

# Hide and seek

## Sandia engineer helps design a way to expose suicide bombers before they walk into a crowd

By Nancy Salem

On the chilling list of terrorist tactics, suicide bombing is at the top. Between 1981 and the end of 2015, an estimated 5,000 such attacks occurred in more than 40 countries, killing about 50,000 people. The global rate grew from three a year in the 1980s to one a month in the 1990s to one a week from 2001 to 2003 to one a day from 2003 to 2015.

Terrorism experts say suicide bombings are pervasive because they generate publicity and require little expertise, resources, or planning. They instill fear and breed distrust in the public, a goal of groups determined to spread terror. Perhaps most importantly, suicide bombings are almost impossible to prevent.

"The suicide bomber can walk into a crowded place unnoticed and inflict a horrifying amount of death and destruction," says Albuquerque businessman Robby Roberson. "It's very hard to stop. There's no technology to deal with it."

Until now, Roberson says. His company, R3 Technologies, is working with a group of small businesses to develop a way to prevent suicide attacks by detecting

concealed bombs before they go off. After a frustrating start, the group decided it needed more technical help and turned to the New Mexico Small Business Assistance (NMSBA) program, which pairs entrepreneurs with scientists and engineers at Sandia and Los Alamos national laboratories.

### Turning things around

R3 found a partner in Sandia sensor expert JR Russell (6514) who, during the past two years, has helped bring the company's Concealed Bomb Detector, or CBD-1000, close to commercialization.

"JR has been all over it and really turned things around for our company," Roberson says. "He is ter-

*(Continued on page 4)*

WEARING A MOCK SUICIDE VEST, Albuquerque businessman Robby Roberson stands in front of his company's CBD-1000 bomb detector, being adjusted by Sandia scientist JR Russell. JR worked with R3 Technologies to iron out technical issues and bring the suicide bomb detector close to commercialization.

*(Photo by Randy Montoya)*



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# Sandia LabNews

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### National Labs Day at Howard University

On Feb. 4, Sandia led the coordination of National Labs Day, a career fair at Howard University featuring 15 national labs, DOE, and NNSA. The event was designed to introduce STEM students to career opportunities at the national laboratories. Story and photos on page 12.



# Speaker Norm Augustine laments low US value given education, research

## Former LM CEO describes need for increased funding in critical areas

By Neal Singer

Peppering his sobering remarks with wry humor, apt quotes, and sometimes surprising statistics in a speech at Sandia, retired Lockheed Martin chairman and CEO Norm Augustine delivered an analysis of America's declining state of readiness to compete educationally, economically and, eventually perhaps, technologically in the international arena.

The solutions he proposed were increased funding for research and education, and a social adjustment that would value academics over athletics.

In terms of funding, he said, "Once when I advocated for more funding for research, [a colleague on a panel] warned me that the country has a serious budget problem. I told him that when I was a young engineer, I worked with a lot of airplanes too heavy to fly in the design stage, but none ever flew by taking out the engine."

Among his comments regarding education, he said, "Teachers should be the heroes but you get what you celebrate. The highest paid employee [at some universities] is



FORMER LOCKHEED MARTIN CEO Norm Augustine addresses Sandians as part of the Labs' National Security Speakers Series. *(Photo by Randy Montoya)*

the football coach. What message does that send?"

### \$20,000 a pitch

He reported calculating that top baseball pitchers get \$20,000 for every strike they throw.

"A pessimist," he said, "is an optimist who sees the facts."

He quoted a statement from Bill Gates: "When I see our high schools and compare them with what I see when traveling abroad, I'm terrified for our nation."

His Feb. 11 talk, titled "The Foundation of National Security," was part of Sandia's National Security Speakers Series. It was presented in Steve Schiff Auditorium and videolinked to Sandia/California and to Sandia's Washington, D.C., facility.

Augustine, a man with a resume that VP 1000 Rob Leland described in his introduction as "enough for any three men," has had a wide view of American life. Among his many achievements and honors, he's been under secretary of the Army, chairman of the Council of the National Academy of Engineering and the American Red Cross, and president of the American Institute of Aeronautics and Astronautics and the Boy Scouts of America. He's taught at Princeton and served for 16 years on the Presidential Council of Science and Technology. He has been presented the National Medal of Technology by the *(Continued on page 4)*



### Sandia marks Engineers Week

#### 'Synergy between science and engineering'

By Div. 1000 VP and Chief Technology Officer Rob Leland . . . Pages 6-7

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## That's that

I read an article a few years back – I think it was about a presentation by a popular business guru – that goes something like this: A traveling music teacher visits a kindergarten class to introduce the kids to some basic music concepts. Before beginning her lesson, she asks the kids how many of them can sing. Every single child laughs and raises his or her hand. What kind of silly question is that!? Everybody can sing!

Excellent, the teacher says, and proceeds to lead the kids through medleys and rounds and ballads and even some pop tunes. The kids all boisterously join in.

Five years go by. The teacher finds herself back at the same school, but this time with a lesson plan for 4th-graders. She realizes this is the same group of kids she'd taught as kindergartners. Oh, good, she thinks, these kids were fun. Before beginning her lesson, though, she asks the question again: How many of you can sing? Two kids out of the 22 in the classroom tentatively raise their hands.

With National Engineers Week coming up, I was reminded of that story. Just change a few words and make it a story about engineers. How many kids out there "learn," sometime between kindergarten and 4th grade, that they could never be engineers, "learn" that they're no good at math, "learn" that kids like themselves can never succeed? Too many, I'll wager. Sandia's trying to do something about that.

Sandia's Community Involvement team and our various outreach and networking groups are doing great things in the schools, working with committed teachers and involved parents to help kids learn the right lessons about themselves, their options, and the opportunities open to them.

So this year during Engineers Week, let's celebrate not only the engineers of today, but the engineers of tomorrow, too. The ones who learned early on – maybe with some help from Sandians – that they can be whatever they want to be. And just for the heck of it, let us warble in the shower and not give a hoot if we're on-key. Who ever said we can't sing?!

\* \* \*

Speaking of Engineers Week, I hope you get a chance to read Div. 1000 VP and Sandia Chief Technology Officer Rob Leland's fascinating essay beginning on page 6 that explores what he calls a "virtuous cycle," the synergy between science and engineering and what that means for Sandia. Here's a little sneak preview:

*Engineering deeply rooted in science is a common theme permeating much of Sandia's work. The intentional cross-pollination between scientific disciplines and the practical application of the resulting insight to challenging engineering problems is one of Sandia's great strengths and underpins our value proposition to sponsors and customers alike. Perhaps less appreciated are the cases in which our engineering skills enable a new frontier in scientific discovery. On the occasion of Engineers Week, I'd like to share a few of these stories, and thereby offer the perspective that there is actually a virtuous cycle, a deep synergy, between science and engineering that often enables our most exceptional results.*

Again, be sure read the whole essay beginning on page 6.

\* \* \*

A colleague just came back from a personal trip to Antarctica – yeah, I'm jealous – and she says it was just as amazing and incredible as you imagine it would be. In the course of her travels, she noted something that also struck me on a trip in December to visit our son in New Zealand: Being that the Southern Hemisphere's summer is our winter, when you cross the equator and keep going south in December or January, the daylight lingers longer and longer into the evening.

Back in the days of sailing ships, the transition was no big deal; you'd adapt to the difference in daylight bit by bit. But in the age of jet travel, where you can get halfway around the world in 12 hours, the change between winter sunsets at 5 p.m. in New Mexico and summer sunsets in Wellington at 9:30 p.m. are jarring. The physical effect is not unlike jet lag; your body seems to "expect" it to get dark at a certain hour and when it doesn't you vaguely feel there's something wrong. My wife and I even came up with a term for the effect: We call it "light lag" and have gotten some good laughs at the idea of selling homeopathic "remedies" for this previously unidentified affliction. Our concoction would be a proprietary blend of dark and light chocolate. Might not really help light lag, but we'd probably sell a ton anyhow. Medicinal chocolate is the next big thing, you know.

See you next time.

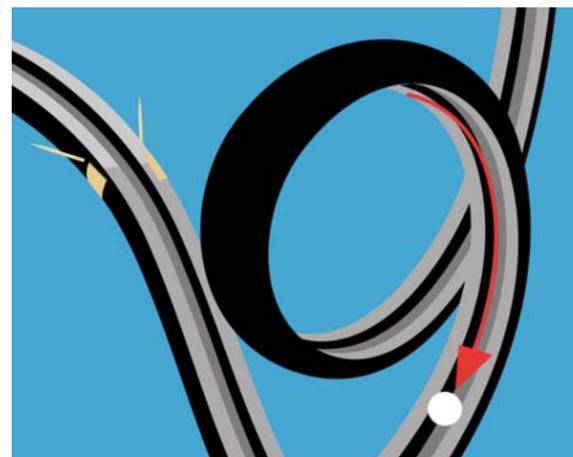
– Bill Murphy (MS 1468, 505-845-0845, wtmurph@sandia.gov)

DISCOVER  
ENGINEERS WEEK

FEBRUARY 21-27, 2016

## THRILL RIDE

Sandians, students celebrate engineering with roller coasters made of paper



Ninth-grade students from Tech Leadership High School and members of ANGLE (Advancing the Next Generation of Leadership Excellence) at Sandia will team up to build roller coasters out of paper during this year's National Engineers Week.

The engineering challenge, open to spectators, will take place from 12:15-2:30 p.m. Wednesday, Feb. 24, at Tech Leadership High School. The charter high school, which opened last August, is in the Sandia Science & Technology Park at 10500 Research Road SE.

Each team will build a paper roller coaster and send a marble along its course.

Teams will have 45 minutes to build their creation from cardstock, tape, and a marble. Judging will be based on such things as the roller coaster's directional changes, use of spirals and loops, and the time it takes the marble to go through the course.

Staff from Explora children's museum and science center will facilitate the competition.

Sandia marks 65th anniversary of Engineers Week

- Activities, events on page 5
- Essay: Synergy of science and engineering on pages 6-7



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IN KEEPING WITH TRADITION, members of the Sandia Emergency Response Team pushed a nearly 13-ton truck — dubbed Squad — through Gate 1, signaling the start of its service. This is the third squad Sandia has received since 2002, the most recent being Squad 2 in November 2013. The tradition of pushing a new truck into service stems from the days when fire departments used hand-drawn and horse-drawn steam engines. Horses were unable to reverse the equipment and align the steam connections on the engines, leaving the firefighters to back the gear in after fire calls. Although Sandia does not have stalls typical of firehouses, the ERT continues a similar tradition. According to ERT Team Lead Ricky Romero (4236-1), the tradition goes, "If you push the truck in the first time, it will always bring you back home safely." (Photo by Randy Montoya)

# Let the competition begin!

## Sandia in 3-D teams take on first design challenge

By Jana Cuiper

If you can imagine it, you can print it. 3-D printing technology is accessible to everyone. No special skills or degrees required.

This message resonated with members of the workforce who enthusiastically gathered for the Sandia in 3-D (S3D) kick-off, held simultaneously in California and New Mexico on Jan. 12.

"Everyone can see the possibilities for this technology and learn how to use it," says Bonnie Antoun (8343). She spent several months working with Mike Hardwick (8240), deputy director for advanced weapons systems, and a team of 30 committee members to create the S3D design challenge.

With an ambitious set of objectives, S3D aims to increase awareness of 3-D printing technology, while providing a fun, creative, and friendly competition that is open to all. Working together in this informal setting creates an opportunity for future collaboration and cross-mission area synergy, all while demonstrating Sandia's ability to create revolutionary design solutions using 3-D printing.

### Three design challenges

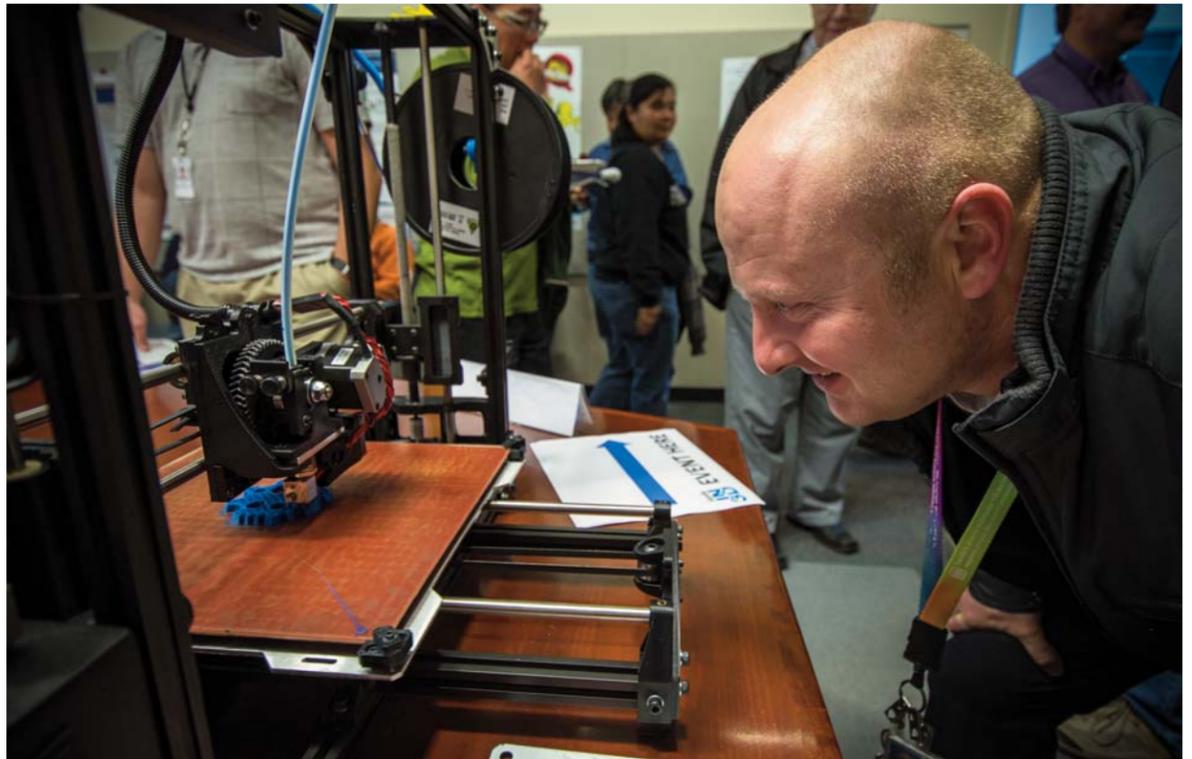
Participants can choose among three design challenges: a musical instrument capable of playing as many notes as possible, a piece of Sandia memorabilia that represents multiple mission aspects, or improvements to an existing product.

More than 300 attendees in New Mexico and California received a warm welcome from Mark Smith (1801), deputy director of additive manufacturing. He opened the event with an overview of Sandia's 30-plus years of pioneering development and commercialization of additive manufacturing (AM) technology, also known as 3-D printing.

"You can do things with additive manufacturing you can do no other way," Mark says. "This technology has the advantage of design freedom at lower cost, with reduced waste, energy, and risk, and it has broad applicability throughout the laboratories."

For example, the W80-4 systems engineering team is committed to using 3-D printing in its product development.

"3-D printing has the potential to be used for everything



AT THE SANDIA IN 3-D KICKOFF, Bert Debusscherre (8351) watches an idea come to life through 3-D printing technology. Sandia in 3-D is a friendly design competition meant to spark interest in 3-D printing and encourage diverse teaming.

from low-risk tooling to higher-risk critical components that fly with the warhead," says Mike Hardwick (8240). "The progress we make in engineering design and materials science will determine how extensively this technology is incorporated into the weapons program."

Mike says he hopes the design challenge will inspire creativity, innovation, and learning that contribute to Sandia's collective ability to move forward with this technology. "One way to accelerate our AM work is to engage bright and inquisitive minds and draw upon their expertise and passion," he says.

### Bringing together diverse planning committee

Diversity and inclusion are at the core of the 3-D Challenge, so Bonnie, as committee leader, knew the planning

team needed to reflect that. She branched out beyond her network of technical colleagues to recruit people who might not typically participate in planning an event like this.

"We needed the perspective of those who know about and understand 3-D printing and those who are not familiar with it," Bonnie says. "Someone may feel they cannot contribute because they don't have that background, but those are exactly the people we wanted to have on the committee."

A key aim is to encourage people to step outside their comfort zone in creating their challenge teams and designs. Teams that combine technical and non-technical members will be awarded extra points for diversity.

"So many people here have never seen this," says planning committee member Jim Brennan (8625). "It's great to see how excited they are to participate. There is no barrier to entry so you don't have to be afraid to try it."

Kevin Connelly (8343), also on the committee, talked with an attendee at the open house who reported being artistic but with no design background. "That's perfect!" he says. "The goal is to get people from different backgrounds to interact over their ideas."

### Incorporating diversity

As part of their design submission, the teams will define how they incorporated diversity. Among the 36 teams registered, most are mixed gender and include an age range from high school intern to undergrad researcher, to engineers and professionals with up to 20 years of lab experience. Some teams combine administrative and mission support professionals with mechanical and materials science technologists.

"Diversity often shows up in unexpected ways," says Bonnie. "People are surprised to discover just how diverse they are once they take the time to get to know one another and build relationships. We see this as a catalyst for people from all different areas and backgrounds to link up and make connections."

Teams can win prizes in addition to bragging rights. The organizing committee is planning special 3-D-printed awards for the winning teams, as well as commemorative 3-D-printed coins for each participant. An event to announce the winners and showcase all of the entries is planned for early April.

A second design challenge kicks off in April as well, and a third challenge is slated for July. Current teams may continue to work together and new teams will be welcomed at the beginning of each session. The planning committee is considering new challenge projects and accepting suggestions on the S3D wiki.

"We will continue to emphasize creativity as well as technicality in our future challenges," Bonnie says. "Some of the challenges may build on earlier challenge ideas, and teams will be encouraged to demonstrate diversity and inclusion."

A range of training options is available for participants to learn the needed design software and printing skills, and SEI hours are available for this. 3-D printing labs have been set up in New Mexico and California for teams to print their own designs.

Contact Bonnie Antoun at 925-294-4707 or visit the S3D wiki to stay informed about S3D events and plans for the upcoming challenges.

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## 3-D Challenge comes to New Mexico, too



NEW DESIGN SPACE — Shelby Hansen and Luke DeProst (both 10596) stopped by the New Mexico kickoff to see how their work as business management professionals supports efforts such as Sandia in 3-D. Twenty-four New Mexico teams are participating in the challenge. "We're hoping to spark creativity in applying this technology. It opens a whole new design space," says Deidre Hirschfield, manager of Coatings and Additive Manufacturing Dept. 1832 (Photo by Randy Montoya)

## Bomb detector

(Continued from page 1)

rific. He brings in sharp people from Sandia. I love working with those guys.”

JR, a 35-year veteran of the Labs, says his role largely has been to develop metrics to quantify the performance of the technology. He zeroed in on the device’s accuracy by analyzing false positives and pushed to redevelop software so it would more reliably detect a bomb threat. “After getting to know Robby and the team I got more and more interested in the problem,” says JR, who enlisted a couple other Sandia engineers, Matt Erdman and Michael Bratton (both 6514), in the project. “The technical part of me took over. Engineers want to validate the model and we needed to validate the performance of Robby’s system. We threw out a lot of the existing technology and made proposals to Robby, and they went with it. Early versions were a good start, but not where the technology needed to be.”

### Screening in public places

The CBD-1000 uses X-band radar to detect metallic and non-metallic explosives. Roberson says it can detect ball bearings, glass, nails, ceramics, rocks, and other materials frequently used as shrapnel in suicide vests.

The device is designed to detect bombs that current metal detector technology would miss and is intended for screening areas such as airports, embassies, public and government buildings, border crossings, transportation hubs,

signals to determine the presence of a potential threat. If the person is not carrying a threat, the return signal is in the same polarity as when it was transmitted,” Roberson says. “A threat will rotate the polarity of the signal, and it comes back differently.”

The system sets up in about 15 minutes and an operator, who does not need a working knowledge of radar, can be trained in 30 minutes. The scan takes about 1.3 seconds at 9 feet.

“We’re working toward an instantaneous scan so a person can be checked while moving through the beam field. And we hope to extend the range to 100 feet,” Roberson says. “We want to take movement out of the equation. People who want to protect their citizens want to detect at a distance, keep the threat away. They want to scan crowds and stop threats before they get too close.”

Roberson says algorithms are being finalized that will allow scanning at greater distances

while people are moving.

### System reached a plateau

The original technology was developed by the Albuquerque company Safe Zone Systems in the early 2000s as a hand-held, radar-based sensor that police could use to scan people moving at a distance who they suspected might be armed. It evolved into a stationary system. “It was after 9/11 and there was a thought that we could change our approach and see if we could detect suicide bombers,” Roberson says.

After years of development, the technology just didn’t work. “It became apparent that the system was not completely accurate,” Roberson says. “It reached a plateau. We could not get it to get better. The hope was always to improve the accuracy.”

Roberson’s father, homebuilder Coda Roberson, was a shareholder in Safe Zone, and Robby joined the company in 2009. The father and son founded R3 Technologies to further develop and commercialize the technology.

They approached Sandia for help through NMSBA and added partners including Manuel Rangel of APPI Inc. in Las Cruces, the acclaimed radar scientist Don McLemore of McLemore Enterprises LLC in Albuquerque, Lawrence Sher of Wind Mountain Research Associates in Albuquerque, and Julie Seton of Indelible Enterprises in Las Cruces.

“When JR came onboard we all took a hard look at what we had, what it did, and how it worked,” Roberson says. “JR came at this problem from a different point of view. He wanted to know everything about it. He helped us realize we had to go in a completely different direction. We reverse engineered the hardware and software. I can’t stress enough how important JR was. He helped with everything.”

JR says the Sandians studied noise surrounding the radar signal and how it impacted true positives and true negatives. They found a way to reduce noise and strengthen the signal, improving accuracy. “If the signal is bigger than the noise, it can scan people as they’re walking. They don’t have to stop,” he says. “These breakthroughs will enable new applications in security of the future and will increase the marketability and desirability in the field of the CBD-1000.”

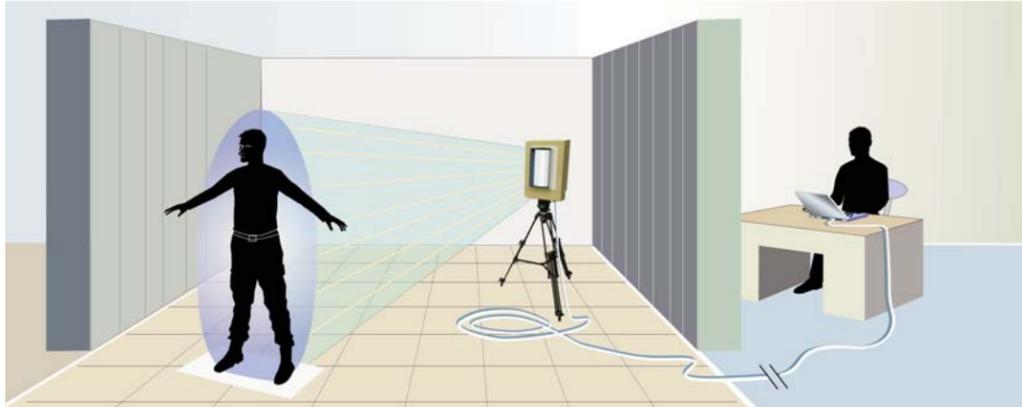
### Starting a third NMSBA project

Roberson says the CBD-1000 will cost about \$50,000 and that several hundred units have been produced. The device is patented, and the company has received inquiries from Pakistan, Afghanistan, Singapore, Kuwait, Saudi Arabia, and Nigeria, he says.

Roberson hopes to go to market this year. His business group has worked with JR under two NMSBA projects over three years and started a third in January to finalize the product by further improving speed, distance, and accuracy. The group meets weekly. “We all clicked as people,” JR says. “We have a common focus and all march in that direction. Everybody brings their technical expertise. These are energized people who are the poster child for a highly effective team. It doesn’t feel like work to me. I’m lucky to work with them.”

JR says he enjoys helping a small business. “It’s good for our community,” he says. “Helping someone succeed helps us succeed, too, as a lab. I get to see science through the eyes of business people. And I’ve learned things that will help me in my work.”

JR says R3’s suicide-bomb detector resonates with Sandia’s national security mission. “We want to help our nation protect our people, our assets,” he says. “If we can save one life, we can make a difference. The opportunity to make us safer from attacks is one of the idealistic things that drive us.”



**RADAR BEAM** — The CBD-1000 uses a spread spectrum, stepped, continuous wave radar to bounce a signal off a subject. Software analyzes horizontal and vertical polarized signals to determine the possible presence of a concealed bomb. If the person is not carrying a bomb, the return signal is in the same polarity as when it was transmitted. If it comes back differently, a bomb could be present. (Illustration courtesy of R3 Technologies)

and military compounds. It is portable and could also be used at special events where crowds are expected.

The CBD-1000 is the size of a cereal box, weighs about 13 pounds, and is mounted on a tripod. It is powered by AC or battery and works with proprietary embedded software. “The device uses a spread spectrum, stepped, continuous wave radar to bounce a signal off a subject. The software analyzes both horizontal and vertical polarized

## A vital tech transfer tool

The New Mexico Small Business Assistance (NMSBA) program was created in 2000 by the state legislature to bring national laboratory technology and expertise to small businesses in New Mexico, promoting economic development with an emphasis on rural areas.

The program has provided more than 2,300 small businesses in all 33 New Mexico counties with \$43.7 million worth of research hours and materials. It has helped create and retain 4,086 New Mexico jobs at an average salary of \$38,488, increase small companies’ revenues by \$200 million, and decrease their operating costs by \$85 million. These companies have invested \$68.3 million in other New Mexico goods and services and received \$77.1 million in new funding and financing.

R3 Technologies was among 364 small businesses in 24

counties that participated during 2015 in NMSBA. In addition to Sandia and Los Alamos, the program contracts with the New Mexico Manufacturing Extension Partnership, University of New Mexico Management of Technology program at the Anderson School of Management, UNM School of Engineering, Arrowhead Center at New Mexico State University, and the New Mexico Tech Department of Management. NMSBA provided \$4.7 million worth of assistance to New Mexico small businesses last year. “The project between Sandia and R3 Technologies is a compelling example of how NMSBA is not only helping a New Mexico small business but also helping Sandia’s national security mission,” says Jackie Kerby Moore, manager of Technology and Economic Development Dept. 1933. “Kudos to JR and his team for helping the company commercialize their technology.”

## Norm Augustine

(Continued from page 1)

president of the United States, and five times received the Joint Chiefs of Staff Distinguished Public Service award.

He also chaired a prestigious National Academies group that produced the paper, *Rising Above the Gathering Storm*, which advocated more than a decade ago for increased attention to education and research.

Citing Russia’s recent experience, he said that “without a strong economy, there could not be a strong defense,” because taxes from the economy pay for research that translates into defense.

Among his solutions was to lower corporate taxes — “the highest in the free world” — to encourage corporations to bring to the US profits stored abroad that have already been taxed in their countries of origin.

### Going where the high IQs are?

He said one executive had said that if America couldn’t get its educational act together, he was going to take his company “where the high IQs are.”

Augustine presented a number of statistics that seemed to show that US students are achieving less than they did decades ago, that the number of students getting degrees in science and engineering are far too few, and that US “world class research institutions” like Bell Labs are declining in number. He criticized cutbacks in government funding that have led universities to increase tuition costs for science and engineering students on the grounds that an engineering education costs more. The long-term result of job creation, he said, should restore parity in tuition.

### Draconian increases in tuition

In California, he continued, “Draconian cuts in budgets

have led to draconian increases in tuition. There’s been a 65 percent increase in tuition in a three-year period.”

Now, he said, “Student debt exceeds the debt for credit cards in this country.” Student tuition fees have been increased, not only to make up for cutbacks from state government but because federal Pell grants have declined in effectiveness.

Further, “If we sustain present spending directions, in a decade or two we will only be able to pay our entitlements and the national debt. This is the front end of the gathering storm. It’s popular to blame China, but does China decide how much to pay our teachers, run our schools, decide how much to invest in research?”

He said that “Instead of paying teachers what they deserve, states can lower their educational standards, and most states are doing the latter.”

He advocated that the national labs find ways to reach out to the private sector as well as contributing nationally, to better show their worth to the tax-paying public. “We need better bridges between the government and universities and industry,” he said.

### National Security Speakers Series

The objective of the National Security Speaker Series (NSSS) is to bring senior policy officials and former officials to Sandia to share their thoughts and interact with Sandians on security issues important to the nation. The goal of the series is to increase understanding of the unique role and contribution of the national laboratories to the national security strategy in the post-Cold War environment.

The NSSS provides Sandians an opportunity to meet and interact with distinguished individuals who have had and continue to have rich careers that impact the security of the nation.



## Sandia activities mark 2016 Engineers Week

FEBRUARY 21-27, 2016

National Security Speaker Series presents Engineers Week speaker

### Johns Hopkins Applied Physics Lab CTO Jerry Krill on 'Engineering at the Edge of Knowledge'

Sandia's National Security Speaker Series will mark National Engineers Week on Tuesday, Feb. 23, with a talk on "Engineering at the Edge of Knowledge" by Jerry Krill, chief technology officer of the Johns Hopkins University Applied Physics Laboratory (APL). He will speak in Steve Schiff Auditorium from 10:30-11:30 a.m.



JERRY KRILL

APL, the nation's largest University Affiliated Research Center, does research and development on behalf of the Department of Defense, the intelligence community, NASA, and other federal agencies. Krill became its assistant director for science and technology and CTO in October 2013, overseeing the laboratory's 5,000-plus staff.

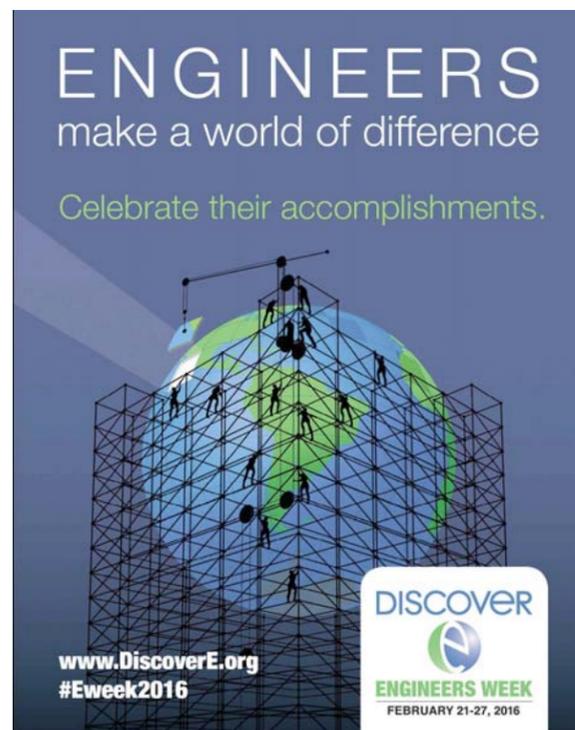
He was APL's assistant director for programs from 2005 to 2010, responsible for more than 700 programs. He also co-led NASA design and mission reviews for the APL-built spacecraft New Horizons and the Van Allen Probes. From 2001 to 2005, Krill served as head of the power projection systems

department, which included experts in cyber, avionics, missiles, electronic warfare, and surveillance.

From 1998 to 2001, he was APL's executive for air and missile defense programs, where he led the Navy/Ballistic Missile Defense Organization Concept Formulation Working Group for a presidentially directed study of the Navy's role in ballistic missile defense. Several of these concepts are being developed for the Aegis Ballistic Missile Defense program.

Starting in 1974, Krill led work on a sensor network, the Cooperative Engagement Capability (CEC). By 1991, in the role of APL's technical development agent, he was responsible to the Navy CEC program manager for meeting an accelerated, congressionally directed fleet introduction timetable. In 1996, he served as technical lead for the Navy's "Mountain Top" advanced concept technology demonstration.

Krill, a member of the Johns Hopkins University Whiting School of Engineering's National Advisory Council, holds 21 patents and has written more than 100 papers and major technical documents. He received the American Society of Naval Engineers "Jimmie" Hamilton Award, was named a *Maryland Daily Record* Innovator of the Year, and was inducted into The Clark School Innovation Hall of Fame at the University of Maryland, College Park. He is featured in the book *CTOs at Work* and co-authored the book *Infusing*



*Innovation into Organizations.*

He earned bachelor's and master's degrees in electrical engineering from Michigan State University and a doctorate, also in electrical engineering, from the University of Maryland.

National Engineers Week is celebrated each February, this year from Feb. 21-27. The National Society of Professional Engineers says it's a time to increase public dialogue about the need for engineers, celebrate how engineers make a difference in the world, and bring engineering to life for children, parents, and educators. — Sue Major Holmes

On next page ... an essay by Sandia VP and Chief Technology Officer Rob Leland

### 'Synergy between science and engineering enables exceptional results at Sandia'



## You know you're an engineer when ...

Sandia's Engineering Sciences Center helped mark National Engineers Week with a contest, asking Sandians to complete the sentence, "You know you're an engineer when..." The center received dozens of entries from around the Labs. The winner will be announced Feb. 23 during the Engineers Week celebrations at Sandia.

A sample of some of the entries:

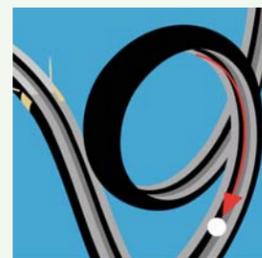
- you wear two pedometers; the second is redundant should the first one fail
- you build a workshop and when it's finished you invite all your friends (also engineers) and have squares laid out so they can check your work — which they do without you saying a word
- you rearrange the egg carton to optimize the mass properties
- you schedule and develop a project plan for your midlife crisis
- thawing frozen chicken becomes a heat transfer problem
- you communicate with a pair of graphs rather than paragraphs
- you judge the success of a BBQ not by the quality of the food, but by how fast your charcoal was ready to cook on
- a beautiful woman asks for a KISS and you explain the concept of "Keep It Simple Stupid" to her
- you see the glass as neither half full nor half empty, but rather twice as large as it needs to be
- you're having a party and the neighbors don't realize it
- your dog goes out more than you do
- your toilet paper has partial differential equations printed on it
- you log the time it takes to get to your building's parking lot by weekday and the time you arrived at the Southern and Eubank intersection street light (the point where no backup has occurred yet due to the security gate authorization), then plot the data to determine the latest possible arrival at the intersection to get to the parking lot by 7:45 a.m. at the latest. However, you remove any outliers during

- weeks related to holiday weekends due to vacations and of course, school holidays when parents might have to take the day off. You determine the latest time to arrive at Southern and Eubank on average for Monday through Thursday is 7:15 a.m., but Fridays are as late as 7:40
- faced with a lack of problems to solve, you invent some
- you recognize your co-workers by their shoes more than their faces
- you're spelling is impeccable
- you can question anything ... even when you don't really care
- you can't answer this
- even your wife knows all the words to the Engineer's Cheer (true story): E to the x, dy, dx/E to the x, dx/Cosine, secant, tangent, sine/3.14159/Square root, cube root, BTU/slap stick, slide rule, Hail Purdue
- you leave your roommate a phone message in Fortran
- you can recite pi to 31 digits but you always forget your anniversary
- you spend time in public restrooms critically examining the material and fixture selections
- your spouse/significant other won't allow you to dress yourself
- you have used a slide rule to do your taxes
- our catch phrase is, "It's not a bug, it's a feature"
- Edison, Faraday, Tesla, Fourier and Laplace start to sound like good names for your dog
- you are as fascinated with how the matching algorithm works as much as the dates it matches you with
- you're next in line for the guillotine, which is not working properly, so you offer to fix it

- you can't decide between duct tape and WD-40
- you understand the most dangerous weapon invented is your pencil
- looking at your co-workers' shoes when talking to them, instead of your own, is considered confrontational
- your kids say, "Dad, I don't want to know the theory, all I want is the answer"
- you calculate the area of medium and large pizzas to see which is a better deal
- you're lying in the hospital bed asking the nurse how the light on your finger is measuring oxygen level (and then hold your breath to test it)
- you personally know every character in the "Dilbert" comic strip
- right after a sloppy sneeze, you produce an estimate of its viscosity
- you are called an extrovert for staring at other people's shoes
- you look forward to assembling IKEA furniture
- you have a clock in your office with equations instead of numbers to mark the hours
- your spouse can give six answers to this question off the top of their head
- a friend has joint replacement surgery and you ask what materials were used

More eWeek activities ...

Sandians, students join to celebrate Engineers Week with roller coasters made of paper ...



Story on page 2

# Synergy between science and engineering enables exceptional results

**DISCOVER**  
**ENGINEERS WEEK**  
FEBRUARY 21-27, 2016

By Rob Leland, Div. 1000 VP and Chief Technology Officer

Engineering deeply rooted in science is a common theme permeating much of Sandia's work. The intentional cross-pollination between scientific disciplines and the practical application of the resulting insight to challenging engineering problems is one of Sandia's great strengths and underpins our value proposition to sponsors and customers alike.

Perhaps less appreciated are the cases in which our engineering skills enable a new frontier in scientific discovery. On the occasion of Engineers Week, I'd like to share a few of these stories, and thereby offer the perspective that there is actually a virtuous cycle, a deep synergy, between science and engineering that often enables our most exceptional results.

## The Red Storm story Engineering to enable world-class computational science

In 2001, Sandia was seeking to acquire a new supercomputer, and the procurement was off to a rocky start. The Labs had issued a detailed request for proposals for the new system,

but neither of the proposals received met the requirements. One of the companies, however, was willing to work with Sandia to build a system to the Labs' architectural specifications.

Sandia ultimately awarded the contract to that company, Cray Inc., and over the next 30 months Sandia scientists and engineers worked side by side with Cray personnel to create the new system, code-named Red Storm. Completed in 2004, Red Storm served as Sandia's primary high-performance computing resource for the engineering and science needed to maintain the nation's nuclear weapons stockpile, and also was used on occasion to meet other critical national security needs. For example, in 2008, Red Storm played a crucial role in enabling the US military to shoot down a defective satellite that threatened to fall to Earth.

### Very successful in the broader marketplace

For the complex engineering simulations it was designed to run, Red Storm was the world's fastest supercomputer. It also proved very successful in the broader market due to its ability to effectively and efficiently solve a wide range of scientific and engineering problems. In fact, over the subsequent decade, the family of systems based on the Red Storm prototype became Cray's most successful product line in history, with more than 120 descendants around the world.

I believe Red Storm's success came about most fundamentally because Sandia is an outstanding engineering institution. That, and the experience gained in the development and use of several previous generations of leading-edge supercomputing platforms, translated into a clear design philosophy and sound



WITH AN UNDERGRADUATE DEGREE in electrical engineering and systems science and graduate degrees in computer science and mathematics, Div. 1000 VP and Chief Technology Officer Leland has a foot in both cultures, science and engineering.

*"It is important to note that many of the scientific advances enabled by Red Storm led, in turn, to important advances in the engineering of materials, components, and systems in a virtuous cycle that continues to this day."*

judgment about just how far to push the state of the art — far enough to achieve breakthrough performance but not so far as to become untenable in that technological era.

This design philosophy led ultimately to a step-change in the depth and breadth of computational science that could be performed at national laboratories, universities, and companies around the world; hence, this is a great exemplar of engineering in the service of scientific advancement.

### Scientific windfall

One example of this scientific windfall is the atmospheric climate modeling simulation work performed by Sandia's Mark Taylor (1446). Access to Red Storm allowed Mark to develop the spectral element method into one of the fastest and most scalable global atmospheric models available. He went on to integrate this into the Community Earth System Model as part of Sandia's Energy & Climate program work for DOE's Office of Science. This made it possible to perform high-resolution climate simulations on Jaguar, the Oak Ridge National Laboratory supercomputer based on the Red Storm architecture. At the time, these were the most detailed global atmospheric simulations that had ever been performed, and it is expected that this capability will be used in the next round of climate studies performed for the Intergovernmental Panel on Climate Change in support of global climate treaty negotiations.

The model is currently being used on today's fastest supercomputers, many of which continue to be Red Storm-derived systems. This work is now an integral part of DOE's program to develop an Earth system model that will make use of future supercomputer architectures to address climate science issues such as the impact of climate change on freshwater supplies in the US and the stability of the Antarctic ice sheet.

To complete the arc of this story, it is important to note that many of the scientific advances enabled by Red Storm led, in turn, to important advances in the engineering of materials, components, and systems in a virtuous cycle that continues to this day.

## Sandia's Z machine Engineering to support world-class experimental science

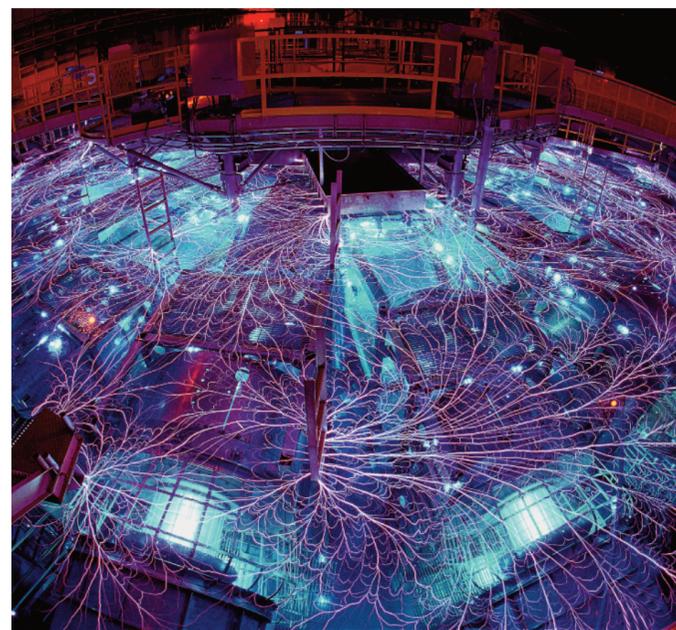
Sandia's Z machine is another important example of this symbiosis between science and engineering. Here, excellence in the engineering of experimental (rather than computational) facilities has enabled world-class scientific research.

Z's origin dates back to Sandia's pulsed power research of the 1960s. Sandia was exploring the use of pulsed power — the generation of high-power energy pulses — for conducting nuclear survivability and hardness testing and for the measurement of material properties in the extreme environments generated by nuclear detonation. Sandia's research in this area spawned the Particle Beam Fusion Accelerator or PBFA-I, and several other exotic experimental facilities. In 1997, PBFA-II was upgraded to PBFA-Z, or more simply the "Z" machine, named after technology that uses an electric plasma current flowing in the vertical direction (labeled the Z axis by mathematical convention) to generate a magnetic field that "pinches" (compresses) plasma around this axis.

### A multi-decade effort

When an upgrade of Z was begun in 2006, Sandia used its exceptional engineering skills to design and deploy an even more powerful machine. This multi-decade effort in pulsed power engineering and science today enables scientists to generate electrical power bursts that, for a few billionths of a second, exceed the entire world's normal generating capacity by a factor of five. This enormous power is used to create extreme states of matter, producing pressures more than three times that at the center of the Earth, and temperatures more than twice that at the center of the sun.

Z experiments have advanced our scientific understanding of materials used in the nuclear weapon stockpile, such as plutonium, and of commonplace elements such as hydrogen that form the bulk of giant planets like Jupiter. The Z



Z MACHINE'S enormous power creates extreme states of matter, producing pressures more than three times that at the center of the Earth, and temperatures more than twice that at the center of the sun. The machine is used in weapons and materials testing, in fusion research, and in seeking answers to basic science questions. (Photo by Randy Montoya)

*"Conducting experiments like these in Z's extreme environment is only possible due to leading-edge, highly innovative engineering. One example of this engineering is the development of an explosively driven, 'ultrafast' closure valve."*

pulsed power system also compresses and heats deuterium in tests aimed at creating a new approach for achieving thermonuclear fusion in the laboratory. This approach, called Magnetized Liner Inertial Fusion (MagLIF), has already

achieved significant fusion yield and was recently selected by DOE as one of three main approaches to achieving fusion. In addition to these core mission efforts, a small fraction of Z experiments are devoted to more exploratory scientific research, which strengthens the connections between Sandia and university communities, and attracts future stockpile stewards.

### Answering previously mysterious questions

One example of such research is Jim Bailey's (1683) investigation of stellar opacity, the property of matter that controls radiation transport inside the sun. These experiments on Z have reproduced the 2.2 million degrees kelvin temperatures at the edge of the solar radiation zone and answered important and previously mysterious questions regarding



ATMOSPHERIC CLIMATE MODEL SIMULATION performed by Mark Taylor used Sandia's atmospheric modeling code on Jaguar, the Oak Ridge National Laboratory system derived from the Red Storm architecture. At the time this was the most detailed global atmospheric simulation performed to date and led to new insights regarding global precipitation patterns. (Photo by Randy Montoya)

the evolution and structure of the sun. Jim's research team was recently recognized with a Lockheed Martin NOVA award and an NNSA Defense Programs Award of Excellence, and has received broad public attention that included a National Public Radio story.

Conducting experiments like these in Z's extreme environment is only possible due to leading-edge, highly innovative engineering. One example of this engineering is the development of an explosively driven, "ultrafast" closure valve.

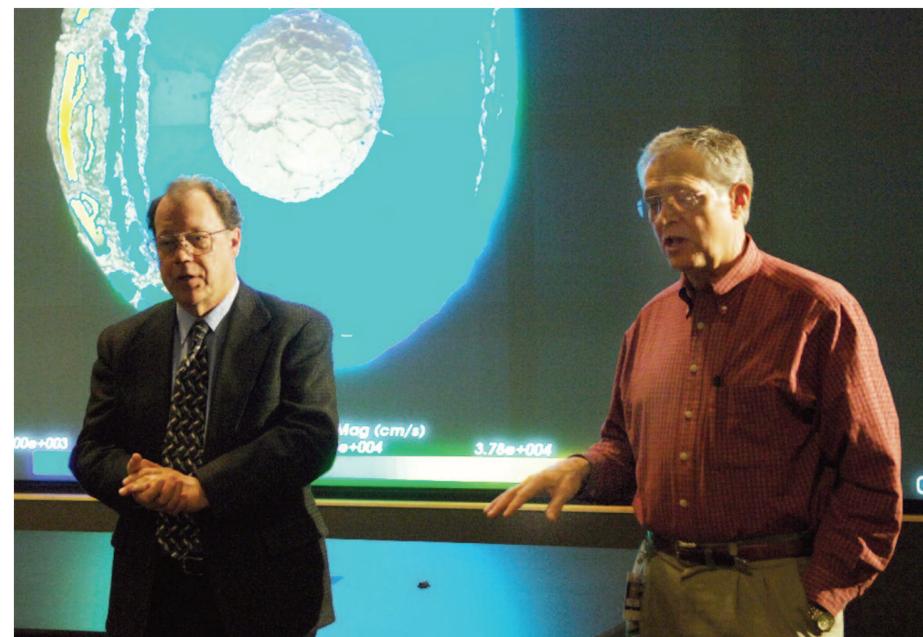
The valve allows millions of amperes of current to pass into a containment vessel through a vacuum gap. The valve then pinches off and hermetically seals this gap before the exploding material can escape from the containment vessel. Another example is the development of the world's fastest digital framing camera, the result of a marriage of capability between Sandia's Microsystems and Engineering Applications (MESA) facility and Z. The camera can take multiple X-ray images at a rate of up to a billion frames per second. This transformative capability allows scientists to observe the evolution of fusing plasmas at a resolution never before possible.

## The persistent challenge and opportunity of two cultures

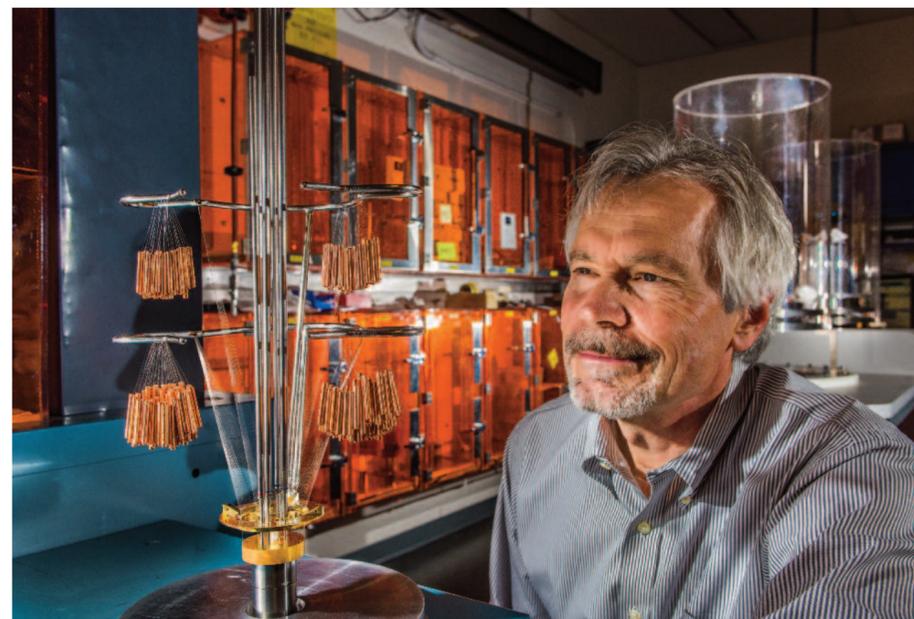
These are just a few examples of Sandia's successful coupling of science and engineering: Advances in science often lead to engineering breakthroughs, which, in turn, enable scientific advances that were previously not possible. This success, however, is not a given.

In his famous 1959 lecture, British chemist and novelist C.P. Snow observed that there are two separate and distinct world-views held by those who train in the physical sciences and those educated in the liberal arts. He argued that because relatively few people had direct experience in both cultures, a breakdown in communication and trust often arises, and that this presents a major barrier to addressing the world's problems. Snow's essay, "The Two Cultures," sparked widespread debate that continues to this day.

In my view Snow's argument has relevance for Sandia today. In fact, Snow later published a more extensive version of his essay in which he describes a similar cultural tension between discovery-oriented scientists and delivery-oriented engineers. His prescribed remedy is the same as in his earlier work: We are called to develop mutual respect and empathy between the two cultures. Part of my vision for Sandia is that we continually strive to present an exemplary model of this mutual respect and empathy. As our history clearly shows, when Sandia honors this ideal and leverages the combined strengths of its scientific and engineering cultures, we achieve exceptional results on behalf of the nation.



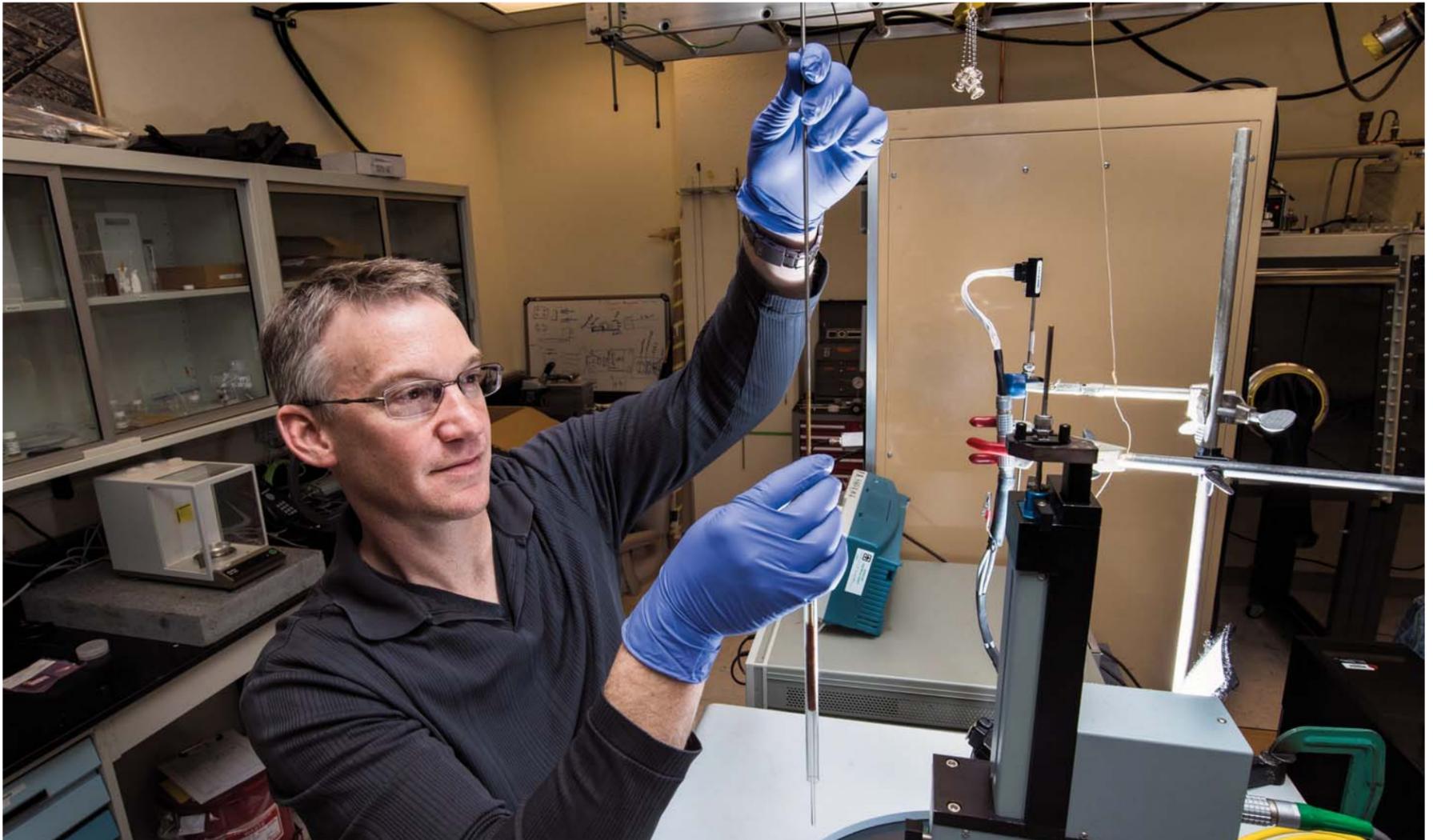
RED STORM WAS ENVISIONED by Bill Camp (right), director of Sandia's computing research efforts at the time, and Jim Tomkins (left) Sandia's lead computing architect of that era. CTO Rob Leland served as the responsible senior manager for the effort. (Photo by Randy Montoya)



PHYSICIST JIM BAILEY OBSERVES A WIRE ARRAY that will heat foam to roughly 4 million degrees until it emits a burst of X-rays that heats a foil target to the interior conditions of the sun. Working at Sandia's Z machine, Jim and his team have been able to determine experimentally, for the first time in history, iron's role in inhibiting energy transmission from the center of the sun to near the edge of its radiative band. (Photo by Randy Montoya)

# Lighter. Cheaper. Better.

*Iron nitride transformers could boost energy storage options*



SANDIA RESEARCHER TODD MONSON and his colleagues have demonstrated the fabrication of iron nitride transformer cores with good physical and magnetic characteristics and now are refining their process and preparing to test the transformers in power conversion test beds. (Photo by Randy Montoya)

**By Stephanie Holinka**

A Sandia-led team has developed a way to make a magnetic material that could lead to lighter, cheaper, and better-performing high-frequency transformers, needed for more flexible energy storage systems and widespread adoption of renewable energy.

Portable energy storage and power conversion systems,

which can fit inside a single semi-trailer, could make it cost effective to rapidly install solar, wind, and geothermal energy systems in even the most remote locations.

“Such modular systems could be deployed quickly to multiple sites with much less assembly and validation time,” says Sandia researcher Todd Monson of Nanoscale Sciences Dept. 1124, who led the team with Stan Atcity of Energy Technologies and System Solutions Dept. 6111.

The magnetic material depends on a method Sandia developed to synthesize iron nitride ( $\gamma$ -Fe<sub>4</sub>N) powders by ball-milling iron powders in liquid nitrogen and then ammonia. The iron nitride powders are then consolidated through a low-temperature field-assisted sintering technique (FAST) that forms a solid material from loose powders through the application of heat and sometimes pressure.

The FAST method enables the creation of transformer cores from raw starting materials in minutes, without decomposing the required iron nitrides, as could happen at the higher temperatures used in conventional sintering. Previously, the  $\gamma$  phase of iron nitride has only been synthesized in either thin film form in high-vacuum environments or as inclusions in other materials, and never integrated into an actual device.

“FAST enables the net-shaping of parts, meaning that iron nitride powders can be sintered directly into perfectly sized parts, such as transformer cores, which don’t require any machining,” Todd says.

Due to its magnetic properties, iron nitride transformers can be made much more compact and lighter than traditional transformers, with better power-handling capability and greater efficiency. They will require only air cooling, another important space saver. Iron nitride also could serve as a more robust, high-performance transformer core material across the nation’s electrical grid.

So far, Todd and his colleagues have demonstrated the fabrication of iron nitride transformer cores with good physical and magnetic characteristics and now are refining their process and preparing to test the transformers in power conversion test beds.

“Advanced magnetic materials are critical for next-generation power conversion systems that use high-frequency linked converters, and can complement Sandia efforts in ultra-wide bandgap device materials for improved power electronics systems. They can withstand higher frequencies and higher temperatures, which ultimately result in high power density designs,” says Stan.

Todd, Stan, and their team built on Sandia’s expertise in power electronics and magnetic materials in strong collaborations with researchers at the University of California, Davis, and Arizona State University, who helped with materials processing and systems level modeling.

Team members from Sandia and UC Davis have filed a patent application for the materials synthesis process.

The work is part of a larger, integrated portfolio of projects funded by DOE’s Energy Storage Program in the Office of Electricity Delivery and Energy Reliability.

## Research Challenges poster session



WHAT IS A RESEARCH CHALLENGE? — Sandia is known for solving tough problems with multidisciplinary teams, combining scientific knowledge and engineering know-how. “Research Challenges strategically address future capability gaps in mission areas using a multidisciplinary approach,” says Ben Cook (1910), senior manager of the CTO Office. On Jan. 27 project leads for most of the Research Challenges gathered at a poster session to answer questions about their Research Challenge and their short-term R&D priorities. Pulsed Power Opportunities for Weapons and Effects Research, Engineering Abiotic-Biotic Living Systems, Power on Demand, and Resiliency in Complex Systems were among those represented. The goal of this poster session was to inspire new Research Challenge-affiliated Laboratory Directed Research and Development projects. The deadline for LDRD submissions is Feb. 25. (Photo by Randy Montoya)

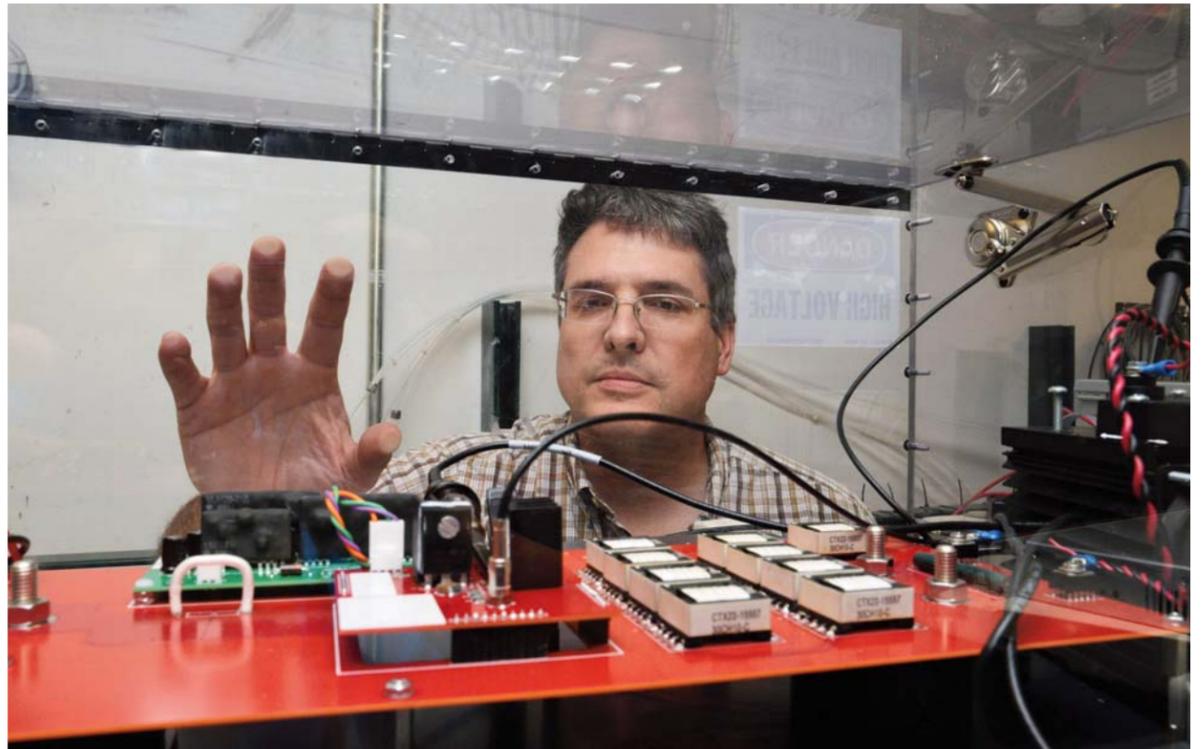
*Silicon has long been the go-to material for semiconductors that power the electronic world. Now scientists are looking far beyond that omnipresent element to materials that could make everything from computers to power grids to electric cars more mighty and energy efficient.*

By Nancy Salem

Electrical power doesn't travel a one-way street. In a technology called power electronics, it is converted from one form to another when you plug in a computer, drive a car, or flip on a light.

"Power electronics use semiconductor devices such as transistors, diodes, and thyristors to control the flow of electrical energy by switching electronic circuits," says electrical engineer Bob Kaplar (1768), who is leading a Laboratory Directed Research and Development (LDRD) project exploring new, more powerful and energy-efficient semiconductor materials. "If you want to convert a DC signal into an AC signal, the actual circuit that does that is complex. But the basic idea is to turn the DC signal on and off."

Semiconductor devices are switching systems that convert voltages and currents. The switches have been made of silicon since about the 1950s when semiconductors were first developed, replacing in many applications power conversion that uses transformers, or coils of wire around magnetic cores. Silicon is at the center of all microprocessors, computer chips, cell phones, and more. "Silicon is the core material that the device that functions as a switch is made of," Bob says. "When semiconductor devices were invented, people started making big transistors that could handle large amounts of power."



POWER CHALLENGE — Sandia electrical engineer Bob Kaplar checks out a test circuit built under a Grand Challenge Laboratory Directed Research and Development project to evaluate the switching performance of wide bandgap and ultra-wide bandgap power semiconductor devices. (Photo by Randy Montoya)

bandgaps significantly larger than one electron volt (eV), typically at least three eV. The bandgap of silicon is 1.1 eV and gallium arsenide, another common semiconductor material, is 1.4 eV. Wide bandgap semiconductor materials such as silicon carbide (SiC) and gallium nitride (GaN) allow devices to operate at much higher voltages, frequencies, and temperatures than the conventional materials, so more powerful, cheaper, and more energy-efficient electrical conversion

AlN and GaN are compatible enough to be mixed. That allows researchers to take small steps toward developing AlN by gradually increasing the amount of AlN versus GaN to study behavior and the effect of lattice mismatch between the semiconductor and the material it's grown on, Bob says.

Estimates predict SiC could perform 100 times better than silicon for power switching, GaN could be 1,000 times better than silicon, and AlN could be 10,000 times better than silicon. However, their potential can't be tapped until researchers better understand how the materials work, develop mature techniques to process them, and address reliability concerns, particularly for high-consequence uses.

# Switched on

Because power electronics process substantial amounts of electrical energy, and energy is lost when power is converted, there has been a move over the past decade to replace silicon with other materials that would be more energy efficient. "The more you can reduce the loss, the better the energy efficiency," Bob says. "Power electronics had been viewed as a not-so-exciting area in the past. But now there is a resurgent interest in it."

## Bandgaps and energy

The new semiconductor materials are referred to as wide bandgap. Bandgap, a fundamental materials property, is an energy range in a solid where no electron states can exist. In the electronic band structure of solids, the bandgap generally refers to the energy difference in electron volts between the top of the valence band and the bottom of the conduction band in insulators and semiconductors. If the valence band is full and the conduction band is empty, electrons cannot move in the solid. But if some electrons transfer from the valence to the conduction band, then current can flow. So bandgap is a major factor determining the electrical conductivity of a solid.

Wide bandgap refers to higher-voltage electronic

systems can be built.

Wide bandgaps have already revolutionized lighting, particularly in the area of light-emitting diodes, or LEDs, which are widely available and are replacing incandescent and fluorescent bulbs. But as transistors, or switches, in modern power electronics, they also have the potential to vastly improve the performance of electrical power grids, electric vehicles, motors for elevators and HVAC systems, and even computer power supplies. Smaller, faster switches mean less loss of power. "Faster switching also means you can make other parts of the circuit smaller, such as capacitors and inductors," Bob says.

Wide bandgap has the potential to substantially reduce the estimated 10 percent energy loss between generating electricity and transmitting it into a home or business. "In a decade or two, the giant transformers in your neighborhood distributing power from the electric grid to homes, which now weigh 10,000 pounds, could be replaced by things the size of a suitcase that weigh 100 pounds," says Sandia Fellow and materials scientist Jerry Simmons (1000).

And if electric vehicles could tap the potential for wide bandgap power electronics to withstand higher temperatures, they might not need a liquid cooling system, reducing the system's complexity and improving vehicle range because the car would weigh less. "There are non-civilian applications as well," Bob says. "The military wants small power converters on unmanned aerial vehicles, and the Navy is interested in electric ships. You want as much power as you can get in a confined space. These advantages are pretty universal."

## Leapfrog to the generation after next

Sandia is researching SiC and GaN, but it's also working to leapfrog over these next-generation materials to the generation-after-next, ultra-wide bandgap materials such as aluminum nitride (AlN), which has a bandgap of 6.2 eV. The Ultra-Wide Bandgap Power Electronics Grand Challenge LDRD project that Bob is leading is at the end of its first year. Grand Challenges are three-year LDRD projects that focus on bold, high-risk ideas with potential for significant national impact.

"Potential benefits like shrinking system size and high-temperature operation become even greater with ultra-wide bandgap materials," Bob says. "We're also interested in other harsh environments. There the challenges become greater."

## Lots of energy in a small package

The Ultra-Wide Bandgap Grand Challenge is the flagship Laboratory Directed Research and Development project for Sandia's Power on Demand Research Challenge aimed at developing electrical power systems with the smallest size and weight, while handling the largest possible amount of energy. The research challenge tackles underlying fundamental science questions, engineering applications, and technical challenges for devices, materials growth, and power systems.

The Grand Challenge covers three areas: materials growth; device design, fabrication, and testing (including demonstration of efficient switching); and defects and radiation resistance. It's exploring ways to grow ultra-wide bandgap materials with fewer defects and different device designs to exploit the properties of materials other than silicon.

Although some devices using SiC and GaN are on the market, thorny problems remain, Bob says. Common performance issues include defects, incompatibility with the microelectronics substrates on which the materials are grown, and the impact of integrating a device into a larger system. Sandia researchers can evaluate those problems impartially, building on expertise from decades of nuclear weapons work.

The downside to wide and ultra-wide bandgap technology is that it is not as mature as the silicon industry, which has a huge manufacturing infrastructure. "It's easy to control the properties of silicon and related materials," Bob says. "People know how to process those really, really well."

Researchers are not at the point of making a power converter out of ultra-wide bandgap materials but envision such a device several years down the road. "At the circuit level we're characterizing the devices, measuring how much voltage we can put across before it goes into breakdown and how fast the switching transient is when we turn it on and off," Bob says. "We have voltage targets for the devices we're building. We can see all the pieces fitting together and moving toward the devices and circuit demonstrations."

About 50 scientists are working on the Ultra-Wide Bandgap Power Electronics Grand Challenge, and Bob hopes the research will continue when the challenge ends. "This is forefront materials science," he says. "This is a brand new field to go beyond the wide bandgap materials, and not many people are working on it. The impact potential is huge."

## Why switch?

Different methods exist to convert electrical energy from one form to another. For example, direct current (DC, or constant) voltage can be converted to a lower DC voltage by connecting two resistors in a series arrangement known as a voltage divider. But that method of conversion is inefficient and wastes much of the power as heat. An alternative approach is to switch the DC voltage on and off, and take the average of the resulting on-off-on signal. That switching approach is known as power electronics and is much more efficient, so that little power is wasted as heat. The switching approach also allows for a wider variety of types of power conversion, for example, from a lower DC voltage to a higher DC voltage, from DC to alternating current (AC), from AC to DC or from one AC frequency to another.

# Opportunity knocks Eastern Cherokees explore IT and partnership at Sandia

By Nancy Salem

The Eastern Band of the Cherokee Indians is considering an alliance with Sandia that could take its information technology system to a higher level and potentially spur economic development.

Tribal representatives toured the Labs on Jan. 25, visiting the Cyber Engineering Research Laboratory (CERL) and the Data Center. "It was a wonderful experience," says Anita Lossiah, a Tribal Council member from the Yellowhill community in western North Carolina. "It was a learning experience to see what Sandia has to offer the tribe, very informative."

Vice Chief Richard Sneed says the Eastern Cherokees want to enhance and advance the tribal government IT infrastructure with a focus on cybersecurity, emergency management, and data center systems. "If we were to enter into a relationship with Sandia we could implement best practices that are known and have been tested," he says. "It could serve our people better to partner on the front end instead of starting from scratch."

Andrew Conseen Duff, technology adviser to the Tribal Council, says it is important that IT infrastructure meet industry-based standards and be secure and defensible. "We want to remove vulnerabilities," he says. "Information used wrongly can be devastating."

## IT a trillion-dollar business

Sneed says enhanced IT could produce economic development opportunities in the Internet and emergency response fields. "IT is a trillion dollar business across the globe," he says. "If our tribe builds a solid infrastructure we can look to a clear roadmap into new areas that could be a boon for economic development."

Conseen Duff says the Eastern Cherokee delegation heard the word opportunity spoken often dur-



**BIG DATA** — David Martinez (9324), project lead for Scientific Computing Systems, gives members of the Eastern Band of Cherokees delegation a tour of Sandia's Data Center. Tribal Vice Chief Richard Sneed (center in the blue shirt) says he was impressed by the center's water-cooled system. "It's counterintuitive — water and circuitry — but when you learn how much energy is saved using water to cool everything instead of air, it is just amazing," he says. (Photo by Randy Montoya)



**CYBER TALK** — Eastern Band of Cherokees Vice Chair Richard Sneed, left, talks with Laurence Brown (163), Tribal Government Relations manager, about the importance of cybersecurity in the digital world. "We want our information to be secure and available to be used for good," Sneed says. (Photo by Randy Montoya)

ing the Sandia presentations. "Every time I heard it, I listened closely," he says.

Sneed says government is often reactive instead of proactive. He says he was inspired by the Sandia scientists who spoke to his group. "Just to know there are folks who spend every waking hour engaged in research and development is encouraging from a government perspective," he says. "It would be beneficial and more cost-effective to be able to not be reactive but to have a plan knowing what the outcome is going to be. IT is not an area where you want to be wrong."

Curtis Keliiaa (9336), principal investigator for Tribal Cyber Infrastructure Assurance, says Sandia's tribal strategic partnerships address national and tribal cyber critical infrastructure challenges regarding modernization, protection, security, and

resilience. His team has developed eight deep science, engineering, and technical interdisciplinary abilities drawn from across Sandia and designed to apply to the 16 Department of Homeland Security defined critical infrastructure sectors.

Curtis says his group, in coordination with Tribal Government Relations, has worked with or is currently working with tribes in the western, northwest, and southwest United States. "The Eastern Band of Cherokee Indians visit to Sandia was very well received and provides potential opportunity to work in the eastern region of the United States to the mutual benefit of the nation and the tribe," he says.

Sneed and Lossiah say the next step is to take what they've learned back to the tribe and review and discuss the partnership potential.

Sneed says the Eastern Cherokees have new executive and Tribal Council leadership and are looking to a dynamic future. "We're on the precipice of a lot of growth potential," he says. "We want to see where we can go with infrastructure. If we have a solid foundation we can go to many other places. We feel an energy. It's an exciting time for the tribe."

## Ancestral home in North Carolina

The Eastern Band of Cherokee Indians is primarily descended from about 800 Cherokee who did not participate in the 1839 Trail of Tears to Indian Territory, now Oklahoma, following the Indian Removal Act. The tribe numbers about 15,000 spread across the world. About 5,000 live on ancestral tribal trust lands in western North Carolina south of the Great Smoky Mountains National Park. The Eastern Band of Cherokee Indians is one of three federally recognized Cherokee tribes, the others being the Cherokee Nation and the United Keetoowah Band of Cherokee Indians, both in Oklahoma.



Recent Retirees

New Mexico photos by Michelle Fleming  
California photos by Randy Wong

Larry Brandt 47                      8110	Joanne Volponi 37                      8633	Ron Kulju 36                      5966	Carlos Quintana 35                      9344
Bess Campbell-Domme 32                      4021	Jeff Gilkey 32                      5416	Peggy Clews 25                      1746	Judy Roberts 18                      9544
Linda Holle 15                      10667			

# SANDIA CLASSIFIED ADS

## 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: On internal web homepage, click on News Center, then on Lab News link, and then on the very top of Lab News homepage "Submit a Classified Ad."  
 If you have questions, call Michelle at 844-4902.  
 Because of space constraints, ads will be printed on a first-come basis.

## Ad rules

- Limit 18 words, including last name and home phone (If you include a web or e-mail address, it will count as two or three words, depending on length of the address.)
- Include organization and full name with the ad submission.
- Submit ad in writing. No phone-ins.
- Type or print ad legibly; use accepted abbreviations.
- One ad per issue.
- We will not run the same ad more than twice.
- No "for rent" ads except for employees on temporary assignment.
- No commercial ads.
- For active Sandia members of the workforce, retired Sandians, and DOE employees.
- Housing listed for sale is available without regard to race, creed, color, or national origin.
- Work Wanted ads limited to student-aged children of employees.
- We reserve the right not to publish any ad that may be considered offensive or in bad taste.

## MISCELLANEOUS

**ARMOIRE**, dark finish, \$275; entertainment center, oak finish, \$100; recumbent stationary bike, Schwinn Active20, \$150. Wolf, 856-8539.  
**DINING TABLE**, high-top, w/2 chairs, dark cherry finish, great condition, can email photo. \$50. Craven, 505-514-3589.  
**LEATHER COUCH**, beautiful, like new condition, 6'10" wide, Oxblood color, very comfortable, \$700. Babb, 228-5225.  
**TIMESHARE WEEK**, New Orleans, 3-bdr., 2 baths, March 4-11, Hotel De L'Eau Vive, 2016 fees already paid. Reis, 505-856-1138, tessreis@msn.com.  
**'JOSEPH AND THE AMAZING TECHNICOLOR DREAMCOAT' TICKETS**, 2, April 23, 8 p.m., Popejoy, seats AA105/106, mezzanine, \$70 ea. Verley, 221-7827.  
**DRUM SET**, 5-pc., Tama w/Zildjian hi-hat & ride cymbals, green/cobalt color, excellent condition, \$400. Holmes, 873-5255.  
**ELLIPTICAL EXERCISER**, ProForm Cardio Crosstrainer, photos available on request, \$120. Dawson, 281-1235.  
**KID'S SKIS**: Salomon Jr., Marker bindings, 130-in. \$40; K2 Scratch Jr, Salomon, 118-in., \$60; K2 Marker bindings, 155-in., \$40. Alam, 505-363-7369.  
**ELECTRIC MOWER**, Homelite, 12-amp, 20-in. corded, 3-in-1, \$250. Dinge, 505-818-8933.  
**STAR WARS THEATER POSTERS**, Star Wars, Empire, Jedi, framed, \$40 ea. Felix, 573-0595.  
**NINTENDO DSi**, pink, w/>20 games, \$100. Coverdale, 286-2664.  
**FILM CAMERA**, Nikon AF N6006 body, AF Nikkor 75-300 lens, Nikkor-S 50 mm lens, \$100 OBO. Donnell, 241-9111.  
**DISHWASHER**, Frigidaire, ultra-quiet, stand-alone, rolls to sink, w/hook-up to kitchen faucet, \$100. Wimpy, 822-0223.

**FUNDRAISER**, non-profit, FabulousFelines Wild Love, win jewelry, dinner, flowers, chocolates, <http://fabulousFelines.org>. Stubblefield, 263-3468.  
**WATER BED**, super single, 86" x 52", dark pine frame, mattress, heater, sheets, needs new liner/fill kit, \$50. Geib, 505-281-6793.  
**RV CAMPING EQUIPMENT**, folding lounge chairs & table; folding ladder, \$125; RV water pump; electric heater; vacuum cleaner, \$50; LP gas kit, \$45; 5-gal. gas cans, \$18 ea. Garcia, 554-2690.  
**WEDDING DRESS**, 2015 Alfred Angelo, style 2527, size 0-4, perfect, professionally dry-cleaned, w/hairpiece, veils, wrap, stole, retails \$2,675, asking \$1000. de la Fe, 974-8670.  
**TOBY MAC TICKETS**, 2, Santa Ana Star, Feb. 25, 7 p.m., sec. 203, row E, seats 16-17, \$165. Valdez, 505-550-1993, valdezjv07@msn.com

'07 PRIUS, desert gold, original owner, 131K miles, runs/looks great, dealer serviced, \$7,500, cash/certified check. Andersen, 299-1636.  
 '01 CORVETTE COUPE, all options, loaded, two tops, torch red, 55K miles, excellent condition, motivated seller, \$18,500 negotiable. Marchi, 306-7533.  
 '09 CHEVY TAHOE LT2, 4WD, leather, 3 rows, seats 8, black, professionally serviced, 79.5K miles, <than NADA, \$24,500. Mahler, 505-681-7642.  
 '05 FORD F150 XLT, regular cab, 2WD, 6-ft. bed w/liner, ~92K miles, nice truck, asking KBB value, \$7,000. Edwards, 505-903-1692.

## REAL ESTATE

**VACANT LAND**, Tome NM, near Tome hill & UNM extension, owner will negotiate price, \$55,000/acre. Ramos, 304-593-3425 or 304-562-8546.

## WANTED

**CAREGIVER**, for 12 hrs., 5 days/wk., East Mountains, for elderly male stroke victim. Dotson, 281-9057.  
**SOFTBALL LEAGUE**, looking for women to join, 50+, this summer, in Albuquerque. Staloni, 298-7903.  
**HELP DRIVING TEENAGER**, from St. Pius to Albuquerque Academy at noon, this summer, June 6-July 15. Martinez, 505-792-3608.

## TRANSPORTATION

'08 ACURA MDX, w/tech & entertainment pkg., 15/20/17-mpg (city/hwy/combined), seats 7, V6 engine, 97.9K miles, \$12,000. Hernandez, 313-850-0420.  
 '99 FORD EXPLORER, engine, tires, transfer case good, 4x4, transmission not so good, extremely good price. Hanks, 249-1931.  
 '05 CHEVY CAVALIER, manual, 93K miles, 30-mpg city, runs/looks great, \$1,750. Reece, 505-414-3018, text or call.  
 '03 TACOMA PRERUNNER, 4-dr., TRD pkg., 140K miles, brand new tires, great shape, \$9,500 OBO. Sabo, 510-542-7490.  
**PONTIAC VIBE**, (same as Toyota Matrix), 5-spd., PW, PL, CC, 17-in. alloys, 119K miles, \$3,600. Dwyer, 271-1328.

Exceptional service in the national interest

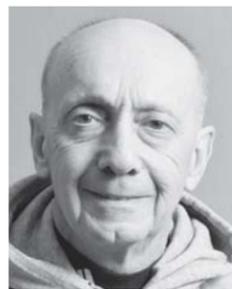
## Sandia LabNews

Lab News is available in news racks at 25 locations throughout the Labs. A digital version of Lab News continues to be available on Tech Web as well as on Sandia.gov.

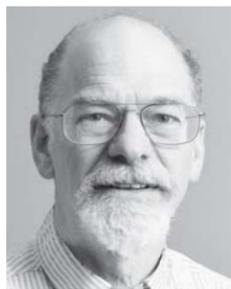
- |                                    |   |
|------------------------------------|---|
| 1. Bldg. 802, elevator lobby       | 14. Bldg. 870, lobby                            |
| 2. Bldg. 810, east lobby           | 15. Bldg. 701, 1st floor hall, next to elevator |
| 3. Bldg. 822, south entrance       | 16. IPOC, lobby                                 |
| 4. Bldg. 858 EL, lobby             | 17. CGSC, lobby                                 |
| 5. Bldg. 880, Aisle D, north lobby | 18. CRSI, lobby                                 |
| 6. Bldg. 892, lobby                | 19. M.O. 308, lobby                             |
| 7. Bldg. 894, east entrance, lobby | 20. Bldg. 960, lobby                            |
| 8. Bldg. 898, east lobby           | 21. Bldg. 962 (TA III), lobby                   |
| 9. Bldg. 887, lobby                | 22. Bldg. 6585 (TA V), lobby                    |
| 10. Bldg. 891, lobby               | 23. Bldg. 905, lobby                            |
| 11. Bldg. 836, lobby               | 24. 800(A), outside of Vicki's                  |
| 12. Bldg. 831/832 north lobby      | 25. Bldg. 905, lobby                            |
| 13. Bldg. 861, cafeteria lobby     |   |

## Mileposts

New Mexico photos by Michelle Fleming



John Cerutti  
40 4842



Jeff Romine  
40 2666



Steve Sanderson  
40 6622



Victor Rimkus  
35 2133



Mark Smith  
35 1801



Timothy Drummond  
30 2121



Michael Gilbert  
30 54032



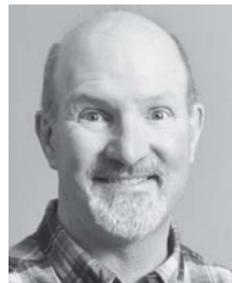
Susan Harty  
30 857



Tan Chang Hu  
30 9336



Tim Mitchell  
30 10262



Bradley Smith  
30 153



Dan Sprauer  
30 5355



Robert Urias  
30 4847



Joe Weatherby  
30 5532



Sharon Deland  
25 6832



Michelle Leshner  
25 9538



Heather Brown  
15 10611



Armando Fresquez  
15 2546



Jeanne Oselio  
15 11000

## National Labs Day

# Introducing STEM students to careers in national service



**BUILDING RELATIONSHIPS** — Sandia recruiters Dennis Owens (423), left, and Tim O'Hern (1512) talk with a Howard University student about career opportunities at Sandia. In addition to serving as a recruiter, Tim works with four to six Howard mechanical engineering students each year to help them complete a capstone design project. "I always tell the student groups that this is what they will be doing after they graduate, whether they go to graduate school or take a job. They need to be able to solve problems that don't have answers in the back of the book, work as members of an effective team, and communicate their results to a paying customer," he says. (Photo by Charles Votaw)

By Valerie Larkin

On Feb. 4, Sandia led the coordination of National Labs Day, a career fair featuring 15 national labs, DOE, and NNSA. Held at Howard University in Washington, D.C., the event was designed to introduce science, technology, engineering, and math (STEM) students to the unique career opportunities available at the national laboratories.

The day's events included panel discussions with representatives from the national labs and DOE, and a showcase of research being conducted at Howard. Students from Howard and neighboring minority-serving institutions (MSIs) were invited, and more than 200 took part.

### Event increases visibility of labs among students

"National Labs Day is among the first coordinated steps toward strengthening relationships between the nation's DOE labs and historically black colleges and universities to foster talent development and acquisition," says Melonie Parker, VP of Human Resources and Communications Div. 3000.

"This event provided an opportunity for the national labs to showcase the unique capabilities and the importance of complex-wide mission programs and deliverables. It also



**INCREASING ACCESS** — Introducing a panel discussion, Div. 3000 VP Melonie Parker said, "Today we're increasing access and visibility into the national labs, and helping students explore the art of the possible." (Photo by Charles Votaw)

helps us attract and hire the most qualified applicants in STEM fields. Like other technical companies, the nation's labs are at a pivotal point in addressing growing attrition rates in critical skill areas while ensuring diversity in our workforce, and we are working to extend access and visibility into the work of the national labs to those who may not have it."

### Howard was a natural fit for event

Howard was selected as the site for the first National Labs Day because of its central location, and also because in 2015 it received a grant, along with 12 other MSIs, from the DOE Office of Economic Impact and Diversity to help strengthen the pipeline of students from MSIs to careers in the national laboratories. Howard is also ranked among the nation's top 150 universities, and second among historically black univer-

sities and colleges, which made it a natural fit for this event, says Annie Hanawalt (3555-2), a Sandia employment, staffing, and recruiting specialist.

Steve Rottler, deputy Laboratories director and Executive VP for National Security, attended National Laboratories Day. After the research showcase, he said, "The research going on here is first-rate and very well aligned with the capabilities of Sandia and our mission area needs. I'm impressed by the emphasis at Howard on service, leadership, and excellence."

Plans are already underway to expand National Labs Day to other laboratories and universities.

Kim Sawyer, deputy Laboratories director and executive VP for Mission Support, said, "This is a major breakthrough in terms of having DOE and the laboratories at a joint event. Today I've seen tremendous enthusiasm from the students, but also from the representatives of the labs and DOE. The students I've encountered were bright and thoughtful, and it's clear to me this is an untapped resource."



**REAL-WORLD IMPACT** — Cybersecurity specialist Cedric Carter (5621) spoke on a panel about his work, which includes developing software, identifying vulnerabilities, and testing new technologies before they enter the market. "It was a humbling experience to go recruit at Howard University. It was also great to share my enthusiasm for the work I do for the Labs and for national security," he said. (Photo by Charles Votaw)

## Sandia hosts New Mexico African American community leaders



**NEW MEXICO AFRICAN AMERICAN COMMUNITY LEADERS** visited Sandia earlier this month to learn about the Labs' mission and to hear more about its progress in a key outreach objective, "Strengthening the community where we live and work." HR and Communications Div. 3000 VP Melonie Parker welcomed the visitors at Sandia's Center for National Security and Arms Control. Also greeting the visitors were Carl Rhinehart, manager of Mechanical Design Dept. 2993, and Black Leadership Committee Executive Champion Steve Rottler, deputy Laboratories director and executive VP for National Security Programs, who provided a Sandia overview. Visitors heard about the background, accomplishments, and activities of Sandia's Black Leadership Committee and an overview of the Labs' community outreach and employee recruiting programs. Staff mem-

bers talked about how they were recruited to the Labs and their experiences working at Sandia and living in the community. After the presentations, the group toured a display of homeland security and nonproliferation technologies in the Center for National Security and Arms Control. In the photo, left to right, are Carl Rhinehart (2993), chair of Sandia's Black Leadership Committee; Rena Bendaw, Grant Chapel AME Church Lay Organization president; James Lewis, retired New Mexico state treasurer; Melonie Parker; Chuck Crawley, team supervisor, Custodial Services; Pamela Herndon, executive director of the Southwest Women's Law Center; Yvette Kaufman-Bell, director of the Office of African American Affairs; and Dionne Rodgers, president of the Network of Intel African American Employees. (Photo by Randy Montoya)