SANDIA —— Vol. 75, No.4, Feb. 23, 2023 Truman Fellows 7 Expanding G3P3 going up hvbrid work at the Labs Mileposts Page 11 Biden picks ALD 13 PUBLISHED SINCE 1949

Hackers could try to take over a military aircraft; can a cyber shuffle stop them?

Sandia, Purdue team up to test cyberdefense against an algorithm trained to break it

By Troy Rummler

cybersecurity technique that shuffles network addresses like a blackjack dealer shuffles playing cards could effectively befuddle hackers gambling for control of a military jet, commercial airliner or spacecraft, according to new research. However, the research also shows these defenses must be designed to counter increasingly sophisticated algorithms used to break them.

Many aircraft, spacecraft and weapons systems have an onboard computer network known as military standard 1553, commonly referred to as MIL-STD-1553, or even just 1553. The network is a - CONTINUED ON PAGE 4



AIR DEFENSE — Aboard the 58th Special Operations Wing's C-130 transport aircraft at Kirtland Air Force Base, Christy Sturgill, Jacob Hazelbaker, Eric Vugrin and Nicholas Troutman, from left to right, were part of the Sandia team working on a moving target defense that makes a computer network commonly used on space and aircraft less vulnerable to cyberattack. **Photo by Craig Fritz**

Studying ship tracks



CLOUDY WITH A CHANCE OF ... — Sandia statistician Lyndsay Shand stands in front of a satellite image of ship tracks. Ship tracks are an unintentional example of one method to reflect some sunlight back to space before its heat is absorbed. Photo by Craig Fritz

Developing computer tools to study, inform climate intervention By Mollie Rappe

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cientists from Sandia are studying ship tracks - clouds that reflect sunlight and are formed by moving ships, similar to contrails from planes - to help inform decision-makers of the benefits and risks of one technology being considered to slow climate change.

To understand how these ship tracks move and dissipate, the scientists created a mathematical model of ship tracks and how long they last, which they shared in a paper recently published in

- CONTINUED ON PAGE 5



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LABNEWS Notes

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Can clay capture carbon dioxide? Scientists study clay for snatching carbon dioxide from air

By Mollie Rappe

he atmospheric level of carbon dioxide — a gas that is great at trapping heat, contributing to climate change — is almost double what it was prior to the Industrial Revolution, yet it only constitutes 0.0415% of the air we breathe.

This presents a challenge to researchers attempting to design artificial trees or other methods of capturing carbon dioxide directly from the air. That challenge is one a Sandia-led team of scientists is attempting to solve.

Led by chemical engineer Tuan Ho, the team has been using powerful computer models combined with laboratory experiments to study how a kind of clay can soak up carbon dioxide and store it.

The scientists shared their **initial findings** in a paper published Feb. 9 in The Journal of Physical Chemistry Letters.

"These fundamental findings have potential for direct-air capture; that is what we're working toward," said Tuan, lead

author on the paper. "Clay is really inexpensive and abundant in nature. That should allow us to reduce the cost of direct-air carbon capture significantly, if this high-risk, high-reward project ultimately leads to a technology."

Why capture carbon?

Carbon capture and sequestration is the process of capturing excess carbon dioxide from the Earth's atmosphere and storing **it deep underground** with the aim of reducing the impacts of climate change, such as more frequent severe storms, rising sea levels and increased droughts and wildfires. This carbon dioxide could be captured from fossil-fuel-burning power plants, or other industrial facilities such as cement kilns, or directly from the air, which is more technologically challenging. Carbon capture and sequestration is widely considered one of the least controversial technologies being considered for climate intervention.

"We would like low-cost energy, without ruining the environment," said Susan Rempe, a Sandia bioengineer and senior scientist on the project. "We can live in a way that doesn't produce as much carbon dioxide, but we can't control what our neighbors do. Direct-air carbon capture is important for reducing the amount of carbon dioxide in the air and mitigating the carbon dioxide our neighbors release."

Tuan imagines that clay-based devices could be used like sponges to soak up carbon dioxide, and then the carbon dioxide could be "squeezed" out of the sponge and pumped deep underground. Or the clay could be used more like a filter to capture carbon dioxide from the air for storage.

In addition to being cheap and widely available, clay is also stable and has a high surface area — it is composed of many microscopic particles that in turn have cracks and crevasses about a hundred thousand times smaller than the diameter of a human hair. These tiny cavities are called nanopores, and chemical properties can change within these nanoscale pores, Susan said.

This is not the first time Susan has studied nanostructured materials for capturing carbon dioxide. In fact, she is part of a team that studied a **biological catalyst for converting carbon dioxide** into water-stable bicarbonate, tailored a **thin, nanostructured membrane** to protect the biological catalyst and **received a patent** for their bio-inspired, carboncatching membrane. Of course, this membrane is not made of inexpensive clay and was initially designed to work at fossil-fuel-burning power plants or other industrial facilities, Susan said.

"These are two complementary possible solutions to the same problem," she said.

How to simulate the nanoscale?

Molecular dynamics is a kind of computer simulation that looks at the movements and interactions of atoms and molecules at the nanoscale. By looking at these interactions, scientists can calculate how stable a molecule is in a particular environment — such as in clay nanopores filled with water.

"Molecular simulation is really a powerful tool to study interactions at the molecular scale," Tuan said. "It allows us



CAUGHT IN CLAY — Sandia bioengineer Susan Rempe, left, and chemical engineer Tuan Ho peer through an artistic representation of the chemical structure of a kind of clay. Their team is studying how clay could be used to capture carbon dioxide. Photo by Craig Fritz

to fully understand what is going on among the carbon dioxide, water and clay, and the goal is to use this information to engineer a clay material for carbon-capture applications."

In this case, the molecular dynamics simulations conducted by Tuan showed that carbon dioxide can be much more stable in the wet clay nanopores than in plain water, he said. This is because the atoms in water do not share their electrons evenly, making one end slightly positively charged and the other end slightly negatively charged. On the other hand, the atoms in carbon dioxide do share their electrons evenly, and like oil mixed with water, the carbon dioxide is more stable near similar molecules, such as the silicon-oxygen regions of the clay, Susan said.

Collaborators from Purdue University led by professor Cliff Johnston recently used experiments to confirm that water confined in clay nanopores absorbs more carbon dioxide than plain water does, Tuan said.

Sandia postdoctoral researcher Nabankur Dasgupta also found that inside the oil-like regions of the nanopores, it takes less energy to convert carbon dioxide into carbonic acid and makes the reaction more favorable compared to the same conversion in plain water, Tuan said. By making this conversion favorable and require less energy, ultimately the oil-like regions of clay nanopores make it possible to capture more carbon dioxide and store it more easily, he added.

"So far, this tells us clay is a good material for capturing carbon dioxide and converting it into another molecule," Susan said. "And we understand why this is, so that the synthesis people and the engineers can modify the material to enhance the oil-like surface chemistry. The simulations can also guide the experiments to test new hypotheses about how to promote the conversion of carbon dioxide into other valuable molecules."

The next steps for the project will be to use molecular dynamics simulations and experiments to figure out how to get carbon dioxide back out of the nanopore, Tuan said. By the end of the three-year project, they plan to conceptualize a clay-based direct-air carbon capture device.

The project is funded by Sandia's Laboratory Directed Research and Development program. The research was performed, in part, at the Center for Integrated Nanotechnologies, an Office of Science user facility operated for the DOE by Sandia and Los Alamos national laboratories.

Cyber shuffle

CONTINUED FROM PAGE 1

tried-and-true protocol for letting systems like radar, flight controls and the heads-up display talk to each other.

Securing these networks against a cyberattack is a national security imperative, said Chris Jenkins, a Sandia cybersecurity scientist. If a hacker were to take over 1553 midflight, he said, the pilot could lose control of critical aircraft systems, and the impact could be devastating.

Chris is not alone in his concerns. Many researchers across the country are designing defenses for systems that utilize the MIL-STD-1553 protocol for command and control. Recently, Chris and his team at Sandia partnered with researchers at Purdue University in West Lafayette, Indiana, to test an idea that could secure these critical networks.

Their results, recently published in the scientific journal IEEE Transactions on Dependable and Secure Computing, show that done the right way, a technique already known in cybersecurity circles, called moving target defense, can effectively protect MIL-STD-1553 networks against a machine-learning algorithm. Sandia's Laboratory Directed Research and Development program funded the research.

"When we talk about protecting our computer systems, frequently there are two main pieces we rely on," said Eric Vugrin, a Sandia cybersecurity senior scientist who also worked on the project. "The first approach is just keeping the bad guy out and never permitting access to the system. The physical analogue is to build a big wall and don't let him in in the first place. And the backup plan is, if the wall doesn't work, we rely on detection. Both of those approaches are imperfect. And so, what moving target defense offers as a complementary strategy is, even if those two approaches fail, moving target confuses the attacker and makes it more difficult to do damage."

Moving target defense must keep cyberattackers guessing

Like a game of three-card monte, in which a con artist uses sleight of hand to

shuffle cards side-to-side, moving target defense requires randomness. Without it, the defense unravels. Researchers wanted to know whether a moving target defense would work to constantly change network addresses, unique numbers assigned to each device on a network. They weren't sure it would work because, compared to other types of networks, MIL-STD-1553's address space is small and therefore difficult to randomize.

For example, the strategy has proven useful with internet protocols, which have millions or billions of network addresses at their disposal, but 1553 only has 31. In other words, Sandia had to come up with a way to surreptitiously shuffle 31 numbers in a way that couldn't easily be decoded.

"Someone looked me in the face and said it's not possible because it was just 31 addresses," Chris said. "And because the number is so small compared to millions or billions or trillions, people just felt like it wasn't enough randomness."

The challenge with randomizing a small set of numbers is that "Nothing in computer software is truly random. It's always pseudorandom," said Sandia computer scientist Indu Manickam. Everything must be programmed, she said, so there's always a hidden pattern that can be discovered.

With enough time and data, she said, "A human with an Excel sheet should be able to get it."

Indu is an expert in machine learning, or computer algorithms that identify and predict patterns. These algorithms, though beneficial to cybersecurity and many **other fields of research and engineering**, pose a threat to moving target defenses because they can potentially spot the pattern to a randomization routine much faster than a human.

"We're using machine-learning techniques to better defend our systems," Eric said. "We also know the bad guys are using machine learning to attack the systems. And so, one of the things that Chris identified early on was that we do not want to set up a moving target defense where somebody might use a machine-learning attack to break it and render the defense worthless."

Sophisticated algorithms don't necessarily spell the end for this type of



SKETCHING A DEFENSE — Sandia cybersecurity expert Chris Jenkins sits in front of a whiteboard with the original sketch of the moving target defense idea for which he is the team lead. When the COVID-19 pandemic hit, Chris began working from home, and his office whiteboard remained virtually undisturbed for more than two years. Photo by Craig Fritz

cyberdefense. Cybersecurity designers can simply write a program that changes the randomization pattern before a machine can catch on.

But the Sandia team needed to know how fast machine learning could break their defense. So, they partnered with Bharat Bhargava, a professor of computer science at Purdue University, to test it. Bhargava and his team had been involved previously in researching aspects of moving target defenses.

For the last seven years, Bhargava said, the research fields of cybersecurity and machine learning have been colliding. And that's been reshaping concepts in cybersecurity.

"What we want to do is learn how to defend against an attacker who is also learning," Bhargava said.

Test results inform future improvements to cybersecurity

Chris and the Sandia team set up two devices to communicate back and forth on a 1553 network. Occasionally, one device would slip in a coded message that would change both devices' network addresses. Chris sent Bhargava's research team logs of these communications using different randomization routines. Using this data, the Purdue team trained a type of machinelearning algorithm called long short-term memory to predict the next set of addresses.

The first randomization routine was not very effective.

"We were not only able to just detect the next set of addresses that is going to appear, but the next three addresses," said Ganapathy Mani, a former member of the Purdue team who contributed to the research.

Ship tracks

CONTINUED FROM PAGE 1

the scientific journal Environmental Data Science.

"Ship exhaust is an example of aerosol injections into the lower atmosphere, impacting the local environment, and is a daily occurrence," said Lyndsay Shand, a Sandia statistician and the project lead. "We've been developing analytical tools to understand exhaust impacts on clouds from observational data collected by satellites. For example, we can locate a newly formed ship track and follow its evolution to better understand how it affects the local marine environment over time. We have found ship tracks to persist for more than 24 hours, longer than previously documented."

Forming ocean clouds to slow climate change

Ship tracks are an unintentional example of marine cloud brightening, a group of technologies being considered for slowing climate change and its impacts. Marine cloud brightening works by creating ocean clouds that reflect some sunlight back to space before its heat is absorbed in the atmosphere or by Earth's surface.

Another, similar group of climate intervention technologies is called stratospheric aerosol or gas injection. This involves adding tiny particles, called aerosols, or gases high into the upper The algorithm had scored 0.9 out of a perfect 1.0 on what's called a Matthews correlation coefficient, which rates how well a machine-learning algorithm performs.

But the second set of logs, which used a more dynamic routine, resulted in a radically different story. The algorithm only scored 0.2.

"0.2 is pretty close to random, so it didn't really learn anything," Indu said.

The test showed that moving target defense can fundamentally work, but more importantly it gave both teams insights into how cybersecurity engineers should design these defenses to withstand a

atmosphere, mimicking the effects of a large volcanic eruption, to reflect some sunlight and reduce climate change.

These two groups of technologies have the potential to counteract the effect of greenhouse gases, which work by trapping heat, but could have negative side effects.

Climate scientists across the nation and around the globe want to understand how marine cloud brightening and other climate intervention technologies affect both the local and global climate to better inform decision-makers, said Erika Roesler, a Sandia atmospheric scientist machine-learning-based assault, a concept the researchers call threat-informed codesign.

Defenders, for example, could "Add fake data into it so that the attackers cannot learn from it," Mani said.

The findings could help improve the security of other small, cyber-physical networks beyond MIL-STD-1553, such as those used in critical infrastructure.

Chris said, "Being able to do this work for me, personally, was somewhat satisfying because it showed that given the right type of technology and innovation, you can take a constrained problem and still apply moving target defense to it."

heavily involved in the project.

The Sandia researchers hope to understand the potential effects of marine cloud brightening on global precipitation, regional temperature differences and more well before any large-scale experiments are conducted on the planet we all call home, Lyndsay and Erika said.

Tracking clouds and reducing uncertainty

The focus of Lyndsay's project was to develop analytical tools to understand the formation and behaviors of ship tracks. The goal was to be able to



THE CLOUDMAKERS — Watch an animation of marine cloud brightening, a group of technologies under consideration for slowing climate change and its impacts. Scientists from Sandia are studying ship tracks to help inform decision-makers of the benefits and risks of these technologies.

determine when ship tracks form and how long they last using publicly available satellite images and ship location information.

Ship tracks, formed by water vapor in the air condensing around ships' emissions, reflect sunlight, Erika said. Ship tracks have been spotted across the globe, far more frequently than previously thought, providing inexpensive and unintentional experiments for the research team.

"Understanding how aerosols from ships, power plants and other human activities impact the climate is one of the biggest sources of uncertainty in climate models," Lyndsay said. "If we can better understand those effects, we can reduce the uncertainty in climate models and lead to improved decision-making for policymakers." 2019-06-17 05:02:38

CLOUD TRACKING — Watch satellite images of ship tracks form, move and change off the coast of California. Sandia scientists have developed computer algorithms to follow ship tracks and mimic their behavior inside the computer. Video courtesy of Sandia

Through this project, the team can now identify and follow a newly formed ship track as it moves with the cloud layer while the ship that produced it continues to move in another direction and form new track segments, Lyndsay said. This is important to better understand the long-term impacts of ship exhaust on the surrounding clouds. This knowledge can help the scientific community to refine and improve climate models, she added.

Satellite images and innovative algorithms

For this study, the researchers used data from National Oceanic and Atmospheric Administration and NASA's Geostationary Operational Environmental Satellites. Each satellite takes a snapshot of a fixed region of the Earth every five to 15 minutes. Each pixel in a single snapshot represents a region of 500 meters squared to two square kilometers, or about one-fifth of a square mile to three-quarters of a square mile, Lyndsay said.

The team focused on satellite images from three three-day periods in 2019 of the North Pacific Ocean from Baja California up to Alaska. They have also observed ship tracks in the South Pacific Ocean off the coast of Chile and in the East China Sea from Shanghai to Japan.

"In the paper, we introduced two new algorithms to follow ship track formations," Lyndsay said. "One algorithm uses observed images, and one algorithm uses physical phenomena, such as known wind speed and direction. Both algorithms allow us to determine how long the ship tracks persist, but the image-based one performs much better for tracks persisting more than eight hours. This enables us to study how the ship exhaust dissipates into the cloud bank and how long it takes to disappear from sight."

With its new image-based algorithm, the research team was

able to follow the behavior of ship tracks for more than 12 hours and sometimes up to 29 hours, Lyndsay said. This is significantly longer than most atmospheric modeling simulations, which study ship tracks for six to eight hours. It's also longer than most airplane contrails last, created high above where ship tracks form, which can remain visible for up to four to six hours, in the right conditions.

To make such a big performance improvement, the team needed to overcome two key challenges. First, they adapted a motion-tracking algorithm to follow low-forming ship tracks, less than 3,000 feet above the ocean surface. Low clouds are more challenging to track than faster and larger clouds at an altitude above 30,000 feet.

Second, the new algorithm also can follow the tracks through the challenging light changes at sunset and sunrise. "One of the really neat things about this project is that we can follow the track through a full daily cycle," Lyndsay said.

In addition to following ship tracks, the algorithms should be helpful in studying any future intentional marine cloud brightening experiments. The team is working on making its algorithms available to other researchers.

This project has led to collaborations and conversations with federal and academic researchers, Lyndsay said. The tools developed during this project are being expanded as part of **multiple projects** that started last year.

"There are risks in doing these kind of climate interventions," Erika said. "It is the role of the climate science community to understand these emerging technologies, their risks and benefits, to better inform decision-makers in the future, should climate intervention be necessary to save the planet."

This research project was funded by Sandia's Laboratory Directed Research and Development program.

Sandia names Truman Fellows

By Michael Ellis Langley and Neal Singer

ince 2004, Harry S. Truman Fellows in National Security Science and Engineering have come to Sandia each year to pursue high-risk, high-reward ideas that support the Labs' national security mission.

Sandia recently welcomed 2023 fellows Joseph Cuozzo and Josefine McBrayer, who began their three-year postdoctoral appointments last year.

The fellowship is extended to early-career researchers pursuing independent ground-breaking research and is named for President Truman who saw the possibility for Sandia in 1949 to provide "an exceptional service in the national interest."

Joseph Cuozzo: Taking highspeed computing forward

Joseph plans to use his fellowship to develop quantum-scale technologies that can evolve high-speed computing to the next level of performance and capability and he is well on his way to doing so.

"My area of expertise is in describing how electrons behave in very small devices at very low temperatures," he said. "Some of these devices are only hundreds of atoms thick, roughly a thousandth of the thickness of a single human hair, and operate at temperatures colder than deep space."

Joseph said most people have experienced how hot a laptop computer can get when running. Electrons are moving around inside the system and as they encounter resistance, they generate heat — like rubbing your hands together on a cold day. He adds that many metals, when cooled to intensely cold temperatures, no longer resist the movement of electrons, a phenomenon called superconductivity.

"Superconductivity is a quantum mechanical effect, and there are many quantum effects we can observe when we study devices at low temperatures and small length scales," Joseph said. "We can also investigate how quantum properties of different materials interact by stacking them on top of one another, forming a heterostructure. Creating heterostructures allow us to engineer devices with very exotic properties. I'm interested in investigating these exotic properties. For instance, we can design heterostructures to create topological superconductors that can be used as the basis of quantum computers."

Joseph is investigating if it is possible to craft topological features in a structure that allows superconductivity that becomes the basis for quantum computing. He hopes his work can help reduce errors in quantum calculations.

"By reducing errors, quantum computers have the potential to address problems ranging from ambient-pressure, room-temperature superconductivity — for use in low-power technologies — to chemical and biological processes, such as the reaction mechanism for biological nitrogen fixation in nitrogenase," he said, explaining the enzymes produced by certain bacteria that are responsible for the reduction of nitrogen to ammonia.

Joseph graduated from the University of South Florida in 2017 with degrees in math and physics and completed his doctorate at the College of William & Mary in 2022, authoring his dissertation, "Electronic transport in topological superconducting heterostructures." His road to Sandia and to the Truman Fellowship began quite young.

"My father works at a hospital as an MRI safety officer," he said. "As a child, he would show me his MRI machine, which is more or less a giant magnet, and demonstrate some pretty amazing features of magnetism and what a really powerful magnet can do. Those experiences sparked my curiosity and orientated me towards developing practical technology that can benefit society."

He chose Sandia for his postdoc work after working as a year-round graduate intern in materials physics.

"I enjoyed the camaraderie with those on my team and the support I received from my mentor Wei Pan while I explored new ideas. The combination of a highly collaborative environment, strong support of cutting-edge



GOOD FELLOW — Joseph Cuozzo will use his Truman Fellowship to develop quantum-scale innovations for high-speed computing. Photo by Randy Wong

research from the Nano Micro LDRD program, and a strong sense of mission at Sandia to support the national interest made my decision to work here an easy one," he said, recounting that he is most proud of his work on the discovery of a Leggett mode in Dirac semimentals. "I feel extremely honored to be named a Truman Fellow at one of the premier research laboratories in the world. The freedom and resources that the Truman Fellowship offers will bring my vision to fruition and I'm very excited about that."

Josefine McBrayer: Battery improvements her goal

Josefine has always loved math and science.

"If you don't remember a name or date, you have to look it up," she said. "In math, if you don't remember a solution, you can work it out."

She always had a passion for school, earning all A's from first grade in an Albuquerque public school through her doctorate in chemical engineering at the University of Utah. Her stopover at the University of New Mexico for a bachelor's in chemical engineering and a master's in nanoscience and microsystems engineering also met with academic success.

Probably as important for Sandia's Truman Fellowship committee were Josey's groundbreaking experiments to improve battery lifetimes — a major problem for U.S. industry and defense — and the impressive letters of references that preceded her.

As one letter put it, "... working with Josey on research problems [was] not like working with a student — it [was] much more like working with a professional colleague who possesses excellent judgment and maturity about research directions."

As a master's student studying energy storage, she sought to improve the longevity of lithium-sulfur batteries. Promising because of their high energy density, the batteries are typically plagued by intermediate chemicals that, appearing and diffusing, weaken the mix — the so-called "polysulfide shuttle" problem.

Josey developed a spectroscopic technique to track the concentration and location of the various polysulfides in-situ as they changed and diffused through the battery cell during its discharge cycle. Researchers used the chemical transformations her observations revealed to suggest methods to mitigate polysulfides' formation and transformations. By applying these methods, the cycle life of lithium-sulfur cells, which had been limited to less than 10 recharges, could be extended to almost 10 times that amount.

For her doctoral research, Josey developed techniques to determine how long a lithium-ion battery with a silicon anode maintains a charge while sitting idle. Determining how long a battery will work once it's off its charger and deployed in the field is critical to national defense. Batteries may be deployed for years before being activated. The usual method is to accelerate the aging process by heating battery components to higher temperatures, which works but also activates chemical interactions that would not necessarily occur in batteries sitting on a shelf.

Josey helped develop a voltage-hold protocol, which provides an early indicator of performance in model silicon anodes in a fraction of the time and without the complicating side effects. These techniques have become the standard within the DOE's Vehicle Technologies Office Silicon Battery Projects and are being deployed as a best practice in performing shelf-life aging studies on new battery material. Academia and industry also routinely use the techniques when studying battery shelf life.

Josey's doctoral dissertation aligned her to be the principal investigator of a joint Laboratory Directed Research and Development and Homeland Security project requesting "... modifications to improve performance and safety in rechargeable lithium metal batteries."

Josey credits much of her success to now-retired senior scientist Chris Apblett and current mentor Katie Harrison. She said Apblett introduced her to electrochemistry as an undergraduate intern at Sandia, and "changed my life by being the first person in my field to respect me as a scientist." Apblett allowed Josey to design her own projects on lithium-metal batteries and, through these projects, found money to help pay for her master's. As an officer in the Society of Women Engineers, she helped others succeed in science.

Josey grew up with a family foundation in science: her mother, father, brother and sister all took jobs in technical fields. As



BATTERY DETECTIVE — Truman Fellow Josefine McBrayer is working to improve performance in rechargeable lithium metal batteries. Photo courtesy of Josefine McBrayer

a child, she wanted to be a scientist with a doctorate, like her dad.

"I'm never bored building batteries and doing electrochemical testing," she said. "A growing field — such a broad use, so many different chemistries with a variety of applications."

G3P3 build begins



FROM THE GROUND UP — Concentrating solar managers and staff break ground on the Gen 3 Particle Pilot Plant during a ceremony on Feb. 16. The new plant will stand next to the existing tower, pictured in the background. Photo by Craig Fritz

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Jack Martinez

Anand Ganti





Cris Fritz



Evan Johnson



Lu Fang

Recent Retirees





Gracie Brown





Michael Oliver



SSALLANIA

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Anthony Leyba



Larry Zamora

Al Hart



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Bill Beenau

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Sandia Fellow Tina Nenoff: It's all about materials

By Neal Singer

avorable circumstances in her youth combined with her own intelligence and drive has enabled Sandia Fellow Tina Nenoff to contribute to an exceptionally wide range of materials science.

As of January, she had published 185 peer-reviewed articles and four book chapters, been awarded 17 U.S. patents and made more than 100 presentations at national and international conferences.

"Both my parents were proponents of science," she said. Her mother, Lydia, was a biologist and her father, Vladimir, was a medical doctor. "Also, my great aunt Dr. Maria Pamukoff, a pediatrician, was a dynamic go-getter ahead of her time. She constantly encouraged me throughout my life to go after anything and everything. This was amazing mentoring in the '70s and '80s for a girl, young woman.



sandia.gov/LabNews

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"I also went to an all-girls high school where my chemistry teacher Mrs. Tomkufsic was both a great teacher and a wonderful mentor. She really guided my interest in the field."

These early mentors may have formed a touchstone that allowed her to choose well later in life, Tina agreed.

At the University of Pennsylvania, she studied chemistry as an undergraduate. "I was strongly encouraged by the program to join a research group to gain experience and to strengthen my experience for work post-degree. I spoke to a number of research professors and very much liked Dr. (Alan) MacDiarmid's enthusiasm and multidisciplinary group. He had not yet been awarded the Nobel and would not be for a few years, but everyone could feel the energy and excitement of the work that was ongoing in his labs. That was enthralling to me."

Among the many examples of her own research, her investigation of the properties of crystalline silico-titanates with Sandian James Krumhansl led to the cleansing of an estimated 40 million gallons of radioactive waters at Japan's Fukushima Daiichi nuclear power plant, after its reactors and buildings were damaged when an earthquake caused a tsunami in 2011.

Tina's resourcefulness as an experimentalist made her a welcomed addition to the Sandia Red Team. Its yearly report to Director James Peery supports his signing of the annual assessment certifying the state of the nuclear stockpile.

Recognition of the value of her technical counsel underlay her recent selection as deputy and science advisor to NNSA Administrator and DOE Under Secretary for Nuclear Security Jill Hruby, a former director at Sandia. The two-year post starts in March.

Will this most recent appointment be the end, or even crimp, the new fellow's startlingly productive research career, which now includes her mentoring of other researchers?

"I hope to keep my research going at Sandia through discussions with my amazing co-principal investigators and postdocs," Tina said. "I still get jazzed by solving the puzzles of the data, and I love the excitement of pulling together a multidisciplinary team that explores and discovers new aspects of materials and applications."



DEDICATED FELLOW — Sandia Fellow Tina Nenoff credits early mentors for inspiring her career and success as a materials scientist. Photo by Lonnie Anderson

Sandia Fellows program adds five

Labs Director James Peery recently announced five new Sandia Fellows. For the first time in Labs history, the fellows program has expanded beyond research and development positions to include all professions that are required to meet Sandia's mission.

"This is a rare and highly selective honor that recognizes pioneers with the highest accomplishments among their peers," James wrote in his announcement. "A promotion to this level allows each fellow to focus on advancing the frontiers of their fields and enhancing Sandia's reputation."

Cynthia Phillips, Tina Nenoff, Ted Kim, Elizabeth Roll and Amber Romero joined the Sandia Fellows this year. This spring, Lab News will profile each fellow.

Hybrid work model advances

Expansion planned over the next 5 years

By Kim Vallez Quintana

he COVID-19 pandemic forced businesses around the globe to suddenly embrace a telecommuting work environment. Nearly three years since the pandemic began, many businesses have returned workers to their traditional desks, cubicles and office spaces. Sandia is doing things differently.

Recognizing the success of telecommuting, and the desire by many professionals to work at home or far from its main campuses, Sandia is developing a more extensive and immersive hybrid work model to help create the workforce of the future and attract and develop top talent.

As of January, there were approximately 1,700 full-time and 1,100 part-time telecommuters, and 1,200 remote Sandia employees around the country. That is about 30% of Sandia's workforce.

Remote work can provide benefits to both the employer and employee, according to results from the 2020 Labswide Telecommuting Experience Survey. The top benefits include less commuting to and from work, no parking challenges, flexible

REMOTE WORK: BENEFITS OF TELECOMMUTING



work schedules, more opportunities for exercise and self-care, more interaction with family, increased productivity and fewer interruptions.

A 2021-2022 remote work study by Sandia also showed significant increases in the number of qualified candidates applying for a remote position that was identical to



TECH SOLUTIONS - Stan Atcitty, leader of Sandia's Energy Storage Power Electronics subprogram, left, is helped by Donavan Moore, a member of the support staff at the Swift Bar in IPOC.

an on-site position. The study found remote work options can be a significant recruitment and retention tool and are necessary to remain competitive in the future.

In response to this shift, Sandia has created a five-year plan to build a permanent hybrid workforce that will include a mix of remote workers, full and part-time telecommuters and on-site workers. That plan began with the stated goals of Sandia embracing its remote workforce, addressing key pain points and creating positive messages about the hybrid model. It included identifying remote or telecommuting positions in areas that wouldn't traditionally be considered compatible, such as those that involve classified work. Broadening the scope of remote work should help improve innovation, competitiveness and the ability to meet strategic goals.

In fiscal year 2023, the hybrid work strategy will focus more on how people work and less on where people work. Sandia is committed to opening one to two remote hubs this fiscal year in order to attract a more diverse talent pool with critical skills. The plan includes three different hub types: mirroring Sandia's on-site experience, drop-in classified work at partner facilities

Photo by Craig Fritz

and hubs with reciprocity agreements.

The plan's criteria for choosing hubs include existing workforce and talent migration hotspots; proximity to schools with strong talent pools; cost of living; proximity to federal headquarters, labs and plants; and sites where Sandia doesn't yet have a strong physical presence. Sandia considered more than a dozen sites and has immediate plans for three hubs:

- Sandia's Minnesota site.
- Pacific Northwest National Laboratory.
- Texas A&M University.

Touchdown spaces, IT fixes help hybrid workers succeed

According to a fiscal year 2022 year in review report, 1,600 telecommuters moved home, creating square footage for other needs and those who work on-site. It also allowed Sandia to move out of some leased space and begin major modifications in nine buildings.

Leadership is working to provide the tools necessary for remote workers and telecommuters to do their job efficiently and safely. This includes an ergonomic assessment for every employee who transitions to a home office to ensure they are working in a healthy environment and to reduce their exposure to such physical hazards as uncomfortable postures, repetitive tasks or straining of the neck and eyes.

Because not all work can be done at a home office, 170 individual touchdown spaces are available on-site through a reservation-based system. Many teams also have designed local touchdown spaces for team members. There are also three large collaboration centers open, with more to come. These drop-in collaboration spaces provide a more relaxed place to meet with co-workers or to get away from a traditional desk.

There are also private spaces to work in nontraditional open office settings that keep online meetings from being disruptive to others.



COLLABORATION STATION — From left, Clint Moore, Chris Lucero, Colin Laskar and Natalie Jung, with Strategic Facilities and Infrastructure Integration, take part in a hybrid meeting at the collaboration space in IPOC. Photo by Craig Fritz



WINNING TOUCHDOWN — Matthew-Ryan Morrell, strategic site planning manager, uses a soundproof booth to participate in a Teams meeting at the collaboration space in IPOC. Photo by Craig Fritz



Hybrid work provides IT challenges. As part of the strategy moving forward, the IT team is gathering information on hybrid workforce needs and IT service gaps. One way to answer that call was by creating a drop-in Swift Bar for employees to get help with their IT issues, located off base at IPOC.

Sandia recognizes that there are challenges in adapting to a hybrid workforce. Remote workers often want ways to better connect with one another, or report feeling loneliness and uncertainty about their ability to advance in the organization, or they have trouble reconciling time zones when working far from their home site, the survey reported. Sandia's strategy calls for introducing more ice breakers, regular

formal and informal team meetings and meetings with managers, among other things. Some leaders are also experimenting with other ways to build connections, no matter the physical distance.

Overall, the study found managers and employees view remote work as beneficial because it provides needed flexibility for workers who would otherwise leave or not consider joining Sandia, without any detrimental effects on productivity.

REMOTE WORK: HUB TYPES

MIRROR SANDIA'S EXISTING ONSITE EXPERIENCE

HUB TYPE I



Graphic by Dane Snyder

Sandia's strategy aims to complete its hybrid work policies and best practices in the next five years, with the goal of increased physical capacity, increased workforce engagement across the country, improved access to resources that help Sandia further its mission, increased ability to attract and retain staff and, most of all, increased ability to perform classified work outside the confines of Sandia's main sites. 🛅

Biden taps Labs' senior leader for quantum advisory committee

By Troy Rummler

eborah Frincke, associate laboratories director of national security programs, has been appointed to the National Quantum Initiative Advisory Committee.

As a member of this presidential advisory committee, Deborah will help provide an independent assessment of the National Quantum Initiative Program, which was established in 2019 to maintain U.S. leadership in quantum information science and its technology applications and to make recommendations to the nation's highest offices for future revisions to the program.

President Joe Biden announced the appointment in December.

"Quantum science and technology are believed to have enormous potential in a wide variety of sectors," Deborah said. "Quantum computing, imaging and sensors are among the areas where important breakthroughs may lead to significant advances.

It is an honor to be part of the NQIAC, designed to both advise the president and to represent the needs of industries, universities and federal laboratories."

Deborah is a seasoned leader in national security research. At Sandia, she steers and oversees projects for the DOD, the U.S. intelligence community and the DOE in areas such as hypersonic flight systems, cybersecurity, advanced radar, microelectronics, threat intelligence, machine learning and quantum science. She also recently concluded a term on the NATO Advisory Group on Emerging and Disruptive Technologies.

Formerly, she served as the associate laboratory director for national security sciences at Oak Ridge National Laboratory and held several senior executive positions at the National Security Agency, including director of research, where she also served as a past co-chair of the White House committee on the Economic and Security Implications of Quantum.

Deborah is a fellow of the Association for Computing Machinery and holds a doctorate in computer science and security from the University of California, Davis. 🛅



TRUSTED ADVISER — Deborah Frincke, the associate laboratories director of national security programs at Sandia, has been appointed to the National Quantum Initiative Advisory Committee. Photo by Lonnie Anderson