. Several agencies, supported by the United Way of Central New Mexico, use dogs to help children and adults process trauma through emotional support as well as assist people with disabilities to perform essential tasks that improve their quality of life and increase independence.

Sandian steps up as a puppy raiser and dog handler

Sandian scientist Mary Moya has been involved with Assistance Dogs of the West since 2010. This program trains and places facility service dogs, courthouse facility dogs and crisis response canines. These highly trained assistance dogs are placed with professionals in criminal justice, crisis response, first responder, victim advocacy, mental health, physical health and occupational therapy settings as well as children's advocacy centers.

Mary's official title is puppy raiser and dog handler. The dogs live with the trainers and learn everything they need to know for their jobs during the week, and the puppy raisers keep them on the weekend. Mary is given instructions on tasks to work on over the weekend that reinforce their training,



HELPING HAND — Service dogs can help with tasks like picking up objects off the floor to help make their owner's life a little easier. **Photo courtesy of Assistance Dogs of the West**

like picking up items off the floor and being calm. "We also take the dogs with us when we go into public, like to the credit union, grocery store, sporting events and church so the dogs get exposed to different venues and people," Mary said. The dogs can be trained to pick things up for a person that is in a wheelchair. They can also learn to pull doors and dresser drawers open to help their person get dressed.

"We have a number of dogs all over the country that we've helped train and they go off into the community and do great things," Mary said. She has helped raised dogs that work for the FBI, dogs that work in San Bernardino, California and Roswell,

UNCONDITIONAL LOVE — A veteran interacts with his emotional support dog Nanook, who is a graduate of Paws and Stripes, a nonprofit that benefits from Sandian donations to United Way.
Photo courtesy of Paws and Stripes

NAPTIME — Cassie and Nicole take a snooze after a long day of providing emotional support to children and adults in court. **Photo courtesy of NM Kids Matter**

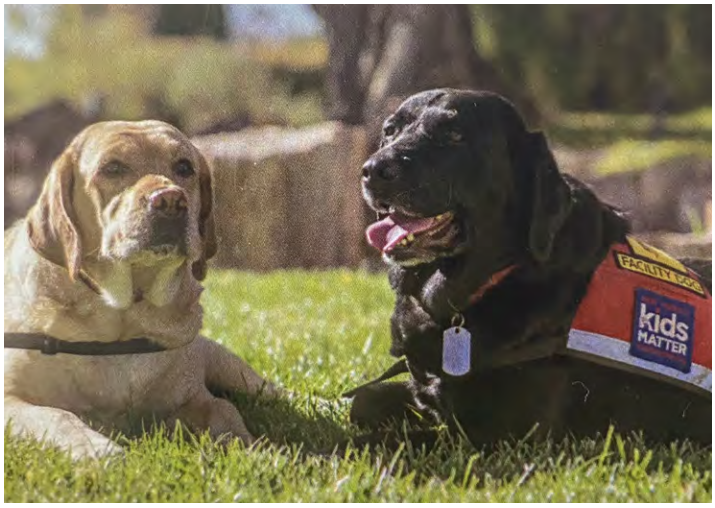
New Mexico and a few dogs that work in Albuquerque, including Cassie who works for New Mexico Kids Matter. "She was one of our puppies," Mary said. "We helped raise her and when she was ready, she graduated and went to work for the CASA Program."

The facility courthouse dogs have a positive impact and help bring people together during contentious and tense situations. Mary said the dogs "make such a difference in the courtroom because without the dog, the lawyers are against the judge, the judge is against the lawyers and the defendant is against the prosecution, but when the dog is there, everybody breathes a sigh of relief, and it makes a whole difference in the atmosphere of the courtroom."

Mary said it is a rewarding experience but also challenging when the training is complete, and the time comes to say goodbye. Assistance Dogs of the West hosts a graduation ceremony so the trainers and puppy raisers get to know the person the dog has been placed with. During the ceremony, the owners speak about how the dog has impacted their life. "I think when you see what a difference you've made for people, there's no way you could keep the dog after that," Mary said.

Comforting children under extreme stress

New Mexico Kids Matter is an agency in Albuquerque that advocates for children who have been abused or neglected. They train volunteers, Court Appointed Special Advocates, who work with a child's family, teachers, doctors, caregivers and anyone else involved in the their life to help make independent and informed recommendations to help the judge decide what's best for the child.



ON THE CLOCK — Nicole, left, and Cassie work as courtroom facility dogs at New Mexico Kids Matter, an organization that benefits from Sandian contributions to United Way. **Photo courtesy of New Mexico Kids Matter**

Sometimes, children in foster care must appear in children's court or criminal court, which can be scary and stressful. That is when service dogs like Cassie and Nicole are there to help. Michelle Gonzalez manages the COMPASS program for New Mexico Kids Matter and works as a handler for Cassie and Nicole, two vital members of the team who happen to be very special Labrador retrievers.

Cassie and Nicole's jobs are to accompany children in court so they have a friend to pet and help them feel safe and calm. A child can be in court due to termination of parental rights or hearings about their cases every six months.

Cassie is a 10-year-old black Lab and Nicole is a 6-year-old yellow Lab. Both dogs were raised and trained by Assistance Dogs of the West. "Cassie is meant for court and works with people who are having emotions or some type of trauma," Gonzalez said.

Cassie and Nicole have different personalities and approaches to the people they help. Cassie supports both children and adults who are pressing charges against someone who hurt them earlier in their lives. "If they can feel that you're having a hard time and can feel that you are struggling, they're going to go to that person,"

Gonzalez said. "Cassie does a little nudge on your hand when she feels that you need extra support, and Nicole does a really good job of laying across your feet or putting her head on your legs."

Gonzalez relayed the story of Cassie's support at a court hearing for the termination of parental rights. In this case, two children testified against their mother. "Cassie knew that the little girl really needed her, and she crawled under the cramped podium and laid across her feet. And then when the little boy came to testify, Cassie would not hold still and seemed agitated," Gonzalez said. "She picked up her leash and she walked over to the mother, who was crying, and laid across her feet. Cassie knew that the mom was sad, and that she needed to go and give her comfort." This story sticks out to Gonzalez because the mother deserved support and compassion, and Cassie provided that to her in a difficult moment.

Nicole's strength is children's court. She loves kids. She wiggles a lot and plays with them. Both dogs choose who needs support, even in the New Mexico Kids Matter office staff. Sandia's community involvement team looks forward to the Holiday Gift Drive every year in December because they get to interact with Cassie and Nicole. "In years past, when we were collecting gifts in-person, one of our highlights was interacting with Cassie and Nicole," community relations specialist Roberta Rivera said. "It's a chaotic time and the dogs really do ground you."

"I like to say they are there for everybody. They walk into the courtroom, the attorneys get on the floor with them, the workers interact with them and the judges love them," Gonzalez said. Cassie is nearing retirement and deserves some rest after all the emotion she has taken on during her work. She will spend her golden years with Veronica Montano-Pilch, executive director of New Mexico Kids Matter.

The money that comes from the United Way helps New Mexico Kids Matter programs grow their staff and recruit more volunteers to become CASAs. "Our volunteers are incredible and with more volunteers, we can advocate for more children in foster care, support them and give them a voice," Gonzalez said.

Saving lives two at a time

Lindsey Kay founded service animal training program Paws and Stripes in 2010 out of her passion for dogs and love for her country and service members. Kay was inspired to create the program by a veteran family member who suffers from post-traumatic stress disorder and traumatic brain injury. She researched multiple organizations, but the cost of service dogs was too high — more than $60,000. She created Paws and Stripes to provide service dogs to veterans at no cost. All dogs in the program are rescued from animal shelters.

The Paws and Stripes program is 15 weeks and includes weekly training sessions, group classes, workshop lectures and mental health counseling. After graduation, veterans adopt a fully trained service animal to help them recognize the onset of symptoms and triggers and alert them to increasing pain levels. They awaken handlers from nightmares, provide medication reminders and assist in public settings.

Jasmin Perry, development manager at Paws and Stripes, said other programs in the country do similar work, but "what's different about us is that instead of giving the dog to the veteran already trained, we go through the entire training process together, so it's actually a bonding experience." Veterans are able to choose their dog once Paws and Stripes have selected dogs from the shelter that meet their criteria. To qualify as a service dogs in their program, they must be able to help with mobility, alert the owner of medication reminders and serve as a buffer between the veteran and society.

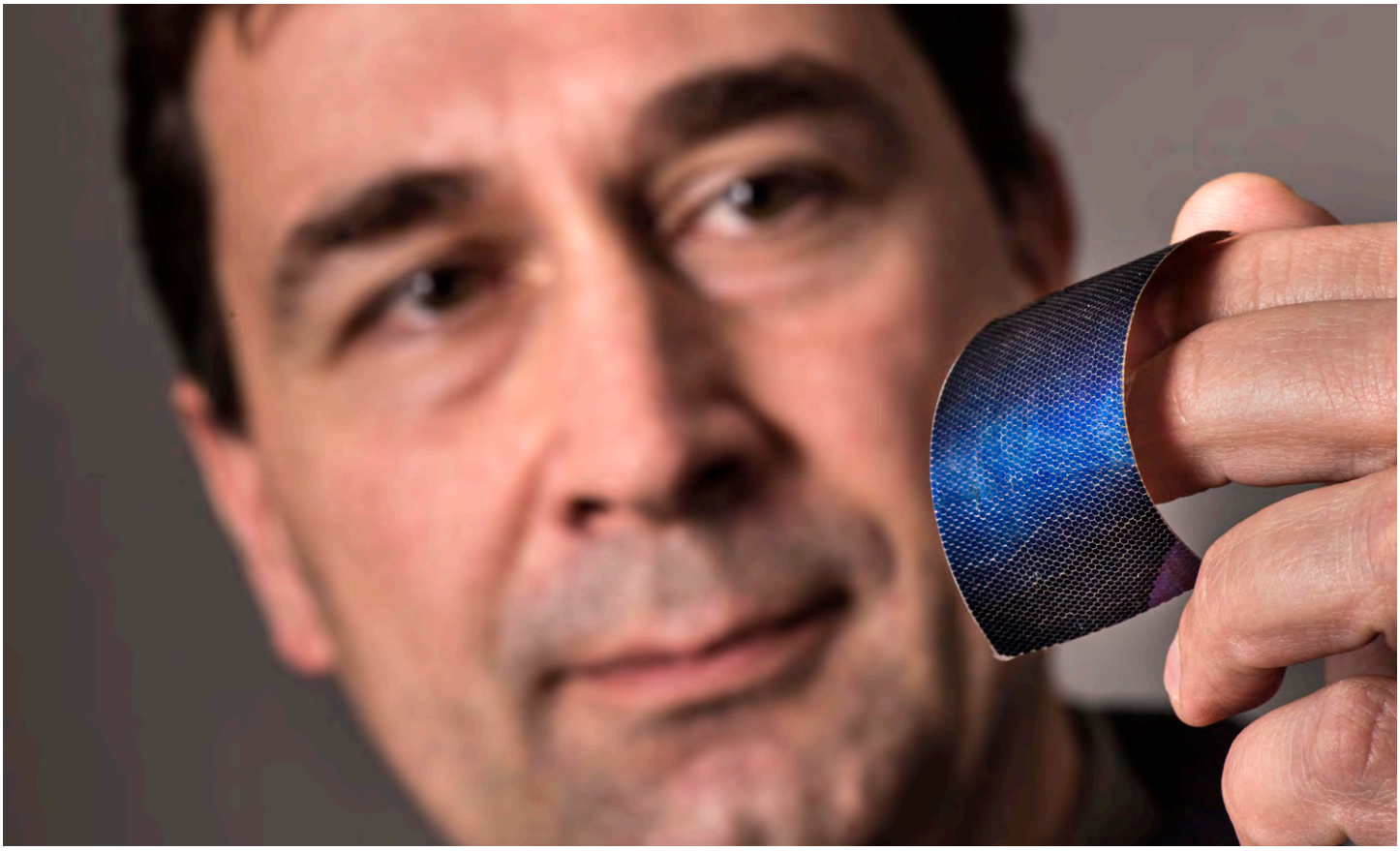
Veterans in their program experience post-traumatic stress disorder, traumatic brain injury and military sexual trauma —sometimes all three. Many have also been injured during combat and need help with mobility.

"We've seen an uptick with our veterans needing mental health services recently with everything going on in the world,"

— CONTINUED ON PAGE 14

THE BIG CHECK — In addition to support from United Way of Central New Mexico, the New Mexico Kids Matter CASA program is a longtime recipient of support from Sandia's corporate contributions grant program. **Photo courtesy of NM Kids Matter**

SHOPPING SPREE — A veteran and her dog Whiskey, a graduate of Paws and Stripes, take a trip to the bookstore. **Photo courtesy of Paws and Stripes**



SOLAR CELL SUCCESS — Former Sandia scientist Murat Okandan in 2017 shows a prototype of small, lightweight, flexible solar cell technology developed at the Labs. The technology was licensed by mPower Technology, a small New Mexico company founded by Okandan. The tiny photovoltaic cells are now orbiting Earth for the first time on a small satellite. **Photo by Randy Montoya**

Sandia-developed solar cell technology reaches space on board small satellite

By ***Manette Newbold Fisher***

Somewhere among the glitter of the night sky is a small satellite powered by innovative, next-generation solar cell technology developed at Sandia.

mPower Technology's DragonSCALES, consists of small, highly interconnected photovoltaic cells formerly known as solar glitter at Sandia. They are orbiting Earth for the first time on a **Lynk Global Inc.** satellite that supports direct connection to unmodified mobile phones. The satellite was launched this summer.

The technology is being **evaluated** as a potential solar power solution for the Lynk Global constellation fleet. Data collected will provide valuable feedback to validate the product's performance in space.

"It's been amazing to watch this technology emerge from the Labs and become a product sought after by satellite companies and federal agencies," said Mary Monson, senior manager of technology partnerships and business development.

The miniscule solar cell technology was developed at the Labs to reduce the cost of creating solar technology and increase its efficiency. mPower Technology, a small, New Mexico company, **licensed the technology** from Sandia and commercialized it as DragonSCALES, which are interconnected cells made of highly efficient silicon that can be meshed into any shape, size or form.

mPower executives say benefits of the technology include ease of installation and system integration. Development costs are lower than other solar technologies because microcells require little material to form well-controlled and highly efficient devices.

"This was the first launch of our innovative DragonSCALES product with Lynk Global, and we look forward to a successful on-orbit demonstration for their constellation," said Kevin Hell, mPower Technology president and CEO. "With the rapidly increasing interest in our technology for a wide range of new space power missions, we expect many more launches in the near future."

Aiming for the stars and a future lunar landing

Future projects may take the technology as far as the moon.

mPower and spacecraft systems company Honeybee Robotics, Inc., were

recently selected by NASA as one of five commercial teams to develop designs for deployable solar array systems to be used on the surface of the moon and one day as charging stations to recharge rovers, battery packs and other electrical equipment used by spacecraft and astronauts.

The teams' designs must be maneuverable, fold into a volume of less than half a cubic meter and, if selected by NASA, the developed station would be dropped off by lunar rovers to supply power. The team is focused on a Honeybee concept called Lunar Array Mast and Power System that incorporates DragonSCALES. The design will use some of the most cost-effective, lightest, large area extendable solar panels ever made, according to mPower.

Murat Okandan, mPower chief technology officer said, "Some of the most exciting and challenging systems coming up have characteristics that are very similar to LAMPS, where cost-effective, large-scale deployment of power systems is going to be critical in being able to meet the mission needs and support the envisioned expansion of activity in orbit and for landed systems."

Labs enabled technology to reach private sector

Sandia announced the development of solar glitter in 2009 after the solar cells were fabricated by researchers using technologies to fabricate microelectromechanical systems in Sandia's Microsystems Engineering, Science and Applications facility, giving it the nickname MEPV for microsystem-enabled photovoltaics.

The original Sandia team continued to advance the technology through various projects sponsored by Sandia's Laboratory Directed Research and Development program, the military and NASA. Today, some of the fabrication approaches pioneered by MEPV, such as oxide bonding, continue to be used for research involving semiconductors.

"DragonSCALES began as a Laboratory Directed Research and Development project in our lab over 12 years ago," said Keith Ortiz, manager of the microelectromechanical systems technologies department. "Now, the technology is in space and I'm looking forward to the next 12 years of development beyond Sandia."

Okandan, one of the researchers who developed the technology, left Sandia through the Entrepreneurial Separation to Technology Transfer program and founded mPower. The program enables Sandia to transfer technology to the private sector by permitting employees to leave the Labs to start up or expand tech companies. Entrepreneurs are guaranteed reinstatement for up to two years if they choose to return to Sandia.

In 2017, solar glitter was licensed to mPower. While the technology could be applied to a variety of devices of any shape, the company is currently focused on the space market and rapidly deployable, portable solar power systems.

"We couldn't be prouder of the researchers who developed solar glitter and established a technology bound for space," Mary said. "This is exactly the type of impact we are dedicated to at Sandia through our technology transfer programs. When technology leads to new companies, jobs and commercialization, it's a win-win all around."

Mini solar cells garner years of recognition

Solar glitter and DragonSCALES have received recognition through awards and news stories. In 2012 when the technology was new, Sandia received a prestigious R&D100 Award.

Following successful efforts to transfer the technology to mPower, Sandia and the company have been recognized multiple times by the Federal Laboratory Consortium. Earlier this year, the partnership received a national Excellence in Technology Transfer Award from the consortium for transforming space power and other commercial markets.

Sandia gives

CONTINUED FROM PAGE 12

Perry said. "They sometimes need help just getting out of bed. Some veterans need medication reminders because they have PTSD, depression and anxiety and they forget about their own health," Perry said. "The dog can remind them to take the medication they need."

Dogs in the Paws and Stripes program work for up to 10 years. When dogs in the program die or retire, veterans can rejoin the program to adopt a new dog. Retired dogs stay with their owner.

"Here in New Mexico, we have a really bad problem with illegal breeding. Many dogs end up in shelters and only have a certain amount of time to be adopted before they're euthanized. We're also saving these shelter dogs who in turn are helping save veterans' lives. We've seen that, since having received these dogs and completing our program, 50% of suicidal tendencies have gone down in our veterans.

"In New Mexico, we have the largest veteran community per capita in the nation. And we're top in the nation for veteran suicide, so though it may seem that giving money out of your paycheck may not make a difference, it could quite literally be saving a life," Perry said.

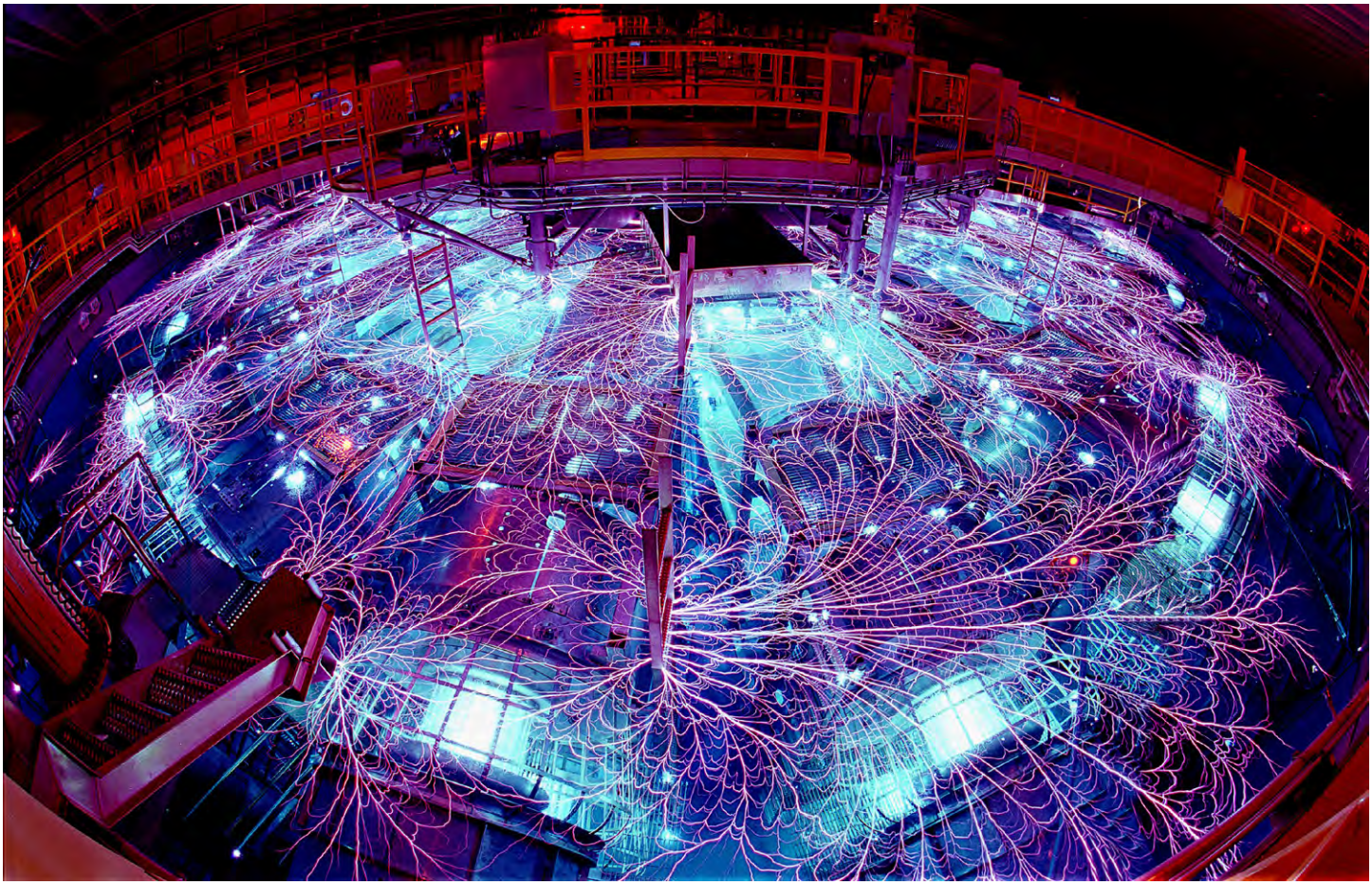
Paws and Stripes uses funds from donations, including those from United Way, to pay for veterinary visits, dog food and supplies, trainers and the certification of dogs, as well as expanding mental health services and substance abuse programs for veterans.

Each contribution matters

These agencies share more than dogs helping humans with emotional and physical needs. They have all received funding from the United Way of Central New Mexico to support their important work. The Sandia Gives campaign starts October 4. Sandia makes it easy to support our communities by conveniently giving to through the United Way of Central New Mexico using payroll deductions. Sandians can allocate their donations to United Way or choose to give to other charities that support our communities.

Enrolling in the Sandia Gives campaign is a simple way to give for the first time. There are a variety of initiatives that these donations support: helping a person with a disability get a trained assistance dog, helping a single mother learn how to read so she has a better chance of keeping a job, increasing a community's access to nourishing food and many others. Together, Sandians can support nonprofit organizations that provide vital services to the people in the communities where we work and live.

Look who's turning 25



HAPPY BIRTHDAY Z — An **open-shutter photo** showing electrical energy coursing through the transmission line sections of Sandia's Z machine.
Photo by Randy Montoya

Z machine celebrates its colorful history at Sandia

By ***Neal Singer***

In early September, Sandia celebrated 25 years of research conducted at its **Z Pulsed Power Facility** — the gymnasium-sized accelerator commonly referred to as Z or the Z machine.

Due to COVID-19 restrictions, only a limited number of former leaders of the pulsed power program at Sandia gathered to share their experiences with Z.

Z began with a simple idea — running large pulsed electrical currents through targets at the center of the machine — that has resulted in startling science even after 25 years.

"We have seen continuous innovation over the history of Z, and we still have about another decade of exciting research lined up," said Dan Sinars, Sandia's pulsed power sciences director.

The adventure began 25 years ago, said former director Don Cook, when Sandia researchers modified a machine built in 1985 called the Particle Beam Fusion Accelerator. That machine — Z's ancestor, in a sense — employed a very high voltage and smaller current to make lithium-ion beams for fusion research. The experimental output was powerful, about 15 terawatts, but had hardly increased in a decade of testing.

So, trying a different approach, the machine was restructured to deliver very high currents and lower voltages. Currents 100 times larger than those in a bolt of lightning efficiently vaporized arrays of tiny wires into clouds of ions. Then the powerful magnetic field accompanying the electric current slammed the ions into each other, a process that emitted copious X-rays that could be used for fusion research and other applications.

The new method, attempted first on a smaller Sandia machine called Saturn, immediately increased the output to 40 terawatts, and led to many experiments to improve the number, size, material choice and placement of succeeding arrays.

"Once it was confirmed in experiments in 1996 on a machine temporarily called PBFA II-Z that enormous pressures (millions of atmospheres) and very high temperatures (millions of degrees Celsius) could be produced by z-pinches, we renamed the machine simply Z in 1996.

So, 2021 is the 25th anniversary of Z," said Cook.

Researchers around the world marveled at the huge output increase, which quickly reached more than 200 terawatts, said former Sandia vice president and early Z leader Gerry Yonas. The Z-pinch work — called Z because the operation occurs along the Z axis in three-dimensional graphs — generated data for the U.S. nuclear stockpile.

Z hasn't yet created fusion ignition, though the effort to increase its fusion output continues. "Achieving nuclear fusion in the lab isn't for people who give up easily," said Sandia fellow Keith Matzen, Z director from 2005-2013 and again from 2015-2019, who cautions it will take a bigger version of Z to demonstrate that the fusion energy emitted by the process is equal to the electrical energy stored in the facility, a milestone known as break-even.

Meanwhile Z researchers have delved into other areas, including determining where life elsewhere in our galaxy may have evolved; investigating the existence of diamonds on Neptune and liquid helium on Saturn; determining the age of white dwarf stars and the behavior of black holes in space; and the amount of water in the universe and its age, said Dan.

To achieve these unusual capabilities, he said, researchers over decades reimagined work on Z so that the huge magnetic fields naturally accompanying Z's powerful electrical discharges became instruments in their own right, testing materials by creating pressures exceeding those at Earth's core or aiding in the effort to create breakeven nuclear fusion by pre-compressing the target fuel environs.

"In the meantime," said Cook, "Z has become the most energetic source of X-rays for fusion research and for stockpile stewardship on the planet. Its capabilities as a pre-eminent research facility for high energy density sciences are known and appreciated worldwide."

Two Sandians join 2021 class of 40 Under Forty honorees

By ***Katherine Beherec***

Engineer Rachel Gupton and manager Gabriel Mondragon have been named to the Albuquerque Business First's 2021 class of 40 Under Forty honorees.

Now in its 20th year, Albuquerque Business First annually honors up-and-coming professionals under the age of 40 in New Mexico. Nominees are judged on their career achievements and philanthropic and community outreach, according to the program's website. They will be recognized at a ceremony in October.

Rachel Gupton: Creating a solution to boost local restaurants and support families impacted by COVID-19

In March 2020, when the effects of COVID-19 temporarily halted dining in restaurants and impacted many families, Sandian engineer Rachel and her husband Billy were focused on a creative way to support the Albuquerque community. "At the time, we felt helpless, but we were in very blessed situation with the time and resources to give back," Rachel said.

Rachel and her husband partnered with United Way to create the Feeding Families Fund. The fund was distributed among nonprofit organizations that care for local families. The nonprofits used the donations to buy meals from local restaurants to feed families in their care. Rachel and her husband raised $250,000 in a few months to benefit organizations like All Faiths, Casa Esperanza, CLNkids, Endorphin Power Company, Haven House, Ronald McDonald House and St. Terese of Calcutta Soup Kitchen.

"At the time, many people and companies felt like we did — they wanted to help but didn't know how — so they were very willing to donate. We raised a lot of money in a short amount of time. It was before many companies had their own outreach solutions, so there was a lot of enthusiasm to help out."

Since starting her career as a Sandia intern in 2011, Rachel was an assembly integration and test engineer for a satellite payload before becoming the technical lead of that program. Rachel holds master's and bachelor's degrees in electrical and computer engineering from the University of Arizona.

In addition to her work, Rachel loves to spend time with her husband and two dogs, travel internationally and serve the Albuquerque community. She volunteers for United Way in a

INNOVATION TO IMPACT — Rachel Gupton is an electrical engineer and project lead of a satellite payload at Sandia. Last year, she fundraised and donated $250,000 to local nonprofits that bought meals from restaurants to serve families impacted by the pandemic.

Photo courtesy of Rachel Gupton

LEADING WITH PURPOSE — Gabriel Mondragon is the manager of a project management team for the W80-4 systems program. He volunteers for several local organizations and is active in Big Brothers Big Sisters of Central New Mexico.

Photo courtesy of Gabriel Mondragon

variety of roles, serves on several nonprofit boards and is active in prison ministry through her church. Rachel and her husband recently welcomed their first child, a baby girl.

Gabriel Mondragon: Giving back to the community that shaped his success

Gabriel is a manager of project management for the W80-4 program, currently the largest program at Sandia. He started as an intern in 2011 and has spent his career in different roles supporting various parts of the nuclear deterrence mission. He joined the W80-4 in early 2018 and became a manager later that year.

"The people I've worked with at Sandia have given me the blueprint for how to be successful," he said. "I've put in the work, but the accomplishments are a result of the culture we have of helping and empowering each other."

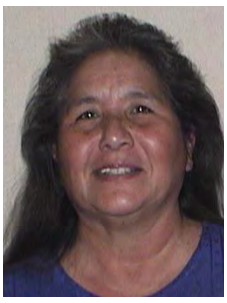
Born and raised in Albuquerque, Gabriel generously gives his time to local nonprofit organizations, like the Roadrunner Food Bank, Habitat for Humanity and Special Olympics of New Mexico. "In the last 15 years, I've been a big fan of investing my time back into Albuquerque. I want to give back to the community that shaped who I have become," he said.

Recently, he has volunteered as a big brother with the Big Brothers Big Sisters of Central New Mexico Mentor2.0 Program. Gabriel has mentored a high school student from freshman year to now, as his mentee prepares for life after high school. He is grateful for the opportunity to positively impact someone on an individual level and provide support to a student at such an important juncture in life.

When he is not working or volunteering, Gabriel enjoys spending his time with his wife, playing with his two young children and helping with everyday household duties. "It's not a resume booster, but I wouldn't have it any other way. Getting more time at home over the past year has been such a blessing to me and our family," he said.

Gabriel holds an MBA in information assurance and a bachelor's degree in accounting, both from the University of New Mexico.

Mileposts



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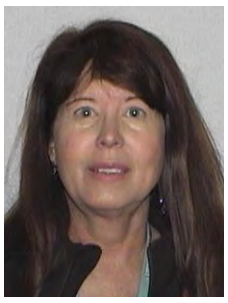
Jon Rogers 35

Paul Clem 25

Marcos Sanchez 25

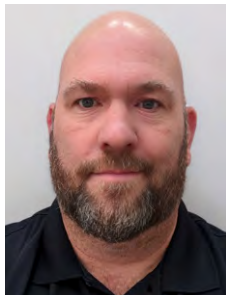


Diane Armijo 20

Brad Boswell 20

Dan Kammler 20

Vivian Kammler 20



Patrick Lynch 20

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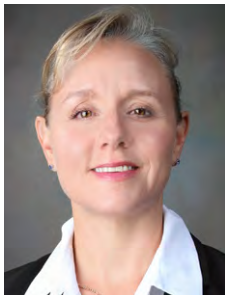
Luis Amezcua 15

Lenora Baca 15

Bill Brizzee 15

Jared Collins 15

Jacques Hung 15



Carrie O'Hara 15

John Zavadil 15

From orchard to food bank

Sandians supply Roadrunner Food Bank with a truck of fresh apples through Seed2Need initiative

Photos by ***Randy Montoya***

FALL HARVEST — Troy Baker, left, and Alanna Jornigan helped harvest 13 pallets of apples that were donated to Roadrunner Food Bank. The food bank sources, acquires and distributes enough food to feed nearly 70,000 people per week year-round.

FAMILY FUN — Gail Granot, right, and her daughter Liah worked together to pick apples on a beautiful fall day in Corrales. Sandians supplied Roadrunner Food Bank with a truck full of fresh apples.

NO BAD APPLES — Zach Thomas volunteered on Sept. 11 to glean apples with Seed2Need, a nonprofit that grows and harvests produce for people experiencing food insecurity. Ladders and picking poles were used to glean the apples that were too high to grab with hands.

TALL TOOLS — Diane Ottman, right, and her daughter Maya take a break from gleaning apples. The apples will be distributed to feed people across New Mexico.