Neutron Generation: From tubes to chips

By Sue Major Holmes

It was a figurative whack on the head that started Sandia distinguished technical staff member Juan Elizondo-Decanini (2625) thinking outside the box — which in his case was a cylinder.

He developed a new configuration for commercial neutron generators by turning from conventional cylindrical tubes to the flat geometry of computer chips. For size comparison, he says small neutron generators, which are like mini accelerators, are 1 to 2 inches in diameter.

"The idea of a computer chip-shaped neutron source — compact, simple, and inexpensive to mass-produce — opens the door for a host of applications," Juan says.

The most practical, and the most likely to be near-term, would be a tiny medical neutron source, implanted close to a tumor, that would allow cancer patients to receive a low neutron dose over a long period at home instead of having to be treated at a hospital, he says.

The technology is ready to be licensed for some commercial applications, but other more complex commer-

(Continued on page 12)

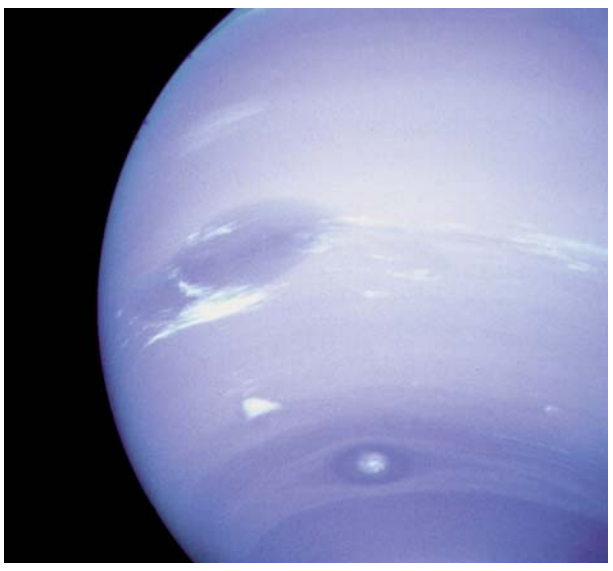
HELLO, MR. CHIPS — Juan Elizondo-Decanini (2735), left, Matt Senkow (2735), right, and Kevin Youngman (2625) discuss a new configuration for neutron generators. A three-year Laboratory Directed Research & Development project Juan led demonstrated the basic technology necessary for a tiny, mass-produced, chip-based neutron generator that he said can be adapted to medical and industrial applications.

(Photo by Randy Montoya)

Experiments may force revision of astrophysical models of universe

Findings suggest ice giant planets have greater water volume

By Neal Singer



ICE GIANT PLANETS like Neptune may have more water than previously thought. (NASA image)

That water expands when boiled, rattling pot tops on stoves, is no secret. But that it can be compressed is foreign to our daily experience.

Nevertheless, an accurate estimate of water's shrinking volume under the huge gravitational pressures of

(Continued on page 7)

Sandia LabNews

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Sandia National Laboratories

IP Ecosystem

Sandia boosts impact of intellectual property through lifecycle approach

By Nancy Salem

Sandia's Mission Leadership Team has developed a new objective for intellectual property that promotes IP management throughout its lifecycle to more powerfully deploy results of the Labs' publically funded R&D for the US public good.

This objective is embodied in a strategy that will ask Sandians to think about intellectual property development, protection, and deployment much earlier in a project lifecycle than has traditionally been done.

"We will manage IP as a strategic asset to both enhance mission impact and strengthen our research foundations," says Laboratories Director Paul Hommert. "We are confident that this transformation will help us continue to deliver exceptional results in our service to the nation and to become a leader in innovation and IP management across all national laboratories."

"We will manage IP as a strategic asset to both enhance mission impact and strengthen our research foundations."

Sandia President and Labs Director Paul Hommert

Mark Allen, manager of Intellectual Property Management, Alliances & Licensing Dept. 1931, says the core of the strategy is to be more systematic and intentional with intellectual property. He says an IP

(Continued on page 6)

Celebrating

Women's History Month

Inside . . .

Celebrating

Asian American Engineers

Engineers from across the country gathered in Albuquerque for the 2012 Asian American Engineer of the Year awards ceremony and conference. Story and photos on **pages 8-9.**

That's that

It didn't quite rise to the level of the pre-Y2K concerns (remember Y2K?), but a massive solar storm that was predicted to sweep over the planet earlier this month did generate a host of guarded warnings from solar physicists and electronics experts. Electronics of all kinds could be affected, communications could go on the blink, and even global power grids might be vulnerable to disruptions, the experts warned.

As far as I can tell based on an Internet search, the worst didn't happen — this time. It appears, though, that we may not be out of the woods yet. The sun is in a particularly active phase right now, a phenomenon tied to an 11-year cycle. As the sun moves toward the peak of the cycle — the next crest is expected in May 2013 — its surface is wracked by roiling storms that spew out monstrous solar flares, releasing almost inconceivably vast amounts of energy. How vast? According to Wikipedia, a big flare can release up to 160,000,000,000 megatons of TNT equivalent. If I'm counting my zeroes right, that's 160 billion megatons. That energy screams through space at millions of miles per hour, indiscriminately slamming into everything that gets in its way — including small, rocky planets — like an electromagnetic tsunami.

With energies like these in play we are all reminded of just how awesome are the forces that shape and reshape the planet, the solar system, the universe. Humbling and inspiring at the same time, these immense happenings remind us at once of how small we are and yet how we have our own part in this great cosmic mystery.

* * *

Speaking of awesome forces, do you remember that day a couple of weeks back where the winds reached hurricane level around Albuquerque? If we weren't living in so-called '"flyover country" (as the sophisticates think of places like New Mexico), winds like that would have likely made national news. Instead, it was just another typical March day in the Land of Enchantment.

As it happens, during my morning commute that day, the wind was blowing so hard it was finding its way into my car through the closed windows. Admittedly, the rubber seals around the doors and windows of my $500 winter-beater aren't what they once were, but still! To feel the wind blowing across your face with the windows closed is a bit disconcerting. With the car literally rocking, the passenger compartment acted like an echo chamber, amplifying and changing the pitch and resonance of the wind until it wailed like those sound effects from the classic science fiction movie, *The Thing*. In this case, my old winter-beater held the banshees at bay, but just barely.

* * *

Elsewhere in this issue (on pages 10-11) we celebrate Women's History Month with a poster (on page 10) highlighting some of 2012's most outstanding among the many outstanding women at Sandia. Also, we have a historical perspective (on page 11), written by Sandia historian Rebecca Ullrich, about Ruth Whan, a true pioneer who was the third female PhD hired to the technical staff, following Louise Patterson and Katheryn Lawson.

After making a mark with her work, Ruth was the first woman promoted to technical department manager, which at the time was the second level of management, just above division supervisor.

While reading about Ruth, I started thinking about Jackie Robinson, another pioneer, the first African American to be allowed to play in baseball's major leagues. (With Opening Day less than a month away, my mind invariably turns to baseball.) Robinson played the game under intense scrutiny and even outright hostility, on and off the field. More than a few — a lot more than a few — hoped with all their hearts that he would fail miserably. His failure would justify and reinforce their own prejudices. But Robinson didn't fail. He was honored as Rookie of the Year in 1947 and as the National League's Most Valuable Player in 1949. His success — and his sacrifices — opened the door for other African Americans, whose long-overdue participation transformed the game and made it better than it had ever been.

The thing about heroes, the thing about pioneers — like Jackie Robinson and Ruth Whan — is that they have to be better than the best. They have to prove themselves over and over and over again. They have to perform at a higher standard than us mere mortals. It's an unfair burden to impose on anyone, of course, but such is human nature. And by all accounts, both Ruth and Jackie Robinson bore the burden with grace, dignity, and critic-shaming excellence. Thanks, Jackie. Thanks, Ruth.

See you next time.

Bill Murphy (505-845-0845, MS 0165, wtmurph@sandia.gov)

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Sandia garners two tech transfer awards

By Nancy Salem

Sandia will be honored twice for its work to transfer innovative technologies to the private sector at an awards ceremony May 3 at the Federal Laboratory Consortium (FLC) national meeting in Pittsburgh, Pa.

The Sandia Science & Technology Park (SS&TP) will receive the State and Local Economic Development Award, and the Fuel Cell Mobile Light is a winner of the Award for Excellence in Technology Transfer.

A FUEL CELL mobile light unit lit the grounds at the final space shuttle launch at the Kennedy Space Center in July 2011. (Photo by Steffan Schulz)

"Both of these awards recognize successful public-private partnerships in promoting technology transfer," says Jackie Kerby Moore (1933), SS&TP executive director and Sandia's representative to the FLC.

The State and Local Economic Development Award recognizes successful initiatives that involve partnerships between state or local economic development groups and federal laboratories for economic benefit.

The SS&T Park opened in 1998 as a partnership between Sandia and public and private partners. Adjacent to Sandia's multibillion-dollar engineering and science facilities, SS&TP's mature companies and startups collaborate with the Labs on a broad assortment of technologies, products, and services.

The 33 companies and organizations in the park employ more than 2,230 people at an average annual wage of $71,612. Investment in the park is currently at $356 million.

"It is very satisfying to be recognized by our peers in the tech transfer industry," Jackie says. "This award demonstrates the impact that Sandia has had in economic development and job creation."

The Award for Excellence in Technology Transfer recognizes employees of FLC member labs and non-lab staff who have accomplished outstanding work in the process of transferring federally developed technology.

The Fuel Cell Mobile Light helps bring clean hydrogen (H_2) fuel cell lighting products to industry. A quiet, zero-emissions fuel cell replaces the noisy, diesel-powered generators that provide energy for mobile lights used by highway construction crews, airport maintenance personnel, film crews, and many others.

The project was initiated as part of the Sandia/Boeing Umbrella Cooperative Research and Development Agreement (CRADA) and strategic partnership. It included a coalition of institutional partners — funding sponsors, fuel cell and lighting technology experts, equipment manufacturers, and diverse end users.

The coalition's work has led to a commercial product, the H_2LT (H_2 Light Tower), being developed by partner Multiquip Inc. of Carson, Calif.

Among other uses, the hydrogen-powered lighting system last year illuminated the red carpet at the Academy Awards in Hollywood and lit the grounds at the final space shuttle launch at the Kennedy Space Center. Sandia project lead Lennie Klebanoff (8367) estimates that deployment of a single hydrogen fuel cell-powered lighting system would offset 900 gallons of diesel fuel per year and eliminate pollutants, allowing the system to be used indoors.

To finalize the commercial design, the CRADA and partnership is constructing six units that will be subjected to rigorous environmental and performance testing. Multiquip hopes to offer the lighting unit for sale soon.

"The FLC Award is a true honor for the Fuel Cell Mobile Light Project. It is a wonderful recognition of the very purpose of this DOE-funded project, namely to get hydrogen fuel cells into more widespread commercial use via technical transfer from the national labs to industry," Lennie says.

The FLC is a nationwide network of more than 300 members that provides the forum to develop strategies and opportunities for linking laboratory mission technologies and expertise with the marketplace.

The FLC Awards Program annually recognizes federal laboratories and their industry partners for outstanding technology transfer efforts. Since its establishment in 1984 the FLC has presented awards to nearly 200 federal laboratories, becoming one of the most prestigious honors in technology transfer.

Promising diesel alternative biofuel

JBEI Researchers clear potential roadblock

By Patti Koning

The road to finding a biofuel that can truly replace traditional petroleum-based fuels, in terms of both performance and cost, is a long and hard one. A team of researchers at the Joint Bio Energy Initiative (JBEI) may have found a shortcut with a scientific breakthrough that solved the structure of an enzyme in the Grand Fir (Abies grandis) tree.

"Another JBEI team recently discovered that bisabolane holds promise as a biosynthetic alternative to No. 2 diesel fuel. But there is a bottleneck in the enzyme synthesis process — it's too slow," explains biochemist Masood Hadi (8634), one of the researchers on the team led by Paul Adams and Jay Keasling of JBEI. "Solving the protein crystal structure of AgBIS (Abies grandis-bisabolene synthase) means we can do rational design and engineering to make the enzyme more catalytically active."

The work is described in the paper "Structure of a Three-Domain Sesquiterpene Synthase: A Prospective Target for Advanced Biofuels Production," which appeared in the Cell Press journal *Structure*. Adams, who heads JBEI's Technologies Division, is the corresponding author of the paper with co-authors Ryan McAndrew, Pamela Peralta-Yahya, Andy DeGiovanni, Jose Pereira, and Masood.

Before the team could work on solving the protein crystal structure, they first needed to purify the enzyme in greater quantities. Masood, DeGiovanni, and Peralta-Yahya spent nearly six months evaluating various conditions to identify the best protein expression and purification process.

MASOOD HADI (8634), preparing a protein purification column for the fast protein liquid chromatography system, is part of a JBEI research team that helped solve the crystal structure of the Grand Fir, knowledge that could help overcome a roadblock to microbial-based production of bisabolane biofuel. (Photo by Dino Vournas)

MASOOD HADI is shown here checking the concentration of a protein in a nanodrop. (Photo by Dino Vournas)

"You can spend five years on this type of research," says Masood. "Fortunately, we had liquid handling automation to go through this process development stage quickly. The researchers were then able to purify, stabilize, and crystalize the enzyme. To solve the three-dimensional crystal structure of AgBIS, they turned to the protein crystallography capabilities of Berkeley Lab's Advanced Light Source (ALS), a DOE Office of Science national user facility for synchrotron radiation, and the first of the world's third generation light sources.

The researchers determined that the AgBIS enzyme consists of three helical domains, the first three-domain structure ever found in a synthase of sesquiterpenes — terpene compounds that contain 15 carbon atoms. The discovery of this unique structure holds importance on several fronts.

"That we found the structure of AgBIS to be more similar to diterpene (20 carbon terpene compounds) synthases not only provides us with insight into the function of these less-well characterized enzymes, it also provides us with clues to the evolutionary heritage as the archetypal three-domain terpenoid synthases became two-domain sesquiterpene synthases in plants," explains Adams.

"Furthering our knowledge of the structures and functions of terpenoid synthases may prove to have abundant practical applications aside from advanced biofuels because these enzymes produce a wide variety of specialized chemicals."

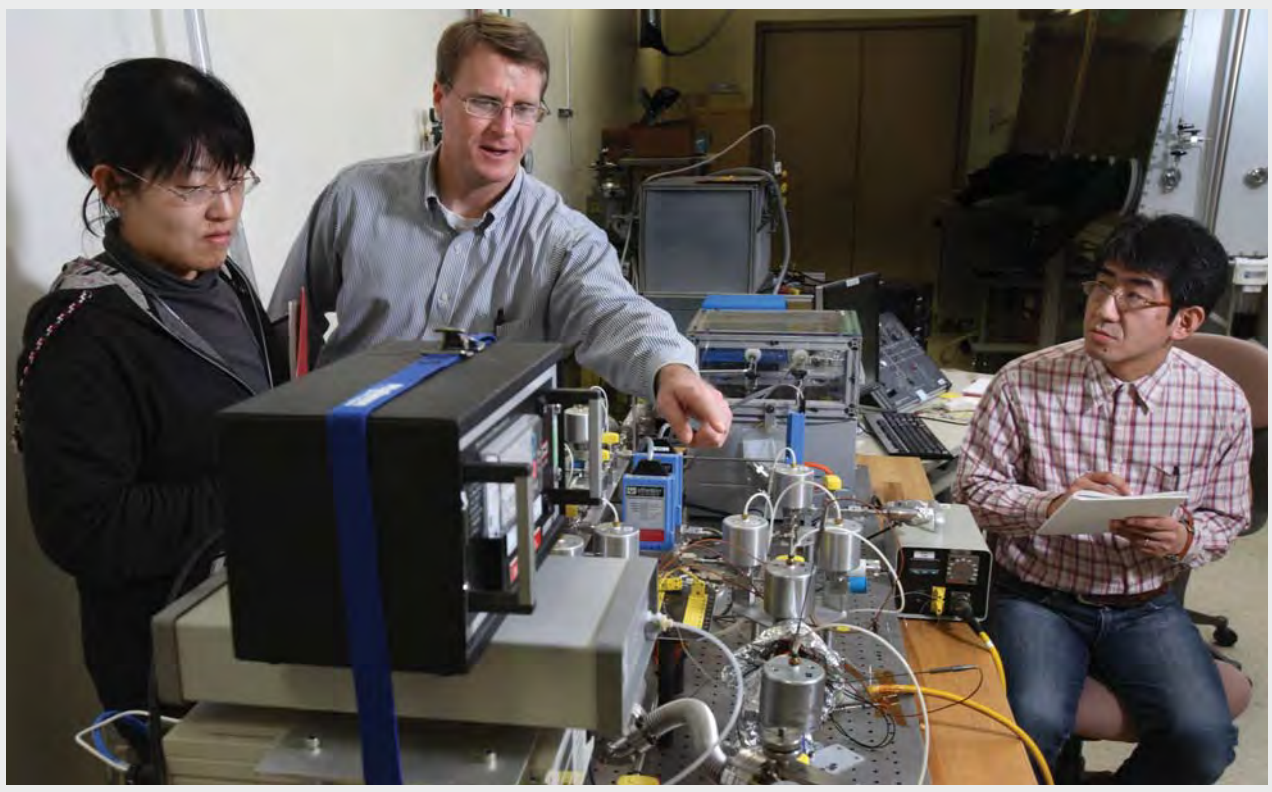
Masood and his JBEI colleagues have already started the next challenge, engineering AgBIS to produce bisabolane in greater quantities. "We can now design much more informed experiments," he says. "This is a pretty big breakthrough because we are targeting the final conversion step of converting sugars into heavier chemicals in the 15-carbon atom range, where development needs to be more diesel and other products."

Sandia CaliforniaNews

International collaboration

Sandia's Joe Pratt (8366) demonstrates his experimental method for determining what happens when metal hydrides are exposed to contaminants and oxygen during everyday use. His colleagues, Mayumi Tode (far left) and Nobuhiko Takeichi (seated), both from Japan's National Institute of Advanced Industrial Science and Technology (AIST), also work in the field of metal hydrides for hydrogen storage and were at Sandia/California recently as part of a DOE effort to encourage international collaboration in the area of hydrogen research. The work is considered part of Sandia's Research, Engineering and Applications Center for Hydrogen (REACH), an initiative that houses various hydrogen research activities on the grounds of the Livermore Valley Open Campus (LVOC).

(Photo by Dino Vournas)



Navy pilot training enhanced by AEMASE 'smart machine' developed at Sandia

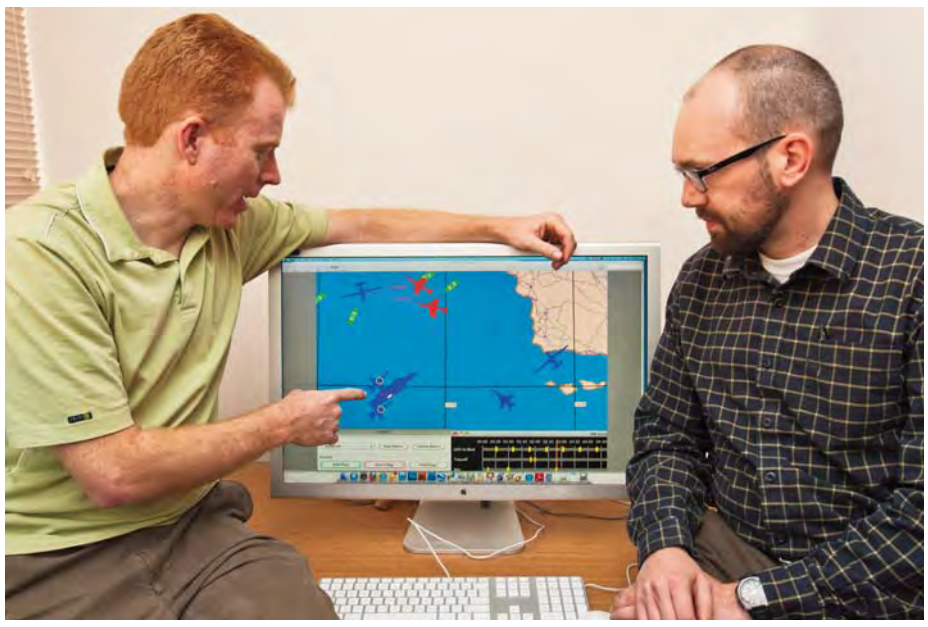
By Heather Clark

Naval aviators will soon have a new "smart machine" developed at Sandia and installed in training simulators that learns from expert instructors to more efficiently train their students.

The Automated Expert Modeling & Student Evaluation (AEMASE, pronounced "amaze") is sponsored by the Office of Naval Research and is being delivered to the Navy as a component of flight simulators. It is being used to train Navy personnel to fly H-60 helicopters and will soon be used for the E-2C Hawkeye aircraft, says AEMASE's inventor, computer scientist Robert G. Abbott (1463).

AEMASE, a cognitive software application, updates its knowledge of expert performance on training simulators in real time to prevent training sessions from becoming obsolete and automatically evaluates student performance, both of which reduce overall training costs, Rob says.

"AEMASE is able to adapt and be aware of what's going on," he says. "That's what's driving our cognitive modeling and automated systems that learn over time from the environment and from their interactions with people."



COMPUTER SCIENTIST Rob Abbott, left, and computer software developer Jon Whetzel (both 1463) show how the Automated Expert Modeling & Student Evaluation (AEMASE) cognitive software application will be used to help train naval aviators on flight simulators. (Photo by Randy Montoya)

New system will save taxpayers money

In the past, simulators have not done well with ambiguous or new situations that required time-consuming reprogramming and made it more difficult for the military to quickly adapt to changing environments and tactics.

"With AEMASE, when the automation does something stupid and you get annoyed with it, you can tell it to stop. Likewise, if it's not doing what you want, you can tell it to start alerting you when certain things happen and it will do so," Rob says. "It does all this without re-engineering or reprogramming the system."

Melissa Walwanis, a senior research psychologist at the Naval Air Warfare Center's Training System Division in Orlando, Fla., says AEMASE will enhance the Navy's training capabilities by providing trainees with specific ways to improve performance, machine learning, automated performance measurement, and recordings of trainees' voices during the training sessions.

AEMASE will save taxpayers money by allowing better training to take place on simulators. The resulting increase in pilots' skills means the Navy can better use limited flight time or decrease the need for flight time, reducing fuel costs and wear on the aircraft, she says.

Sandia experiments showed that AEMASE's scoring capabilities agreed with human graders 83-99 percent of the time. In a study of students learning to operate the E-2 Hawkeye aircraft's battle space management system, those whose training was enhanced by AEMASE performed better than those whose simulators lacked the software, says Rob and Sandia cognitive psychologist Chris Forsythe (1462).

AEMASE grew out of Sandia's research into cognitive systems that started more than a decade ago. It was a spin-off of research for a Laboratory Directed Research and Development Grand Challenge, Chris says. At the time, he says, massive computers were able to compute large amounts of data, but software that could model how people make decisions was missing.

The idea for AEMASE came from Rob's doctoral research done as a participant in the University Part-Time program, under which he received his doctorate from the University of New Mexico while working at Sandia, he says.

AEMASE addresses a needle-in-a-haystack problem. Just as Google finds certain words across the Internet, AEMASE scans hundreds of training sessions to find certain actions or scenarios to compare, Rob says.

Recognizes multiple right answers

The software is designed for context recognition. It searches through a large number of facts to recognize a situation it has seen before and determine whether the actions of a student encountering the same situation are desirable, Rob says.

The software recognizes that there may be multiple right answers to incorporate different ways of doing things, Chris adds. For example, AEMASE tracks certain flight parameters — say distance, the angle of the aircraft from the ground, and velocity — to create vectors that are treated as points within a multidimensional space defined by the parameters. Different "right" answers are expressed as points in the space, but will tend to gather in one area, while poor performance can be measured by a point's distance from the "expert" points.

For instructors, AEMASE's interface is simple. They can flag actions by pushing a one-click thumbs-up button to record good behavior or a thumbs-down button when students, say, fly too low or too close together in the simulation, Rob says.

AEMASE places those flagged events on a timeline display, so that instructors and students can review errors in recordings of student performance. Then AEMASE uses that information to recognize other instances of the errors, helping the instructors become more efficient by automatically flagging errors for them to review with other students.

These flags are the seeds for the model's future development as scenarios and preferred actions evolve over time, Chris says.

Works well in ambiguous situations

AEMASE bypasses lengthy interviews of instructors and reprogramming once the simulator is running. Instead, instructors fly the simulator themselves to capture their expertise, a feature that works particularly well in ambiguous situations where it's difficult to program a set of explicit rules, Rob says.

AEMASE also incorporates speech recognition technology to assess how effectively teams communicate.

"Are people talking to each other often and using the terminology that we would expect if they know what they're doing or are they hmmm-ing and hawing a lot, using a lot of filler words like uh, ah, or um, which indicates how proficient they are?" Rob says. "That's one of the things we want the system to assess."

While AEMASE is being considered for other training by the Navy, it also could readily be adapted to monitor live operations. For example, it could model operators at the height of their ability, and then alert them when they later fail to take the same actions in similar situations, perhaps due to fatigue or distraction, the researchers say.

Currently, the software is being adapted to train computer security analysts, and it has applications in other areas such as driver's education and automating robots, Rob says.

US Navy experience and instrument data shows climate alterations, Sandia speaker says

By Neal Singer

Because its presence is worldwide, the US Navy is already experiencing the effects of climate change, the fifth lecturer in Sandia's Climate Change and National Security Speaker Series told Sandia audiences on Feb. 28 at the CNSAC auditorium in Albuquerque and, by teleconference, Livermore.

"The findings are independent of climate models," said speaker Antonio Busalacchi, professor and director of the Earth System Science Interdisciplinary Center (ESSIC) at the University of Maryland and former chief of the NASA/Goddard Laboratory for Hydrospheric Processes.

Busalacchi, whose lecture topic was "Climate Research in Service to Society," began his talk by describing climate research as coordinated over the past 32 years by the World Climate Research Programme (WCRP), which Busalacchi co-chairs.

WCRP subprograms enjoyed significant successes in multiyear surveys of rolling averages that demonstrated an ability to predict regional climate effects, according to Powerpoint graphs and charts Busalacchi displayed.

These included a successful attempt to link ocean and atmosphere data to forecast seasonal effects of El Nino from 1997/98, and "unprecedented sampling of the world's oceans" during an ocean circulation experiment.

Helpful in gathering data for that effort was a fleet of 3,000 "argo float capsules," each (from Busalacchi's gestures) apparently a few feet long, capable of submerging 2,000 meters before floating to the surface while recording ocean temperatures and salinities. Their telemetry capabilities enabled them to send data elsewhere for analysis.

Busalacchi was most vivid in describing his work co-chairing a National Academy of Sciences committee to determine national security implications of climate change.

Among those who briefed his committee were the supreme allied commander of the US European command, members of the National Intelligence Council, and the White House Office of Science and Technology Policy.

The Navy's current problems, he said, include more extreme temperatures, the melting of sea ice and glaciers, the rise of sea levels at isolated locations, more frequent high-intensity storms, more droughts, regional flooding, ocean temperature increase, and declining potable reserves because of increased salinity.

Because melting ice gives all comers greater arctic access, the Navy faces strategic issues of potential cooperation, competition, or conflict because of significantly increased shipping and exploration in the region. The possibility exists for open summer navigation passages by 2030, as well as the opening of new international and territorial waters.

"The implications of reduced Arctic Ocean sea ice require immediate planning and attention by US naval forces," he said. Specific logistical challenges include remoteness of locations, lack of ports and airbase facilities, limited US icebreakers, and insufficient charting, along with increased maritime traffic.

Vulnerability assessments for naval coastal installations include storm surge, salt water intrusion, and changes in ocean circulation and wind patterns. "Global rises don't matter here," he said. "Sea level rise can be local."

Antisubmarine warfare impact and future R&D needs were addressed in the NAS report, Busalacchi said, but he drew a curtain over this aspect of the report.

Disparities in current climate science projections "means that the Navy should plan for a range of contingencies," he said, "given our limited ability to predict abrupt change or tipping points for potentially irreversible change." The military, he said, "has a long history dealing with information that is uncertain but far from unknown."

Cloud radiative feedback is the largest uncertainty in climate prediction, Busalacchi said, but researchers now are getting better handles on that data from field and spacecraft observations. Still, he said in a question-and-answer session, "The most significant missing capability in our satellite portfolio is finding an affordable means of on-orbit calibration [to link] stable measurements over a long period of time, and the ability to piece together climate data records … as satellite sensor sensitivity evolves."

"Our bathymetry [the underwater equivalent of topography] in the region is poorly done," he also said. "Since the end of the Cold War, we've lost our experience and equipment for the arctic area."

Among other unknowns are the related effects of climate change on projected global population growth, which could greatly amplify geopolitical stress. Because increased humanitarian assistance and disaster relief could strain US systems, he said that US Navy hospital ships should be retained and that the limited ice breaker fleet should be expanded to support an increased operational presence in the arctic.

In the Q&A session, Busalacchi lamented the lack of national strategy for long-term space-based climate observation in this country. Some scientists seem to have little sense of cost-benefit analysis in their proposals, he said. "As a nation, we haven't come to grips with what are the unique responsibilities of NASA, NOAA, and the USGS." The cost of satellites, he said, "is eating the agencies' lunch. . . . Until we can break that Gordian knot, we're all going to be subject to the pieces falling to the floor."

The global community, he concluded, needs the scientific capacity to improve and sustain global observations, more realistic global and regional climate models, more computing power, and increased and enduring education in the developed and developing world.

SPIDERS Microgrid project secures military installations

By Stephanie Hobby

When the lights go out, most of us find flashlights, dig out board games, and wait for the power to come back. But that's not an option for hospitals and military installations, where lives are on the line. Power outages can have disastrous consequences for such critical organizations, and it's especially unsettling that they rely on the nation's aging, fragile, and fossil fuel-dependent grid.

A three-phase, $30 million, multi-agency project known as SPIDERS, or the Smart Power Infrastructure Demonstration for Energy Reliability and Security, is focused on lessening those risks by building smarter, more secure and robust microgrids that incorporate renewable energy sources.

Sandia was selected as the lead designer for SPIDERS, the first major project under a memorandum of understanding (MOU) signed by DOE and DoD to accelerate joint innovations in clean energy and national energy security. The effort builds on Sandia's decade of experience with microgrids — localized, closed-circuit grids that both generate and consume power — that can be run connected to or independent of the larger utility grid.

The goal for SPIDERS microgrid technology is to provide secure control of on-base generation.

BILL WAUGAMAN (6512) is the SPIDERS operational lead at Sandia. (Photo by Randy Montoya)

Tying solar and wind to grid

"If there is a disruption to the commercial utility power grid, a secure microgrid can isolate from the grid and provide backup power to ensure continuity of mission-critical loads. The microgrid can allow time for the commercial utility to restore service and coordinate reconnection when service is stabilized," says Col. Nancy Grandy, oversight executive of the SPIDERS Joint Capability Technology Demonstration (JCTD). "This capability provides much-needed energy security for our vital military missions."

SPIDERS is addressing the challenge of tying intermittent clean energy sources such as solar and wind to a grid.

"People run single diesel generators all the time to support buildings, but they don't run interconnected diesels with solar, hydrogen fuel cells, and so on, as a significant energy source. It's not completely unheard of, but it's a real integration challenge," says Jason Stamp (6111), Sandia's lead project engineer for SPIDERS.

Currently, when power is disrupted at a military base, individual buildings switch to backup diesel generators, but that approach has several limitations. Generators might fail to start, and if a building's backup power system doesn't start, there is no way to use power from another building's generator. Most generators are oversized for the load and run at less-than-optimal capacity, and excess fuel is consumed. Furthermore, safety requirements state that all renewable energy sources on base must disconnect when off-site power is lost.

A smart, cybersecure microgrid addresses these issues by allowing renewable energy sources to stay connected and run in coordination with diesel generators, which can all be brought online as needed. Such a system would dramatically help the military increase power reliability, lessen its need for diesel fuel, and reduce its "carbon bootprint."

"The military has indicated it wants to be protected against disruptions, to integrate renewable energy sources, and to reduce petroleum demand," Jason says. "SPIDERS is focused on accomplishing those tasks. The end result is having better energy delivery for critical mission support, and that is important for every American."

SPIDERS uses existing, commercially available technologies for implementation, so the individual technologies are not novel. "What's novel is the system integration of the various technologies, and demonstrating them in an operational field environment," says Bill Waugaman (6512), SPIDERS operational lead. "Microgrid concepts are still fairly new, and that's where Sandia's microgrid design expertise is coming into play."

An unprecedented level of cybersecurity

It is common practice to connect diesel generators to buildings, but integrating significant amounts of energy from intermittent clean sources such as solar and wind to that system is unique, and it is a challenge that Sandia and SPIDERS are working to address.

Such integration requires data to determine the most efficient and effective way to operate, but that can open system vulnerabilities, so cybersecurity is paramount. SPIDERS addresses that issue by incorporating an unprecedented level of cybersecurity into the system from the outset.

"Any perturbation of information flow by an adversary would possibly cause an interruption to electrical service, which can have significant consequences," Jason says. "It's important that if we build a microgrid system that depends explicitly on greater information flow, that it operate as intended: reliably and securely."

SPIDERS is funded and managed through the DoD's JCTD, which joins the efforts of other government organizations and companies to rapidly develop, assess, and transition needed capabilities to support DoD missions. With DOE's support, the SPIDERS transition plan includes civilian facilities.

Applications beyond military use

"The SPIDERS approach has many applications beyond military uses. Our interest in SPIDERS extends to organizations, like hospitals, that are critical to our nation's functionality, especially in times of emergency," says Merrill Smith, DOE program manager.

Sandia's microgrid expertise spans the past decade, beginning when Sandia designed microgrids for DOE's Federal Energy Management Program and DOE's Office of Electricity Delivery and Energy Reliability. DOE initially asked Sandia to develop a conceptual design for a microgrid at Fort Carson in Colorado Springs, Colo., and another for Camp H.M. Smith in Hawaii.

After Sandia conducted a feasibility analysis and modeling and simulation work for the two bases, US Pacific Command (USPACOM) and US Northern Command (USNORTHCOM) asked Sandia to prove the concept through field work under a JCTD. The two commands pulled together a team of national labs and defense organizations, and selected Sandia to lead the development of the initial designs for three separate microgrids, each more complex than the previous.

The Army Construction Engineering Research Laboratory will use the Sandia designs as a basis for developing contracts with potential system integrators, who will construct the actual microgrids. Other partners in the SPIDERS JCTD include National Renewable Energy Laboratory for renewable energy and electrical vehicle expertise, Pacific Northwest National Laboratory for testing and transition, Oak Ridge National Laboratory to assist with control system development, and Idaho National Laboratory for cybersecurity.

The first SPIDERS microgrid will be implemented at Joint Base Pearl Harbor Hickam in Honolulu, and will take advantage of several existing generation assets, including a 146-kW photovoltaic solar power system, and up to 50 kW of wind power. The integrator for the project has been selected and the final design and construction process is under way.

The second installation, at Fort Carson, is much larger and more complex and will integrate an existing 2 MW of solar power, several large diesel generators, and electric vehicles. Large-scale electrical energy storage also will be implemented to ensure microgrid stability and to reduce the effects of PV variability on the system. Camp H.M. Smith, the most ambitious project, will rely on solar and diesel generators to power the entire base, which will be its own self-sufficient 5 MW microgrid when the national grid is unavailable.

Integration and implementation are scheduled through 2014. The goal is to install the circuit level demonstration at Pearl Hickam and Fort Carson next year, with Camp Smith installed in 2013.

ROCKETEERS

Albuquerque's ACTSO Rocketry Team captains, (from left) Lana Kimmel, 11th grade; Jasmine Morris, 7th grade; and Josiah Inventor, 9th grade, visited Sandia recently to describe their rocketry projects to a panel of Sandia engineers. The projects are part of the annual Team America Rocketry Challenge (TARC).

The team captains described the status of their projects and gathered feedback regarding their progress in the 2012 TARC fly-off qualification that takes place in The Plains, Va., May 11-13. About 750 teams nationally participate in TARC; of them, the top 100 who designed, built, and conducted test flights are selected to compete for prizes and scholarships annually.

Albuquerque ACTSO is a year-round nonprofit educational outreach program supported locally by Sandia and sponsored at the national level by Lockheed Martin to encourage students in grades K-12 to participate in science, technology, engineering, and mathematics (or STEM). This group uses the Team America Rocketry Challenge to engage students in STEM.

Shaping a new IP ecosystem

intellectualproperty
MANAGEMENT, LICENSING, & ALLIANCES

(Continued from page 1)

deployment path, whether through licensing, publication, government use, CRADA, or other avenue, should be considered as early as possible.

"We want to integrate IP thinking into the project lifecycle beginning at the R&D planning stage," he says. "It's all about getting the results of our R&D deployed for the public good. If we develop IP and it sits on a shelf, that doesn't help anybody."

Kerry Kampschmidt (11500), Sandia's chief intellectual property counsel, says it's important that the Labs' licensing and legal groups be involved early in R&D planning. "Involving the partnerships groups in the beginning can prevent missteps in deployment," he says.

Sandia has always had a vibrant industrial partnerships program, and the Labs will continue to identify, protect, and deploy the broad array of inventions of its scientists and engineers, Mark says. "Now, in addition, if an IP position can be developed in direct support of a mission or to enhance a capability, we want to intentionally create a 'portfolio' that can potentially attract industrial partners," he says.

A thoughtful, deliberate approach to IP

VP and Chief Technology Officer Steve Rottler says strategic management of IP will strengthen the impact of Sandia's research and facilitate dissemination of the Labs' results. "Sandia has always been a valued contributor to peer-reviewed journals and leading conferences," he says. "A thoughtful and deliberate approach to intellectual property that begins at the R&D planning stage will support the same distinctive level of quality in dissemination through licensing, open source distribution, CRADAs, and other technology transfer mechanisms. We have many avenues for deploying our IP that enable success."

During his recent visit to Sandia, Steve notes, US Energy Secretary Steven Chu "communicated the role he expects the national labs to play in creating jobs."

"Strong and vibrant IP portfolios appropriately packaged and deployed can ensure technology gets into the hands of US industry and attracts new opportunities and research partners," Steve says. "Commercializing technology not only enhances the local and national economy, but establishes new opportunities for our researchers to contribute to the state of the art in their respective fields, thereby fulfilling Sandia's national security and technology transfer missions."

As part of the new strategy, Mark and Devon Powers (8529), manager of Sandia/California's Business Development Support group (BuDs), are looking at business models that speed up tech transfer transactions. Sandia is already participating in the White House's Startup America Initiative by giving young companies quick, affordable license option agreements. Sandia also is identifying certain technologies that can be licensed nonexclusively on standard terms and aims to put the licenses in place almost as fast as the requests come in.

Part of Prime Contract

"We're looking at different licensing and business models that align with other successful institutions that will ease deployment and make it happen faster," Devon says. "Tech transfer is part of our prime contract. If we have technologies that can support the mission or help the economy, we need to get those out."

Other pieces of the new IP strategy involve better marketing and innovative teaming relationships.

Mark says Sandia will step up marketing of its technologies. One channel is a new website, ip.sandia.gov, that lists technologies available for licensing.

In addition, market research and analytics will assist Sandia in understanding its IP portfolio and where it can be deployed in the market.

"As part of the lifecycle approach, Sandia's Partnerships Development and Business Intelligence Department will contribute competitive landscape analysis, patent portfolio analysis, and market intelligence in different fields of technology," says Mary Monson, manager of Partnership Development & Business Intelligence Dept. 1932.

Sandia also will seek to strengthen strategic relationships with entities that can help deploy, or enable deployment of, the Labs' technologies for the US public good.

Teaming with TVC, universities

"We are discussing ways to more closely team with Technology Ventures Corporation, and we are actively engaging with leadership at university business schools, such as the University of New Mexico, to ensure our technologies can be part of their business plan competitions," Mark says. "And we want to thoughtfully expand our network of venture capitalists and angel investors who have an interest in investing in early-stage technologies. We need to take advantage of the state of New Mexico's efforts to attract risk capital, and the fact that our Sandia/California site is almost next door to Silicon Valley, the world's 'capital for risk capital.' "

Jackie Kerby Moore, manager of Technology & Economic Development Dept. 1933, says the Entrepreneurial Separation for Technology Transfer (ESTT) program can be a great option for Sandians who want to participate in the outside deployment of Labs technology.

"Through our ESTT program, 139 Sandians have left the Labs to start up or help expand 92 companies, and 42 licenses are associated with these companies," Jackie says. "We look forward to continuing to utilize the ESTT program to support Sandia's IP deployment."

The new approach to IP was announced to Sandia directors and senior managers on March 6. Town halls will be held across the Labs during the next several months to further spread the word.

Will you need a partner?

Education and information sharing will be key components of the initiative. Beginning this fall, training sessions will be held that are specifically designed to enable a dialog between Sandia's Partnerships Team and senior managers, managers, and principal investigators from the technical organizations.

"We want to help people understand the direction we're going, and the new strategies and business models we can use across the Labs," Mark says. "If you think about IP in your project, ask up front what you want to achieve in deployment. Will you need a partner at the end of the day? If so, how do we get the partner here to talk to us? Often that comes from developing an IP position, such as a patent or copyright. That's the carrot that attracts people to come."

The IP strategy will apply throughout the Labs, with five centers identified as pilots of the lifecycle approach: 1700, 1800, 5300, 6100, and 8600.

Paul says he wants Sandia to be the gold standard in how a Federally Funded Research and Development Center develops, manages, and deploys intellectual property.

"Achieving excellence in our IP strategy and management is key to our strategic objective to lead the [NNSA] Complex as a model 21st century government-owned contractor-operated national laboratory," he says. "We are trusted by the taxpayers to do research and we owe it to them to be strategic about IP and the role it can play in the accomplishment of our missions. We have much to offer the country."

First steps

Centers

- Investigate what is already in your organization's IP portfolio.
- Decide on an IP strategy to better enable Sandia's mission and/or enhance capabilities.
- Spread the word about upcoming town hall meetings or request intact-workgroup briefings.

SMUs

- Clarify the role of intellectual property in your strategy for engaging industry and pursuing new WFO projects.
- Work with Centers to integrate, coordinate, and align IP strategies.

Technical managers & PIs

- Attend any of the upcoming town hall meetings (to be announced in the *Sandia Daily News*) or,
- Ask you management to schedule an intact-workgroup session with the Partnerships Team.

Patent law changes to impact Sandia

On Sept. 16, President Barack Obama signed the America Invents Act of 2011. The law will switch the US right to a patent from the present first-to-invent system to a first-to-file system for patent applications filed on or after March 16, 2013.

The change is one of several in the legislation that reforms the US patent system for the first time since the Truman administration.

The first inventor to file system is intended to bring the country in line with how the vast majority of industrialized nations handle patents, says Kerry Kampschmidt (11500), Sandia's chief intellectual property counsel.

"This will be a complete culture change for Sandia," Kerry says.

The old first-to-invent system had two principles: conception of the invention and reduction to practice of the invention. When a person conceived of an invention and diligently reduced the invention to practice, i.e., by filing a patent application or practicing the invention, the inventor's date of invention was the date of conception.

So provided an inventor was diligent in reducing an application to practice, he or she was the first inventor and the inventor entitled to a patent, even if another person filed a patent application, constructively reducing the invention to practice, before the inventor.

The concept of conception and reduction to practice generated a lot of extraneous costs in litigation, Kerry says.

Under the new first-to-file system, the first inventor to file an application has the prima facie right to the grant of a patent. Should a second patent application be filed for the same invention, the second applicant can only institute a derivation proceeding — if that applicant can prove the first applicant derived the invention from a publication of the second applicant.

"The concept of first-to-file is intended to streamline patent litigation and reduce court costs," Kerry says. The changes, he says, "make it especially important to plan for IP protection early in the life of a project and to make sure that inventions are protected before they are announced in public, for example at a conference or in a paper."

Ion beam lab takes on studies of cladding materials

By Sue Major Holmes

Sandia is using its Ion Beam Laboratory (IBL) to study how to rapidly evaluate the tougher advanced materials needed to build the next generation of nuclear reactors and extend the lives of current reactors.

Reactor operators are looking for advanced cladding materials, the outer alloys layer of nuclear fuel rods that keep them separate from the cooling fluid. Better alloys will be less likely to deteriorate from exposure to everything from coolant fluids to radiation damage.

Operating a reactor causes progressive microstructural changes in the alloys used in cladding, and that can hurt the materials' integrity. However, current methods of evaluating the materials can take decades.

The IBL, which replaced an earlier facility dating from the 1970s, has been in operation about a year and is doing in situ ion irradiation experiments, potentially shaving years off testing. The ion beams use various refractory elements to simulate different types of damage and thus predict the lifetimes of advanced reactor claddings. Some of the research was highlighted in a presentation by Khalid Hattar (1111) in December at the Materials Research Society conference in Boston in a paper co-authored by Tom Buchheit (1814), Shreyas Rajasekhara, and B.G. Clark (both 1111).

Experiments at the nanoscale

Researchers, trying to understand the changes as a function of radiation dose, inserted a beamline from the tandem accelerator, the IBL's largest, into its transmission electron microscope (TEM). This allows them to do in situ ion irradiation experiments at the nanoscale, and record results rapidly and in real time. Sandia's lab is one of only two facilities in the US and one of only about 10 in the world that can do this, Khalid says.

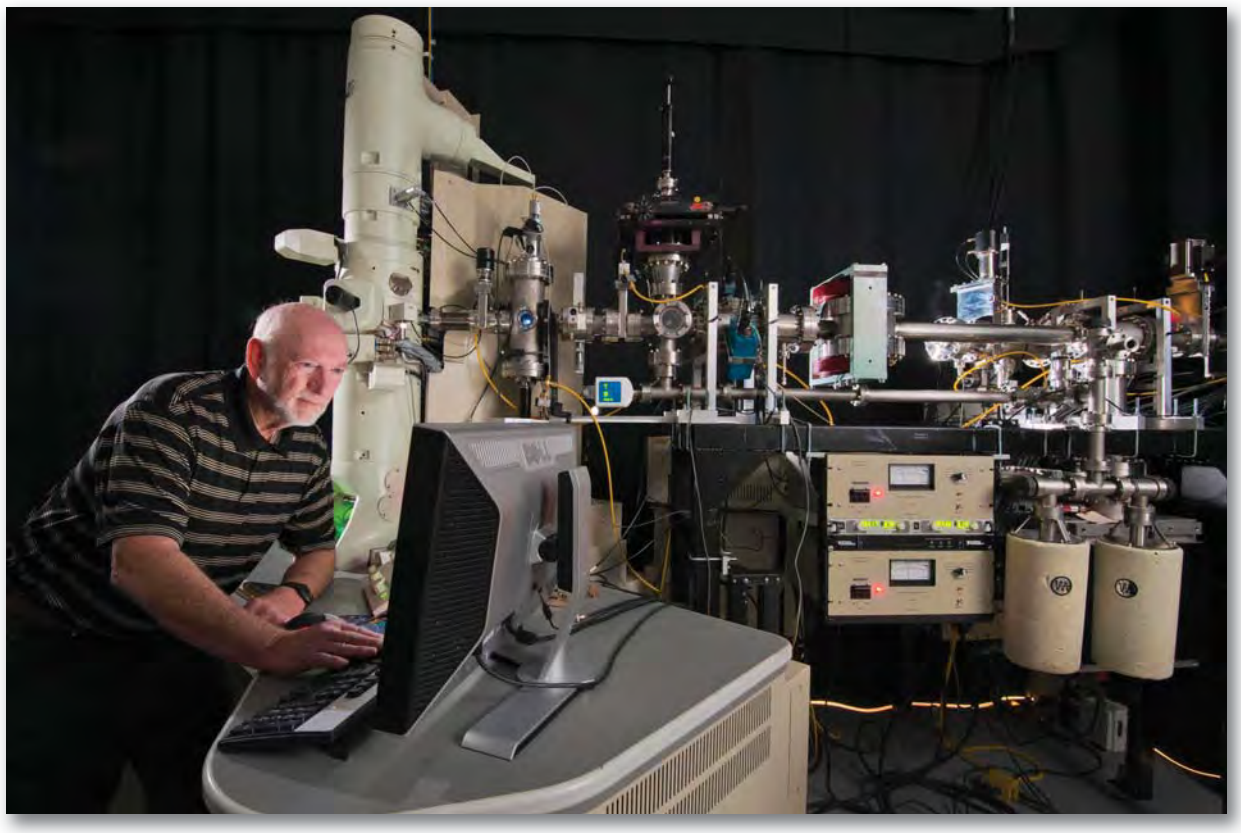
"The idea is to come up with new ways to make different alloy compositions and different materials for next-generation reactors and to understand the materials used in the current-generation reactors," Khalid says. "Then we can find ways of doing a combination of TEM characterization as well as small-scale mechanical property testing in this rapid testing scenario to screen these materials and see which ones are the most suitable."

Better understanding of cladding materials could help improve reactor efficiency.

To that aim, Khalid and his team are using the IBL's capabilities to try to gain a fundamental understanding of how the materials evolve in extreme environments at the nanoscale. They hope that understanding can then be related to events on the macroscale.

Take, for example, something familiar, like rust on a little red wagon.

"If you look at rust, it's nonuniform," Khalid says. "So the location where that first rust starts to occur must be related to some heterogeneous aspect of the microstructure. If we can really understand on the nanoscale what causes it, that initiating factor, then we can prevent the initiation, and without the initiation, you'll never have that rust formation."



TECHNOLOGIST DANIEL BULLER (1111) stands in front of the beamline that connects the tandem accelerator to the TEM. The blue light in the cylinder behind the computer monitor is phosphor luminescing from proton beams hitting it. (Photo by Randy Montoya)

The team developed a system for testing cladding materials Khalid believes can be used for experiments under extreme conditions to simulate the real-life environments. Researchers can work with temperatures up to 1,200 degrees C and pressure up to one atmosphere as well as ion irradiation to gain basic understanding of radiation damage.

Pinpointing the best materials

A recently completed Laboratory Directed Research and Development program worked with a variety of samples, everything from high-purity, single-crystal copper to materials used in today's reactors. The team found that under the right conditions, a combinatorial approach can be used with new alloy compositions produced in-house, Khalid says.

The LDRD project demonstrated a fundamental physics simulation of what's happening to the material. In the next step, Khalid suggests Idaho National Laboratory could expose selected materials to neutrons and then try them out in a real reactor. Since the IBL can run experiments in as little as a day, researchers aim to pinpoint the best material so the Idaho lab, whose tests take much longer, won't waste time testing poorer materials, he says.

In one experiment, the team examined both the composition of and effects of radiation on an alloy being considered for the next generation of reactors, seeking the best composition for different radiation exposures.

"Really understanding how the microstructure evolves lets us know a lot about how the material will perform," Khalid says. "So if we can rapidly determine how the microstructure evolves and understand the mechanisms that it evolves by, we could gain a lot of insight into what happens in the material."

That idea prompted the test in which the team connected the large tandem accelerator to the TEM. The tandem accelerator produces the radiation that is sent into the microscope, allowing team members to watch as they irradiate materials. The TEM setup achieves nanometer scale resolution with results recorded in real time.

In the next generation of testing, the team will have the option of using the beam from a Colutron accelerator recently added to the IBL system.

"This will allow us to do irradiation with both the heavy ions for displacement damage as well as a helium-deuterium combination for understanding the mechanisms of hydrogen embrittlement and swelling of cladding materials," Khalid says.

Two new stages

Once researchers understand those mechanisms, they can go about selecting the proper material for a wide variety of extreme environments where radiation plays a significant role, such as shielding microelectronics from radiation from space.

The in situ ion irradiation TEM includes two new stages that give the IBL even more unique capabilities. A microfluidic stage allows researchers to look at fluids inside the microscope in real time, and a vapor phase environmental cell can be used to study how corrosion occurs as a function of time. The vapor phase studies were made possible by B.G. Clark (1111) and Brad Boyce (1831) with DOE Basic Energy Sciences funding. The microfluidic stage was supported by Readiness in Technical Base and Facilities, an NNSA program.

Khalid says the team is looking forward to using basic science applications to study fundamentals such as oxidation mechanisms in materials as well as gas phase flow experiments to look at the effects of hydrogen or corrosive gases on samples. The system also can do tomography, which enables the researchers to turn 2-D TEM projection images into full 3-D reconstructions. This results in visualization of the sample from all angles simply by compiling 2-D images taken at a range of sample tilts.

IBL researchers hope to provide fundamental insights into a variety of projects, both at Sandia and externally, that are interested in everything from corrosion to radiation damage to materials, Khalid says.

Experiments, however, are in the early stages because the facility is so new.

"We're sitting in a situation where we're just trying to see where they'll lead right now," Khalid says. "It should be fun and there should be lots of different directions."

MATERIALS SCIENTIST KHALID HATTAR (1111) sits in front of the in situ ion irradiation TEM. The green light is electrons hitting phosphor. Khalid has been using Sandia's Ion Beam Laboratory for in situ ion irradiation experiments, potentially shaving years off testing new materials for nuclear reactors. (Photo by Randy Montoya)

2012 Asian American Engineer of the Year honorees have deep Sandia roots

By Nancy Salem • Photos by Randy Montoya

The three Sandia honorees in this year's Asian American Engineer of the Year awards came to the Labs on very different paths but share a longtime commitment to the research and mission.

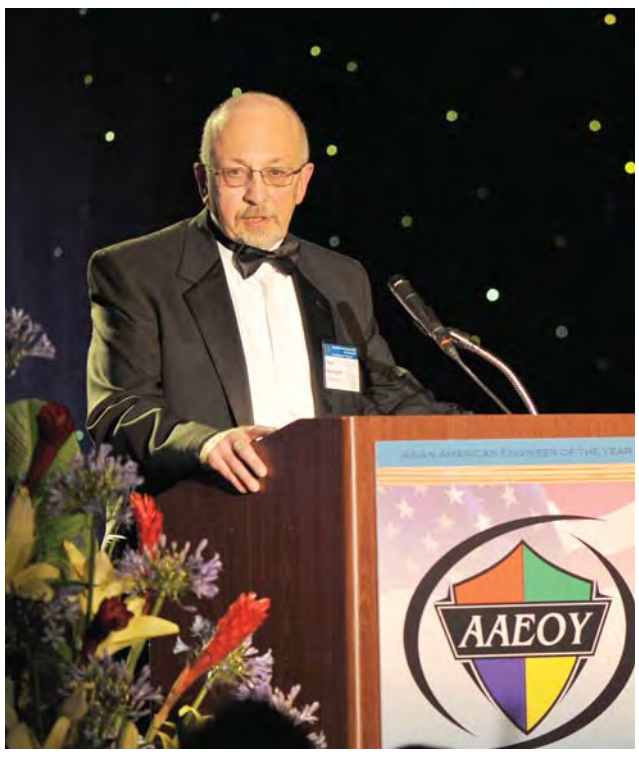
Hongyou Fan (1815), Rekha Rao (1514), and Ming Lau (8230) were among 19 people from across the US receiving 2012 AAEOY awards. They bring to 12 the number of Sandians recognized since the prestigious program was started in 2002 by the Chinese Institute of Engineers-USA (CIE-USA). It recognizes outstanding Asian American professionals in science and engineering for their technical achievement and public service.

The 2012 AAEOY event was held in Albuquerque March 2-3 at the Marriott Uptown. Eliot Fang (1524), a former AAEOY honoree, headed the event's Executive Committee, and Sandia and Lockheed Martin were title sponsors.

Laboratories Director Paul Hommert was keynote speaker at the March 3 awards ceremony.

He talked to the 450 attendees about challenges facing the US, the role of science and engineering in helping to solve them, and the part played by Asian Americans. "As I think of America's human heritage, with people so diverse who have chosen this land as their home, I cannot help but think of how lucky, how rich we are in our quintessential diversity," he said. "We draw strength from our different backgrounds. We have become a nation that values contributions from people of all colors, creeds, and ethnicities."

Paul said Asian Americans helped build the US and have played successful roles in all facets of American life. "As families, you have instilled in your children a deep sense of respect for improving the mind through learning . . . for stressing science and engineering in education, along with a deep sense of civic duty and a wider framework that makes for well-rounded human beings," Paul said. "Our nation has been a direct beneficiary of your efforts."



SANDIA LABORATORIES DIRECTOR Paul Hommert gave the keynote address at the AAEOY awards banquet.

He said the country faces challenges around economic competitiveness and increasingly complex national and global security threats. Those threats must be countered through innovation, creativity, anticipation, and excellence in science and engineering, he said.

"We must be responsive," Paul said. "We must use our scientific and engineering knowledge and make that knowledge stronger."

The country's science and engineering prowess is threatened, Paul said, citing that just 4 percent of the workforce is made up of scientists and engineers, and that the US ranks 27th among developed nations in the proportion of college students receiving undergraduate degrees in those fields. "That's why I am urging you — we must continue to tap into a diverse, highly qualified, and talented pool of candidates who will become our workforce of tomorrow," he said. "Our country relies on you to carry forward the torch of our scientific and technical excellence."

Paul said he is proud of Sandia's support of Asian American scientists and engineers. "This group . . . is engaged in groundbreaking work that contributes directly to Sandia's mission," he said. "We thank them and their families for serving the country by dedicating themselves to work in the national interest."

Paul concluded by thanking the Asian American research community. "You believe that science and engineering define our lives in a profound way, that science and engineering write our history because they are key to solving the national and global challenges we experience today," he said. "For your vision and your contributions, the country owes you a debt of gratitude. Thank you."

Meet the three Sandians (on the next page) honored in the 2012 Asian American Engineer of the Year awards:

AAEOY PARTICIPANTS toured Sandia facilities as part of the two-day event. Dept. 1342 Manager Ray Thomas (in white shirt) uses a scale model to explain the capabilities of the Saturn accelerator.

CONFERENCE ATTENDEES, including Asian American Engineer of the Year award recipient Ming Lau, center, stopped by the International Programs Building during a tour of Sandia.

DANCERS from the National Institute of Flamenco in Albuquerque performed at the AAEOY awards banquet at the Marriott Uptown.

ANITA WONG, wife of Sandia manager Channy Wong (8238), and Sandia engineer Cliff Ho (6123) were co-emcees of the AAEOY banquet.

Sandia claims three Asian American Engineer of the Year recipients

Hongyou Fan

Hongyou has been with Sandia since 2000 and is a principal member of technical staff. His research focuses on assembly and engineering of nanostructured materials and revealing their structure and property relationship for device integration.

Hongyou has developed cutting-edge technologies and received awards including an R&D 100, Federal Laboratory Consortium Outstanding Technology Development, and University of New Mexico Mentor. He has authored or co-authored 60 scientific papers and has more than 4,000 citations and 20 patents and patent applications.

Hongyou was born in China, and earned a bachelor of science in chemistry from Jilin University in Changchun, China, in 1990. He went on to a master of science in polymer chemistry and physics from Changchun Institute of Applied Chemistry.

He moved to Albuquerque in 1995 and earned a doctorate in chemical and nuclear engineering from the University of New Mexico.

"My hometown is very cold," Hongyou laughs when asked about choosing UNM. "We wanted warm weather."

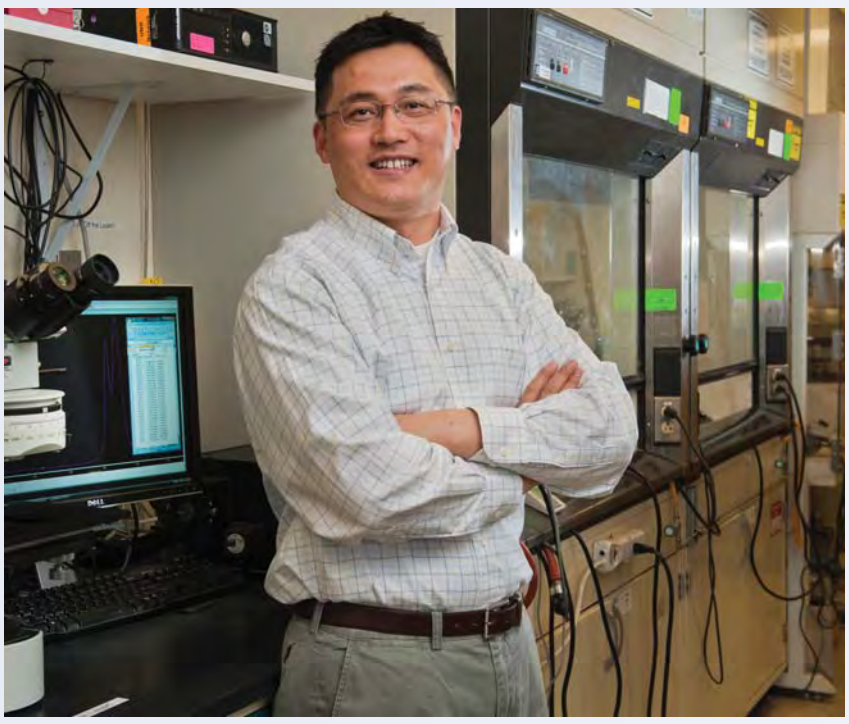
Hongyou did a postdoc at Sandia and later joined the Labs. "I found a home here," he says.

"Hongyou is a delight to work with," says his manager, Bill Hammetter (1815). "He is extremely intelligent and good at applying science to real problems. He serves his community as well as the technical community. He's an all-around really great guy."

Hongyou is married to Dongmei Ye, who has a doctorate in chemistry and biochemistry from UNM and was recently hired at Sandia. They have two children, Charles, 10, and Cindy, 4.

The AAEOY honored Hongyou for his technical work, his mentoring of the next generation of US engineers, and for his community service to K-12 education.

"I feel honored," Hongyou says. "It's very humbling to be among those highly accomplished people. The award motives me to continue to innovate and face challenges. It has inspired me as an Asian American to accomplish all my dreams."



HONGYOU FAN is "an all-around really great guy," says his manager, Bill Hammetter.

REKHA RAO is a working mother whose youngest child, Prem, survived against the odds.

Rekha Rao

Rekha is a principal member of technical staff. She joined Sandia in 1990 and is a finite element software developer and analyst for computational fluid dynamics and multiphysics applications, including free and moving boundary problems and non-Newtonian fluid mechanics.

Among other projects, she has worked on low-level radioactive waste disposal, flow-through porous media, viscoelastic flows, coating flows, fluid-solid interactions, thermal batteries, and nuclear waste reprocessing. She has received numerous awards.

Rekha is a native of Berkeley, Calif., who earned a bachelor of science in chemical engineering from the University of California, Berkeley, her father's alma mater. She went on to the University of Washington in Seattle, where she learned to write finite element codes. She earned a doctorate and landed an on-campus interview with Sandia.

She was hired in late 1990, working first on low-level nuclear waste and moving into fluid mechanics. "I'm so happy to have a job where I can be creative and do research and have an impact," she says. "I can do things that help real manufacturing problems in the real world."

Rekha says the highlight of her career has been working on GOMA, the finite element multiphysics code. "There's so much cooperation at Sandia, so much fellowship," she says. "It's an amazing place to work."

Her manager, Martin Pilch (1514), says Rekha has reached out to the next generation of scientists. "Despite her hectic professional and personal life, Rekha always has time to mentor young staff," he says.

Rekha has two children, daughter Mirabai, 11, and Prem, 7, a medically fragile boy who weighed 1.5 pounds at birth and fought through two years on oxygen and seven surgeries to survive. "He's my miracle baby," Rekha says.

She was honored by AAEOY for her contribution to the development of numerical models for improving manufacturing processes while supporting future scientists and public education.

"I'm thrilled," she says. "I was just amazed to get this, in such esteemed company."

Ming Lau

Ming joined Sandia in 1981. He has worked on terrain-aided navigation, missile guidance, controls and modeling of complex-electromechanical systems, and performance analysis of nuclear weapon fuzing.

As a senior manager at Sandia/California the past three years, Ming oversees three nuclear weapons system engineering departments and one engineering design services department. He was a member of a study group that received the 2005 Leo Szilard Award for Physics in the Public Interest from the American Physical Society.

Ming was born in Canton, China, and went to elementary school in Hong Kong. His family immigrated to Houston, Texas, when he was 11.

Ming was hired by Sandia/New Mexico at age 21 after receiving a bachelor of science from the University of Missouri-Rolla. He was part of Sandia's One-Year-on-Campus program that hired engineers with bachelor's degrees and sent them back to school for a master's. Ming earned a master's and, through Sandia's Doctoral Study Program, a doctorate in electrical engineering, both from Stanford University.

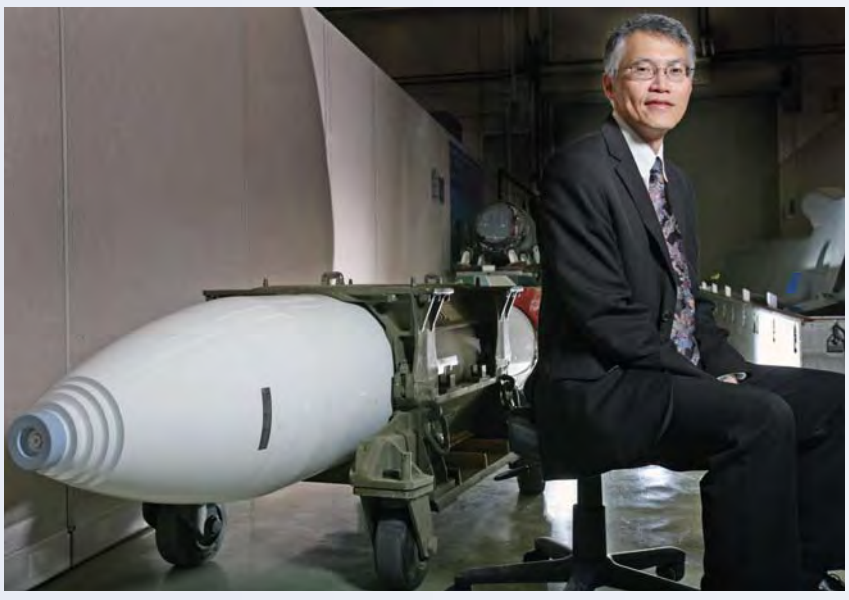
"I owe a lot to Sandia's educational programs," he says.

Ming, who became a manager in 1997, transferred to Sandia/California in 2004 as deputy to the VP for Defense Programs. He was named manager of the B83 system engineering department in 2006 and became a senior manager in 2009.

"I've done really interesting work as a staff member, manager, and senior manager," Ming says.

David Williams (100), who promoted Ming to manager back in 1997, says he admires Ming tremendously. "He's a wonderful man," David says. "There are people who I honestly believe are incapable of failure, and Ming is one of them. He does everything with excellence — as a man, a parent, a son, a husband, a patriot, and as a member of the community."

Ming is married to Lan Lau and has two children, Brian, 19, a freshman at the University of Texas at Austin studying computer science, and Britney, 17, a high school senior interested in medicine.



MING LAU earned a master's degree and PhD through Sandia educational programs. (Photo by Dino Vournas)

Ming was honored by AAEOY for his sustained contributions to stewardship of nuclear weapons systems in the US stockpile.

"It was very overwhelming to be recognized by colleagues and executive management," he says. "It means so much to me.

Outstanding WOMEN at SANDIA NATIONAL LABORATORIES

MARCH 2012

Adams, Marti
Co-Recipient of Environmental Sustainability (EStar) Award

Barraza, Erika
Co-Recipient of Environmental Sustainability (EStar) Award

Burnett, LouAnn
Elected 2012 American Biological Safety Association President

Capitan, Frances Marie
2011 YWCA Women on the Move Award

Coverdale, Christine
IEEE (Institute of Electrical and Electronics Engineers) Fellow

David, Carolyn
Women of Color magazine's Technology Rising Star Award

Dornburg, Courtney
Recognized for exceptional engagement in providing Human Factors Engineering instruction to the Defense Nuclear Facility Safety Board (DNFSB) staff

Funkhouser, Barbara
Recognized by John Bier for her leadership, technical guidance, and trusted advisor role within MDA Enterprise Sensors Lab (ESL) community

Gonzales, Rita
Named Outstanding NNSA employee of the Quarter

Griego, Regina
International Council on Systems Engineering (INCOSE) Fellow

Harvey, Margaret
2011 YWCA Women on the Move Award

Hernandez-Sanchez, Bernadette
Hispanic Engineer and Information Technology Forty Under Forty Rising Star in Science, Technology, Engineering and Mathematics (STEM)

Holm, Liz
Aug 2011 Elected as Vice-President of the Minerals, Metals, & Materials Society (TMS)

Jackson, Nancy
Elected 2011 American Chemical Society (ACS) President
International Union for Pure and Applied Chemists Fellow

Kerby Moore, Jackie
Career Achievement Award from the Association of University Research Parks

Kolda, Tammy
Section Editorship of Society for Industrial and Applied Mathematics Journal on Scientific Computing (SIAM SISC)

Lopez, Elizabeth
Women in Technology Award from the New Mexico Technology Council

McDaniel, Karen
2010 American Indian Science & Engineering Society (AISES) Technical Excellence Award

Miles, Vanessa
Minority in Research Science Trailblazer Award

Miner, Nadine
2011 YWCA Women on the Move Award

Nenoff, Tina
American Chemical Society (ACS) Fellow

Pascual, Jessica
2011 Panama Award for Personal Achievement

Phillips, Julia
Materials Research Society (MRS) Fellow

Phinney, Leslie
American Society of Mechanical Engineers (ASME) Fellow

Pregenzer, Arian
Received the American Physical Society 2012 Joseph A. Burton Forum Award

Raybourn, Elaine
Invited to join Advisory Board of International Journal of Game-Based Learning (IJGBL)

Rempe, Susan
2011 R&D 100 Biomimetic Membranes for Water Purification, Women in Technology Award from the New Mexico Technology Council

Rightley, Gina
2011 - Inducted into the St. Pius X HS Hall of Honor

Rivera, Roberta
Employer Member Representative of the Year by the National Consortium for Graduate Degrees for Minorities in Engineering and Science (GEM)

Smith, Patricia
CY2010 NNSA Defense Programs Award of Excellence

Speed, Ann
Two Certificates of Appreciation from Dept of Army for Patriotic Civilian Service and for her work 2007-2011 on National Research Council's Standing Committee on Operational Science & Technology Options for Deffeating Improvised Explosive Devices

Spomer, Judy
FY11 LMC NOVA Award

Striker, Dana
2011 Federal Electronics Challenge (FEC) Silver Award
Sandia Innovation Best Practice Award

Timlin, Jeri
2010 New Innovator Award from the National Institutes of Health (NIH)

Wells, Charline
Distinguished Service Award from International Society for Performance Improvement

Wenner, Caren
Recognized for exceptional engagement in providing Human Factors Engineering instruction to the Defense Nuclear Facility Safety Board (DNFSB) staff

Sandia National Laboratories

SWAN

Sandia Women's Connection SWC

Celebrating Women's History Month

Ruth Whan: A pioneer who blazed a bright trail for Sandia women

By Rebecca Ullrich, Sandia historian

Women's History Month provides an opportunity to celebrate female pioneers in Sandia's history. In the Labs' early years, they stand out — often beginning as the only woman in their science or math classes and becoming the only female member of the technical staff in their organization. They are inspiring and still serve as role models.

Ruth Whan is of particular note in this regard. High-powered and well-liked, she was admired for her management skills as well as her technical achievements.

Ruth decided as a teenager to study chemistry because she liked science and math and wanted to earn a good salary. She earned her BS in chemistry from Allegheny College and MS from the Carnegie Institute of Technology. She met her husband, Glenn, in graduate school and moved to Albuquerque with him when he joined the faculty at the University of New Mexico. While starting a family, she pursued her doctorate in physical chemistry at UNM.

She started at Sandia in 1962. Part of the wave of new hires with doctorates that began in 1959 with Sandia's recruiting push to bring in researchers with higher degrees, she was the third female PhD hired, following Louise Patterson and Katheryn Lawson.

Breaking new ground in rad effects

Sandia was advancing its capability for studying radiation effects in pursuit of radiation hardening of nuclear weapon components when Ruth was hired. Her initial work was in radiation effects in semiconductors. She conducted the first experiment on the Sandia Engineering Reactor when it became available in the fall of 1962. She quickly established her expertise in the field of radiation effects, breaking new ground in defect-impurity studies of germanium and silicon. She is recognized for establishing the energy of vacancy motion in germanium and for elucidating particle-size effects in irradiated composites.

In 1967, she moved to an analytical group studying materials characterizations and ion implantation. Among other efforts, she conducted the first complete characterization of carbon composites exposed at the Nevada Test Site. A researcher's output is measured largely in publications and Ruth is well-represented in the literature. She authored 48 publications and oversaw preparation of and wrote two of the introductory chapters for volume 10 of the American Society of Metals *Handbook on Materials Characterization* in 1986.

RUTH WHAN was the third female PhD hired at Sandia and the first woman promoted to technical department manager, which at the time was the second level of management, just above division supervisor. In the photo above, Ruth sets up an experiment in Sandia's Van de Graaff accelerator, March 1967. (All photos from Sandia archives)

Ruth did go into management. In 1972, she was promoted to supervisor of the Materials Analysis Division, and, in 1978, became department manager of the Materials Characterization Department.

She was the first woman promoted to technical department manager, which at the time was the second level of management, just above division supervisor.

There are mentions of Ruth in a variety of interviews with staff members in the Sandia archives; she is universally praised for the excellence of her technical work and for being easy to work with, professional, and generous. She shared her love of materials research with students, pointing out that "the science of materials will continue to change our lives well into the future, and I can't think of a more rewarding career field for young college graduates."

A pioneer in many areas, she also held the door open for those coming after her, participating in the Network for Women in Science and Engineering and helping to organize the 1981 Expanding Your Horizons conference to introduce young women to science and engineering careers.

Ruth retired in January 1989 and died a few months later. Glenn Whan established a scholarship fund in her memory at Allegheny College for students interested in the advanced study of materials science. After Glenn's death, UNM established an endowment recognizing Glenn and Ruth Whan. Far from forgotten, she remains an inspiration, a role model for us all.

RUTH WHAN attending to paperwork at the Van de Graaff accelerator, March 1967.

RUTH WHAN attaches thermocouple wires to monitor sample temperatures during irradiation on the Van de Graaff accelerator, while R. S. Neiman hooks up an electrical connection to monitor radiation levels.

Neutristor

(Continued from page 1)

cial applications could take five to 10 years, Juan says.

"It's really revolutionary technology," said Stewart Griffiths, who retired in December as a senior scientist/engineer in Center 2100. "Juan's knowledge, insights and creativity into this enabled this really big jump from today to how we might do neutron generators in the future."

Stewart said the impact won't be known for years, however. "The maturation of the technology is still needed, but if that process is successful, it will have a huge impact," he said.

'Deep in the proverbial box'

An independent committee of Sandia managers selected the technology as one of the Laboratories' eight submissions to compete for the R&D 100 awards in 2012.

A three-year Laboratory Directed Research & Development (LDRD) project Juan led demonstrated the basic technology necessary for a tiny, mass-produced neutron generator that he said can be adapted to medical and industrial applications. He says his team is seeking funding to make sure it works reliably and can be scaled to meet needs.

Juan says it all started when now-retired Dept. 9610 senior manager Mike Sjulin told researchers he needed neutrons and he didn't care how they were produced. Before that whack on the head, Juan says, "we were deep in the proverbial box, concentrating on making the cylinder more cylindrical."

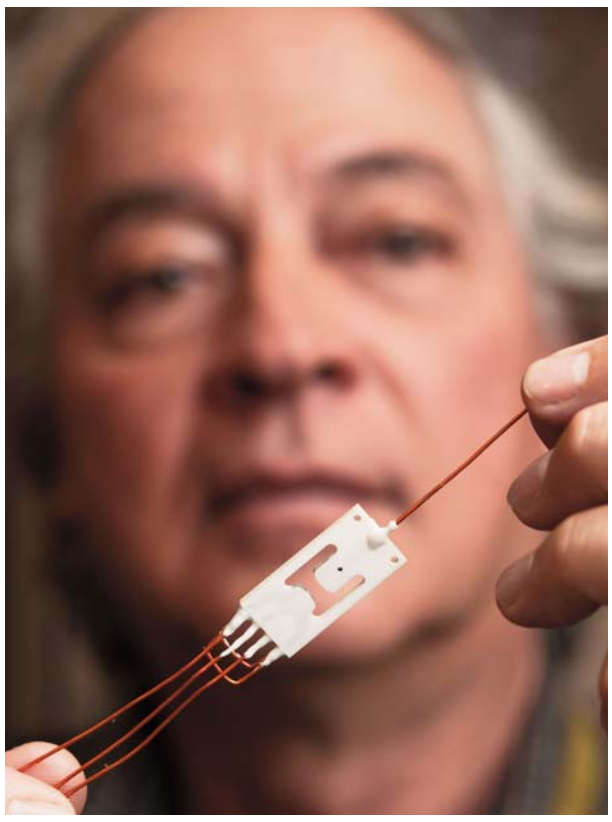
Traditionally, accelerator-based neutron generators with deuterium ion and tritium targets have operated on cylinders, which makes it easy to control the electric field and ion beam shape, he says. But that geometry also limits its size, beam current, and neutron output.

So members of Juan's team turned to computer chip geometry. Noting chips have two transistors per bit, they wondered if they could produce one neutron per transistor — what one of Juan's peers dubbed a "neutristor."

"Once you see it, it's kind of obvious … but before that nobody ever thought of it," Juan says.

The fun began with the technology challenges that presented, he says.

The team's first step was to discover whether it was possible to make a generator shaped like a flat computer chip with all surface-deposited components — everything from the ion source to the target, Juan says.



RESEARCHER Juan Elizondo-Decanini (2625) holds a prototype of a "neutristor," a new configuration for neutron generators. (Photo by Randy Montoya)

"We did not even know the proper scaling to go from cylindrical to flat, or from high operating voltages to lower operating voltages," he recalls.

However, he says, a cross-section diagram of the simplest diode-based neutron tube translated into the ideal surface-mounted topology, and team members knew they had the tools to design it.

The LDRD project pulled together people from all over Sandia, including design, microelectronics, materials, ceramics, precision fabrication, ion gas loading, engineering, and detection calibration, Juan says. He also credits manager Mike Eatough (2735), saying, "It couldn't have happened without his ability to open up space for me to be wild and crazy and talk nonsense."

After seven months of working on an ion beam lens design and an additional six months doing the necessary modeling, the team scaled things down.

"The challenges switched to make the device micron size, and then nano size, until we could scale it down no more," Juan says. To date, the project has demonstrated scaling to the millimeter and micron size, with neutron production demonstrated in the millimeter size and ion sources demonstrated in the micron size, Juan says.

The team moved from a millimeter package that looks a like a printed circuit board to a micron package to the concept of mounting the package on a computer chip. The chip configuration allows varying numbers of layers in a stack. That led to the idea of rotating those layers for radial discharge to ramp up output — a return, in a way, to the cylinder.

To illustrate that, Juan pins down one end of a sample rectangular millimeter design and rotates the free end in a circle, much like rotating a protractor.

Will present at TVC's Deal Stream Summit

"All of a sudden you have a cylindrical cavity like a pill box," he says. "It's still flat but now it looks like a pill box, and I have increased the number of neutrons by one or two orders of magnitude."

He says that if a neutron can be produced from each bit, "that's a neutron source that you can use almost anywhere, in medical applications, in sensors for contraband, for nonproliferation."

Juan presented a paper, "Surface Mounted Neutron Generators," at the NNSA 2011 LDRD Symposium in Washington, D.C., in July as one of three featured technical speakers chosen by each of the NNSA labs to showcase their top LDRD research activity.

A patent has been filed for the millimeter-size hybrid — hybrid because everything is solid state except a vacuum gap — that would be used for neutron capture cancer therapy. In addition, the project sparked half a dozen technical advances, the team is testing micron-size neutron source arrays built using Sandia's MicroElectricoMechanical Systems facilities, and it's initiated commercial technology transfer work.

Technology Ventures Corporation (TVC) accepted Juan's application to present his work at the April 3 Technology Ventures Deal Stream Summit's Parade of Posters, which gives researchers an opportunity to talk with possible investors. The nonprofit TVC was founded and funded by Lockheed Martin to help commercialize technology from the national laboratories.

Juan's vision for the neutron generator of the future is one that uses no tritium and no vacuum, is made in a solid state package and is fabricated at Sandia's Microsystems and Engineering Sciences Applications (MESA) complex.

"That has very dramatic technology implications and challenges," he says. "But that's what I tell people, that's what the national labs are all about."

Waterworld

Research helps astrophysicists trying to model evolution of the universe

(Continued from page 1)

large planets is essential to astrophysicists trying to model the evolution of the universe. They need to assume how much space is taken up by water trapped under high density and pressure, deep inside a planet, to calculate how much is needed of other elements to flesh out the planet's astronomical image.

Overstating water's compressibility

In a challenge to current astrophysical models, researchers at Sandia and the University of Rostock in Germany have found that current calibrations of planetary interiors overstate water's compressibility by as much as 30 percent. The work was reported in the paper "Probing the Interior of the Ice Giants" in the Feb. 27 *Physical Review Letters*.

"Our results question science's understanding of the internal structure of these planets," says lead researcher Marcus Knudson (01646), "and should require revisiting essentially all the modeling of ice giants within and outside our solar system."

To come up with the composition of the so-called ice-giants Neptune and Uranus, as well as any of the ice-giant exoplanets being discovered in distant star systems, astrophysicists begin with the orbit, age, radius, and mass of each planet. Then, using equations that describe the behavior of elements as the forming planet cooled, they calculate what light and heavy elements might have contributed in its evolution to end up with the current celestial object.

But if estimates of the volume of water are off-target, then so is everything else.

The measurements — 10 times more accurate than any previously reported — at Sandia's Z accelerator agree with results from a modern simulation effort that uses the quantum mechanics of Schrödinger's wave equation — the fundamental equation of wave mechanics — to predict the behavior of water under extreme pressure and density.

The model, developed through a University of Rostock and Sandia collaboration, is called "First Principles Modeling" because it contains no tuning parameters.

"You're solving Schrödinger's equation from a quantum mechanical perspective with hydrogen and oxygen as input; there aren't any knobs for finagling the result you want or expect," says Marcus.

The model's results are quite different from earlier chemical pictures of water's behavior under pressure, but agree quite well with the Z machine's test results, says Marcus.

These results were achieved by using Z's magnetic fields to shoot tiny plates 40 times faster than a rifle bullet into a water sample target a few millimeters away. The impact of each plate into the target created a huge shock wave that compressed the water to roughly one-fourth its original volume, momentarily creating conditions similar to those in the interior of the ice giants.

A direct test of First Principles model

Sub-nanosecond observations captured the behavior of water under pressures and densities that occur somewhere between the surface and core of ice giants.

"We took advantage of recent, more precise methods to measure the speed of the shock wave moving through the water sample by measuring the Doppler shift of laser light reflected from the moving shock front, to 0.1 percent accuracy," says Marcus.

The re-shocked state of water was also determined by observing its behavior as the shock wave reflected back into the water from a quartz rear window (its characteristics also determined) in the target. These results provided a direct test of the First Principles model along a thermodynamic path that mimics the path one would follow if one could bore deep into a planet's interior.

Multiple experiments were performed, providing a series of results at increasing pressures to create an accurate equation of state. Such equations link changes in pressure with changes in temperatures and volumes.

Z can create more pressure— up to 20 megabars—even than at Earth's core (about 3.5 megabars) and millions of times Earth's atmospheric pressure. The Z projectiles, called flyer plates, achieve velocities from 12 to 27 kilometers a second, or up to 60,000 mph. The pressure at the center of Neptune is roughly 8 megabars.

Reducing uncertainty

Water at Z's ice-giant pressures also was found to have reflectivity indicative of a weak metal, raising the possibility that water's charged molecular fragments might be capable of generating a magnetic field. This attribute could help explain certain puzzling aspects of the magnetic fields around Neptune and Uranus.

"Reducing uncertainty on the composition of planetary systems by precisely measuring the equation of state of water at extreme conditions can only help us understand how these systems formed," says Marcus.

These techniques also are used to study materials of critical importance to the nuclear weapons program.

In addition to producing the largest amount of laboratory X-rays on Earth when firing, the huge pressures generated by Z make it useful to astrophysicists seeking data similar to that produced by black holes and neutron stars .

Also listed as paper authors are Mike Desjarlais (1640), Ray Lemke (1641), and Thomas Mattsson (1641) from Sandia, and Martin French, Nadine Nettelmann, and Ronald Redmer from the University of Rostock's Institute of Physics.

Research support was provided by the German Science Foundation and NNSA.

Employee death

'Big picture' guy Pete Wilson was a great man and beloved leader

Pete Wilson loved people and the feeling was mutual.

Pete, who died March 3 in his native Oklahoma, was a brilliant technical manager at Sandia remembered by his colleagues as a visionary leader and a great and good man.

PETE WILSON at a Center 1500 picnic in 2010.

In 29 years at the Labs, Pete left an indelible mark, capping off a notable career with his recent assignment as deputy chief information officer working under longtime friend, Div. 9000 VP and CIO Mike Vahle.

Pete is survived by his wife Cindy, his daughters Emily and Elizabeth, his son-in-law John, and his siblings Mark, Scott, and Paula.

In a eulogy for Pete in Albuquerque, Mike recounted that Pete was "something of a James Dean type of young man . . . He enjoyed life, took foolish risks, and questioned authority." All that changed after Pete met his wife, Mike said. Cindy "provided focus and purpose to Pete's interests and energy."

Mike fondly recalled something that became a tradition between him and Pete: their end-of-the-day walk to their cars.

"We would always talk about the day's issues and progress and what needed to be done the next day," Mike says. "Often our conversations would turn to family and what was up at home. Pete always talked with pride about what was the next project at home — new roof, new windows, fixing a washing machine, fixing a car. I knew the excitement he expressed was because he was doing it for his family."

If family was first, his colleagues at Sandia were a close second.

Jim Redmond (0254) worked with Pete for seven years and came to know him well. From his perspective, "the most important quality of Pete was his connection with people. He'd spend time in your office and you'd get the sense that you were the most important person in the world. He believed his role as a leader transcended the boundaries of the lab. It wasn't unusual to find him helping a staff member with a project on the weekends."

Will Holzmann (1523) can attest to that. A few years back, a big leak developed in the water line in Will's front yard. He was talking about it at work, dreading the repair job. Pete offered to come over and help. Will tried to push back, but Pete would have none of it. Sure enough, that weekend, there he was with his tools and a custom-made sump pump. As inevitably happens, the repair job was accompanied by several trips to Lowes for parts.

"On one of the trips," Will recalls, "I pointed out to Pete that he had tools in the back of his pickup that could possibly get stolen. Pete's response was, 'For the most part people are good, so I'm not going to worry about it.'"

Pete grabbed at life with an infectious enthusiasm. Colleague Kristin Dion (1525) remembers the time a few months ago when "Pete spied me getting a glass of water and he ambushed me, saying he had something very important to ask me about."

His daughter was getting married, he said, and he wanted to learn to dance with her on the big day. Did Kristin, whom he knew to be an accomplished social dancer, know of a good instructor? She did, and referred him to one. Subsequently, she says, "Pete's eyes lit up when he said the lessons were going well and he was feeling much more confident about that special dance. I am so sorry that he won't be able to attend his daughter's wedding. His love for his family was clear to me."

Pete knew that life was more than work and that the most important things often happened away from the workplace. Ellen Anderson (1500) relates that Pete would often ask her how her husband, who was stationed in Afghanistan, was doing and how she was bearing up. That meant a lot to her.

And Pete would unabashedly share his own feelings and concerns. A few years back, he had suffered a massive, near-fatal heart attack that was a wake-up call for him, one that brought him even closer to his wife, whom he considered his hero for her courage and faith in helping him through his recovery. "One time while chatting," Ellen says, "he told me what a blessing every day was to him."

Barb Ford (1520) adds, "For the rest of us, his recovery granted a little more time to learn from him and to appreciate and enjoy time with Pete. May we all hold his lessons of loyalty, faith, and trust in our hearts. May we all fondly remember his great enthusiasm for life and for his wonderful wife."

Jordan Massad (1526) loved a familiar Pete Wilson trademark. "I'll miss seeing that hat of his and it uncovering a head of hair that looked like it just came out of a tornado! Like a fellow Oklahoman." And maybe it was those unaffected Oklahoma roots that shaped another Pete characteristic: frankness. "You never wondered what was going on in his head," Jordan says. "He would just tell you."

Chris O'Gorman (2129) remembers Pete as a "big picture" kind of guy. "He was very good at approaching problems by looking at the big picture and thinking about the appropriate strategies to solve them. The details could always be worked out. He was a great man and I will miss him."

Management Consultant Arina Isaacson remembers Pete at the 2010 session of the Coaching Institute at the University of California-Berkeley. At the end of the intensive 12-day seminar, all the attendees were to sing a song at a let-your-hair-down cabaret evening. It was all in fun, but Arina recalls how seriously Pete took the challenge. At every spare moment during breaks, she'd see and hear him practicing his song, "Dare You to Move," by the band Switchfoot. The lyrics, which meant so much to Pete, were "*I dare you to move/I dare you to move/I dare you to lift yourself up off the floor/I dare you to move/ like today never happened/today never happened before*."

— Bill Murphy

Nuclear fusion simulation shows high-yield energy output

Component testing underway for fast-firing magnetic method

By Neal Singer

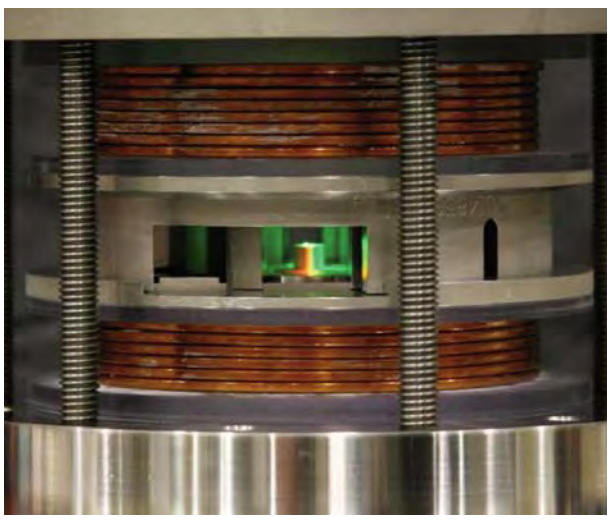
High-gain nuclear fusion could be achieved in a preheated cylindrical container immersed in strong magnetic fields, according to a series of computer simulations performed at Sandia by Steve Slutz and Roger Vesey (both 1644).

The simulations, reported in the Jan. 13 issue of *Physical Review Letters*, show the release of output energy that was, remarkably, many times greater than the energy fed into the container's liner. The method appears to be 50 times more efficient than using X-rays — a previous favorite at Sandia — to drive implosions to create fusion conditions.

"People didn't think there was a high-gain option for magnetized inertial fusion (MIF) but these numerical simulations show there is," says Steve, the paper's lead author. "Now we have to see if nature will let us do it. In principle, we don't know why we can't."

High-gain means getting substantially more energy out of a material than is put into it. Inertial refers to the compression in situ over nanoseconds of a small amount of targeted fuel.

In the simulations, the output demonstrated was 100 times greater than a 60 million amperes (MA) input current. The output rose steeply as the current increased: 1,000 times input was achieved from an incoming pulse of 70 MA.



PROTOTYPE ASSEMBLY of Sandia's magnetized inertial fusion system; the top and bottom horizontal coils enclose the lit target. (Photo by Derek Lamppa)

Since Sandia's Z machine — the test accelerator on premises — currently can bring a maximum of only 26 MA to bear upon a target, the researchers will be happy with a proof-of-principle result called scientific break-even, where the amount of energy leaving the target equals the amount of energy put into the deuterium-tritium fuel.

This has never been achieved in the laboratory and would be a valuable addition to fusion science, says Steve.

Inertial fusion would provide better data for increasingly accurate simulations of nuclear explosions, important for the US nuclear stockpile, which currently does not explode sample weapons to test their capabilities as they age.

High-yield nuclear fusion eventually could produce reliable electrical energy from seawater, the most plentiful material on earth, rather than from the raw materials used by other methods: uranium, coal, oil, gas, sun, or wind.

The MIF technique heats the fusion fuel (deuterium-tritium) by compression as in normal inertial fusion, but uses a magnetic field to suppress heat loss during implosion This magnetic field acts like a kind of shower curtain to prevent charged particles like electrons and alpha particle from leaving the party early and removing needed energy from the reaction.

The simulated process, as reported by Steve and Roger, relies on a single, relatively low-powered laser to preheat a deuterium-tritium gas mixture that sits within a small liner.

At the top and bottom of liner are two slightly larger coils that, when electrically powered, create a joined vertical magnetic field that penetrates into the liner, reducing energy loss from charged particles attempting to escape through the liner's mere physical barrier.

An extremely strong magnetic field is created on the surface of the liner by a separate, very powerful electrical current, generated by a pulsed power accelerator such as Z. The force of this huge magnetic field pushes the liner inward to a fraction of its original diameter. It also compresses the magnetic field emanating from the coils. The combination is powerful enough to force atoms of gaseous fuel into intimate contact with each other, fusing them. Heat released from that reaction raised the gaseous fuel's temperature high enough to ignite a layer of frozen and therefore denser deuterium-tritium fuel coating the inside of the liner. The heat transfer is similar to the way kindling heats a log: When the log ignites, the real heat — here high-yield fusion from ignited frozen fuel — commences.

Tests of physical equipment necessary to validate the computer simulations are already underway at Z and a laboratory result is expected by late 2013, say Sandia researchers.

Portions of the design are slated to receive first tests in March and continue into early winter, says Dean Rovang (1643), who has already led preliminary tests of the coils.

Potential problems involve controlling instabilities in the liner and the magnetic field that might prevent the fuel from constricting evenly, an essential condition for a useful implosion. Even isolating the factors contributing to the hundred-nanosecond event, in order to adjust them, will be challenging.

"Whatever the difficulties," says Sandia manager Daniel Sinars (1648), "we still want to find the answer to what Steve and Roger pose: Can magnetically driven inertial fusion work? We owe it to the country to understand how realistic this possibility is."

The work was supported by Sandia's Laboratory Directed Research and Development office and by the National Nuclear Security Administration.

Mileposts

New Mexico *photos by Michelle Fleming*
California *photos by Randy Wong*


Maryanne Heise
35 10627


Tom Hund
35 2547


Lorri Castillo
30 10262


Judith Jojola
30 10241


Michael Patton
30 4135


Mike Bell
25 8135


Terry Garino
25 1816


Tommy Goolsby
25 6812


Victor Harper-Slaboszewicz
25 1344


Gene Kallenbach
25 6831


Sandy Sanzero
25 6533


Michael Thomas
25 1714


Josh Waley
25 8252


Karen Cardwell
20 8944


Diane Gaylord
20 1123


Roy Gideon
20 4821


Berlinda Gonzales
20 9548


Lisa Hooper
20 4127


Michele Kahn
20 8949


Michael Kent
20 8622


Robert Mariano
20 8005


David Miller
20 6234


Katherine Myers
20 1718


Robert Reese
20 4121


Mike Siegal
20 1114


Clare Stanopiewicz
20 10611


Timothy Buteau
15 6624


Joe Castro
15 1445


Jeff Figiel
15 1126


James Hudgens
15 2622


Bryan Ingram
15 5951


Patrick Knupp
15 1441


David Sanchez
15 2541


Rebecca Ullrich
15 9532

The content here is taken directly from back issues of the *Lab News*.

40 years ago . . . An automated ground station for checking telemetry instrumentation, one of the most advanced facilities of its kind, is now in operation in Bldg. 880. The facility was designed primarily to serve Instrumentation Applications Department 9480, but designers throughout the Laboratories are using its unique capabilities. Telemetry (TM) instrumentation is that equipment which transmits data collected by sensors on board test units. The sensors may be on rockets and howitzer projectiles or units being tested.

The new ground station is designed to provide automated checkout of both kinds of systems during development stages of TM designs and also prior to "flying" the equipment during a test.

The computer programs control a signal generator which simulates signals that the TM equipment should "see" and transmit. The development engineer plugs in the system, selects the appropriate deck of program cards, hits the go key and receives the results of the test almost immediately.


PROJECT LEADER Alan Campbell (9481), right, discusses software of the new automated TM ground station with programmers Bill Whalen, left, and Doug Browne (both 5425). The ground station, one of the most advanced facilities of its kind, provides automated checkout capabilities for telemetry equipment.

30 years ago . . . A parabolic trough solar collector, 70 percent efficient in converting sunlight to 600°F thermal energy has been tested at Sandia. Collector performance increased to 75 percent efficiency at 400°F and 77 percent efficiency at 300°F. This record performance (50 to 60 percent efficiency at 600°F had been the previous maximum) was achieved by combining improvements in the collector structure, reflecting surface, and receiver tube.


PARABOLIC TROUGH collector developed at Sandia offers highest efficiencies yet attained.

CTO a voice for Sandia's strategy for research, infrastructure and business partnerships

By Heather Clark

Every day Sandia's chief technology officer (CTO) is taking a broad view of the Labs' research priorities, capabilities, and strategic partnerships with other national and international laboratories, universities, and industry to support the Labs in meeting its mission now and decades from now.

Currently, Div. 1000 VP Steve Rottler serves as Sandia's CTO, a position he's had since 2009, but one that was redefined by Labs Director Paul Hommert about a year ago.

Steve says Paul wanted the CTO to help better define Sandia's future, so when Sandia's leaders are making decisions — whether they involve business matters or changes to the infrastructure or workforce — the CTO is the executive who we look to, to have considered the broader research, technology, people, and capabilities, and the implication of those decisions.

The CTO's new role is a work in progress. Together with the Research Leadership Team, the CTO:

• Develops and implements a strategy to enable current and future mission execution and achieve world-class leadership in science and technology.

• Designs and administers a Laboratory Directed Research and Development (LDRD) program that sponsors employee-initiated research and development within an institutional framework and provides new capabilities essential to Sandia's mission.

• Develops and implements sustainable capabilities management to secure the Labs' future.

• Leads the development of Science & Technology's strategic partnerships with national and international laboratories, universities, and industry.

The CTO and the Research Leadership Team work to identify key research areas from among many needs and great ideas, Steve says.

Today's environment, he says, creates a risk that Sandia's research directions will be defined primarily by who would fund and by our expertise and interests. While those are important factors, Steve says, it is also important to understand business needs and the technological frontier in a way that allows the Labs to look into the future and choose key research areas that will move Sandia forward strategically in supporting its customers.

Steve wants the team to bring a business perspective to the table. He wants team members to listen to the strategic management unit (SMU) leaders, find out what their major programmatic challenges are, and figure out how Sandia's research can help meet those challenges.

SANDIA CHIEF TECHNOLOGY OFFICER and Div. 1000 VP Steve Rottler during a recent presentation to a visiting contingent of Asian American engineers. (Photo by Randy Montoya)

"It could open up a new customer for the Labs or substantively alter the relationship we have with an existing customer," he says. "When we're successful at it, it will more tightly couple research with our programs."

But defining the Labs' research priorities "can't be a top-down driven process; it has to be participative," Steve says. "I believe the role of senior leadership is to define the boundaries, define the big problems. We must rely on our staff and managers to help us understand where the frontiers are and what's coming over the horizon that either could be very disruptive to us or be a great benefit to us, or both."

Eventually, researchers will begin to see more attention paid to a handful of significant efforts in each research area, he says.

Steve says part of the strategizing will come from strengthening the integration between research and program execution, but he doesn't intend for all research to move to the near-term. Rather, he expects the increased focus to move Sandia toward research that prepares the Labs for the future.

An example, he says, is quantum-related research. Between five and 10 years ago, Sandia began expanding its number of quantum physicists.

"We built a sizeable portfolio in this area that spans the range of fundamental basic research in a lab. Our efforts have included generating the ability to trap and monitor the quantum state of individual ions and atoms all the way to exploring how being able to do that could be applied in ways that would revolutionize some of the things we do for our customers," Steve says. "We've gone from being not very relevant in this field to being a technical leader."

The CTO also takes a bird's-eye view of the Labs' capabilities in terms of employees, facilities, and equipment.

Steve says his view of how to manage capabilities has changed in the two years he's been in his job. Initially, he thought Sandia should be actively managing its capabilities by identifying them and monitoring their health. But now be thinks the market should decide, with certain exceptions like high-performance computing, simulation of extreme environments, and microelectromechanical systems (MEMS) capabilities.

For example, to manage Sandia's capabilities in high-performance computing, the Mission Leadership Team recently decided to formally support on an annual basis institutional computing at the Labs. Until now, Sandia funded procurement and operation of high-end computing platforms on an as-needed basis, but managers in a recent survey said they needed more access to such platforms to complete their work.

So Center 1400 Director Rob Leland led the development of a plan that makes computing a critical capability at the Labs, Steve says.

"We need it to execute the business and to be the kind of institution we have defined in our strategic plan," Steve says. "We've now put into motion the actions necessary for this to be an ongoing investment that we make institutionally."

The CTO needs to speak up for capabilities when their erosion is putting the mission at risk. For example, Steve says he has advocated the recapitalization of the Tonopah Test Range, the Microsystems and Engineering Sciences Applications (MESA) facility, and the environmental test facilities.

When it comes to employees, Sandia needs to become more deliberate about developing and managing competencies at the Labs, consciously promoting skills through mentoring, continuing education, and other means, Steve says.

Steve says the CTO job "immerses me every day" in the Labs' research, which is a "refreshing and exhilarating" experience.

"Having the privilege as the CTO to see all that is going on at this laboratory is truly incredible," he says. "The research and development programs, the potential impact they have, and the contribution they make at the frontiers of science and engineering make me extraordinarily proud to be an employee at Sandia."

50 years on, John Glenn remains a hero for our time

Zero G and I feel fine," John Glenn exclaimed as he entered orbit in his Mercury spacecraft, *Friendship 7*, 50 years ago in February. Glenn, one of the original Mercury 7 astronauts, was not the first American in space — that honor went to Alan Shepard in a 15-minute suborbital hop — but his three-orbit flight was widely perceived as the first American mission comparable to the Russian space spectaculars during at the height of the Cold War. In the wake of the flight, Glenn became an instant national hero, a role he embraced with uncommon grace.

Following his NASA career, the former Marine Corps aviator entered politics, where he represented Ohio as a US senator for many years. In his law-making capacity, Glenn visited Sandia at least twice, in 1988 (photo at left, escorted by then-Executive VP Orval Jones) and again in 1989, where he was accompanied by N.M. Sen. Jeff Bingaman (photo above). Both photos were taken by Randy Montoya, who was able to chat briefly with Glenn on both occasions and has always remembered his easy affability and good will. In 1998, Glenn returned to orbit in a space shuttle mission to explore the effects of weightlessness on the elderly. In that flight he set a record that still stands: He remains the oldest person of any nationality to fly into space.