



Balloons and drones and clouds; oh, my!

Sandia collects more precise weather, climate data with help from unmanned aerial system

By Mollie Rappe

Later this month, Sandia researchers will try flying a tethered balloon and an unmanned aerial system, colloquially known as a drone, together for the first time to get Arctic atmospheric temperatures with better location control than ever before. In addition to providing more precise data for weather and climate models, being able to effectively operate UASs in the Arctic is important for national security.

“Operating UASs in the remote, harsh environments of the Arctic will provide opportunities to harden the technologies in ways that are directly transferable to the needs of national security in terms of robustness and reliability,” says Jon Salton (6533), a Sandia robotics manager. “Ultimately, integrating the specialized operational and sensing needs required for Arctic research will transfer to a variety of national security needs.”

Information on temperature of the atmosphere is critical for predicting the weather, monitoring severe weather, and improving climate models. Unlike tethered balloons or weather balloons, UASs don’t require helium, a nonrenewable resource, and can take off with less preparation, thus they can be launched from more remote locations. Most airports already collect atmospheric temperature profiles twice a day but switching to UASs with distributed temperature sensors would

(Continued on page 3)

UP, UP AND AWAY — Dari Dexheimer prepares a tethered balloon for the first joint balloon-unmanned aerial system test in May at Sandia/New Mexico’s Burn Site.

(Photo by Randy Montoya)



Tech Transfer at Sandia Labs has many avenues to commercialize technology
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Any data. Any time. Anywhere.

Telemetry group’s software improves how data is gathered, analyzed

Sue Major Holmes

Asign near the offices of Sandia National Laboratories’ Telemetry and Software Systems department says it all: Any data. Anywhere. Anytime. That’s possible nowadays largely because of software the group developed beginning in 2005. Sandia copyrighted the Telemetry Analysis and Visualization Suite, first as a version for Sandia that expanded to other national labs and lab-connected contracts, and just last year, as a commercial version.

The telemetry group created the tool, TAVS for short, “because we were getting too much data to keep up with,” says Gary Ashcraft (2662), who has worked in telemetry at Sandia for more than 20 years. “Its original purpose was to keep my ground station data processing team sane.”

Sandia does test flights for mock nuclear weapons systems launched by missiles or carried on submarines and airplanes. The tests produce terabytes of telemetry — radio signals transmitted to a ground station that show how weapon systems are performing.

The analysis and visualization system saves data during a test. Immediately afterward, the telemetry group loads raw archive information into the system, allowing engineers to analyze it on a desktop computer.

Handles massive amounts of data

The suite has three parts: a core engine that enables real-time display of data and 3-D visualization; post-test analysis; and a virtual ground station that makes processing data easier and faster. The group created the software to support nuclear weapons stockpile surveillance, later built in the real-time visualization, and lastly developed the virtual ground station.



TELEMETRY ANALYSIS — Sandia’s Gary Ashcraft (2662) demonstrates the Telemetry and Software Systems department’s copyright Telemetry Analysis and Visualization Suite. The telemetry group created the software, which was released first to Sandia and other national labs and more recently in a commercial version. *(Photo by Randy Montoya)*

TAVS can handle massive amounts of data. Multiple operators can look at different displays, quickly plot data, and filter it to pinpoint specific information. “You’re ready to analyze the test as soon as it’s over,” Gary says. “It’s definitely an engineering tool.”

Better data handling has been a goal for decades.

Gary opens a 1955 report with a section of recommendations — third on the list: improve data reduction.

Sandia first displayed real-time data during a test about 2007, when its software was too new to run as

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That's that

The latest news on North Korea's nuclear ambitions is a throwback to the bad old days. According to reports, in the wake of successful North Korean long-range missile tests, bomb shelter sales in Japan are surging to levels not seen since the darkest days of the Cold War.

And inevitably, as North Korea improves and perfects its missile capability, extending the radius it can hold under threat of nuclear attack, Americans are going to follow the example of the Japanese. Beginning on the West Coast and then across the country, Americans are going to start thinking about how to protect themselves and their families from a threat we had all hoped had been put behind us decades ago.

I was born at the dawn of the Cold War and was a student in the days when we were taught to "duck and cover" under our desks in school if we ever heard the dreaded air raid sirens go off for real. Those sirens were an ugly, scary sound, a banshee scream, the sound of doomsday, and when they were went off, our little hearts would start pumping hard until we reassured ourselves that, whew, it's noon on Tuesday, the day they test the hellish-sounding things.

The threat of nuclear annihilation spawned a whole school of black humor, with the prime example being the movie *Dr. Strangelove – or How I Learned to Stop Worrying and Love the Bomb*. In the genre, comedian George Carlin once joked that the Soviet battle plan would be: "We attack at noon Tuesday when Americans think sirens are test only!" Funny, but we weren't laughing. Maybe our parents were, but at 10 or 12 years old you only get the "dark" part of dark comedy.

Today, when we see newsreel footage of those routine schoolkid drills, we think of them as quaint artifacts of a bygone age, a less enlightened time when nuclear-armed superpowers with radically different ideas about how to organize society coexisted and survived only because they shared the capability to utterly destroy each other – and perhaps the entire planet in the bargain. But believe me, there was nothing quaint about growing up with the ever-present certainty that everything you know and love – your mom and dad, your brothers and sisters, your pets, your friends, the street you grew up on – everything could be obliterated just like that from the face of the earth.

And that's where Sandia comes in. It was the efforts of our forebears here at the Labs that ensured that we kids who practiced hiding under our desks or hugging the inside walls of our schools in Ohio or Georgia or Maine or New Mexico never had to do it for real.

If you'd asked them – our forebears – about their purpose statement, they wouldn't know what you meant: the lingo of the workplace has changed right along with everything else. But if you told them they were developing advanced technologies to ensure global peace, they'd nod and say, "Yep, that's about it." Because they believed then, as I believe today, that what we do here every day – and not just in our weapons work – is perhaps the best guarantor of peace we have.

The North Koreans right now are rattling apocalyptic sabers, but as long as the US maintains its ultimate strategic deterrent, the North Koreans understand that anything beyond some flamboyant posturing and tough talk would be suicidal. And I think the leaders over there like the way they've got things set up too much to risk it all. Could be wrong, but I hope I'm right.

I don't know what the US and its allies should do about North Korean aggression and I'm glad I'm not the one to have to figure it out. I do hope that however the current situation is resolved, it is done so in a way that another generation of schoolkids here or in Japan or South Korea or Taiwan doesn't have to learn how to duck and cover under their desks at school.

See you next time.

– Bill Murphy (MS 1468, 505-845-0845, wtmurph@sandia.gov)

Pavel Bochev wins national award in computational fluid dynamics



Pavel Bochev (1442) has been awarded the Thomas J.R. Hughes Medal by the US Association for Computational Mechanics.

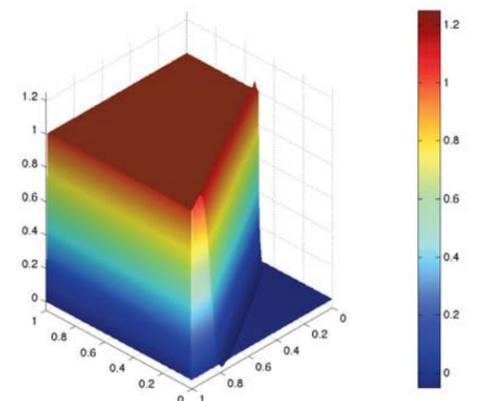
The award is given biannually for "outstanding and sustained contributions to the broad field of computation fluid dynamics."

According to Sandia manager Michael Parks (1442), Pavel was chosen specifically for "...foundational contributions to numerical partial differential equations, especially advances in the development and analysis of new stabilized and compatible finite element methods, and software design for advanced discretizations."



PAVEL BOCHEV

Finite element methods (FEM) are important for many Sandia mission applications, Pavel says. They convert differential equations describing physical phenomena, such as fluid flows and electromagnetism, into algebraic equations that can be solved on a computer. Compatible FEM mimic the mathematical structure of these differential equations and can deliver robust and physically meaningful results. However, they can also be more difficult to implement and solve.



SOLUTION OF ADVECTION-DIFFUSION TEST PROBLEMS by a multiscale stabilized method developed by P. Bochev and collaborators. (From P. Bochev, K. Peterson, and M. Perego, "A multiscale control volume finite element method for advection–diffusion equations" which appeared in the *International Journal for Numerical Methods in Fluids*, 77(11):641–667, 2015.)

Stabilized methods provide an alternative to compatible discretizations that may be easier to implement and solve. But because approximations are involved, the design of successful stabilized finite elements requires careful analysis of the mathematical properties lost and the most appropriate mechanisms to recover them.

"It's not a trivial problem," says Pavel.

The award was presented at the 14th US National Congress on Computational Mechanics in Montreal in mid-July. The biannual congresses have an average attendance of 1,200 participants, according to a history of the organization available on its web site.

—Neal Singer

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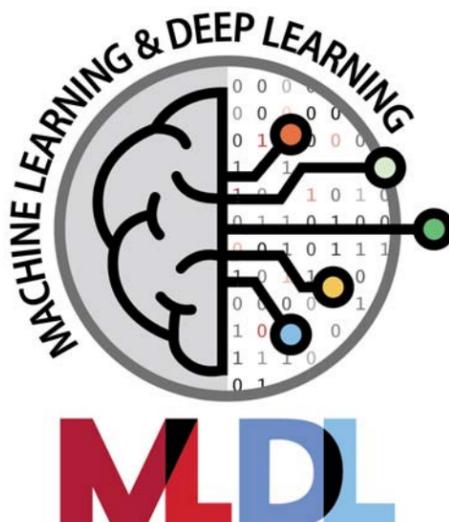
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Balloons and drones

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be better because they would be reusable and could fly more frequently, says atmospheric scientist Dari Dexheimer (8863).

Sky-high research

Dari has regularly flown tethered balloons out of Sandia's dedicated Arctic airspace on Oliktok Point, the northernmost point of Alaska's Prudhoe Bay, since 2015. These 13-foot-tall balloons carry distributed temperature sensors to collect Arctic atmospheric temperature profiles, or the temperature of the air at different heights above the ground, among other atmospheric sensors. The test this August will be the first time Sandia has flown an octocopter in the sky above Oliktok Point.

"The UAS and the balloon really complement each other in that the UAS has a smaller flight time, but it's much more spatially diverse. The tethered balloon can stay up for a long time, giving you a lot of data, but it's not easily mobile," says Dari. The balloon is blown by the wind, to the limits of the tether, but the UAS can be directed to precise GPS coordinates.

Earlier this summer, Dari and the UAS flight team, led by Diane Callow (6533), tested the joint UAS-balloon setup in Sandia/New Mexico. They overcame a series of technical challenges including figuring out how to best secure and reel out the four-football-field long distributed temperature sensor cable while making sure it doesn't get tangled in the UAS's rotors.

They also worked out the logistics of operating the balloon and the system at the same time. To avoid bumping into each other or tangling the cables, the balloon was tethered downwind and the UAS stayed at least 100 feet away from it.

Cool sensors for cool science

The distributed temperature sensor is an angel-hair-pasta thick fiber-optic cable. By seeing how light bends in the cable, Dari can calculate the temperature of that part of the cloud. This measurement has a resolution of one meter, and she sends a light pulse every 30 seconds. This gives Dari and climate modelers an unprecedented level of detail on the temperature profile of the atmosphere.

In addition to the temperature sensor, the tethered balloon carries special supercooled liquid water sensors. Supercooled liquid water is pure water that remains a liquid below its freezing point because it has nothing to crystallize upon. It is important because clouds containing a lot of supercooled liquid water behave differently from normal clouds, sticking around for days and even acting like a blanket to warm the surface below. Better understanding of these kinds of mixed-phase clouds is important for more accurate climate models.

The sensors are vibrating wires upon which supercooled liquid water can freeze. As the ice builds up, the vibration slows, and this tells researchers how much supercooled liquid water is present in that part of the cloud. For the project's next steps, the team hopes to add these supercooled liquid water sensors to a fixed-wing UAS and fly the UAS into the clouds. They hope to see how badly the UAS ices up, determine how to mitigate the effects of icing, and eventually collect useful data on cloud conditions with more spatial control than the balloon could get.

Both the cloud temperature and supercooled liquid water content can be compared between the UAS and the balloon as well as with data



DAVE NOVICK examines an octocopter prior to a test flight with a tethered balloon in May. (Photo by Randy Montoya)

from ground-based Atmospheric Radiation Measurement sensors also at Oliktok Point. Sandia manages the ARM North Slope of Alaska site as part of the ARM Climate Research Facility, a national scientific user facility funded through DOE's Office of Science.

Access to restricted airspace invaluable

"Our ability to run UASs as well as tethered balloon operations in the Arctic, and our ability to combine those measurements and computer modeling in innovative ways allows us to really put the Oliktok facility to use for the national security and science communities," says Lori Parrott (8863), manager of atmospheric sciences.

Sandia is not the only institution using Oliktok Point to test UASs in extreme Arctic conditions; other institutions also fly UAS systems at Oliktok. For example, the University of Alaska Fairbanks' Alaska Center for Unmanned Aircraft Systems Integration flew its UASs at Oliktok Point this summer, through a Cooperative Research and Development Agreement with Sandia. They have a testing facility at Toolik Lake about 130 miles south, but access to the restricted airspace Sandia manages over the Beaufort Sea at Oliktok is invaluable, says Lori.

Discussions are underway with other potential users across multiple federal agencies. Lori says, "The 700-mile-long restricted airspace that Sandia manages for DOE has strategic importance because it can allow scientists to conduct experiments and exercises over Arctic waters without risk to human-piloted aircraft. Flights for search-and-rescue exercises, data collection on ice or atmospheric conditions, or testing technology, would otherwise be very difficult to conduct."

This project combining UASs and tethered balloons was supported by Sandia internal funding. The flight team includes Dave Novick, Dan Small, and Chris Wilson (all 6533). Dari's Arctic team includes technologist Casey Longbottom (8863).

A video about flying tethered balloons in Oliktok Point is available at goo.gl/EK48dc.



DAWI DEXHEIMER and Mike Kuehl (6533) work on a radiosonde, or atmospheric sensor package, that will be carried on an unmanned aerial system aircraft as part of a joint balloon/UAS test.

(Photo by Randy Montoya)

Any data. Any Time. Anywhere.

(Continued from page 1)

the primary data acquisition system. Gary says the tool performed flawlessly and the team presented a real-time, 3-D visualization of the payload, a concept he and colleagues Mark Platzbecker (2626) and Dave Sandison (5200) developed in 1999.

But instant visualization languished because there was no vision for how to use it. Gary recalled that after its inaugural use, "People said, 'That's really cool, and I really don't need that.'"

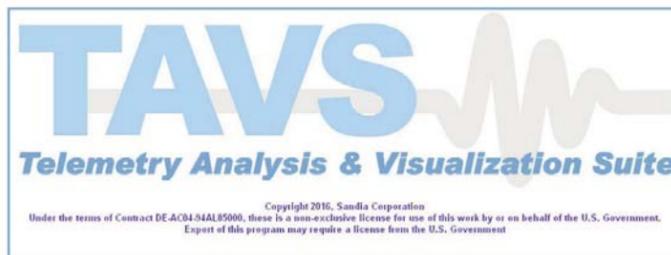
Then came a 2008 test, when Sandia Labs' data acquisition system was the primary system. Suddenly, the 3-D visualization showed an anomaly, and "since our software was young, I was sure it was our software," Gary says. "Then I looked up and saw the cameras that were on board and they were showing the same anomaly."

Two hours after mission's end, everyone assembled to view the data and figure out what went wrong. Gary says missileers showed the colonel in charge the "cool squiggly lines of data" that form the backbone of information for engineers and analysts. When it was time for Sandia Labs' payload presentation, "we showed some squiggly lines and said, 'We also did a 3-D visualization of it during real time and here it is.' The colonel's eyes kind of lit up and he said, 'Did it really do that?' and we're like, 'Yeah, it

really did.' He thanked us. He said, 'I have a much better understanding of what happened now.'"

Software now makes many jobs easier

The software began spreading through Sandia, expanding "from a grassroots 'we need to make our jobs easier' to making a lot of people's jobs easier," Gary says. "Anyone at Sandia can download the software and with a little bit of training can start using it." The TAVS site is <http://tavs.sandia.gov>.



When Sandia began planning a B61-12 flight test at its Tonopah Test Range in Nevada for summer 2015, the telemetry group, supported by integrated stockpile evaluation senior manager Jay Vinson (2250), provided ground station equipment hardware and its software to Tonopah and helped range personnel lay out stations and connections, Gary says. Tonopah now has a modern ground station and the ability to send data to Sandia/New Mexico in real time.

The final part of the suite, the virtual ground station, does digital signal processing. Sandia started using it for flight test data in 2006.

Data is recorded on hard drives, which go to the telemetry group. A flight test might consist of 10 to 15 drives totaling 3 to 10 terabytes of information. Traditionally, analysts plug the hard drive into their equipment, playing it back through a receiver and then to machines that extract the data. Playing it back takes the same length of time as acquiring it, so if a recording is 30 minutes long, it takes 30 minutes for playback. That's a lot of time to process, for example, 10 half-hour recordings one by one.

The virtual ground station reduces equipment and steps by taking data directly off the hard drive and processing it on a computer. "There's no reason to play it back through equipment," Gary says. "With a multicore processor I can run 10 at a time and I don't have to watch it. I don't have to do anything. I can go home and let it run overnight and come back the next day and my data's ready."

"But the real advantage is that the signal analyst can adjust the signal processing algorithms on a signal-by-signal basis and increase the quality and quantity of data extracted. Sometimes the most important data from a test occurs in a noisy environment, and the virtual ground station provides the analyst complete control of signal manipulation to extract all of the information possible.

"The work is still being accomplished. It's just a different way, better quality, and less expensive."

Current TAVS team members are Michael Rimbort, Michael Bridges, and Ray Prior (all 2662), Leisa King and Ron Dulaney (both 2669), Andres Jaramillo (2666), and Adam Peters (5333).

Technology to go

Sandia has bright minds tackling big challenges in science and engineering. That work creates a treasure trove of technology vital to national security but also to everyday life. From solid state lighting to medical diagnostics, the Labs consistently hands over skills, knowledge, and technologies to the private sector, and ultimately the public.

By Nancy Salem

Dan Daily grew up watching his mom run a daycare center for severely disabled children in Taos, New Mexico. “The kids impressed me,” he says. “They were regular people but with disabled bodies. It stuck with me.”

Daily became a musician and, inspired by those kids, dreamt of developing an electronic instrument anyone could play. He wanted to bring music to people who didn't have the mental or physical ability to play a traditional instrument. He envisioned a microcontroller-based system that would send signals through a USB connection to another electronic device, such as a sound module or computer, which would produce the tones of trumpets, horns, strings, drums, and other musical instruments, all controlled with a simple joystick or mouse.

The technology was more than Daily could handle but as a tiny startup venture, he couldn't afford R&D. He turned to New Mexico Small Business Assistance, a state-funded program that lets entrepreneurs get technical help from premier scientists at Sandia and Los Alamos national laboratories. Daily was paired with Sandia microsystems engineer Kent Pfeiffer (8634), who had a background in music and helped him bring his dream to life.

Daily's MidiWing can be manufactured for schools, hospitals, therapy and rehab centers, and other places where people want to make music. “My motivation was to bring music-making to more people,” says Daily, who founded a company, Musicode Innovations. “Kent was pivotal. It was an incredible collaboration because he is a musician. The key to the whole project was that he understood what I was trying to do from a musician's standpoint. He was perfect. He has a music background and designs microcontroller products. I can't imagine how it could have gone better.”

A mandate to share

Hardly a day goes by at Sandia that technology isn't transferred to the private sector. “Tech transfer is a government-mandated mission for institutions receiving federal funding for research,” says Grant Heffelfinger, director of Advanced Science and Technology Program Management Center 1100. “That mission is deeply rooted at Sandia.”

The Labs has a wide variety of programs that pass along skills, knowledge, and technologies to those who can further develop them into new products, processes, and services for the public good.

Programs such as New Mexico Small Business Assistance, Cooperative Research and Development Agreements, and intellectual property licensing ensure that the public can access taxpayer-funded research and world-class scientists and facilities. The Labs works in partnership with private businesses — large and small — and with federal, state, and local agencies, academic institutions, and the local community.

“Tech transfer is a powerful economic development tool,” Grant says. “Sandia's programs have created thousands of jobs, launched dozens of companies, and pumped billions of dollars into the local, regional, and national economies.”

The numbers are staggering. Sandia has signed more than 5,000 partnership agreements in the past five years to develop its own technology and to help others. The Labs worked with 830 unique industrial partners and hundreds more small and startup businesses.

Products that have become a part of peoples' daily lives, such as solid state lighting and high-efficiency engines, came from Sandia R&D that was commercialized.

“Sandia's technologies are vital to national security, and moving them swiftly to the marketplace advances US economic competitiveness,” Grant says. “Sandia's strategic partnerships with industry and universities strengthen and accelerate technology transfer.”

Here's a look at some of Sandia's key technology transfer programs, and their impact on the public:

New Mexico Small Business Assistance

NMSBA lets small companies with technical challenges work with scientists and engineers at Sandia and Los Alamos free of charge. It was established in 2000 by the state legislature, which funds it through a tax credit. From 2000 to 2016, the program provided 2,648 companies in all 33 of the state's counties \$53.3 million worth of research hours and materials.

It has helped create and retain 5,734 New Mexico jobs at an average salary of \$39,000, increase small companies' revenues by \$272 million and decrease their operating costs by \$142 million. Those companies invested \$109 million in other New Mexico goods and services, and received \$111 million in new funding and financing.

“NMSBA is a phenomenal way to help small companies that don't have the resources to do advanced research and development,” says Jackie Kerby Moore, manager of Technology and Economic Development Dept. 1183. “National laboratory expertise helps these business people realize their dreams and stimulates the state's economy.”

Entrepreneurial Separation to Transfer Technology

For more than 20 years, Sandia researchers have been able to leave to start or join small companies, knowing they can return. Their work has made a difference by cre-

A record of tech transfer success

Sandia's tech transfer efforts have been recognized dozens of times by the Federal Laboratory Consortium, a nationwide network of more than 300 federal laboratories, agencies and research centers that fosters commercialization best practice strategies and opportunities for accelerating federal technologies out of the labs and into the marketplace. The Sandia awards have been in categories ranging from Excellence in Technology Transfer to State and Local Economic Development to Regional Partnerships. Among the technologies singled out were:

- **BaDx**,* a credit-card-size device that can detect bacteria that cause anthrax;

* Denotes Laboratory Directed Research and Development origins

ating hundreds of jobs, bringing national lab expertise into the private sector and boosting economic development.

“The Entrepreneurial Separation to Transfer Technology program is an innovative tech transfer tool that has endured,” says Jackie. “We have many success stories and have measured the economic impact, which shows positive benefits to the local community. And entrepreneurs who return to Sandia bring new experiences that benefit the Labs.”

One of Sandia's hottest technologies, the medical diagnostic lab-on-a-disk SpinDx, is being commercialized through the program. Greg Sommer, a former Sandia researcher who helped develop

SpinDx, co-founded and is chief executive officer of Sandstone Diagnostics in Livermore, California, which is bringing the technology to market. “The high-tech environment

- **Sandia Cooler**,* which reduces energy to cool computer processor chips;
- **GazeAppraise**,* an eye movement analysis software;
- **X-Ray Toolkit**, a software program that helps emergency responders perform effectively in the high-stress, time-critical act of disabling improvised explosive devices;
- **Decontamination Technology*** for Chemical and Biological Agents, which neutralizes 99.99999 percent of bacteria, viruses and fungi;
- **Twistact**,* designed to take wind energy to the next level;
- **H₂FIRST**, an effort to increase the number of fueling stations for hydrogen cell electric vehicles.

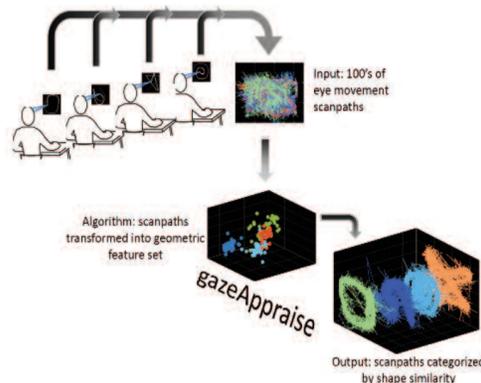
at Sandia is ripe for innovation and game-changing technologies,” Sommer says. “The entrepreneurial separation program allowed us to launch Sandstone and develop cutting-edge medical products based on technology we originally developed for Sandia's biodefense missions.”

Some 156 Sandia researchers have left, 70 to start a business and 86 to expand one. About 30 of the companies they joined or started licensed a Sandia technology.

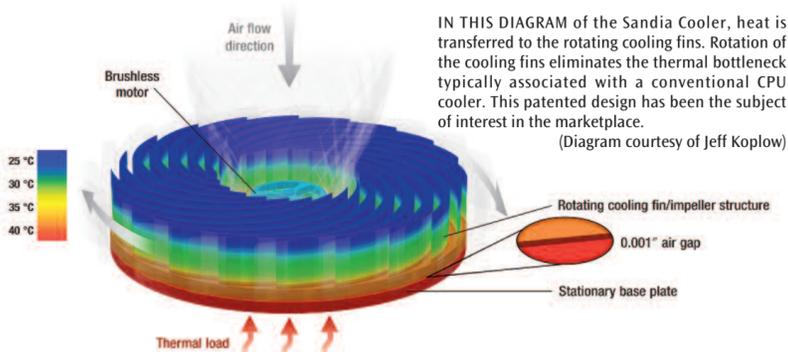
Entrepreneur Exploration

EEx is designed to invigorate an entrepreneurial culture at the labs and inspire researchers whether

they leave or remain at Sandia. The program has been in place about two years and includes entrepreneur office hours, when researchers can meet and talk to members



A SUMMARY OF HOW GAZEAPPRAISE eye movement analysis software works collecting samples from many subjects and then using algorithms to categorize the scanpaths. (Image courtesy of Mike Haas)



IN THIS DIAGRAM of the Sandia Cooler, heat is transferred to the rotating cooling fins. Rotation of the cooling fins eliminates the thermal bottleneck typically associated with a conventional CPU cooler. This patented design has been the subject of interest in the marketplace. (Diagram courtesy of Jeff Koplou)

of the business community; workshops; roundtables; boot camps; and social gatherings.

“More than 1,800 community leaders, entrepreneurs, and Sandians have attended the EEx events,” Jackie says. “It links the community to Sandia with opportunities for entrepreneurs.”

Sandia Science & Technology Park

The park is a 300-plus acre master-planned technology community affiliated with Sandia and adjacent to Kirtland Air Force Base, giving companies easy access to top-notch facilities. The park is home to 42 companies and organizations with 2,008 employees. The average annual salary is \$83,000.

Since the park opened in 1998, public investment has totaled \$89 million and private \$286.5 million. Some 6,593 direct and indirect jobs have been created. Wages and salaries from park activities total \$4.4 billion.

“The park plays a critical role in our economy,” says Jackie, the park's executive director. “It creates high-quality, high-wage, long-term jobs rooted in technology, innovation, and entrepreneurship.”

Small Business Vouchers

Sandia is one of five leads in a DOE pilot that gives small, clean-energy companies access to national laboratory expertise and resources. Eleven DOE labs are working with the private sector with a combined budget of \$22 million. Sandia's 17 vouchers from the program's first three rounds total \$3.7 million and include projects in advanced manufacturing, bioenergy, fuel cells, geothermal energy, solar energy, and wind and water power.

Andy McLroy, director of Energy and Homeland Security Program Management Center 8100, says companies can propose collaborative research with a particular scientist, request technical assistance from an engineer, or gain access to such Sandia facilities as the Microsystems Science and Technology Center, the National Solar Thermal Test Facility, or the Battery Abuse Testing Laboratory.

“The program gives companies an array of options to meet their technical challenges,” Andy says. “Sandia and the other labs have decades of R&D experience in clean energy technologies and an incredible amount of knowledge to share with these small businesses.”

Cooperative Research & Development Agreements

A CRADA is an agreement between a government agency and a private company or university — or at least one non-federal entity — to work together on research and development. Sandia signed 133 during the past four fiscal years, from October 2012 to September 2016; 110 were new and 67 were amendments adding tasks or funding to existing agreements. From 2006 to 2016, 292 new agreements were signed and 312 were amended.

Sandia has active CRADAs with 65 partners ranging from small businesses to nonprofits to industry giants. “This is a great mechanism for getting national laboratory technology into the private sector,” says Sandia CRADA



THE SANDIA DECONTAMINATION TEAM (left to right): Researchers Rita Betty, Bruce Kelley, and Mark Tucker, and licensing executive Bianca Thayer, present examples of spray apparatus used for various decontamination applications.

specialist Jason Martinez (10575). “We develop cutting-edge technology and capabilities with underlying science that is phenomenal. The CRADA is a vehicle to take that work and benefit the US economy.”

Strategic Partnership Projects, Non-Federal Entity Agreements

These are bilateral contracts that lets Sandia do work for a non-federal entity sponsor, making the Labs' resources available to private industry and individuals, state and local governments, colleges and universities, nonprofit organizations, international organizations, foreign governments, and foreign companies. From 2006-2016, Sandia signed 807 new agreements and 767 amendments.

Intellectual property licensing

Partners can license Sandia's IP, including patents, copyrights, trademarks, and mask works, for commercialization or private use.

From 2006-2016, patent activity included 3,319 invention disclosures, 2,076 patent applications, and 1,013 patents issued. There were 1,394 copyright submissions and 3,668 commercial and non-commercial technology licenses granted.

University partnerships

Sandia partners with key universities to do cutting-edge science, hire the best scientists and engineers, and develop strategic collaborations in focused research areas. From 2006-2016, investments in research totaled \$310.9 million at all universities and \$60.8 million at New Mexico universities.

Grants says US taxpayers have invested billions in research and development at federal laboratories, and the return is scientific and technological breakthroughs that lead to new companies, jobs, and growth in the economy. “Our technology transfer programs ensure that the nation receives that maximum return from the R&D investments made at Sandia,” he says. “These are technologies that change lives and make the world a better place.”

“These are technologies that change lives and make the world a better place.”

2018 Truman Fellows boost mission-relevant research at Sandia

By Bill Murphy

This year, three individuals will join the Truman Fellow ranks: Yiyang Li, Daniel Ruiz, and Ethan Secor. The three join the ranks of 25 other Fellows appointed since Sandia's President Harry S. Truman Fellowship in National Security Science and Engineering was launched in 2004.

Because the fellowships are three-year assignments, four Truman Fellows are still doing research at Sandia as part of their fellowship. Additionally, 16 other Truman Fellows subsequently joined the Labs' technical staff upon completion of their fellowship assignments; nine are still researchers at Sandia.

Yiyang received his PhD and MS in materials science and engineering from Stanford University in September 2016 and his BS in electrical and computer engineering from Olin College. His Truman Fellowship work is aimed toward developing a new class of smart materials whose properties are changed through electrochemistry. This is a fundamental new field of research, and the impact is to be able to dynamically and reversibly control material properties at the nanoscale, yielding novel smart devices with tunable material properties. The proposed work is aligned with Sandia's research interests in smart materials. Yiyang will begin his fellowship this month in Materials Physics Dept. 8342 under the mentorship of Farid El Gabaly Marquez and manager Christian Mailhoit. Yiyang discusses his research in more detail below.

Daniel will receive his PhD in plasma physics from Princeton University this month. His MA in astrophysical science, nuclear reactor physics, and lasers/optics/matter was obtained from Institut National des Sciences et Techniques Nucleaires and Ecole Polytechnique; his BA in physics engineering comes from Instituto Tecnológico de Monterrey.

Daniel's Truman Fellowship research will focus on developing new theoretical models to better understand the basic physics of laser-plasma instabilities processes relevant to magnetized liner inertial fusion (MagLIF). Working with Sandia experts, he plans to implement his algorithms in Sandia's high energy density physics codes used to design experiments on Z. This simulation capability would be the first of its kind. His mentors will be Michael Glinsky and manager Kyle Peterson in Radiation and ICF Target Design Dept. 1684. Daniel will begin his Fellowship in September 2017. See below for Daniel's discussion about his proposed research.

Ethan Secor earned his PhD from Northwestern University in materials science and engineering in June 2017. He earned his BS from Drake University, with a double major in chemistry and physics. Ethan plans to design a general nanomaterial ink platform for integration into digital printing methods. This attempts to change the paradigm for ink and material discovery using high-throughput screening, much as high-throughput screening has changed the pharmaceutical industry. Ethan's work will have applications in Sandia's national security mission areas. His mentor will be Bryan Kaehr (a former Truman Fellow) and manager Randy Schunk in Advanced Materials Laboratory Dept. 1815. Ethan will begin his fellowship in October. For more about Ethan's Truman research plans, see his comments below.

The Truman Fellowships are three-year appointments. Candidates are expected to have solved a major scientific or engineering problem in their thesis work or have provided a new approach or insight to a major problem, as evidenced by a recognized impact in their field. The program fosters creativity and stimulates exploration of forefront science and technology and high-risk, potentially high-value R&D and is funded by Sandia's Laboratory Directed Research and Development (LDRD) Program. A panel of senior scientists and engineers reviews and ranks each application, interviews finalists, and makes a hiring recommendation to the Associate Labs Director



President Harry S. Truman Fellowship
in National Security Science and Engineering

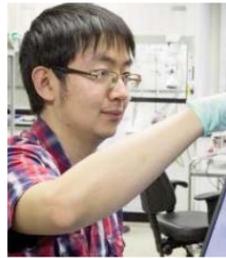
Andy McIlroy, former Div. 1000 Deputy Chief Technology Officer who oversaw the selection of the 2018 Truman Fellows, says, "Being involved in the interviews and interacting with the Truman Fellow candidates were easily the best moments in the last few weeks of the selection process. We look forward to great results from the game-changing research being proposed by Daniel Ruiz, Ethan Secor, and Yiyang Li. We are confident their research will help us advance our mission work in areas of fundamental importance to us and look forward to hearing about their accomplishments over the next three years and beyond. We are grateful to the selection committee for continuing to identify great candidates for Sandia's prestigious Truman Fellowship."

The *Lab News* recently asked each 2018 Truman Fellow to describe the work he intends to pursue at Sandia. Here's what they had to say:

Yiyang Li

Advances in chemistry and physics have given us the ability to precisely control various material properties. However, most material properties are static after synthesis and fabrication and cannot be subsequently modified. The creation of smart materials whose properties can be dynamically tuned and reconfigured can make revolutionary changes to society, with the field effect transistor being the most prominent example. Yet there are not many mechanisms by which materials can be dynamically modified.

As a Truman Fellow, I will explore new mechanisms of using ion movement in solids to make smart materials and devices. Inspired from lithium-ion batteries, such devices use current and voltage to control the chemical composition, which ultimately modifies the electronic and mechanical properties of the material. Reversing the current and voltage restores the material back to its original state. At Sandia, I will develop the foundational principles of smart materials utilizing ion movement. I will merge microelectronics with redox chemistry to create novel



YIYANG LI

for Advanced Science and Technology, Division 1000. Applications are currently being taken for the FY2019 application deadline of Nov. 1, 2017.

The 2018 panelists were: Cynthia Phillips (Chair, 1400); Joe Michael (1800); Philip Kegelmeyer (8700); Tina Nenoff (1800);

Tan Thai (5800); Phil Dreike (6700); Michael Desjarlais (1600), Hy Tran (2500), and Tom Kulp (8700). Sandia's CTO Programs Office (1171) and Human Resources (3555) teamed more than a dozen years ago to create the Truman Fellowship Program and develop the processes necessary to implement the prestigious position. Truman Fellows in FY17 were Adam Backer (8631), Nick Burtch (8341), and Matt Hudspeth (1528).

devices, concepts, and functionalities.

Daniel Ruiz

In recent years, the magnetized liner inertial fusion (MagLIF) experiment at Sandia has become one of nation's leading experiments in inertial confinement fusion. In MagLIF, a pre-magnetized deuterium fuel is heated by a 2.5 kilojoule, 1 terawatt laser and is then magnetically imploded by a 19 megaampere, 100 ns rise-time current. This unique experimental platform has achieved extreme fusion-relevant plasma conditions hard to reproduce elsewhere. More excitingly, MagLIF still has room for improvement.

In particular, much work remains to be done to optimize the MagLIF laser-heating stage. Current experiments suggest that only a fraction of the laser energy is transferred to the fuel in MagLIF, while the rest of the energy is lost. The low-energy coupling is mainly due to the presence of laser-plasma instabilities (LPI), for example laser scattering. The development of a general understanding of LPI processes and the eventual leveraging of that understanding to optimize the MagLIF preheat is of central importance to the entire MagLIF campaign.

At Sandia, I will focus on developing new theoretical models to better understand the basic physics of LPI processes relevant to MagLIF. This research could lead to novel ways in which these processes can be controlled or even exploited in MagLIF. I will be working at the Pulsed Power Sciences Center with Michael Glinsky and Christopher Jennings. Overall, I am excited to begin my work at Sandia as a Truman Fellow. I am looking forward to collaborating with fellow Sandians and contributing to the scientific effort of this institution.

Ethan Secor

Additive printing of functional liquid inks offers opportunities for high-throughput and custom manufacturing of electronic components with applications in electrical wiring, sensing, displays, radio frequency communication, and smart packaging.

However, the complex interplay of materials development, ink formulation, and patterning technologies slows the implementation of this framework in practical settings. At Sandia, I hope to address this challenge by developing unique multimaterial printing capabilities and integrating digital patterning methods within a larger computational framework for high-throughput experimentation.

The Advanced Materials Laboratory (AML) at Sandia is at the forefront in the development of materials and methods central to this goal. Active research at the AML spans nanomaterial synthesis, ink formulation, and printing method development in an integrated environment ideally suited for comprehensive research in this dynamic field.

My research will focus on aerosol jet printing, an advanced patterning technique with strong ties to Sandia. By tailoring this method for multimaterial deposition, unique capabilities to print hybrid and composite materials will benefit efforts in both high-throughput materials science and electronic device fabrication. For this work, I'll be directly supported by my mentor, Randy Schunk, and an interdisciplinary team of researchers at AML.

Seven years ago, I was introduced to Sandia during a summer research program, and the collaborative and engaging atmosphere of the Labs made a lasting impression. With the generous support, independence, and access to world-class researchers and facilities offered by the Truman Fellowship, I'm excited to return to Sandia to begin my scientific career.



DANIEL RUIZ



ETHAN SECOR

Sandia, LANL name new CINT director, co-director

By Mollie Rappe

Andreas Roelofs and Sean Hearne (1880) were appointed director and co-director of the Center for Integrated Nanotechnologies, a DOE Office of Basic Energy Science-funded user facility jointly operated with Los Alamos National Laboratory. They took their positions July 17.

Before being hired by Los Alamos, Roelofs worked at Argonne National Laboratory for six years. He served as the director of Argonne's entrepreneurship program Chain Reaction Innovations and the Argonne Design Works center. He was also the deputy director of both the Nanoscience and Technology Division and the Center for Nanoscale Materials at Argonne.

Sean was selected as the Sandia senior manager after Neal Shinn's retirement in 2016. He started at Sandia as a graduate student intern 20 years ago and progressed from a postdoc, LTE, staff member, to management. Sean has been with CINT since the original proposal was written.

CINT provides users from around the nation access to world-leading equipment and scientists for researchers who are advancing the scientific under-

standing of how to fabricate, characterize, integrate, and model nanoscale materials. Nanoscale materials have the potential to revolutionize energy, human health, and national security. CINT users come from universities, national labs, and private industry – with a cost-recovery agreement.

Deputy Chief Research Officer Grant Heffelfinger (1100) says, "I'm very pleased that our new team is now in place at CINT. I'm looking forward to watching what the leadership of this capable and experienced team will be able to achieve as it enters its second decade as a DOE Basic Energy Science Nanoscale Science Research Center."

Roelofs has experience in scientific research and leadership in private industry, startups, and the public sector. His early work focused on ferroelectric thin films and nanoparticles for ferroelectric random access memory applications. Roelofs spent six years working in the computer memory industry.

Sean was elected 2018 president of the Materials Research Society, an international organization that promotes interdisciplinary materials research, and is currently serving as vice president. His early work focused on stress mechanisms of thin film electrodeposition.



ANDREAS ROELOFS



SEAN HEARNE

SANDIA CLASSIFIED ADS

Note: Classified Ad deadline change for the Aug. 18 edition. The deadline will be Thursday, Aug. 10 at noon instead of Friday, Aug. 11.

MISCELLANEOUS

ANNALEE '91 SOFT FELT SCULPTURE, Elf Under Mushroom, 8" x 8", pristine condition, \$29. Wagner, 505-504-8783.

EXTENSION LADDER, aluminum, 16-ft., \$75; 300 clean golf balls, \$35; other balls, cheap. Murphy, 797-8779.

STUDENT ALTO SAX, w/case, \$325; Ibanez electric guitar, w/amp & tuner, hard case, \$285. Aragon, 888-3473.

OUTDOOR DOG KENNEL, used, Pet Safe, 5' x 5' x 4', w/gate & sunshade top, excellent condition, \$100. Sutton, 217-621-6046.

PORTABLE COOLER, Champion, 40"T x 34"W x 28"W, call for info, \$400. Hidalgo, 505-980-5737.

MICROWAVE, Sharp Carousel, photos, details at <http://www.wmstubblefield.com/sale-items>, \$25. Stubblefield, 263-3468.

TELEVISION, 27-in., Vizio, works fine, good for bdr. or rec room, \$30. Rule, 505-249-7397.

KNEE SCOOTER, w/large pneumatic wheels, light indoor use only, like new, \$150. Prior, 505-239-9586.

STEG METAL LATHE, 9" x 21", 3/4-hp, 110-VAC, Timken bearings, quick-change tool post, some additional tooling, \$500. Boissiere, 505-239-1051.

KITCHENAID PRO STAND MIXER, 6-qt., w/attachments, like new, \$300. Ayers, 505-349-1793.

MOTORCYCLE WHEELS, Harley-Davidson, cast aluminum disc, rims size T16 x 3.00, excellent condition, \$250 ea. Hannum, 505-296-2095.

APPLIANCES: GE refrigerator, side-by-side, \$320; Kenmore washer & dryer, \$300/set; all in very good condition. Cook, 505-256-5196.

PROPANE GRILL, large, Char-Broil, stainless steel, 5 burners, w/side burner, empty propane tank included, \$180 OBO. Corley, 505-681-3705.

TABLE SAW, Delta, 10-in., right tilting, commercial grade Biesemeyer fence, runs on 220-V, \$700 OBO. Sanchez, 296-7784.

THERMOSTAT, Wi-Fi, Emerson Sensi, 7-day programmable, control home temp anywhere from your phone, like new, \$90. Chang, 385-6158.

WOODWORKING MACHINES & TOOLS, 6-in. Delta planer/joiner; 13-in. DEWALT 3-blade planer; Delta mortising machine, dust collector, dovetail feature; all or individual. Schoeneman, 281-0036.

DINING SET, smoked glass, 60" x 36" top, 4 taupe chairs, all gold metal framed, excellent condition, \$200. Harris, 858-0667.

UTILITY TRAILER, 1977, home-built, 57" x 92" x 22" bed, EZ unloader, ST225/75R15 tires, mounted spare, tong wheel/jack, \$650. Glaser, 293-8110.

MATTRESS TOPPER, gel memory foam, new, Lucid, 3-in. thick, queen, \$80. Young, 934-5538.

SPEAKERS, Vandersteen, model 1B, 12"W x 10"D x 36"H, black, w/isolation stands, pair, \$40 OBO. Gelet, 505-797-4599.

CHEST W/MIRROR, antique, solid bird's eye maple, \$250; park bench, new, still in box, \$50. Kilbane, 715-7681, leave a message.

CHILDREN'S TOYS ETC.: new back pack baby carrier, assembled; wooden doll house; tricycle; motorized quad-bike. Stephenson, 238-5825.

RING VIDEO DOORBELL, Wi-Fi enabled, stain nickel, unopened, in original pkg., \$160. Hall, 280-4344.

ROCKING HORSE, Harley-Davidson motorcycle, girl's rocker w/sound, like new, paid \$160, asking \$75; ride-on travel child seat luggage attachment, new, \$40; photos available. Vigil, 400-0639.

TRUNK BIKE RACK, Hollywood model B2, 2 bike, w/manual & extra straps, great condition, \$45. Jensen, 821-2373.

'91 HONDA ACCORD, 4-dr., white w/blue interior, Honda dealer serviced, Michelin tires, gas-saver, perfect condition, \$5,000. Behar, 821-9299.

'09 FORD E250 VAN, wheelchair accessible, 5.4L, V8, 54K miles, very good condition, \$25,000. Fein, 505-301-3942, ask for Wilson.

'14 CHRYSLER TOWN & COUNTRY, 7 passenger, leather, AM/FM/CD/satellite/Bluetooth, rear DVD, Sto-n-Go seats, \$15,000. Babb, 228-5225.

'83 TOYOTA PICKUP, long bed, 5-sp., running condition needs work. Petmecky, 865-5548.

'07 HONDA CRV, AWD, white, garaged, cold AC, tires like new, 96K miles, runs great, \$9,500. Villegas, 505-480-2690.

'06 WILDERNESS YUKON CAMPER, 29-ft., 14-ft. slide, ducted AC/heat, all seasons, w/stabilizer hitch, \$10,950 OBO. Hoyt, 505-350-8341.

REAL ESTATE

4-BDR. HOME, 3 bath, 3,000-sq. ft., new high-efficiency green home, close to base, Volterra, MLS#893720, \$295,000. Dubuque, 505-280-3132.

3-BDR. HOME, 2 baths, 1,050-sq. ft., 2-car garage, covered patio, 2400 Springflower Pl SW, nice neighborhood, \$127,000. Allen, 505-573-5500.

5-BDR. HOME, 3 baths, 4,280-sq. ft., separate in-law quarters, swimming pool, Four Hills, pre-inspections done, \$444,000. Ramos, 972-951-0290.

3-BDR. HOME, 2 baths, 1800+-sq. ft., 2-car garage, custom cabinets, Four Hills, solar panels, open concept, fully remodeled, MLS#895175, \$259,000. Newell, 296-1500.

RECREATION

'09 KAWASAKI 650 KLR, 6K miles, excellent condition, \$3,300. Haberman, 401-5779.

BICYCLE, Scott Sportster hybrid, large frame, disc brakes, 27-gears (Shimano equipment), lockable front shocks, \$350. Kvam, 856-7320.

'12 TTLR, 26 BH, new axial, tires, rims, kitchen cushions, stereo, batteries, kitchen faucet, queen mattress, rifle rack, \$12,500 OBO. Barreras, 505-604-8671.

MEN'S CROSS-TRAINER BIKE, Fuji, brand new, \$500; '15 Chevrolet Malibu, fully loaded, only 15K miles; call for more info on both. Carson, 710-4677.

'06 TRIUMPH SPEED TRIPLE 1050 MOTORCYCLE, lots of extras, 30K miles, great condition, \$4,700. Manzanaras, 505-385-6267, text first.

TRANSPORTATION

'03 PORSCHE BOXSTER S, 62K miles, excellent condition, \$12,000. Corey, 505-610-5752.

'99 NISSAN PATHFINDER, 2WD, new tires, 126K miles, \$2,000. Hiner, 520-820-4341.

FORD F250 LARIAT SUPER DUTY, extended cab, 2WD, 5.4L, power front seat bench, 93K miles, \$5,500. Brewer, 505-604-7546.

'13 TOYOTA TACOMA SR5, 4x4, 6-sp., 4.0L V6, access cab, camper shell, 97K highway miles, \$23,900. Stanley, 505-440-3974.

'00 MITSUBISHI ECLIPSE, AT, 4-cyl., PL, PW, 30-mpg, 118K miles, good commuter, good AC/heat, clean, garaged, \$3,000 OBO. Diamond, 505-350-9678.

How to submit classified ads

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

Submit by one of these methods:

- EMAIL: Michelle Fleming (classads@sandia.gov)
- FAX: 844-0645
- MAIL: MS 1468 (Dept. 3651)
- INTERNAL WEB: From Techweb search for 'NewsCenter', at the bottom of that page choose to submit an ad under, 'Submit an article'. If you have questions, call Michelle at 844-4902. Because of space constraints, ads will be printed on a first-come basis.

Islamic Center kids, Sandia coach, win big in STEM competition

By Neal Singer

Motivated by the national importance of involving kids in STEM (science, technology, engineering, and math) applications, Mohamed Ebeida (1441) initiated a robotics program last year at the Islamic Center of New Mexico (ICNM) for boys and girls six to 14 years old.

Earlier this July, two teams of six children from the program were among forty international teams chosen to compete in a NASA-organized First Lego League (FLL) tournament in West Virginia. One of the two teams won the Inspiration Core Value award, a major prize involving working together in a helpful spirit. (See photo at right of Mohamed with his award-winning team.)

"This kind of success is great insulation for the kids from all the issues they face in public school," Mohamed says. "By the time they reach the age when other teenagers are causing trouble, these kids will be getting internships from Silicon Valley. These kids now feel they are special."

This year, the FLL theme — "Animal Allies" — involved programming Lego robots built by the contestants to collect and distribute food to animals according to their type. Each team got 2.5 minutes to finish

as many missions as they could. "Our team was unique in its strategy," Mohamed said. "The children took advantage of a no-ceiling rule and built a five-foot-tall Legos structure that rotated

and achieved multiple tasks at the same time." The team also competed in robot design and research projects. "We trained them for this competition for more than a year and a half, and received a lot of support from different communities, both financially and from volunteers."

Sandia helps sponsor the New Mexico FLL competition. The team's performance there led to their invitation to the international tournament in West Virginia.

"Our program is open to everyone," says Mohamed. "Multiple Sandians have reached out to me and want their kids to join. The goal is diversity and getting kids excited about STEM."



(Photo by Randy Montoya)

Mileposts



New Mexico photos by Michelle Fleming
California photos by Randy Wong



Scott Rowland
30 4722



Laura Owens
25 10618



Ted Borek
20 9432



Manny Barreras
15 4743



John McClendon
15 5321



Philip Ortiz
15 2622



Sara Pecak
15 2623



Ruth Smelser
15 2635



Elizabeth Spindle
15 4748



Marcos Zamora
15 4742

EXERCISE • EXERCISE • EXERCISE!

Annual emergency exercise tests response in active shooter scenario

More than 200 people from across the Labs and the local community participated July 26 in the annual Emergency Management full-scale exercise at Sandia/New Mexico. In this year's scenario, an active shooter incident with casualties provided first responders, including "armed" Protective Force officers and emergency medical personnel, an opportunity to rescue employees, triage the wounded, neutralize a gunman, and secure a facility.

Sandians across the New Mexico site were notified in advance of the exercise and cautioned that the simulated incident could appear to be real. Clearly identified exercise messages advised employees to use the classic active shooter response of "Run. Hide. Fight," as safety, prudence, and circumstances dictated.

In addition to Sandia first responders, the exercise also involved personnel from the FBI, NNSA, Kirtland Air Force Base, Albuquerque Police Department, University of New Mexico Hospital, and Albuquerque Ambulance Service, as would be the case in a real-world active shooter event.

Emergency Management uses the annual exercise as a self-assessment to verify the effectiveness of its program in accordance with the site's plans and procedures and the DOE order covering the comprehensive emergency management system.

— Bill Murphy

