SANDIA LABNEWS
PUBLISHED SINCE 1949

Vol. 75, No. 3, Feb. 9, 2023

Celebrating Black History Month **Page 10**

New superalloy could cut carbon emissions from power plants

EYES ON THE PRIZE — Sandia technologist Levi Van Bastian works to print material on the Laser Engineered Net Shaping machine, which allows scientists to 3D print new superalloys.

Photo by Craig Fritz

Researchers repurpose 3D printing to discover high-performance material

By **Troy Rummler**

As the world looks for ways to cut greenhouse gas emissions, researchers from Sandia have shown that a new 3D-printed superalloy could help power plants generate more electricity while producing less carbon.

Sandia scientists, collaborating with researchers at Ames National Laboratory, Iowa State University and Bruker Corp., used a 3D printer to create a high-performance metal alloy, or superalloy,

— CONTINUED ON PAGE 4

Securing supply chains with quantum computing

Programming technique could help solve massive optimization problems

By **Troy Rummler**

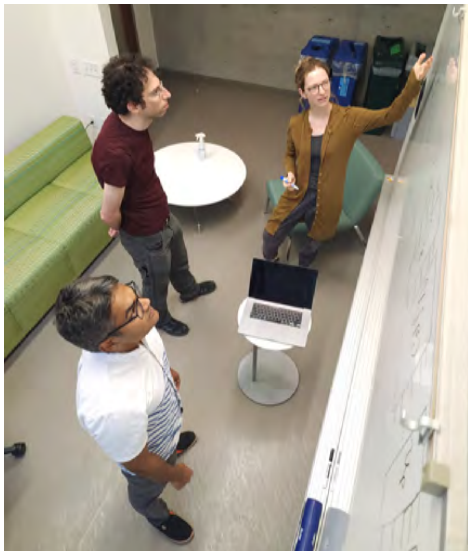
The Russo-Ukrainian conflict and the COVID-19 pandemic have shown how vulnerable global supply chains can be. International events can disrupt manufacturing, delay shipping, induce panic buying and send energy costs soaring.

New research in quantum computing at Sandia is moving science closer to being able to overcome supply-chain challenges and restore global security during future periods of unrest.

"Reconfiguring the supply chain on short notice is an exceptionally difficult optimization problem, which restricts the agility of global trade," said Alicia Magann, a Truman Fellow at Sandia. She has led the development of a new way to design programs on quantum computers, which she and her team think could be especially useful for solving these kinds of massive optimization problems someday in the future when quantum technology becomes more mature.

The Sandia team recently published the new approach in two joint papers in the journals Physical Review Letters

— CONTINUED ON PAGE 9



FALQON PUNCH — Sandia scientists Alicia Magann, right, Kenneth Rudinger, top left, Mohan Sarovar, bottom left, and Matthew Grace, not pictured, developed Feedback-based Algorithm for Quantum Optimization, or FALQON, as a new framework for programming quantum computers, an emerging technology that could become a powerful tool for global security. **Photo by Robin Blume-Kohout**

SANDIA LABNEWS
PUBLISHED SINCE 1949
Managed by NTESS LLC for the National Nuclear Security Administration

Sandia National Laboratories

Albuquerque, New Mexico 87185-1468
Livermore, California 94550-0969
Tonopah, Nevada | Kauai, Hawaii
Amarillo, Texas | Carlsbad, New Mexico | Washington, D.C.

Katherine Beherec, Editor kgbeher@sandia.gov
Alicia Bustillos, Production abustil@sandia.gov
Craig Fritz, Photographer cvfritz@sandia.gov
Michael Langley, California Contact mlangle@sandia.gov

CONTRIBUTORS

Michelle Fleming (milepost photos, 505-844-4902), **Neal Singer** (505-846-7078), **Kristen Meub** (505-845-7215), **Troy Rummler** (505-284-1056), **Valerie Alba** (505-284-7879), **Luke Frank** (505-844-2020), **Meagan Brace** (505-844-0499), **Mollie Rappe** (505-288-6123), **Skyler Swezy** (505-850-2063), **Kim Quintana** (505-264-1886), **Michael Baker** (505-284-1085)

Sandia National Laboratories is a multimission laboratory managed and operated by National Technology & Engineering Solutions of Sandia, LLC, a wholly owned subsidiary of Honeywell International Inc., for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-NA0003525.

Published on alternate Thursdays by Internal, Digital and Executive Communications, MS 1468

LAB NEWS ONLINE: sandia.gov/LabNews

TABLE of CONTENTS

LABNEWS Notes

Lab News may contain photos shot prior to current COVID-19 policies. Individuals in photos followed all social distancing and masking guidelines that were in place when photos were taken.

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

AMD selected to improve stockpile mission

By **Neal Singer**

Sandia, in partnership with Los Alamos and Lawrence Livermore national labs, has awarded a contract to AMD that funds research and development of advanced memory technologies expected to accelerate high-performance simulation and computing applications in support of the nation's stockpile stewardship mission.

The NNSA's **Advanced Simulation and Computing program**, through its Advanced Memory Technology program, is sponsoring the work. The three labs will collaborate with Advanced Micro Devices Inc., a company recognized for high-performance computing, graphics and visualization technologies.

"The goal for ASC's Advanced Memory Technology projects is to develop technologies that will have an impact on future computer system architectures for our complex modeling and simulation workloads," said ASC Program Director Thuc Hoang. "We have selected projects that will have the potential to deliver more than 40 times the application performance of our forthcoming NNSA exascale systems."

The new contract is part of NNSA's post-Exascale-Computing-Initiative investment portfolio. Its objective is to sustain technology research-and-development momentum and provide strong engagement with industry that the initiative had started via its **PathForward** program. The intent is to foster a more robust domestic high-performance computing ecosystem by increasing U.S. industry competitiveness in next-generation, high-performance computing technologies.

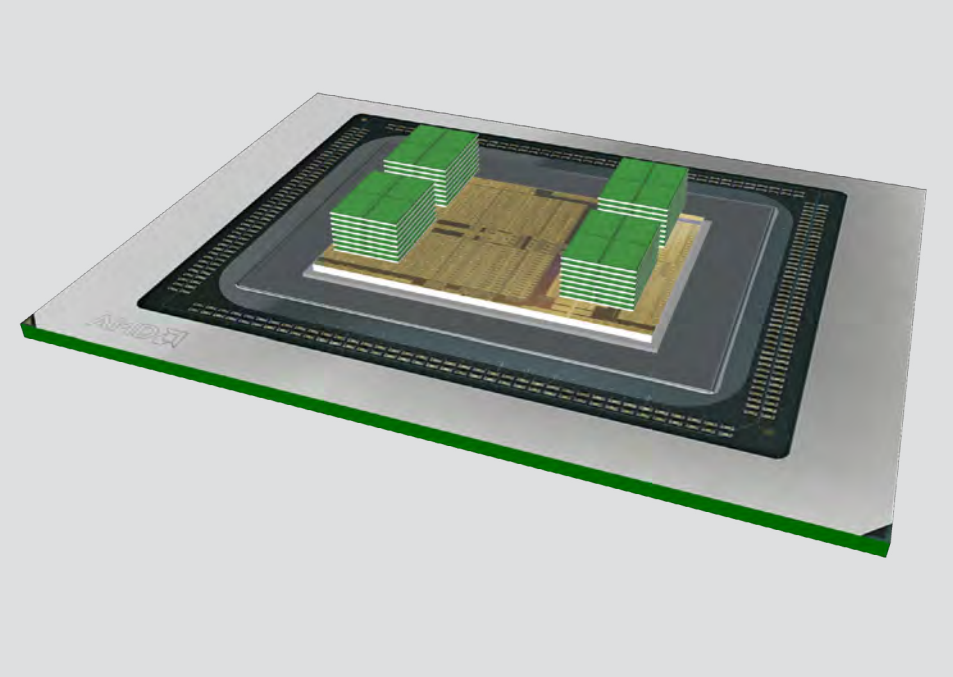
"AMD is excited to collaborate with the pioneering researchers and scientists at Sandia, Lawrence Livermore and Los Alamos national laboratories," said Alan Lee, corporate vice president and head of research and advanced development at AMD. "We will work together to explore integration of advanced memory technologies into future systems, leveraging our track record of collaboration and co-design with the NNSA laboratories and AMD's active leadership in the Joint Electron Devices Engineering Council standards organization."

James Laros, Sandia project lead and distinguished member

of technical staff, said, "We are pursuing memory bandwidth and latency improvements. If successful, this effort will positively affect both aspects of future memory systems for our advanced and commodity technology platforms."

Simon Hammond, federal program manager for the ASC Computational Systems and Software Environments subprogram, said, "AMD has been a long-time partner with the ASC; this collaboration continues our work together in developing technologies to provide improvements in the memory subsystems that are critical to the performance of our production simulation workloads."

Robert Hoekstra, senior manager of the Extreme-Scale Computing group at Sandia, said, "This partnership is a great example of how the NNSA can invest in and influence commercial companies to develop technologies that will be impactful on our mission."



ADVANCED MEMORY — Artist depiction of a potential 3D memory configuration — green stacked rectangles — paired with a general-purpose processor immediately below them. In most configurations, memory shares a geometric plane with processors. Inserting additional memory physically closer to computation can improve bandwidth and latency characteristics, which have the potential to accelerate applications in support of stockpile stewardship. **Image courtesy of AMD**

Retiree Deaths

July 6, 2022 - Jan. 9, 2023

Cecille Johnston (age 75)	July 6, 2022
Robert Male (101)	July 20
Benjamin Dominguez (78)	July 27
Donald Arquette (92)	July 28
Alan Beattie (88)	Aug.13
Wayne Lee Cyrus (92)	Aug. 20
Leonardo Griego (74)	Aug. 22
Elefonso Manzanares (82)	Aug. 25
T. Dean Wilson (89)	Aug. 27
James Barham (91)	Aug. 30
Epifanio Waquiu (65)	Aug. 31
Carroll Hungate (89)	Aug. 31
Donald Stone (86)	Sept. 1
Paul Martinez (87)	Sept. 1
James Garsow (66)	Sept. 2
Norma Hibbs (89)	Sept. 7
Nicasio Nolasco (83)	Sept. 7
Daniel Shawver (82)	Sept. 9
Paul Simmons (73)	Sept. 9
Louise Dow (95)	Sept. 9
David Waymire (79)	Sept. 14
Lorraine West (77)	Sept. 15
Daniel Saladin (75)	Sept. 16
Robert Martin (93)	Sept. 16
Robert Galloway (71)	Sept. 18
Stanley Spray (90)	Sept. 19
James Mitchell (90)	Sept. 22
Francis Cunningham (85)	Sept. 24
Richard Prairie (89)	Sept. 27
Tony Lopez (96)	Sept. 30
Tara Allen (80)	Oct. 3
John Malpas (88)	Oct. 3
Charles Winter (101)	Oct. 4
Rosemary Hriczko-Zdunczyk (86)	Oct. 4
Albert Sandoval (69)	Oct. 7
Judith Hansen (81)	Oct. 12
Milton Zimmerman (95)	Oct. 13
James Solberg (81)	Oct. 15
F. Rebarchik (91)	Oct. 17
Avelino Zuni (84)	Oct. 19
Frank Baca (83)	Oct. 21
Bruce Draper (68)	Oct. 25
James Manweller (93)	Oct. 25
David Zittel (74)	Oct. 27
Wilma Salisbury (97)	Oct. 27
John Seuser (92)	Oct. 28
Patricia Rosario (85)	Nov. 2
Lorena Schneider (97)	Nov. 5
Jean Hunt (89)	Nov. 6
Phillip Walkington (79)	Nov. 6
Larry Harrah (91)	Nov. 6
Kendrick Frazier (80)	Nov. 7
Martin Molecke (77)	Nov. 9
Harry Hardee (85)	Nov. 9
Adron Pritchard (83)	Nov. 10
Richard Elrick (92)	Nov. 12
Dennis Gutierrez (76)	Nov. 16
Gilbert Lovato (85)	Nov. 20
George Davidson (70)	Nov. 20
Federico Salas (86)	Nov. 21
Richard Granfield (78)	Nov. 22
Donald Amos (93)	Nov. 26
Charles Duvall (99)	Nov. 27
Jay Chamberlin (87)	Dec. 11
Sandra Klassen (70)	Dec. 12
Anna Nusbaum (70)	Dec. 15
Jack Burkhardt (93)	Dec. 18
Jack Mortley (92)	Dec. 18
Mary Gilliland (82)	Dec. 22
Donald Stoner (88)	Dec. 22
Paul Elder (82)	Dec. 22
Sharla Bertram (79)	Dec. 23
Eddy Jacobs (91)	Dec. 23
Diane Cline (78)	Dec. 28
Dennis Hayes (84)	Jan. 2, 2023
Elizabeth Luna (96)	Jan. 9

Superalloy

CONTINUED FROM PAGE 1

with an unusual composition that makes it stronger and lighter than state-of-the-art materials currently used in gas turbine machinery. The findings could have broad impacts across the energy sector as well as the aerospace and automotive industries, and hints at a new class of similar alloys waiting to be discovered.

"We're showing that this material can access previously unobtainable combinations of high strength, low weight and high-temperature resiliency," Sandia scientist Andrew Kustas said. "We think part of the reason we achieved this is because of the additive manufacturing approach."

The team published their findings in the journal Applied Materials Today.

Material withstands high heat, essential for power plant turbines

About 80% of electricity in the U.S. comes from fossil fuel or nuclear power plants, according to the U.S. Energy Information Administration. Both types of facilities rely on heat to turn turbines that generate electricity. Power plant efficiency is limited by how hot metal turbine parts can get. If turbines can operate at higher temperatures, "then more energy can be converted to electricity while reducing the amount of waste heat released to the environment," said Sal Rodriguez, a Sandia nuclear engineer who did not participate in the research.

Sandia's experiments showed that the new superalloy — 42% aluminum, 25% titanium, 13% niobium, 8% zirconium, 8% molybdenum and 4% tantalum — was stronger at 800 degrees Celsius (1,472 degrees Fahrenheit) than many other high-performance alloys, including those currently used in turbine parts, and still stronger when it was brought back down to room temperature.

"This is therefore a win-win for more economical energy and for the environment," Sal said.

Energy is not the only industry that could benefit from the findings. Aerospace researchers seek out lightweight materials that stay strong in high heat. Additionally, Ames Lab scientist Nic Argibay said Ames and Sandia are partnering with industry to explore how alloys like this could be used in the automotive industry.

"Electronic structure theory led by Ames Lab was able to provide an understanding of the atomic origins of these useful properties, and we are now in the process of optimizing this new class of alloys to address manufacturing and scalability challenges," Argibay said.

The DOE and Sandia's Laboratory Directed Research and Development program funded the research.

Discovery highlights changes in materials science

Additive manufacturing, also called 3D printing, is known as a

POUR ME ANOTHER — Sandia technologist Levi Van Bastian fills a hopper with raw material to print on the Laser Engineered Net Shaping machine. What appears to be a liquid is powdered metal. **Photo by Craig Fritz**

versatile and energy-efficient manufacturing method. A common printing technique uses a high-power laser to flash-melt a material, usually a plastic or a metal. The printer then deposits that material in layers, building an object as the molten material rapidly cools and solidifies.

But this new research demonstrates how the technology also can be repurposed as a fast, efficient way to craft new materials. Sandia team members used a 3D printer to quickly melt together powdered metals and then immediately print a sample of it.

Sandia's creation also represents a fundamental shift in alloy development because no single metal makes up more than half the material. By comparison, steel is about 98% iron combined with carbon, among other elements.

"Iron and a pinch of carbon changed the world," Andrew said. "We have a lot of examples of where we have combined two or three elements to make a useful engineering alloy. Now, we're starting to go into four or five or beyond within a single material. And that's when it really starts to get interesting and challenging from materials science and metallurgical perspectives."

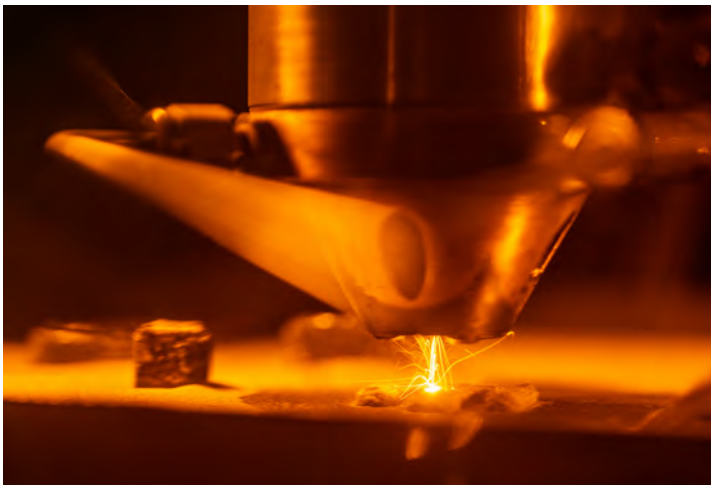
Scalability, cost are challenges to overcome

Moving forward, the team is interested in exploring whether advanced computer modeling techniques could help researchers discover more members of what could be a new class of high-performance, additive manufacturing-forward superalloys.

"These are extremely complex mixtures," said Sandia scientist Michael Chandross, an expert in atomic-scale computer modeling who was not directly involved in the study. "All these metals interact at the microscopic — even the atomic — level, and it's those interactions that really determine how strong a metal is, how malleable it is, what its melting point will be and so forth. Our model takes a lot of the guesswork out of metallurgy because it can calculate all that and enable us to predict the performance of a new material before we fabricate it."

Andrew said there are challenges ahead. For one, it could be difficult to produce the new superalloy in large volumes without microscopic cracks, which is a general challenge in additive manufacturing. He also said the materials that go into the alloy are expensive. So, the alloy might not be appropriate in consumer goods for which keeping cost down is a primary concern.

"With all those caveats, if this is scalable and we can make a bulk part out of this, it's a game changer," Andrew said.

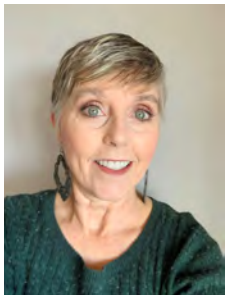


LITTLE SPARKY — 3D-printing technologies like Laser Engineered Net Shaping, shown here, are helping scientists at Sandia rapidly discover, prototype and test new materials. **Photo by Craig Fritz**

Mileposts

Karla Simoes 30

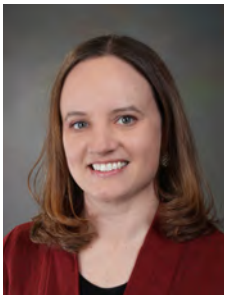
Richard Drake 25



Wendy Friedt 20

Charles Graham 20

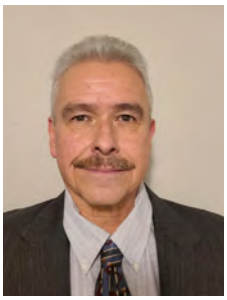
Rudolph Griego 15



Lori Hengeveld 15

Recent Retirees

Eden Eager 36



David A. Sanchez 25

Sandia cyber specialists are turning purple, and that's a good thing

DOE cybersecurity competition trades red-versus-blue mentality for a more cooperative tack

By **Troy Rummler**

It's often said there's nothing like a little friendly competition to bring out the best in people. In recent years, DOE has been emphasizing the friendly part at its annual undergraduate cybersecurity competition, CyberForce. The event is increasingly incorporating a relatively new, cooperative concept in cybersecurity called purple teaming, reflecting a shift in how national laboratories and industry are approaching cyber defense.

CyberForce, hosted by Argonne National Laboratory, began in 2016 with eight college teams. Following a conventional training format, students formed what are called blue teams, scoring points for mounting successful defenses against cyberattacks from a red team composed of volunteer ethical hackers from national laboratories and private industry.

"We're trying to give them a really quick crash course in infrastructure," specifically in the energy sector and how defenders think through threats, said Amanda Theel, CyberForce program director with Argonne National Laboratory during a webinar in September.

The event serves a broader purpose too, seeking to build up a workforce to fill a huge shortfall in cybersecurity specialists.

"The number is still right around half a million open cybersecurity positions within the United States alone. And so that number, if we're ever going to try to reduce that gap, we really need to start thinking through how to get better and more qualified candidates," Theel said.

Sandia's Kevin Nauer said, "Recruiting, training and retaining cybersecurity professionals really is a matter of national security and a challenge that Sandia has been attempting to address with programs like Tracer FIRE and CyberForce."

Tracer FIRE is an educational program focused on developing and training students in cyber incident response, Kevin said. Sandia develops threat scenarios that emulate real-world attacks, then lets students at universities practice detecting and investigating the events in a simulated environment, with coaching from Sandia staff.

CyberForce has rapidly expanded since its inception, ballooning to 118 teams for the 2022 competition, which took place as a hybrid event in November, with many teams that participated remotely and others physically gathered in St. Charles, Illinois.

Its traditional, competitive red-blue dichotomy has long helped other organizations identify system vulnerabilities and train staff. As the DOE competition was growing, however, some people noticed the format was failing some of their students because red teams had vastly more experience than the blue teams.

"Earlier iterations of CyberForce competitions, and other competitions that are very similar, unfortunately ended up where just the red team is kind of beating up on the students, the defenders. And then the question is: What's the value there? What's the takeaway?" said Sandia's Kandy Phan, a red team lead during the 2022 competition.

To improve the educational experience for the students, Kandy said, the program made a dramatic change.

They added a chat box.

In 2019, the competition implemented a new rule that made the red team responsible for scoring a blue team's knowledge of what was happening. Organizers created a chat box — called the score chat — so the red team could probe their blue team's understanding with questions.

The change was introducing to the competition the concept of purple teaming, a practice that was already appearing in industry.

"Everyone has their own definitions of these things, but 'purple teaming' is a result of collaboration and discussion after a red team engagement with a blue team," said Cam Stark, a member

FRIENDLY COMPETITION — A team of experts from Argonne National Laboratory lead student competitors through challenges in St. Charles, Illinois, at the 2022 DOE CyberForce Competition.

Photo courtesy of Argonne National Laboratory

of Sandia's CyberForce red team. "The attacks from the red team are a test of the blue team's capability to defend against attacks and discover persistence or exfiltration mechanisms. A deliberate purple team exercise is an in-depth interaction that explores the process the red team took and seeks to improve blue team's response."

Kandy said the addition of the score chat and the new scoring rule triggered a major shift in the attitudes of red teamers.

"What I found really interesting was that usually red teamers have a very adversarial mindset, and they just kind of see the defenders as the enemy that they have to defeat. But with the score chat, they kind of reenvisioned their role."

The new rule, Kandy said, forced the red team to think about what the blue team knew and how they were performing. With the chat box, feedback began flowing back and forth throughout the competition, something Kandy called a big achievement.

For some people, it also lightened the mood. Cam said his blue teams have fun sending him memes.

HAPPY TO BE HACKED — Students from Lewis University defend an emulated solar facility on their laptops from national lab employees posing as hackers at CyberForce.
Photo courtesy of Argonne National Laboratory

This was Cam's third year as a CyberForce red teamer. He said purple teaming doesn't just make the competition more enjoyable; it can make cybersecurity better, too.

"It requires that both the red and blue team focus on improving our defenses and not on 'winning' by red getting in or blue keeping them out," Cam said. "If both teams can check their ego at the door and engage on a technical level, then our information security can be improved to its highest level."

Jacob Valencia, a graduate student at New Mexico Tech and a Sandia intern who also was involved in CyberForce, said, "In this industry, you'll never know everything, and ideas are constantly changing, so allowing for such a collaboration really expands the horizons of safety and security in cybersecurity."

The 2022 event was purpler than ever, expanding red-blue communication beyond basic knowledge checks to include more deliberate instruction. Red teams also launched duplicate attacks so blue teams could practice responding to suspicious activity they missed the first time.

"This year in particular emphasized that the blue team should be walked through what red did so that they can understand what they could have done had they been looking in the right places," Cam said.

"The blue team is getting better as the day goes along, and now they can take that back into the industry at large. This is how we really improve the defenders, actually helping them and trying to communicate with them instead of just competing against them and trying to beat them," Kandy said.

Sandia Fellow Cynthia Phillips: Happiness is solving problems

By **Neal Singer**

Anyone in need of a dose of modesty about their achievements might contemplate the vita of Sandia Fellow and computer scientist Cynthia Phillips. Be prepared to spend a few hours.

Consider the papers she's published, approximately 100, including conference publications; number of technical program committees she sits on, 34; professional conference leadership, 18; professional society leadership roles, 15; honors and awards, 13; advisory boards and funding panels, seven; patents, three; and many mentoring opportunities.

"There's so much joy in getting great research results. It buoys you," she said. "There's a great burst of happiness when you solve a problem. And then you never get it right the first time. You think you had it and the next morning realize you didn't, so there can be multiple bursts of happiness for a single problem."

Cynthia has an unusual capability to tolerate small amounts of sleep. In her college years, she sometimes slept two hours a night for a week, and when her children were young, she regularly reserved Wednesdays for all-nighters.

At Sandia, which she praised for its promotion of work-life balance, when her children were young, she worked six hours a day at Sandia and at night after her family was in bed. "There are fewer distractions at night," she said.

She never rested on her academic laurels after attending Harvard for her bachelor's degree in 1983 and the Massachusetts Institute of Technology for her master's degree in 1985 and doctorate in 1990, all involving mathematics and computer science.

She learned about Sandia from working summer and part-time jobs at Thinking Machines, the company that built the Connection Machine supercomputers. Her husband, realizing Sandia was an employment opportunity for his wife, ranked the University of New Mexico as his top choice for his radiology residency and was offered a position.

"I was fortunate to get a job at Sandia," Cynthia said, "since not long afterward, there were some hiring freezes."

Among the projects the modest fellow has undertaken was optimizing the placement of contaminant sensors for municipal water supplies after the destruction of 9/11, when fear of further attacks from adversaries was high. The team, primarily from Sandia and the Environmental Protection Agency, developed award-winning combinatorial models and optimization algorithms that were used by many municipalities to place sensors most effectively.

She also developed a graph-based framework for analyzing the vulnerability of computer networks to cyber intrusions. This patented framework was widely adopted by the security community, and her paper introducing the model has more than 1,000 citations.

To further help deal with cybersecurity challenges, she partnered with professors and Sandians to bring ideas from the database community. They created write-optimized data structures for external memory to enable better detection of multipiece patterns in streaming cyber data.

Some of Cynthia's recent work has contributed combinatorial insights to the use of quantum and neuromorphic architectures. Her recent papers with other authors demonstrate the advantages of neuro-inspired machines for practical applications in graph algorithms and dynamic programming. Elements of this work have been patented.

CYBER FELLOW — Computer scientist Cynthia Phillips has been named one of five Sandia Fellows this year. Her influence has advanced Sandia's work in cybersecurity during her time at the Labs. **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 researcher.

She also was a key member of a team developing a novel approach to assigning workloads to processors in a large parallel computer. For efficiency, it's best to allocate a job to a set of processors that are close together in the network. The team developed a patented methodology that did this and built a tool that demonstrated a significant increase in overall throughput. This tool was installed in high-performance computing centers worldwide.

Among her goals, she hopes that the higher level of influence she will have as a fellow will help make everyday life easier "for Sandians doing important work." This involves modifying conservative processes in sharing ideas that have kept Sandia out of negative limelight but also have made things hard on collaborating university or industry colleagues.

"And there are other issues as well," she said. "It's hard to put my work in a box. As you can see, its focus is always changing as fields and mission priorities evolve."

Securing global supply chains

CONTINUED FROM PAGE 1

and Physical Review A. Research was funded by DOE's Office of Science, Office of Advanced Scientific Computing Research; the DOE Computational Science Graduate Fellowship; and Sandia's Laboratory Directed Research and Development program.

Optimization algorithms help industry perform tasks like coordinating trucking routes or managing financial assets. These problems are generally difficult to work out, Alicia said, and as the number of variables increases, finding good solutions becomes harder.

One of the potential long-term solutions to solving complex optimization problems is to use quantum computers, an emerging technology which experts believe will be able to find answers to some problems much faster than supercomputers.

But building quantum computing technology is only one of the challenges.

"There's also this other question of: Here's a quantum computer — how do I actually program this thing? How do I use it?" Alicia said.

Better solutions needed for large-scale applications

Researchers around the world are actively developing algorithms for large-scale optimizations on future technologies, with the hope that these programs could help industries manage limited resources more effectively and pivot operations more quickly in the face of rapid changes to the labor market, supplies of raw materials or other logistics.

Mohan Sarovar, the principal investigator on the project, said, "It's very difficult to come up with quantum algorithms. One of the big reasons for this, apart from quantum computing being very unintuitive, is that we have very few general frameworks for developing quantum algorithms."

A leading idea for programming quantum optimization algorithms has involved coupling quantum computers and conventional ones to solve a problem together, called the variational approach. The conventional computer performs an optimization of control settings that dictate the behavior of the quantum computer.

One issue with this approach is that its impact is constrained by the ability of the conventional computer to solve optimization problems with a large number of parameters.

Sandia scientist Kenneth Rudinger, who also worked on the project, said the variational approach might not be practical when quantum computers finally become capable of living up to their promise.

"We have good reason to believe that the size of the kinds of problems you would want to solve is too large for the variational approach; at that scale it becomes essentially impossible for the conventional computer to find good settings for the quantum device," he said.

New framework to solve intricate problems

The Sandia team succeeded in greatly reducing the role of classical computing. With the new framework, called FALQON — short for Feedback-based Algorithm for Quantum Optimization — the classical computer does not do any optimization. It only needs the computational power of a calculator, letting the quantum computer do all the heavy lifting and theoretically allowing it to work on much more complicated problems, like how to efficiently reroute a shipping fleet when a major port suddenly closes.

A framework, in this case, means a structure for how to write an algorithm. Sandia's core concept is for a quantum computer to repeatedly adapt its structure as it moves through a calculation. Layers of quantum computing gates, the building blocks of quantum algorithms, are determined by measurements of the output of previous layers through a feedback process.

"After I run the first layer of the algorithm, I measure the qubits and get some information from them," Alicia said. "I feed that information back to my algorithm and use that to define the second layer. I then run the second layer, measure the qubits again, feed that information back for the third layer, and so on and so forth."

Mohan said, "It defines another class of quantum algorithms that operate through feedback."

Until quantum computers become more powerful, the framework is largely a theoretical tool that can only be tested on problems classical computers can already solve. However, the team believes the framework shows great potential for formulating useful algorithms for the medium-to-large-scale quantum computers of the future. They are eager to see if it can help develop quantum computing algorithms to solve problems in chemistry, physics and machine learning.

Finding purpose in progress

Sandia manager Camron Proctor shares his story as part of the Labs' celebration of Black History Month

By **Camron Proctor**

As an African American, I am conflicted as I look back at U.S. history and consider how Black people have been treated. A history of sanctioned and codified slavery, oppression, discrimination and otherness is not one that immediately fills me — or many others — with national pride.

And yet, I do take pride in our work at Sandia. Our motto is "Exceptional service in the national interest." I genuinely believe in serving our communities and the value of our contributions to our nation and the world.

So how do I reconcile these mixed feelings? When reflecting on our shared history, I acknowledge the bad while seeing a country and institutions grappling with history and some doing the hard work to better align reality with our values. I think about my family's commitment to personal excellence and service to the nation. My enduring hope is that our collective efforts are contributing to creating a better future.

EYE TO THE FUTURE — Camron Proctor, manager of Sandia's Thermal and Fluid Science and Engineering department, with his wife and daughter.

Photo courtesy of Camron Proctor

Family values: Lifelong learning

Education was a big deal in my home growing up. Academic excellence was THE path to elevating yourself, your family and your community. The value of hard work and high achievement was impressed upon us very early: If an A-, why not an A? If an A, why not an A+? And if an A+, is your room clean?

My mother is bright and graduated from high school early, but no one strongly encouraged her to pursue college. Despite the Supreme Court's Brown v. Board of Education ruling in 1954, my father grew up in Arkansas attending segregated schools — until 1969 when he finally attended a newly integrated high school. He too graduated from high school early. Searching for better opportunities than in the divided South, he then moved to California and joined the Marines.

Although my parents did not attend four-year universities or receive degrees, they continuously demonstrated hard work and stressed the importance of not squandering opportunities you are given. Both said more educational opportunities were available to them than to my grandparents, and certainly more educational opportunities were available for myself and my siblings. The three of us have five graduate degrees: three master's degrees and two doctorates.

My father's paternal grandmother lived to be 102 and exemplified our family's value of lifelong learning, even taking classes in her nursing home. She raised her hand one day and corrected the instructor, "That's not how it happened. I was there."

A career journey inspired by service

One unassuming September morning, I was eating Corn Pops as I watched the second tower fall. Even as a 12-year-old, it was clear to me that this was not an accident. The United States was under attack, and in that moment, I resolved to become a fighter pilot.

Despite attaining the necessary grades, I realized that my height — and my penchant for motion sickness — would preclude this dream. You know what they say? If you can't fly 'em, build 'em. Thus, I pursued a career in aerospace engineering instead. In graduate school, I focused on optimization research with an eye toward turbine design.

To be honest, I had never heard of Sandia, but after connecting with one of my advisor's former students, Rad Bozinoski, I completed two graduate internships at Sandia before being hired and finishing my doctorate in engineering. I started my career at Sandia in the Weapons Engineering Rotation Program, which gave me an opportunity to contribute in areas of analysis, systems analysis and systems engineering.

I loved working at Sandia — the people, the projects and the community. However, I kept wondering about aerospace

engineering. In 2021, an opportunity arose to move my family to San Diego (HOME!) and explore aerospace engineering at a consulting firm. It was there that I deepened my knowledge about organizations, strategy, speed, execution and how to work well with customers in a high-stress environment. I also finally contributed to a real propulsion system.

In August 2022, I returned to the Labs, ready to learn another new skill set as a manager. Sandia's hybrid work environment has enabled my family to stay in San Diego. Watching my parents interact weekly — or even daily — with my daughter is a true blessing.

A shared history of exceptional service

Much has changed since that September morning, and my understanding and love of country have become more nuanced. Before accepting the Sandia manager position, I reflected on my role in supporting the Labs' mission. Considering everything I've learned in books (engineering and history) and life (as a student, Sandian, consultant and especially in the summer of 2020), I asked myself, "What is my anchoring motivation for serving the nation?"

GENERATIONAL INFLUENCE — Camron as a young boy with his father and paternal great-grandmother, who lived to be 102.

Photo courtesy of Camron Proctor

At that point, it had been more than 20 years since the 9/11 event that sparked my desire to serve. I had also grown up listening to my family talk about their service: the Marines for my father and two uncles and the Navy for two aunts and my maternal grandfather. I was raised with passion and pride for our country, and my desire to serve has guided my education and career. But as I've grown and learned more about our shared national history and how it has affected my family, I have developed my own passion and pride.

I stood at our biannual (pre-pandemic) family reunion and retold the heartbreaking story of how an ancestor, the youngest boy, was sold away from his family at four years old and never saw them again. Despite knowing that this experience was no aberration, but rather a fundamental tenet of an institution that formed our nation's financial foundation, I still want to serve. I serve because nearly 100 years later — almost by chance — that sold-away child's descendants found the descendants of his siblings and came together to create our current reunion. The nation has progressed.

This progress did not just happen. It is the result of consistent and concerted effort — sometimes through education, building the credibility required to have a seat at the table. More often, progress is achieved via the small and large risks taken by so many to build a better place in a country where they may have felt unwelcome. Ultimately, progress is attained through those — of all ethnicities and backgrounds — willing to do the work to improve upon yesterday for a better tomorrow.

I see a parallel in our work at Sandia. It is filled with innovation and progress. In our culture, I see leaders committing to being more thoughtful, more vulnerable, more open and more willing to make our company better for more people. If I squint, I can even see the nuclear weapons that my department supports as being an analogue. We are in the midst of a significant modernization and improvement process for our deterrents — again, progress.

Black History Month events at the Labs

FEB 15 Black History Month health fair

Wednesday, Feb. 15, 11 a.m.–1 p.m. MT

Kirtland Air Force Base is hosting a health fair at the Base Exchange. A variety of booths from clinics will have booths providing outreach. Blood pressure checks will be conducted for DOD civilians and active-duty members.

FEB 21 3-on-3 basketball tournament

Tuesday, Feb. 21, 11 a.m.–1:30 p.m. MT

The African American Heritage Committee will be hosting the tournament at the Westside Fitness Center on Kirtland Air Force Base. Visit the Black Leadership Committee website to find the sign-up link.

FEB 24 Join the Black Leadership Committee in supporting a local Black business

Friday, Feb. 24, 11 a.m.–1:30 p.m. MT

Join the BLC Outreach team at Frank's Famous Chicken & Waffles in Albuquerque. Seats are limited. Email or call Leslye Collins by Feb. 17 to RSVP.

FEB 28 Black History Month luncheon

Tuesday, Feb. 28, 11 a.m.–1:30 p.m. MT

The African American Heritage Committee will wrap up Black History Month with a luncheon and surprise guest speaker at the Mountain View Club.

Preventing the next pandemic

Federal agencies, labs examine climate-driven zoonotic risk

By **Diana Hackenburg**

Sandia biodefense program manager Cathy Branda knew the question of climate change possibly setting in motion the next pandemic occupied the minds of many federal government stakeholders. In response, she brought together stakeholders interested in discussions to chart a course for future research and collaboration.

According to the Centers for Disease Control and Prevention, an estimated 75% of emerging infectious diseases, including COVID-19, are zoonotic, meaning they spread from animals to humans. Rapidly changing environmental and social conditions driven by climate change could increase the risk of pathogens being transmitted from animals to humans, Cathy said.

Managing these climate-driven zoonotic risks was the focus of a two-day workshop organized by Cathy and a team of Sandians in July. Participants represented 11 federal agencies and six national laboratories, including Sandia, Lawrence Livermore, Lawrence Berkeley, Los Alamos, Oak Ridge and Pacific Northwest. Sandia released a report on the workshop in December.

"Everyone was excited by the idea of bringing a community together to address this," Cathy said. "They all have their own piece of the pie, and they knew it interconnected with others."

Sandia was well positioned to fill that integrator role as a federally funded research and development center with a mission to address homeland security by understanding and countering biological threats. The work also draws on Sandia's capabilities in atmospheric monitoring, climate modeling and bioscience. The specific focus on climate-driven zoonoses also intersects with other strategic work across the Labs to promote climate security nationally and globally.

PLANNING TEAM — A Labswide team of Sandians led planned and executed the workshop including, from left, Jessica Baxter, Jazmine Price and Jessica Techel. **Photo courtesy of Diana Hackenburg**

Spillover effects

Georgetown University assistant research professor Colin Carlson, who studies the relationships between climate change and zoonotic disease, began the workshop with his keynote address.

Carlson said researchers have underestimated the link between climate change and zoonotic spillover by focusing primarily on exposure at the animal-human interface. Climate change will also alter exposure patterns between wildlife species, he said. In the Arctic, for example, melting sea ice is causing seals to move to new areas, exposing sea lions and sea otters to a deadly viral disease.

That's not just bad news for susceptible wildlife populations — these jumps between hosts could make it easier for viruses to reach humans. Fortunately, Carlson said, people already do many of the activities required to solve these climate-driven zoonotic risks; they just need to be more targeted with their efforts.

Anthony Falzarano, a Sandia systems analyst, saw this issue come up in various ways in reading he did to prepare for the workshop. That review, along with briefs given by federal agency representatives at the workshop, revealed the growing importance of the One Health model in recognizing the inextricable linkages between human, environmental and animal health.

"It's a paradigm shift in how we look at these risks," Anthony said. "You can't address any one aspect of that triangle without addressing all of them. We need to break down the silos between government agencies to streamline and integrate detection and response."

Cathy agreed, saying COVID-19 is an example of where a more targeted, centralized early response could have

made a difference. "There's renewed interest across agencies to get ahead of the problem, as well as concrete ideas about how to get ahead of the next pandemic. Everyone has limited resources on their own, but together you can do some pretty amazing things," she said.

Integrating data to inform preparedness

In preparing for the workshop, Cathy also conducted more than 80 interviews with stakeholders across many different federal agencies. One common theme that came up repeatedly in interviews and the workshop was the idea of better standardization, integration and sharing of existing and future data.

"I think an 'aha!' moment for me was that there's lots of data out there that people are not taking advantage of," Cathy said.

For Cathy, this included learning about the many types of relevant data collected by the DOE national laboratories. Sandia, for example, has translated the atmospheric research capabilities developed in the 1950s for nuclear testing into a robust climate monitoring program that uses innovative technologies, such as distributed acoustic sensors and tethered balloons. Sandia also develops assays and deployable platforms that can be used to detect viruses and bacteria in people and the environment.

Improving the knowledge of and access to all this existing data can make efforts to understand risk more efficient and effective. Similarly, it makes it easier to identify actual data gaps that might require new forms of data collection.

In addition to collecting environmental and biological data, Sandia offers experience in data integration and analytics. "We have got a group working in the area of understanding how data can be integrated across disparate places to create much better disease models that actually correlate to data being collected in the field," Cathy said.

"We are the ones who can take all this data and put it into a system-of-systems model," Anthony said of the national laboratories. In addition to our top-notch researchers, he said, the national laboratories are a trusted source of unbiased information and innovation that could be used both by the federal government and communities to prepare for countering climate-driven zoonoses.

WORKSHOP SUCCESS — In July, Sandia brought together federal employees and DOE lab scientists to discuss their roles in managing climate-driven zoonotic risks. More than 80 people participated in the workshop, representing 11 federal agencies. **Photo by Jazmine Price**

"The idea is that we can use these models to create tools that could be used even by under-resourced communities to respond and deal with these issues in their local jurisdictions," Cathy said.

Catalyzing collaboration through community

One of the big successes of the workshop was the opportunity for those interested in this topic to connect and identify possible areas for coordination and collaboration, Cathy said. "We know that there's already been some interesting connections made, and we hope that those continue to be developed."

To keep those conversations going, Cathy and her team are planning a series of meetings to dive deeper into specific themes, such as data standardization, integration and modeling needs.

There's also been a push to create an interagency working group to spearhead some of the challenges identified through the workshop. Anthony said this group could play an important role in building a community that brings these issues to the forefront of the global health security agenda — and to the attention of potentially interested early- to mid-career professionals.

"A lot of people don't quite know that this space exists," he said. "I think many lawyers would be interested in global health law and many researchers would want to do One Health research if they knew more about it. We need to show them there is a career path."

Cathy attributed the success of the initial workshop and any follow-on efforts to the support provided by the team of research, business development, executive protocol and communications staff at Sandia. "It was definitely a team effort."

"It was clear to me if we ran with this idea that there would be a lot of resonance across these agencies. I hope the participants saw themselves in what could become a much larger vision."

Learn more about efforts to manage climate-driven zoonotic risk by reading the full workshop report.