

Modeling terrorist behavior with Sandia social-cultural assessments

By **Mollie Rappe**

Part of what makes terrorists so frightening is their penchant for unpredictable, indiscriminate violence. One day they could attack a global financial center. And the next they could hit a neighborhood bike path.

A team of Sandia social-behavioral scientists and computational modelers recently completed a two-year effort, dubbed “Mustang,” to assess interactions and behaviors of two extremist groups. The purpose was to inform U.S. and U.K. decision-makers about the group’s possible reactions to specific communications. The model suggested several communication options that are most likely to reduce the recruitment and violence of the extremist group over time.

“Extremist groups are tricky to model. We can’t give them surveys. Their behaviors are purposefully hidden from us. They try not to let us know how their organizations are structured,” said Asmeret Naugle, a lead modeler for this effort.

The Sandia team, which includes psychologists, sociologists, economists and computational modelers, integrated information gathered from experts with equations based on leading theories of human behavior and human decision making to create their dynamic cause-and-effect model. Then they ran many simulations to see how different U.S. and U.K. actions might affect the recruitment and violence of the extremist group and a faction within it.

“It’s not a crystal ball. We model how humans make decisions at many scales. We take well-established theories to help model individual leaders, groups, even whole countries depending what the question requires,” said Mike Bernard, a computational psychologist and principal investigator for the overall effort.

Model tailored to answer specific questions

Before the team begins, they sit down with the sponsoring agency to determine the precise questions they want the model to answer. They sort out everything from the main question and secondary



MODELING BEHAVIOR — Mike Bernard, left, and Asmeret Naugle translate a web of psychology, social science, economics and politics into a framework to better understand how groups make decisions. **Photo by Randy Montoya**

questions, to the bounds of the region of interest and the time range of the model, Mike said.

The research is also reviewed and approved by Sandia’s Human Studies Board.

The Mustang effort was sponsored by the United States’ Counter Terrorism Technical Support Office and the United Kingdom’s Defence Science Technical Laboratory. Together they defined the range and scope of the model, but the U.K. laboratory also had a secondary goal. They sent a social scientist, Grace Williams, to Sandia to learn how the team develops its dynamic behavioral models, from start to finish, as well as the model’s strengths and limitations.

“Working with Mike and the Sandia team was a great experience,” said Williams. “Being able to learn from a multidisciplinary team and contribute to an innovative process was incredibly valuable. Not only did the project accomplish its goal in determining the utility of the model for the military, but it also enhanced my understanding of the value of combining social science with computational models to provide a deeper understanding of group behavior.”

Mike’s team consults with experts with different perspectives and backgrounds. For Mustang, they

interviewed experts from the U.S. intelligence community, the departments of State and Defense and the U.K. Ministry of Defence.

The team has a formal, consistent way of gathering information from experts. This allows them to more easily compare and contrast the experts’ knowledge and identify conflicting areas that might require additional analysis or information, Asmeret said.

Next, the team captured knowledge from these diverse experts, as well as information from other sources, to devise mathematical equations that are incorporated into the modeling framework. The framework takes into account perceptions, motivations, past behaviors and even irrationality, Mike said. It is based on well-established theories across the social-behavioral sciences, including psychology, sociology, behavioral economics and political theory, when it makes sense, he added. The team has been working on the general framework for about 10 years.

Once the interactions between groups and their decision-making processes are captured within

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Sandia Labs spending tops \$1 billion, economic impact booms in FY18



BUSINESS IMPACT — Sandia engineer David J. Martinez, center, shows Westwind Computer Products Inc. President Steve Hull and CEO Frances Jaramillo aspects of the Astra supercomputer. Westwind, based in Albuquerque, has partnered with Sandia since 1999.

Photo by Rebecca Gustaf

By **Michael J. Baker**

Sandia spent nearly \$1.3 billion in goods and services in fiscal year 2018, with spending on New Mexico companies up by \$55 million compared to the previous year, according to the Labs’ latest economic impact report.

“We had a really good year and topping \$1 billion with nearly half a billion for New Mexico businesses is a significant milestone,” said Jodi A. Maheras, supply chain director. “Sandia’s supply chain is built on a diverse supplier community to achieve our national security mission and further economic prosperity.”

Sandia spent more than \$1.18 billion in subcontracts and \$88 million in procurement card payments, for a total of \$1.27 billion in goods and services from suppliers in fiscal year 2018, up about \$93 million from the previous year. Combined subcontract and procurement card purchases to New Mexico businesses topped \$475 million.

The 2018 data, reflecting actual payments made, is based on Sandia’s fiscal year from Oct. 1, 2017, to Sept. 30, 2018. The data is available with breakdowns of Sandia’s spending in the 2018 Sandia National Laboratories Economic Impact brochure, which spotlights the Labs’ role in the economy.

New Mexico businesses received more than \$462 million in subcontracts, or 39 percent of the total subcontracting amount. New Mexico small businesses

— CONTINUED ON PAGE 2

“White Christmas” and a wish for current and future generations

By **Pam Hansen-Hellwege**



January is a wonderful month. It begins the year ahead with hope for the future. Whether the hope is personal, perhaps in the form of a resolution or goal, it can also have a larger reach, a bigger audience. For those of us in the United States, a major January milestone is the celebration of Martin Luther King Jr.’s birthday on the third Monday of the month. His actual date of birth was January 15, 1929. Ninety years later his influence on the course of history continues.

While quantifying things numerically makes many of us feel secure, confident in our understanding and willing to extrapolate on the basis of how, over the decades, his life has influenced history, a recent event underscores for me both the personal and global audience of King’s influence.

As part of the seasonal activities in December, I joined a multi-generational group of friends to watch White Christmas at a large Albuquerque movie theater. Our diverse group included two children, ages eight and ten, four millennials and two baby boomers. The eight of us represented about one-third of the total audience in the theater. There I go quantifying things again.

My friend and I — the baby boomers — and one millennial were the only ones in our group who had seen the movie before, and so it was easy to ask the others over ice cream after the movie, “How did you like it?”

It immediately became clear that the children did not like the movie or any aspect of it. From their point of view the costumes were not interesting, the music was not memorable and the storyline of falling in love was missed entirely. However, the millennial moviegoers who saw it for the first time had a completely different impression than the children. They each made direct eye contact with me and said it was a really white Christmas with no one else — no Asian, no Hispanic, no black people or any diversity. We think the dancing guy (Danny Kaye) might be gay, but we’re not sure.

As the conversation drifted to what America represented in 1954, the year White Christmas was released, there was general astonishment that the movie may have been marketed to a very “white”

America and that representation for all citizens only came to the forefront with activism by the Southern Christian Leadership Conference.

As I sat stirring my ice cream into slush and only half listening to the conversation around me, I was struck by the truth of my friends’ critique of the movie. World War II provides the foundation of the movie’s plot, and yet I could not remember seeing any diversity among the soldiers depicted in the movie. The kids, as I now lumped the millennials and children into a group, have not seen movies, television or other media in their lifetimes that have been cast so narrowly. Their sphere of entertainment includes people from all walks of life, not just one. The same holds true for their dining experience, right here, right now, at the ice cream parlor and not at a segregated lunch counter in Alabama.

Hope burns in my heart that there are at least two generations of citizens that I interact with on a regular basis that see a whole community of people when they look at the horizon. Hope fuels my thoughts as I re-think my favorite holiday movie of all time to be Polar Express and no longer White Christmas. Hope enters my prayers that we will continue to have the courage of our convictions to make the world a better place for all of us, just as Dr. Martin Luther King Jr. envisioned. 

“I have a dream that my four children will one day live in a nation where they will not be judged by the color of their skin but by the content of their character.”

— Martin Luther King Jr., I Have A Dream speech, August 28, 1963.

Economic Impact

CONTINUED FROM PAGE 1

received more than \$317 million, or 69 percent of payments to New Mexico companies.

U.S. small businesses, including those in New Mexico, received 55 percent, or \$656 million, of all Sandia subcontract spending.

Compared with fiscal year 2017, subcontract spending was up more than \$57 million with New Mexico businesses and up nearly \$50 million with the state’s small companies, while procurement card purchases to New Mexico businesses were down over \$2 million because of a switch to payments based on subcontracts rather than procurement cards. Total U.S. small business spending increased by more than \$75 million.

“We continue to set and achieve ambitious small-business goals,” said Paul Sedillo, who manages small business programs. “This past fiscal year we increased spending in many major small business categories, including Woman-Owned Small Busi-

ness, Historically Underutilized Business Zone (HUBZone) company, Small Disadvantaged Business, Veteran-Owned Small Business and Service-Disabled-Veteran-Owned Business.”

Small businesses, diverse suppliers wanted

Sandia supplies small and diverse business owners with information on doing business and seeks capable local suppliers through a variety of programs, such as public forums with suppliers and civic leaders to discuss subcontracting opportunities and listing opportunities on its website.

In October 2016, Sandia began hosting open houses to meet personally with business owners and representatives. During fiscal year 2018, more than 550 visitors from more than 360 companies attended, meeting with subcontract professionals, supplier diversity advocates, other Sandia personnel and members of the Labs’ partner, the New Mexico Procurement Technical Assistance Center.

In fiscal year 2018, Sandia added more than 460 new small businesses to its supplier base. Small businesses represent 65 percent of all Sandia suppliers.

Sandia’s overall economic impact in 2018:

- About \$1.95 billion was spent on labor and non-subcontract-related payments.
- More than \$1.18 billion went to subcontract-related payments.
- More than \$95.1 million went to the state of New Mexico for gross receipts tax.
- About \$88.1 million was spent through procurement card purchases.

The report demonstrates Sandia’s continued commitment to small business, Paul said. Sandia’s Supplier Diversity department oversees and negotiates small business subcontracting goals with the NNSA, which promotes use of small businesses, including those that are small disadvantaged, owned by women or veterans and service-disabled veterans, and small businesses in impoverished, HUBZone areas.

“Looking forward to fiscal year 2019, Sandia is committed to seeking, growing and partnering with the small business community,” Paul said. “Small businesses in our country, particularly here in New Mexico, have a major impact to Sandia and its mission. Our economy is stronger when small businesses are prospering, and Sandia is proud to be a part of those successes.”

Sandia also helps the state’s economy through the New Mexico Small Business Assistance program. In 2000, the state Legislature created the Laboratory Partnership with Small Business Tax Credit Act to help companies get technical support



from the national labs. In 2017, the Sandia NMSBA provided \$2.4 million in assistance to 188 small businesses in 21 New Mexico counties. Since 2000, Sandia has provided \$36.4 million in assistance in all 33 counties.

Sandia job growth bolsters local economy, giving

Sandia spending on New Mexico labor topped \$1 billion as hiring and the number of employees increased at the Labs. Sandia made 2,342 hires in fiscal year 2018, 350 more than in fiscal year 2017.

Those hires include regular and limited-term employees, students, postdoctoral researchers and faculty, bringing the total of Labs employees to 12,769, an increase of more than 500 since last fiscal year and 750 since fiscal year 2016.

The Labs will continue to grow, and Sandia’s population will likely top 13,000 this fiscal year, as Sandia anticipates hiring about 1,800 employees. Student positions could account for 700 to 800 additional hires, bringing the number of anticipated hires in fiscal year 2019 to more than 2,500.

Sandia employees gave more than \$4.5 million in 2018 to nonprofits in New Mexico, California and the nation. Sandia also provided \$1.4 million in corporate contributions to support the work of local nonprofits. The labs’ K-12 science, technology, engineering and math programs encouraged thousands of students to consider STEM careers. In addition to other community volunteer projects, Sandia gave more than 1,000 retired computers and accessories to more than 40 New Mexico schools, and employees donated 4,000 holiday gifts to children in need.

“Sandia is committed to our communities,” said Delfinia Salazar, senior manager for supply chain. “We value our existing relationships and will continue to grow those partnerships as we continue to be fully committed to maximizing business opportunities and making a difference to local and national economies.” 



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Heat it and read it

Story and Photo by **Jules Bernstein**

You're sweating and feverish, and have no idea why. Fortunately, Sandia scientists have a device that can pinpoint what's wrong in less than an hour.

Unlike most medical diagnostic devices, which can perform only one type of test — either a protein or nucleic acid test — Sandia's SpinDx can now perform both. This allows it to identify nearly any cause of illness, including viruses, bacteria, toxins or immune system markers of chemical agent exposure.

The new addition of a heating element allows SpinDx to do nucleic acid tests, which search for genetic codes found in any kind of virus, parasite or bacteria. The technology also can detect toxin proteins at the same time, and determine whether they are active or not — a critical distinction for correctly tailoring the level of medical response.

The device's portability, affordability, rapidity and reliability are critical for addressing infectious disease outbreaks in places most affected by them and least able to afford a laboratory with traditional instruments. In developing nations, diarrhea is the second leading cause of death in children under age 5, according to World Health Organization reports. These deaths are largely preventable when the causes are detected and treatment is administered early.

Helping save these lives is why Sandia's scientists decided to test the new SpinDx capabilities on potential causes of diarrheal disease. Sandia's

research shows SpinDx successfully detects both diarrhea-causing toxins and bacteria in stool samples. Results of these tests were recently published in the journal *Biosensors and Bioelectronics*.

Spinning toward solutions

SpinDx looks a bit like a DVD player inside a weather-resistant plastic case. It features a disposable disc that distributes drops of raw, unprocessed biological samples into different channels that function, according to Sandia chemist Chung-Yan Koh, like “dozens of tiny test tubes.”

The automatic distribution step is a great time saver. Chris Phaneuf, a former Sandia bioengineer, explained. “Instead of having to drop processed samples one by one into dozens of tiny chambers, you can load one raw sample into a single, central port that evenly distributes your sample into every channel.” Phaneuf is now senior fluidics engineer at Illumina in San Diego, where he develops technologies for genetic research.

When the disc spins, the samples interact with test reagents inside the channels, and, as Phaneuf puts it, “if there's a match, they'll attach.” In other words, if there is a chemical interaction between the sample and reagent, a red laser causes the tip of the channel to glow, signaling an infectious agent to a software interface that displays the result.

Previously SpinDx performed only protein tests, which look for pathogen-specific proteins and antibodies. Antibodies are proteins manufactured by immune systems in response to infections. When

viruses later disappear from the blood, the antibodies that flushed them are still detectable. Protein tests also can identify lethal toxins like botulinum neurotoxin, a teaspoon of which has the potential to kill around 100 million people.

Shining a LAMP on symptoms

Thanks to its new heating element and ability to do a new assay, SpinDx can conduct nucleic acid tests able to identify the virus or bacteria responsible for causing symptoms like diarrhea.

“It's much quicker to detect the causative pathogen in a sample than to wait for a body to produce antibodies to an infection,” Phaneuf said. “Being able to do

both kinds of tests paints the most complete picture of what's in a person's system.”

Conventional viral testing (via polymerase chain reaction or PCR) requires heating and cooling a biological sample many times to multiply any viral DNA or RNA to detectable levels. Phaneuf and Chung-Yan implemented a new, Sandia-developed assay and detection scheme in the SpinDx update, which uses chemistry that requires heating the sample only once.

In other systems, the loop-mediated isothermal amplification (LAMP) method of heating a sample takes place atop a small heating block that creates a single, uniform temperature inside a device. SpinDx uses a tiny infrared heat emitter that hovers at the top of the device, targeting the part of the spinning disc performing the test and nowhere else.

Being able to control the heat flow allows for different temperature zones inside SpinDx, enabling the simultaneous nucleic acid and protein tests.

Nucleic acid tests require a temperature that would ordinarily destroy a sample's proteins.

A diagnostic revolution

SpinDx has been licensed by industry partners for uses as diverse as male fertility testing and water supply safety monitoring.

With its new capabilities, SpinDx has the potential to improve diagnostic problems in settings around the world, and not just for humans.

Phaneuf described a highly contagious virus ravaging goats and sheep in parts of the world where those animals are central to peoples' livelihoods. These communities often don't have access to a laboratory, but this tool could quickly diagnose their animals and allow for proper treatment.

Sandia is also using the technology for research into applications as diverse as bioenergy and chemical warfare detection. In the former case, scientists are using SpinDx to search for predators that could cause the crash of algae being cultivated for biofuels and renewable chemicals.

In the latter case, Chung-Yan is testing soldiers for exposure to chemical warfare agents. The project, funded by the Defense Threat Reduction Agency, will use SpinDx to search for biomarkers of exposure. Temperature control in this research is essential because it makes the test more precise, Chung-Yan said.

In addition, there is a very short window for treatment should a soldier be exposed to a chemical agent. The speed with which SpinDx can deliver results could help ensure the treatment is administered in time for it to be effective.

The ability to accurately conduct all these tests at the same time in one portable device and read the results in an hour or less sets SpinDx apart from other available systems. Traditionally, these results have required a well-equipped laboratory staffed with experienced technicians.

Chung-Yan and Phaneuf said they'd like to see batteries and solar panels added to SpinDx, making it deployable almost anywhere. It could one day even help a doctor quickly determine whether sickness symptoms are from flu, food or something else entirely. 



BRAND SPANKING NEW — Sandia chemist Chung-Yan Koh (left) and former Sandia bioengineer Chris Phaneuf hold the newly updated SpinDx diagnostic device.

Modeling terrorist behavior

CONTINUED FROM PAGE 1

the computer model, the team confirms a visual representation of the model with the experts. Mike said, “Ultimately you have a very complex web of interactions. If you have a visual way of looking at everything, then the experts can examine it, critique it and change it.”

Then the team runs numerous simulations to look at potential U.S. actions and the results. “Because we model the psychology and why people are making decisions, we can go back and understand why things might happen,” Asmeret said. “The most useful thing we can find out is: Are there unanticipated consequences?”

For Mustang, they investigated different communication plans. Communications can range from public service announcements and other traditional broadcasts, to social media campaigns, speeches or even word-of-mouth. Ultimately, the team presented its findings for different communication plans that best reduce the recruitment and violence of the extremist group to decision-makers in the U.S. and U.K.

Williams hopes the collaboration between her lab and Sandia will continue for many years. She said she found both the model development process and the results generated by the models quite useful.

Continually improving the framework and applying it to different questions

The team has used the same dynamic behavioral assessment framework to answer many national security questions in the geopolitical realm, from propaganda and cyberterrorist attacks to factors affecting country stability, and many others. However, because the underlying principles of how people make decisions are essentially the same, they have also used the framework to study a few questions not related to national security.

For example, in 2015 they studied how different public service announcements would affect rates of teenage smoking as a part of a larger project for the Food and Drug Administration. They found that even modest increases in anti-smoking public service announcements can decrease the amount of positive talk about smoking within the modeled group of teens, and increase the number of teens who have never smoked by the end of the model's

time frame. Their results were published in the Proceedings of the 2015 Winter Simulation Conference.

One challenge they have, Mike said, is making sure the model has as much theory as it needs to be accurate, without throwing in behavioral or political theories that aren't needed. Also, because scientists are continually learning about how humans make decisions and interact in groups, the underlying framework will never be completely finished, he said.

The Sandia team is trying to improve the framework to make it quicker and easier to produce a final model and results. It now takes at least two months to build a new model, which is often too slow when answers are needed immediately.

Some of the methods that Asmeret has considered for speeding up Sandia's process include incorporating machine learning and text analysis capabilities to make data collection faster. She added it wouldn't be helpful for every question, but it could be a big time-saver for some tasks, such as determining opinions about smoking by analyzing vast quantities of social media posts.

“It's really important to make sure that we understand the human side of the systems that Sandia works on,” Asmeret said. 

Sandians Receive NNSA Defense Programs Awards of Excellence



Sandia is celebrating the Labwide recipients of the NNSA Defense Programs Awards of Excellence for 2017, based on teams' contributions to stockpile stewardship. Four Sandians and 21 multimember Sandia-led teams are being honored, totaling more than 600 participants.

These prestigious, annual awards are granted to Nuclear Security Enterprise teams nominated from across the complex. They are selected by NNSA representatives from the office of Phil Calbos, NNSA's acting deputy administrator for Defense Programs.

Winning teams meet stringent eligibility criteria, require written justification and go through a

competitive process. The tradition started in the 1980s when Maj. Gen. Ted Hoover created the Department of Energy Weapons Program Excellence Award. Today, the awards honor the ingenuity and innovation of NSE's world-class talent who every day make positive advances benefiting U.S. national security in an everchanging and complex global environment.

Seven of Sandia's award-winning teams include members from outside Sandia, including representatives from Los Alamos National Laboratory, Kansas City National Security Campus, NNSA, U.S. Navy, U.S. Air Force and the University of Michigan. [f](#)

INDIVIDUAL HONOREES



Scott Coffman

Scott distinguished himself through strong technical knowledge, superb interpersonal skills, professionalism and a work ethic that had exceptionally positive influence on the B61-12 program.



Matthew Kerschen

Matt's engineering excellence and extraordinary leadership were critical in successfully navigating through many technical and programmatic challenges in the B61-12 Life Extension Program.



Jeffrey Meador

Jeff has a very strong safety and security focus, is the most technically proficient member on a very strong team and has significantly contributed to the success of the B61-12 Life Extension Program.



Albert Owen

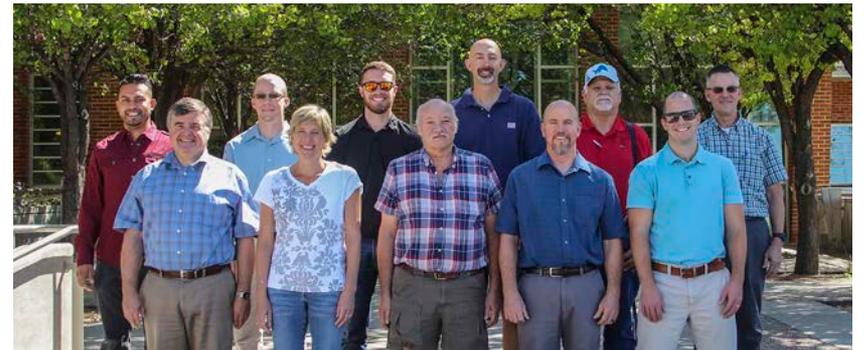
Albert's excellent organization and management skills were crucial to guiding the B61-12 through an ambitious schedule with challenging programmatic and technical delivery requirements.

TEAM HONOREES



Neutron Threat Circuit Simulations for the W88 ALT370 Team

In support of qualification of Arming Fuzing & Firing components for the W88, members of the Qualification Alternatives to the Sandia Pulsed Reactor project team predicted the response of circuits with heterojunction bipolar transistors in hostile neutron environments. This is the first time that circuit-level simulations for such environments were made to support qualification. These simulations were made possible by significant advancement in our understanding of the physics of neutron-induced damage in electronics. The QASPR project discovered a new type of radiation damage, single neutron displacement effects, that cause stochastic variation in the radiation response of transistors.



Dev. of a New Multi-Axis Capability for Qualifying Systems to Hostile Shock Team

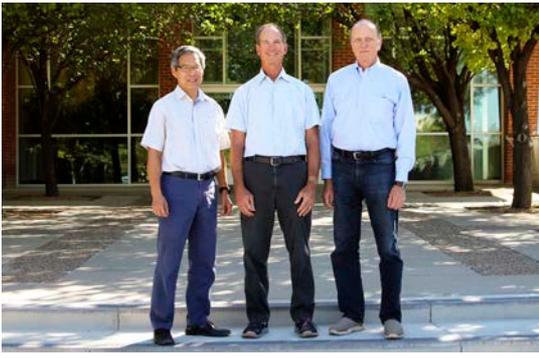
A new capability was successfully developed at Sandia to support the qualification of hardware to hostile shock environments. This new capability greatly reduces the cost of the qualification process while increasing the quality, productivity and safety of the process. The new capability combines Finite Element Analysis with Resonant Plate Testing to change the way hardware is qualified. It is now a much safer and less costly test due to elimination of explosives and minimizes the number of units needed for testing. The new capability also greatly improves efficiency while allowing for hardware functionality to be assessed during the test.



Tonopah Test Range — Operations and Mission Support Integrated Test Team

Tonopah Test Range successfully accomplished 100 percent of assigned flight testing in 2017. These flight tests were vitally important for national nuclear weapons development. The innovative and professional staff at TTR coordinated countless program details, including extensive teaming with Air Force, customer and mission support partners. The team meticulously developed procedures involving joint recovery planning across nine organizations, with unique recovery area remediation efforts incorporated into the processes. TTR technical and mission support teams innovatively

sustained the range infrastructure, systems and facilities to meet an ever-expanding mission set. TTR completed major technical and systems improvements, from fiber integration sensor sites to integration of four remote sensor systems, achieving organic remote functionality and standardizing configuration on optical systems. The team members exemplify the value sets and professionalism, and Team Tonopah repeatedly exceeds the standards of NNSA and the Lab's customers.



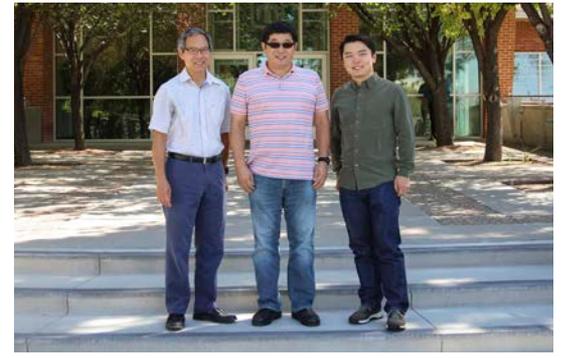
B61-12 Nose Bomb Subassembly Mechanical Analysis Team

Multiyear efforts by the B61-12 Nose Bomb Subassembly Mechanical Analysis Team at Sandia provided key insight and performance margin evaluations in stockpile-to-target environments. High-fidelity finite element models predicted detailed response of the NBSA through the final design evolution. Margin evaluations were conducted with thousands of impact simulations using 13.2 million CPU-hours on supercomputers at Sandia and comparable resources at Los Alamos National Laboratory. Simulation results showed that the final design of the B61-12 NBSA met its performance requirements over the full range of impact conditions. As a result, the performance capability of the NBSA for its intended impact space was established, contributing to the overall capability of the B61-12 system.



B61-12 Cybersecurity for Aircraft Integration Team

The team developed a cybersecurity approach to meet USAF requirements to connect and remove NNSA B61-12 test assets to and from USAF aircraft and system integration labs (SIL). The team coordinated technical information on test assets and ground support equipment used for testing with USAF aircraft and SILs, including a first-of-its-kind mobile ground station being used on the flight line. B61-12 test assets were successfully integrated with and removed from aircraft and SILs, including data for the B-2A Weapon System Sustainment Center, a first for any program since its inception in 1990. Team efforts support numerous activities required for B61-12 qualification, nuclear certification and keeping program activities on schedule. The team's coordinated efforts are an identifiable and significant achievement and contribution to addressing cybersecurity as a key emergent area of enhanced surety for the B61-12.



B61-12 Ground Fuzing Development Team

The B61-12 Ground Fuzing Development Team has made a substantial breakthrough that has resulted in increased quality and surety for the B61-12. This breakthrough involves properly quantifying the mechanical stimulus that is generated in a ground impact, ranging from water to reinforced concrete targets. Prior to now, defining the mechanical environment necessary for the B61 to generate a ground impact fuzing signal had always been a difficult challenge. Performing expensive impact and flight tests to verify ground fuzing requirements never provided an understanding of the mechanical response that causes the impact sensors to produce fuzing signals, making it a challenge to know how sensitive an impact sensor should be designed to meet requirements. However, through the team's creative approach, they were able to overcome this challenge.



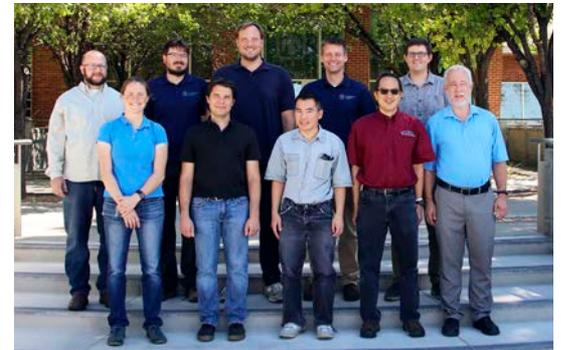
Enterprise Modeling Team

NNSA had to evaluate the ability of the national security enterprise to meet proposed requirements that would result from the new Nuclear Posture Review. Given the significant changes to the geopolitical environment, more options were sought to ensure continued deterrence. This team supported the NNSA NPR team by developing detailed stockpile requirements for the proposed options, as well as an estimate of design agency capacity utilization. The team also collaborated with all the other NSE sites to facilitate input into the enterprise modeling and analysis consortium tools and moved the information out of the tools and into a presentation-ready format for NNSA to incorporate into the final document that was presented to the NPR team. The team accomplished this large suite of work within four weeks to meet NPR schedule demands.



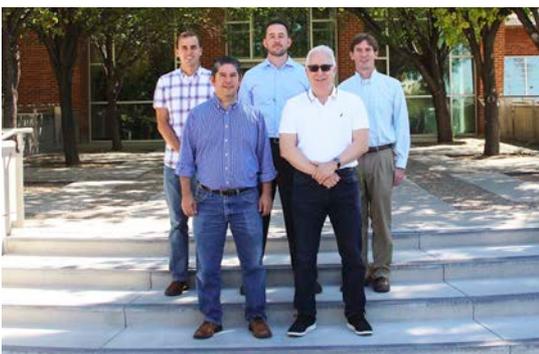
RT-2 Test Team

RT-2 is a critical test series in the radiation qualification of the W88 ALT 370 system. This test series was successfully executed and completed over a three-month test window using three facilities: HERMES III, Saturn, and ACRR. All objectives were successfully met, including secondary objectives. In order to successfully execute the RT-2 test series, the team needed to make changes to the approach used in its predecessor, including developing additional external support hardware, developing new previously unused flight sequences, modifying test units, and working closely with the test facilities to reduce risks in their execution. All of these modifications and progressions were realized in an extremely time-constrained schedule that had firm start and finish dates for facility activities.



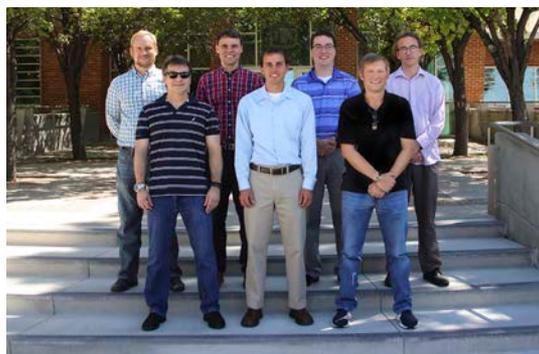
Sierra Solid Mechanics Team

Sierra Solid Mechanics Team developed reliable and credible production capability contact algorithms that enabled extreme deformation simulation in B61-12 Nose Bomb Subassembly impact fusing. This capability allowed analysts using modeling and simulation, for the first time, to sample the entire v-gamma map as part of the Mod Sim plan for B61-12 qualification. It was used by Engineering Science analysts to sample the conditions of velocity-impact angle (v-gamma map) possible in the normal mechanical environment. Reliable simulations of extreme deformation events have been a historical challenge for mechanics numerical simulations. Continued refinement of contact and fracture simulation are essential for improved analysis and design.



Novel Target Design Exceeding 30 Mega Amps on Z Team

A breakthrough in 2017 was the realization of a class of pulsed-power targets for which electrical losses are extremely low. Using numerical modeling tools, an experiment was designed to reduce initial inductance, and thus the inductive voltage driven back on the power feed where losses may occur. This target was fabricated and fielded at the Z pulsed-power facility and achieved more than 30 mega-ampere peak electrical current coupled to the load, which is a record for an imploding, magnetically-driven target. This approach facilitated record warm x-ray yields, supporting nuclear survivability research at Z. The idea was also spun off to other programs, including inertial confinement fusion, which then demonstrated increases in peak current of 4 MA. It is a very powerful idea that electrical losses can be essentially mitigated through target design, which optimizes drivertarget coupling. This suggests that as we consider a next-step pulsed-power facility, there will be classes of X-ray and neutron sources for which very low losses are achievable.



Z-Circuit-Model Development Team

The Z-Circuit-Model Team has developed a revolutionary physics-based transmission-line-circuit model of the entire 85-terawatt 25-megampere Z pulsed-power accelerator. The model is the most advanced such model ever developed by the entire international pulsed-power community, throughout the entire 60-year history of pulsed power. The model has become the baseline circuit model of Z. As such, the model is used to design Z experiments and analyze the results. The model has been incorporated into the Chicago, Gorgon, and LASNEX codes, and is used to drive physics simulations conducted with the codes in support of Z shots. The model represents the entire 33-meter-diameter Z accelerator, everything from Z's 36 Marx generators to the physics load. The model comprises more than 100,000 circuit elements altogether. The model can be used to simulate an entire Z shot on an office computer in 100 seconds. Results of Z-circuit simulations agree with data acquired on Z to within 2 percent.



Power Flow Physics and Spectroscopy Team

The team developed more than one dozen new diagnostics to characterize the environments in the transmission line regions of the Z facility. Previously, power flow through these regions was characterized by one or two diagnostics. These unprecedented diagnostics are providing new insights into the plasma conditions, existence and timing of negative and positive particle current losses, and providing direct and unambiguous measurements of the current that is actually coupled to the targets. This instrumentation will enable the science underlying power flow, current loss, and target coupling to be validated with direct measurements for the very first time. The validation data will inform improvements on Z power flow and power flow designs for next generation systems such as Z. Next, plasma formation in all high voltage applications (e.g., radiography), and power flow in transmission lines for explosive pulsed-power high-current generators.



Advances in Magneto-Inertial Fusion Targets on Z Team

Magneto-inertial fusion has long been proposed as a promising path to fusion since it relaxes many of the difficult-to-achieve requirements for thermonuclear ignition and burn. In the past year, this team has made remarkable progress advancing magneto-inertial fusion on the Z machine. With the unclassified Magnetized Liner Inertial Fusion concept, the team demonstrated a 25 percent increase in neutron yield over previous record highs. With another classified concept, a 50 percent increase in neutron yield over previous record highs was demonstrated. Furthermore, both increases were consistent with simulation code predictions. These results are helping build a strong case that scaled, pulsed-power-driven magneto-inertial fusion targets could provide transformative testing capabilities for stockpile stewardship that do not currently exist, and at a fraction of the cost of other approaches.



B61-11 JTA Surveillance Cable Pulldown Test Team

In 2017, the Sandia Validation and Qualification Group successfully completed the B61-11 Joint Test Assembly surveillance test, a rocket-assisted pull down at Sandia's Aerial Cable Facility. Control of impact conditions replicates extreme worst-case environments, enabling evaluation of the system at drop conditions not achievable elsewhere. The B61-11 JTA was suspended from wire cables at a height of more than 400 feet after being temperature conditioned, and was accelerated into a massive concrete and soil target. Impact speed was measured at within 1.1 percent of the desired impact velocity, which is an unprecedented level of control. Resources from across the Labs were instrumental in providing critical support in the areas of target fabrication, industrial hygiene, ES&H, radiological protection, emergency operations, fire protection, and safety engineering. The partnership between the Validation and Qualification Group, the Integrated Stockpile Evaluation Group, Sandia Field Office, Kirtland AFB Fire Department and LANL enabled successful test completion.



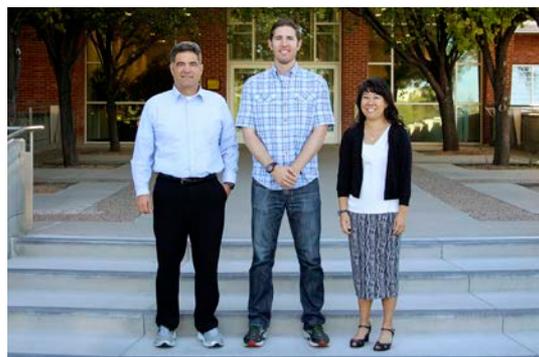
W88 ALT 370 JT5ALT-6A Hostile Environment Blast Tube Test Series Team

In 2017, the Sandia Validation and Qualification Test Team, in conjunction with their partners in the W88 ALT 370 Tech Basis Group, successfully executed the hostile environment blast tube test series. This series marked the end of a two-year, \$4 million program that included a diverse set of experiments. Every milestone was completed on time and within budget, and met the customer requirements to provide model validation data and support weapon qualification. This integrated test and analysis series enabled the further revitalization of Sandia's large-scale testing capabilities, including blast tube facility and bulk explosive operations, and integration of instrumentation and photometrics to measure blast wave shape, intensity and propagation. This series demonstrated our competence in engineering, execution and operations, helping to rebuild confidence of the Labs.



JTA61AE-Crush1 Rocket Sled Track Test

In 2017, the Validation and Qualification Group, in partnership with the B61-12 Technical Basis Group, completed the JT61AE-Crush1 test for the B61-12, meeting all technical, safety, and programmatic objectives. The forward ballistic sled test at the 10,000-foot Rocket Sled Track Facility was a clear example of our ability to address a broad set of complex requirements for a high-velocity impact event critical to the qualification of the B61-12 gravity bomb. The test validated the system mechanical model and provided data to designers about the safety of the weapon in an extreme accident scenario. All test execution and post-test activities were completed effectively through numerous innovative engineered safety methods.



NAP-24A Stamping and Marking Improvements Core Team

The NAP-24A Stamping and Marking Policy Improvements Core Team's work enabled a more than 80 percent reduction in stamping and marking complexity, with resulting labor savings and cost avoidances estimated at more than \$10 million in the next five years. This demonstrated not only that cross-site collaboration can yield significant dividends, but that the individuals across the enterprise can come together and proactively, preventatively address a problem before it has fully arrived. Through their work, collaboration and commitment, this team demonstrated that significant change can move forward in a short period of time, enabling less confusion, complexity, and schedule and cost impacts.



Master Production Schedule Team

To support Application Specific Integrated Circuit production rates that are six times higher than for previous programs, Sandia's MESA group developed and implemented a Master Production Schedule capability that identifies optimal operational and tactical execution plans that improve production efficiency, performance, and stability under tight resource constraints. The MPS team has provided an analytic capability that enables proactive operational planning and improves production performance and stability. The team has demonstrated exceptional performance, dedication, and contributions to the nuclear deterrence program.



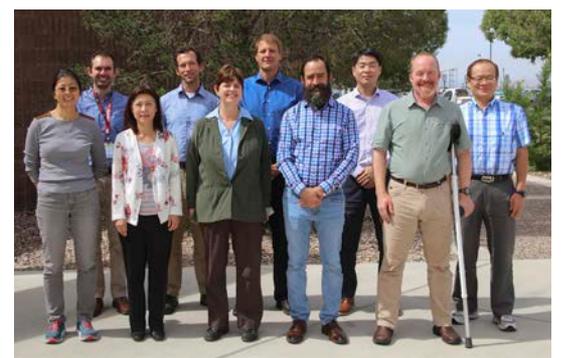
Advanced Control Systems Development Team

The Advanced Control Systems Development Team led the modernization and implementation of computer-controlled systems for the high-energy-density-physics facilities within Sandia's Pulsed Power Sciences Center. The facilities support the national security mission and nuclear weapons research. This team has enabled more rapid development of new HEDP facilities and integration of advanced physics subsystems into the Z facility. These achievements are essential components of the technical foundation for Z-Next, a proposed next-generation pulsed-power accelerator that is expected to achieve high-yield fusion.



B61-12 VIPr Coded Switch Software Development Team

The B61-12 LEP VIPr Coded Switch Software Team has continuously exceeded expectations with additional software development deliveries, contributed above and beyond to systems and production facility needs, and accommodated hardware concerns to produce use control software that pushed security and surety further than any previous system. This software has successfully completed the full NSA software evaluation process culminating last December with NSA signing off on witnessed security verification testing. The software has also passed Sandia's Independent Vulnerability Analysis.



Tri-Lab Tantalum Strength Team

The Tri-Lab Tantalum Strength Team used research from a variety of experimental platforms to evaluate tantalum strength models used in weapon codes. The project included forming a compendium of experimental results, identifying and conducting additional experiments to increase the overlap between different platforms, and beginning to identify potential theoretical gaps.

Mileposts



New Mexico photos by Michelle Fleming
California photos by Randy Wong



Ciji Nelson 15



Thor Osborn 15



Jason Petti 15



Megan Slinkard 15



Karen Smith 15



Eric Sorensen 15



Patricia Taylor 15



Gayle Thayer 15



Tanya Walbridge 15



John Wharton 15



Steven Wolfley 15



Allan Yaklin 15



Shari Tucker-Mehler 20



Mike R. Lopez 15

SANDIA CLASSIFIED ADS

MISCELLANEOUS

VINTAGE 35 MM CAMERA & LENS, \$400; Nikon F3 camera; Nikon 35mm 1:2 lens; Nikon 80-200mm lens; Sigma 28-70mm lens; Nikkormat EL camera. Krukar, 505-292-3917.

MOTORIZED WHEELCHAIR, Quantum Edge, front & rear joysticks, 14-in. solid drive tires, like new, \$4,784 OBO; Oreck Steam-It floor cleaner, w/accessories, \$75. Mann, 401-0988.

CARGO TRAILER, small Scout, \$325; 110-W mobile generator, \$700; Craftsman tractor attachment snow blade, \$75; Christmas luminarias, 2 sets, \$35. Willmas, 505-907-9324 or djwillmas@gmail.com.

DINING TABLE, w/6 leather lined chairs, \$300; leather sofa & chair, \$200; text for photos. Lifke, 382-9448.

HOME GYM, Parabody Life Fitness G2, perfect condition, will help move & assemble, photos on request, \$1,000. Oldham, 505-681-0483.

LITTLE GIANT LADDER SYSTEMS, plus work platform, complete, new, \$75 OBO. Hagerman, 505-401-1402.

HI-FI SPEAKERS, Monitor Audio Silver RX8, 3-way floor standers, 10.9"W x 37.9"H x 15-1/4"D, \$1,200 OBO/pair. Poulter, randomle7@yahoo.com.

TRANSPORTATION

'13 NISSAN ALTIMA, white exterior, tan interior, excellent gas mileage, 113K miles, really good shape, \$8,000. Myers, 505-220-1929.

'12 SUZUKI EQUATOR RMZ SPORT, 4WD, crew cab, clean, 63K miles, great condition, \$15,500. Gurrieri, 303-929-3162.

'13 MAZDA CX-5, AWD, top trim level: level, navigation, moonroof, silver, 81K miles, good condition, \$11,750. Alvin, cdvalvin@gmail.com.

'12 FORD FOCUS SE, 4-dr. hatchback, AT, AC, Sync, 35+mpg, 80.2K miles, excellent condition, \$8,000 OBO. Brothers, 505-369-9899.

'16 SUBARU WRX PREMIUM, Stage 2, built motor <10K miles, 36K miles, garage-kept, nonsmoker, tint, clean, lots of extras. Martin, 806-206-1739.

'17 TOYOTA HIGHLANDER LTD, hybrid, V6, fully loaded, seats 7, only 7K miles, \$42,000. Washburn, 220-1791.

'06 SUBARU OUTBACK WAGON, AWD, 4-cyl., AC, standard transmission, 93K miles, \$6,990. Cochran, 505-842-1528.

'07 CAMRY LE, AC, CD, cruise, new struts, oil pan gasket, w/2 additional snow tires, clean, nonsmoker, \$6,500. Young, 214-458-1580, ask for Nancy.

1940 HOT ROD, custom built, Chevy 350 engine, Chevy turbo 400 transmission, Ford 9-in. diff., build has 1,200 miles, \$6,500 OBO. Meyer, 505-263-2766.

'01 DODGE RAM 1500, runs great, new battery, good tires, needs body/interior work, \$500. Mullen, 505-980-4426.

'13 FORD F150 XLT, 4x4, supercrew, 5.0L V8, tow pkg., 36-gal. tank, bed liner, Race Red, 41K miles, \$23,000. Lyon, 505-750-1667.

RECREATION

MOUNTAIN BIKE, specialized Stumpjumper, Rock shock in front, Fox shock in rear, from High Desert Bicycles new \$3,800, asking \$1,700 OBO. Benson, 505-220-1161, ask for Duane.

REAL ESTATE

3-BDR. HOME, 2-1/2 baths, 1,660-sq. ft., 5121 Noreen Dr. NE 87111, MLS#931444. Giar, ryangiar@gmail.com.

WANTED

USED TRUCK/SUV, AT, 2WD, excellent mechanical condition, for handicapped condition, female to drive to Dr. visits & errands, \$3,000 or under. Tafoya, 505-238-0135.

NINTENDO 64 GAMING SYSTEM, controllers, games. Forster, 505-250-6753.

AD SUBMISSION DEADLINE: Friday noon before the week of publication unless changed by holiday.

Questions to Michelle Fleming at 505-844-9402.

Due to space constraints, ads will be printed on a first-come, first-served basis.

Submit by one of the following methods:

- **EMAIL:** Michelle Fleming (classads@sandia.gov)
- **FAX:** 505-844-0645
- **MAIL:** MS1468 (Dept. 3651)
- **INTERNAL WEB:** Click on the News Tab at the top of the Techweb homepage. At the bottom of the NewsCenter page, click the "Submit a Classified Ad" button and complete the form.

AD RULES

1. Limit 18 words, including last name and home phone (web or email address counts as two or three words, depending on length).
2. Include organization and full name with ad submission.
3. Submit ad in writing. No phone-ins.
4. Type or print ad legibly; use accepted abbreviations.
5. One ad per issue.
6. The same ad may not run more than twice.
7. No "for rent" ads except for employees on temporary assignment.
8. No commercial ads.
9. For active Sandia members of the workforce and retired Sandians only.
10. Housing listed for sale is available without regard to race, creed, color or national origin.
11. Work wanted ads are limited to student-aged children of employees.
12. We reserve the right not to publish any ad that may be considered offensive or in poor taste.

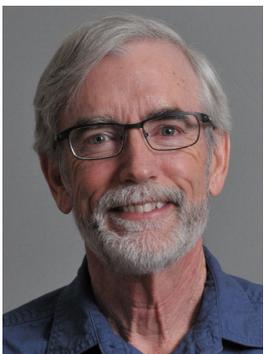
Recent Retirees



New Mexico photos by Michelle Fleming
California photos by Randy Wong



Mark F. Smith 38



Don Funkhouser 36



Chuck Andraka 34



John Williams 32



John Fuller 42



Daryl Reckaway 38



Wilma Convissor 17



Elaine Gutierrez 16

LABNEWS Notes

EDITOR'S NOTE: Lab News seeks guest columnists with observations on life at the Labs or on science and technology in the news and in contemporary life. If you have a column (500-750 words) or an idea to submit, please contact Jim Danneskiold, the acting editor.

Celebration at the intellectual property finish line includes family and friends



THE LOOT — Trophies commemorated the achievements of Sandia employees in four categories: Patent Inventors, Copyright Authors, Mission Innovators, and Up and Coming Innovators. **Photo by Lonnie Anderson**

by **Troy Rummler**

“They give patent awards in a blue binder,” Mark Grubelich said. “And one year, I handed one to my wife and said, ‘Put it with the other ones.’ She said, ‘What other ones?’”

Loved ones are sometimes in the dark about work that goes on at Sandia. But for one night last month, they joined the Labs in celebrating partners, parents and friends at the ninth annual Innovation Celebration, organized by Integrated Partnerships Organizations.

The event, at the Albuquerque Museum, recognized individuals who added patents and commercial copyrights to Sandia’s intellectual property portfolio in 2017. IPO also handed out Mission Innovator awards for creative contributions toward the Labs’ national security mission and honored director-nominated Up & Coming Innovators for individuals who have showed potential to generate future intellectual property.

Since 2010, the blue patent binders have been accompanied by modest trophies given out at this public ceremony. And Mark brings his wife.

“That’s a big deal to the both of us, because we’re kind of a team, that she can participate in a Sandia event,” he said.

IPO oversees technology transfer and intellect-

ual property management at Sandia and provides legal and strategic guidance for researchers wishing to form partnerships with organizations outside the Labs.

“This event gives us the opportunity to recognize the individual scientists and engineers whose innovative work makes Sandia a leading national laboratory in intellectual property generation,” said Mary Monson, senior manager for technology partnerships and business development. “We’re proud of the work carried out at Sandia, and we’re happy to share this annual celebration with family, friends and co-workers.”

Learning opportunity

Joshua Beutler from microsystems assessments brought his 9-year-old son. They talk a lot about what it means to be an inventor, he says, and the celebration was an opportunity to show his son first-hand.

Joshua was being recognized for a patented visible-light probe designed to diagnose problems in integrated circuits with better resolution than conventional infrared light. He demonstrated the technology at a Family Day his kids came to several years ago, which led to another conversation with his son — why the patent process takes so long.

The event produced revelations among coworkers, too. Ted Borek and Mark Grubelich have known each other since college. Over two decades

of overlapping careers at Sandia, they’ve collaborated on some of the same projects, and today they’re good friends.

But when they bumped into each other at the Innovation Celebration, where they both received awards for different patents, they were surprised to see each other. “I didn’t know you were doing that,” Mark recalled thinking.

Flexing technological prowess

“The breadth of intellectual property generated at Sandia is one of the great assets of this lab,” said Deputy Labs Director Dave Douglass, who delivered opening remarks. “The spirit of innovation found here is what has enabled Sandia to reliably solve changing national security challenges for the past 70 years.”

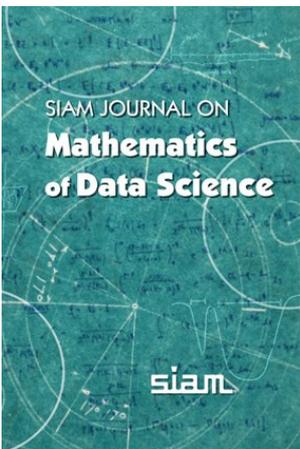
The Innovation Celebration gave out 284 awards, honoring a tremendous range of technical achievements. Ted was granted a patent for a neutron-detecting material that uses boron instead of the conventional, but much rarer, helium-3 isotope. Mark was recognized for three patents: a device that prevents leaks from gas and oil wells into ground water by centering underground pipes; an epoxy that temporarily seals a hole bored for a well and then safely burns away to open the hole again when needed; and a mobile water cannon designed to disable a vehicle non-lethally.

Mohamed Ebeida from computing research was honored with both an Up and Coming Innovator and a Copyright Author award. He invented algorithms and developed accompanying software that redefines the paradigm for meshing — or partitioning objects for computer simulation. Existing algorithms create meshes that analysts need to check and manually tweak. But Mohamed believes his new system could become a fully automated process.

“Right now, I have a very ambitious, exploratory LDRD where we propose to solve the meshing problem once and for all.”

Mohamed was glad to bring his wife, too. He said he wished she could have learned more about the award-winning work. It keeps the ceremony short, Mohamed acknowledged, but he also values the recognition that takes place at work, where recipients are acknowledged individually. 

Tamara Kolda named editor-in-chief of new SIAM Journal on Mathematics of Data Science



By **Michael Padilla**

Data science has become increasingly important in science, engineering and business. Breakthroughs in data analysis, including deep learning, require mathematical and statistical innovations — leading to the creation of a new domain at

the intersection of inferential and computational thinking. Despite many recent innovations, data scientists have barely begun to tackle the hardest problems. Thanks to a new journal, foundational mathematical and statistical advances in data science are being put on center stage.

To help guide the new journal, Tammy Kolda has been named founding editor-in-chief of the SIAM Journal on Mathematics of Data Science (SIMODS), published by the Society for Industrial and Applied Mathematics (SIAM).

Tammy is joined by section editors Alfred Hero (University of Michigan), Michael Jordan (University of California, Berkeley), Robert D. Nowak (University of Wisconsin-Madison), and Joel A. Tropp (California Institute of Technology). The team has assembled a renowned team of associate editors from top universities, including Carnegie

Mellon, Duke, MIT, Princeton, Stanford, UCLA and others.

The electronic-only publication’s intention is to focus on the mathematical constituency’s role in the ascent of data science, while strengthening the connections to complementary communities.

“As we move forward, SIMODS will establish the importance of mathematics in the fast-growing domain of data science and curate the best work at this intersection of mathematics, statistics, computer science, network science and signal processing,” Tammy says. “Papers published in SIMODS will develop useful theories, propose new algorithms, describe clever implementations and share novel methodologies across disciplines.”

Tammy says she anticipates that these journal articles will not only be useful to data science but also have ramifications for traditional areas of applied mathematics research since this research incorporates methods that have advanced in the data science regime.

During its first six months, the journal received more than 100 submissions, breaking all records for new SIAM journals. A few examples of topics to be published include analysis of deep neural networks, sparse coding in signal processing, statistical sampling techniques, analysis of data clouds, security of pooled data and low-rank approximability. The first issue will be published in early 2019.

Check out SIAM’s video: “Mathematics of Data Science — Data Science is Everywhere,” created with Tammy’s guidance to promote the new journal and explain the field to non-experts. 



Tammy, a distinguished member of the technical staff, has been at Sandia since 1999. Her research interests include multilinear algebra and tensor decompositions, graph models and algorithms, data mining, optimization, nonlinear solvers, parallel computing and the design of scientific software. Her work has received more than 15,000 citations. Tammy has received several awards, including a Presidential Early Career Award for Scientists and Engineers in 2003, an R&D 100 Award in 2004 and three best paper prizes. She is a fellow of SIAM and a distinguished member of the Association for Computing Machinery.