

Div. 8000 uses fuze expertise for Air Force ICBMs

By Holly Larsen

If the term “fuze” seems more prevalent around Sandia these days, it’s no accident. Technical staff and managers, systems engineers, flight test specialists, and project managers across the Labs are actively engaged in the Mark (Mk) 21 Fuze Replacement program for the W87 warhead on the US Air Force Minuteman III intercontinental ballistic missile (ICBM), an engineering development effort that promises to remain a key activity for Sandia’s nuclear weapons mission for years to come.

Mounted at the forward end of the warhead, the fuze tracks the path of the warhead and gives the signal to detonate. To fulfill this role, many intricate components must operate perfectly in challenging environments, which in turn calls for very careful engineering. Sandia has been providing such engineering for decades for the arming, fuzing, and firing (AF&F) sets of several US Navy submarine-launched ballistic missile warheads.

The Mk21 Fuze program — led by Dept. 8242 in California and
(Continued on page 4)



STEPHEN DOWNEY (8135) and former Sandian TaiWen Ko evaluate adaptable telemetry hardware components as they build up the telemetry system to be used to test the Mark 21 replacement fuze. TaiWen is inspecting an environmental sensor measurement card of the telemetry system while Stephen modifies the firmware to be loaded onto the card’s field programmable gate array. Stephen and TaiWen are adjusting the hardware and firmware capability to increase bandwidth and hence provide more measurement capability of the W87 fuze and its environments during test flights.
(Photo by Randy Wong)

Sandia LabNews

Vol. 66, No. 17

August 22, 2014

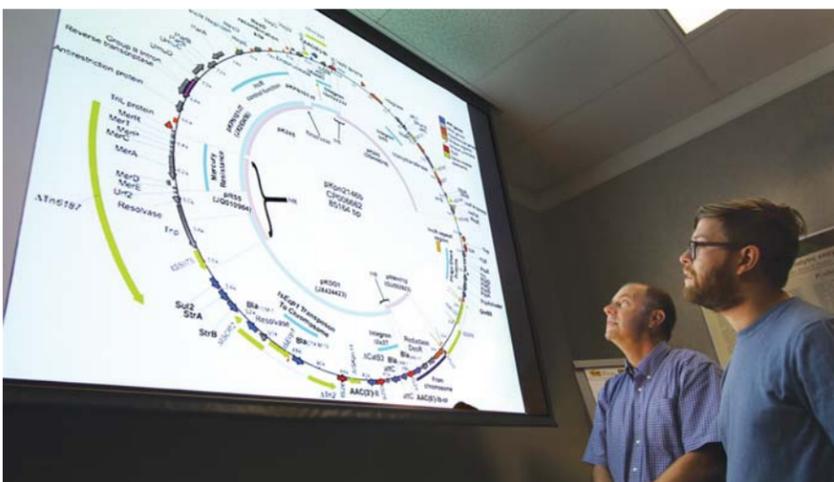
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California site hosts 200 summer interns.
Photo spread on pages 6-7.

LIVERMORE, CALIFORNIA

Sandia researchers find clues to superbug evolution



KELLY WILLIAMS, right, and Corey Hudson (both 8623) look at the mosaic pattern of one of the *Klebsiella pneumoniae* plasmids and discuss mechanisms that mobilize resistance genes.
(Photo by Dino Vournas)

By Patti Koning

Imagine going to the hospital with one disease and coming home with something much worse, or not coming home at all.

With the spread of antibiotic resistance, healthcare-associated infections have become a serious threat. In fact, on any given day about one in 25 hospital patients has at least one such infection and as many as one in nine of those die as a result, according to the Centers for Disease Control.

Consider *Klebsiella pneumoniae*, not typically a ferocious pathogen, but now armed with resistance to virtually all antibiotics in clinical use; it is the most common species of carbapenem-resistant Enterobacteriaceae (CRE) in the United States. Carbapenems are considered the antibiotic of last resort.

But there is hope — a team of Sandia microbiologists recently sequenced the entire genome of a *Klebsiella pneumoniae* strain encoding New Delhi Metallo-beta-lactamase (NDM-1), an enzyme that breaks down carbapenems and renders them ineffective.

(Continued on page 3)

Low impact

Adoption of natural gas vehicles would have little effect on emission objectives, study finds

By Mike Janes

The broad adoption of natural gas-fueled cars and small trucks would do little to lessen greenhouse gas emissions since buyers of such vehicles would otherwise be purchasing electric or other alternative-energy vehicles, thus “canceling out” the environmental benefit of natural gas vehicle adoption.

That’s the primary conclusion of an in-depth systems study performed by Meghan Peterson, Garrett Barter, Todd West, (all 8114) and Dawn Manley (8350) and published in the journal *Applied Energy* in a paper titled “A parametric study of light-duty natural gas vehicle competitiveness in the United States through 2050.”

The work was performed for DOE’s Office of Vehicle Technologies, a longtime sponsor of Sandia’s Combustion Research Facility but new to the systems studies group in Center 8100.

“If you imagine a world with natural gas vehicles and a world without them and compare the level of greenhouse gas emissions in each scenario, you can’t really tell a difference in terms of the emissions,” says Todd. “We learned that natural gas vehicles would essentially compete against other alternative fuel vehicles.” In fact, Todd says, the study concluded that

(Continued on page 3)



Inside . . .



- Can there be too much data? 5
- Mindfulness: A new approach to safety, security, well-being 8
- Refining climate models through uncertainty quantification. 9
- Adventure! Travel! Sandia! 12



That's that

What swimming taught me about doing good science

By Cathy Branda, Manager,
Systems Biology Dept. 8623

What do competitive swimming and science have in common? Not much in practice, but I recently realized the tactics I used many years ago to prepare for swim races are also effective for safely planning research.

A few months ago, I presented a safety case outline for a bioremediation project. While preparing the talk, I reflected on my own safety journey since starting as a research intern 20-plus years ago to becoming a Sandia manager.

As a young scientist, I vividly recall being told to "learn to take the heat or get out of the kitchen" after I raised a laboratory safety concern. Wanting very much to become a scientist, I developed the attitude that doing good science is inherently risky due to the ubiquity of hazardous materials in most laboratory settings.

During my early career, I witnessed two significant laboratory accidents. In the first, while hurrying to complete a procedure, a graduate student upset a large container of phenol-chloroform waste. The phenol-chloroform splashed out, causing painful burns on her bare legs and closing the lab for the rest of the day.

The second lab accident occurred when a fellow graduate student reached for a bottle of ethidium bromide on a high shelf. The bottle slid off the shelf and smashed, splashing the concentrated solution into her eyes and mouth. It was a frightening scene: the student was rushed to an ES&H facility where every inch of her skin was scrubbed with a wire brush to remove as much of the carcinogenic chemical as possible.

As an eager graduate student, I saw the accidents as deeply regrettable sacrifices made by dedicated scientists in the pursuit of knowledge. I failed to see the true nature of these incidents; in reality, they were utterly preventable accidents that resulted from poor planning.

At Sandia, we are incredibly fortunate that our work environment promotes a "safe by design" mindset and Labs-wide resources have been committed to implement engineered safety when planning any research. We are encouraged to think through every step, consider what can go wrong, and minimize or eliminate risks to the extent possible.

In my bioremediation example, we effectively eliminated our key hazard by reducing the amount of energetic material, yet we still achieved our research objectives. To further reduce risk, we tasked qualified, experienced personnel to weigh and pre-mix the energetic material in a lab designated for such work.

So where does swimming come into this? If I had time and a quiet space before a race, I would visualize every aspect – from stepping on the starting block to the finish. Without fail, I performed better in races when I took time to think them through beforehand.

The thought process for thinking through an experimental design – considering the full system of where the work will be conducted and with what equipment and reagents – is elementally the same process I used for my swim races. If my long-ago colleagues and I had applied this thought process to laboratory safety and had taken time to visualize each step of our work, we would have handled dangerous chemicals differently and likely prevented the two accidents I described.

Engineered safety isn't just about safety; it's about good planning in any activity you undertake. If you think through the entire process from start to finish, you will be safer, you will work more efficiently, and you will conduct higher-quality research. By applying engineered safety, we can each do our part to prevent things from going wrong and to ensure that Sandia remains a great place to work.

– Cathy Branda (MS 9291, 925-294-6833, cbranda@sandia.gov)



VISUALIZATION TECHNIQUES Cathy Branda learned as a competitive swimmer have helped her think through experimental designs, considering each step of the work to ensure it is being done safely. In the photo above of her high school swim team, Cathy is at the far right in the swim cap.

Sandia California News



Patti Koning and Mike Janes (both 8521) once again took over the helm of *Sandia Lab News* as guest editors for the 8th annual California issue, which highlights the site's research, people, and happenings. (Photo by Randy Wong)



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Albuquerque, New Mexico 87185-1468

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Tonopah, Nevada • Nevada National Security Site

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Sandia National Laboratories is a multiprogram laboratory operated by Sandia Corporation, a wholly owned subsidiary of Lockheed Martin Corp., for the US Department of Energy's National Nuclear Security Administration.

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Lab News fax 505/844-0645

Classified ads 505/844-4902

Published on alternate Fridays by Internal & Digital Communications Dept. 3651, MS 1468

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MISSION SUPPORT ALL HANDS MEETING

Presented by:

Kim Sawyer

Deputy Labs Director & Executive
Vice President for Mission Support

9:00–10:30 AM MDT
Wednesday, August 27

NM: Steve Schiff Auditorium
CA: Bldg. 904 Auditorium

Special guest: **Jill Hruby**

VP, Energy, Nonproliferation, and High-Consequence Security, will provide a Mission Area Overview



*FY14 Accomplishments
Celebration and Networking
(10:30 – 11:00 MDT)*

Emissions

(Continued from page 1)

the footprint for greenhouse gas emissions is actually slightly better for electric vehicles than for natural gas vehicles.

The results of the study were delivered to the sponsor via a written report and other materials, leading to briefings to government officials, including those at the White House.

The work builds upon a successful LDRD effort designed to leverage the Labs' deep expertise in combustion engine science with its growing capability in systems analysis, a capability that is usually applied to national security activities.

The merging of the two capabilities, says Todd, led to a dynamic, predictive model that focuses on "stocks and flows." In the study, for instance, the team assumed a stock of light-duty vehicles in circulation, a flow out of vehicles being retired, a flow in of new vehicles being purchased, as well as similar stocks and flows with regard to fuels and energy sources. Using the model, the researchers could make predictions on prices and other factors and conclude what makes one vehicle technology more competitive with another.

What differentiates Sandia's work in this area, Todd adds, is that no particular scenarios were assumed.

Commodity prices fluctuate wildly

"Other academic papers on this topic have tended to start with a supposition, like 'let's say electric vehicles are 50 percent of the fleet in 2050.' That doesn't get you very far, since there is so much about the future that we don't know." Commodity prices and vehicle technology, for instance, can fluctuate wildly and are next to impossible to accurately predict years and decades down the road.

Sandia's approach, says Todd, was to make no firm assertions regarding the market share of a given technology, instead allowing the model to make that determination using data and various parameters. "If we didn't know something, we wanted to be explicit about that," he says.

Sandia's conclusions, then, came from a conglomeration of outputs of several thousand computer simulations. Data such as the current vehicle stock, state-by-state locations of registered light-duty vehicles in the US, advancements in battery technologies, and DOE projections on prices for oil, biomass, natural gas, and coal were all fed into the model. Additional projections were



A SANDIA STUDY has found that adoption of natural gas vehicles would have little effect on emission-lowering objectives.

used, too, including the anticipated performance and cost of vehicles through 2050, as well as possible policies the government might enact.

"We wanted to parameterize as much as possible," says Garrett. The team conducted "sensitivity" studies that sought to identify the factors that were most likely to make qualitative differences in driving outcomes. The primary outcome in question was whether natural gas vehicles would get adopted. "We often find that most characteristics turn out to be relatively unimportant in actually driving outcomes, but in this case natural gas prices versus petroleum prices turned out to be an important driver."

The study's key finding, says Garrett, would not have emerged without the parametric approach employed by the research team.

"If we'd just run a handful of scenarios, it would have been tough for us to land on this finding," he says. "But it was something we could see pretty easily using the data and parameters that we did."

Model factors in purchasing choices

Another important tool used in the study was a decision model that helped the researchers to understand what drives consumers to make certain choices.

"At some point, consumers have to decide which [vehicle] powertrain they're going to use," Garrett explains. But their decisions, he points out, are often based on emotions and not necessarily rational facts, so the model — a common tool known as multinomial logit choice — has allowances built in to take this into account. The study factored in the segmentation of American consumers, such as how some people drive

more (or less) than others, drive more (or less) in urban environments, and so on. Such driving patterns, of course, impact the kinds of vehicles consumers are likely to purchase.

The study also looked at the importance of home refueling for consumers owning natural gas vehicles, and what factors might move the needle in terms of their adoption. The research team concluded that the ability for consumers to refuel at home, while somewhat important during any transitional period, is not a "make or break" factor in the long term. Instead, they found that — beyond economics and pricing — a public infrastructure for refueling is the most notable factor.

"Consumers really need to be able to fill up while they're on the road," Todd says. "So ultimately, fuel availability and infrastructure are very important."

The study took roughly eight months to complete and took advantage of the multidisciplinary talents of team members Meghan (chemical engineer), Garrett (aerospace engineer), Todd (theoretical physicist), and Dawn (chemical engineer).

Next up: heavy duty vehicles, other fuels

Todd calls the briefings from DOE to other decision-makers "the ultimate impact" in terms of feedback on the natural gas/vehicles study. The team — led by Amy Askin (8114) — is in the midst of a similar study focused on heavy-duty vehicles. Though the modeling tools will be similar to those employed for the light-duty vehicle study, there are significant differences with heavy-duty vehicles that promise some interesting results.

"The ownership model is very different with heavy-duty vehicles," says Amy. The vehicle fleets are larger, for one, since heavy-duty trucks are used for commercial and not private purposes. Consequently, infrastructure issues are also different, as fleet owners can and do build their own refueling stations.

The team will look at these issues and others, including the alternative fuel situation with heavy-duty vehicles, the adoption of such vehicles into the future, and the ever-important issue of greenhouse gas emissions.

Todd says he hopes to continue building on the work he and his team have accomplished to date and perhaps begin to include other elements in the models, including other energy sources such as hydrogen fuel cells. The team is also talking with potential industry partners about applying systems analysis tools to other transportation energy issues.

Superbug

(Continued from page 1)

CREs are a wholly different group of antibiotic-resistant bacteria than the better-known methicillin-resistant *Staphylococcus aureus* (MRSA). CREs are considered a "triple threat" because of their resistance to nearly all antibiotics, high mortality rates, and ability to spread their resistance to other bacteria.

Having sequenced the entire genome of the NDM-1 strain *Klebsiella pneumoniae* for the first time, the Sandia team of Corey Hudson (8623), Zach Bent (8623), Robert Meagher (8621) and Kelly Williams (8623) are beginning to understand the bacteria's multifaceted mechanisms for resistance. They presented their findings in a paper recently published in *PLOS One*, "Resistance Determinants and Mobile Genetic Elements of an NDM-1 Encoding *Klebsiella pneumoniae* Strain."

An eye-opener

"Once we had the entire genome sequenced, it was a real eye-opener to see the concentration of so many antibiotic-resistant genes and so many different mechanisms for accumulating them," says Kelly, a bioinformaticist. "Just sequencing this genome unlocked a vault of information about how genes move between bacteria and how DNA moves within the chromosome."

Robert first worked with *Klebsiella pneumoniae* ATCC BAA-2146 (Kpn2146), the first US isolate found to encode NDM-1, last year. Along with *E. coli*, it was used to test an automatic DNA sequencing preparation platform for the RapTOR Grand Challenge, a project that developed techniques to allow discovery of pathogens in clinical samples.

"I've been interested in multi-drug resistant organisms for some time. The NDM-1 drug resistance trait is spreading rapidly worldwide, so there is a great need for

diagnostic tools," says Robert. "This particular strain of *Klebsiella pneumoniae* is fascinating and terrifying because it's resistant to practically everything. Some of that you can explain on the basis on NDM-1, but it's also resistant to other classes of antibiotics that NDM-1 has no bearing on."

Unlocking *Klebsiella pneumoniae*

Assembling an entire genome is like putting together a puzzle. The researchers needed two genomic datasets, Illumina and Pacific Biosciences (PacBio), to assemble *Klebsiella pneumoniae*. The Illumina pair-end genomic sequence dataset, done at Sandia, provided accurate but short reads. The PacBio dataset contained much longer reads with less accuracy.

Klebsiella pneumoniae turned out to have one large chromosome and four plasmids, smaller DNA circles physically separate from and able to replicate independently of a cell's chromosomal DNA. Plasmids often carry antibiotic-resistant genes and other defense mechanisms.

The researchers discovered that their *Klebsiella pneumoniae* bacteria encoded 34 separate enzymes of antibiotic resistance, as well as efflux pumps that move compounds out of cells and mutations in chromosomal genes that are expected to confer resistance.

"Each one of those genes has a story. How it got into this bacteria, where it has been, and how it has evolved," says Kelly.

The researchers also identified several mechanisms that mobilize resistance genes: acquisition of plasmids and genomic islands; integron cassette swapping; transposition events from chromosome to plasmid and vice versa; and homologous recombination at high copy repeats.

Necessity leads to development of new tools

In the course of mapping out the many tricks and weapons of *Klebsiella pneumoniae*, the research team developed several new bioinformatics tools for identify-

ing established mechanisms of genetic movement.

Kelly and Corey detected circular forms of transposons, or "jumping genes," in movement, which has never before been shown this way, and discovered sites within the genome undergoing homologous recombination. By applying two existing bioinformatics methods for detecting genomic islands, they found a third class of islands that neither method alone could have detected.

"To some extent, every extra piece of DNA that a bacteria acquires comes at some cost, so the bacteria doesn't usually hang onto traits it doesn't need," says Corey. "The further we dug down into the genome, the more stories we found about movement within the organism and from other organisms and the history of insults, like antibiotics, that it has faced. This particular bacteria is just getting nastier over time."

Translating findings to diagnostics

The researchers are now applying their understanding of *Klebsiella pneumoniae*'s mechanisms of resistance and their new bioinformatics tools to develop diagnostic tools to detect bioengineering. Looking across 10 related but distinct strains of *Klebsiella pneumoniae*, they pinpointed regions that were new to their strain, and so indicate genetic movement.

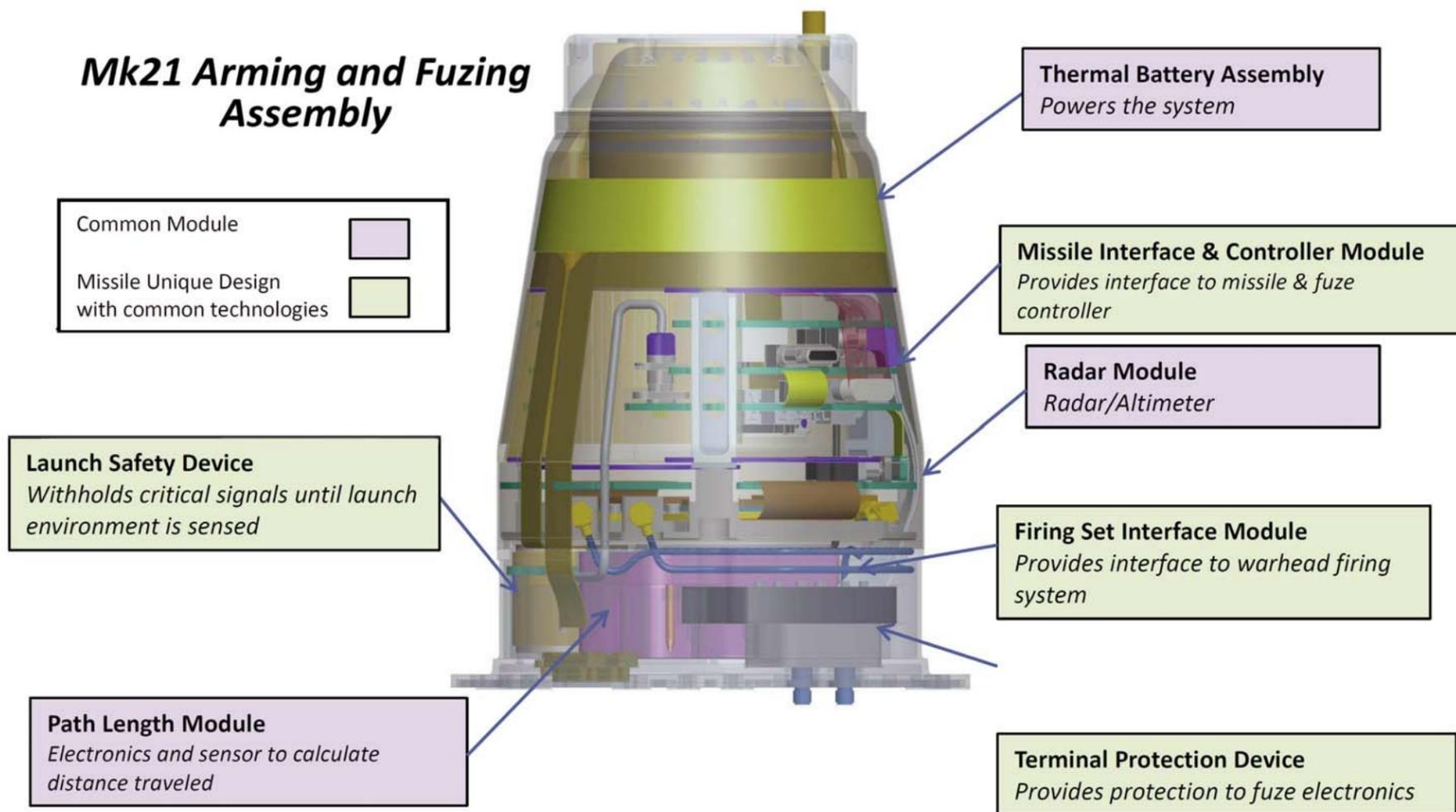
"By studying the pattern of movement, we can better characterize a natural genomic island," says Corey. "We are now using that knowledge to characterize unnatural islands, which would be an indication of bioengineering."

The findings are also being applied to another Laboratory Directed Research and Development project led by Eric Carnes (8635) that is examining alternative approaches for treating drug resistant organisms. "Instead of traditional antibiotics, we use a sequence-based approach to silence expression of drug resistant genes," explains Meagher.

The importance of this research can be summed up nicely by an oft-quoted line from Sun Tzu's *Art of War* — know the enemy.

Fuze program one of 3 weapon programs in 'Phase 6.3' — full-scale engineering development

The radar module tracks the path of the warhead and sends the signal to detonate at the right moment. The purple boxes below show fuze modules common to both the Navy and Air Force systems, while modules highlighted by the green boxes are unique to the Air Force but use common technologies.



(Continued from page 1)

drawing on extensive engineering from New Mexico teams in Divisions 2000 and 5000 — leverages and consolidates Sandia's proficiency. "Sandia has provided fuzing systems for the Navy for more than 40 years," says Curt Nilsen (8242), manager of the ICBM Fuze Systems Engineering Group. "We're now proud to bring our expertise to the Air Force."

Optimizing commonalities

Sandia's long-standing and productive working relationship with the Navy was a strong factor in the Air Force selection of Sandia to design the replacement Mk21 fuzes. Contracting with Sandia also created the opportunity to gain efficiencies by leveraging commonalities between the Air Force and Navy fuzes through the W88 ALT 370 program.

"The two fuzes themselves won't be identical, but several of the key components will be the same," Curt says. "Other parts will use similar technologies, but will be modified to meet unique Air Force needs. Both the Navy and the Air Force have been actively supporting efforts to optimize this integration," he adds.

Sandia started work on the project in November 2011 with the goal of creating the first production units in the early 2020s. Production is expected to continue through 2029.

The Sandia teams have been busy refining product requirements, creating and prototyping their designs, and planning for qualification. Still to come is more detailed component design that will further specify the form and function of elements — and show how these specifications allow the elements to meet all requirements. Qualification activities will demonstrate component and system performance and robustness and will include a series of system-level ground and flight tests.

Top-of-the-line program management

In embarking on the Mk21 project, Sandia and the Air Force recognized the challenges created by a decision to apply the NNSA Phase 6.X NW development process, rather than the Defense Acquisition Process (known as the DoD 5000 process) historically used by the Air Force.

"Both processes are thorough, but it isn't possible to map every step in one process to a step in the other," says Curt. "So to gain the customer's confidence that

Cutting-edge projects such as the Mk21 Fuze Replacement Program keep Sandia employees at the forefront of a wide range of technology advances, from electronics to environmental testing.

Phase 6.X would fulfill the letter and spirit of DoD 5000 and ensure that all project requirements would be met, we knew top-of-the-line project management processes would be required."

As a first step, project leaders built a team of technical project managers that included several hires with extensive DoD 5000 experience. Because of customer needs, leaders also decided to implement an earned-value management (EVM) system — a highly structured way to assess work completed and budget spent against a plan. They then fostered an environment that enabled the project managers to work as peers with their R&D counterparts in implementing EVM.

Curt says that EVM increases the rigor of project management and offers the team an accurate picture of the status of the project and progress against plans and budgets.

Coordination is key

The project relies heavily on teams from across all of Sandia. In broad strokes, Dept. 2135, led by Ron Franco, is responsible for engineering the fuze hardware, while Dept. 8242 is taking the lead on systems engineering, flight tests, and project management. All these activities must take place in tandem and drive toward the common goal of ensuring that the fuze meets all of its customer requirements, on time, and within budget.

Curt says the need for close coordination has required an extra emphasis on communications between the two sites, a message seconded by Ron. "This project is exceptional in bringing people together across the sites and ensuring that we are aware of the work of other teams and actively contributing across sites as needed," he says.

Other key California organizations working on the project include W87 Systems Engineering (8231) and Telemetry and Stockpile Support (8135). Fuze component development is provided by Nuclear Weapon Arming & Fuzing Systems (5350), Firing & Embedded Systems (2620), Advanced Mechanical Design (2610),

and Power Sources & Metrology (2540). Centers 1700, 1500, 1300, and 1800 also play important roles.

Maintaining a cutting-edge NW workforce

Besides extending Sandia's fuze expertise to a new system, the Mk21 program is significant because it is one of three Sandia programs — along with the B61-12 Life Extension Program (LEP) and W88 Alteration (ALT) 370 effort — that are in "Phase 6.3" or full-scale engineering development.

Sandia activity in weapons modernization has not been this high since the early 1990s, a fact highlighted by Labs Director Paul Hommert in his testimony to the US House Armed Services Subcommittee on Strategic Forces, provided in October 2013.

Cutting-edge projects such as the Mk21 Fuze Replacement Program keep Sandia employees at the forefront of a wide range of technology advances, from electronics to environmental testing. The fuze project also gives employees opportunities to develop and work with hardware — work that many find deeply satisfying.

In testifying to the House subcommittee, Paul noted that 500 of Sandia's new hires, many in the early stages of their careers, are working on new weapon projects. Said Paul: "The modernization program provides opportunities for these new technical staff to work closely with our experienced designers: from advanced concept development to component design and qualification, and ultimately to the production and fielding of nuclear weapon systems."

In turn, this provides new technical staff with "the multiyear learning it takes to technically steward the nation's nuclear stockpile now and into the future, after the modernized warheads are in the stockpile."

Put simply, programs such as these are critical to building the skilled technical workforce Sandia needs to execute its mission and ensure an effective nuclear deterrent for decades to come.

Can there be too much data?

By Patti Koning

Knowledge is power, but too much knowledge — in the form of data — can be a bad thing. “More information doesn’t always lead to better decisions,” says Philip Kegelmeyer (8900). “In fact, sometimes the two can be anti-correlated.”

An expert in machine learning, Philip has spent a lot of time pondering dangers and opportunities in “big data” — essentially, large and complex data sets that can only be processed on a supercomputer. He’s given numerous presentations to answer questions related to the use of personal data to enhance national security data analysis.

“Does all that data make a difference? Is it worth the privacy concerns?” he asks. “Big data is tricky. It can help or hurt your analysis, depending on how you use it.”

To understand these issues, Philip says you first have to appreciate how data can influence, or fail to influence, human decision-making. “The leading theory in evolutionary psychology is that intelligence evolved to win arguments, not to arrive at the truth. So in a roomful of people, the opinion of the most charismatic person often wins out,” he says. “That’s fairly depressing, and a good argument for thinking carefully about how data and judgment interact.”

The base rate fallacy

One way data can lead us astray is the base rate fallacy — an error in thinking in which we fail to take into account how likely things are to happen, or not to happen.

Philip gives the example of a bozometer that can accurately detect bozos 99.99 percent of the time. “I point it at you and it says you are a bozo. But are you really? The very counterintuitive answer depends on who else I test. This is not solely about you and the accuracy of the instrument,” he says.

On a pre-selected group of 2,000, of whom 1,000 are known bozos, the device will accurately find 999 bozos with one false alarm. But add a lot of untargeted data — the rest of the US population of approximately 300 million people — and you now have 300,000 false alarms.

“If you know there are only about 2,000 bozos in the entire data set, 99.99 percent accuracy isn’t so great,” says Philip. “The chances that you are really a bozo become quite small. This is the danger of adding untargeted data to any analytic.”

Even an analytic with 99.999 percent accuracy would still turn up 30,000 false alarms. “So you either need an incredibly accurate analytic, or a situation in which a high false alarm rate is acceptable,” he says. “This can work in the medical community, when medical tests are given to a broad population to screen for critical conditions. In this situation, a high false alarm rate may be tolerable.”

On the flip side, extra untargeted data can fill in connections and help you understand the importance of those connections. Philip invents the example of Abe and Abigail, who are both people of interest and have both been seen in Damascus. With additional flight information, you’d learn that they both frequently fly into Yemen and their time in Damascus



PHILIP KEGELMEYER uses the Bayes Rule, a theorem of probability theory, to evaluate the bozometer results. In cautioning about the potential pitfalls of relying too heavily on big data, Philip notes that if a bozometer worked with 99.99 percent accuracy, it would return more than 300,000 false readings when sampling the US population — 300,000 people incorrectly deemed to be bozos. (Photo By Dino Vournas)

almost always overlaps by a day.

“Without broad data, that is all you have and those facts seem very suggestive,” Philip explains. “But if you look at the entire set of normal flight records for that region, you might learn, for example, that 80 percent of all travel to Yemen goes through Damascus, most of that travel requires an overnight stay for refueling, and that 90 percent of that travel happens in three months of the year. With this additional, non-specific data, the odds that any two random travelers to Yemen would be in Damascus at the same time go way up.”

This is an example of how large amounts of properly used data, even if the vast bulk of that data is about people who are not of security interest, can enhance national security data analysis. Such data, he explains, is useful in providing context for what is normal and what is truly unique, as in the case of Abe and Abigail’s travel patterns. “The human mind prefers simple stories. The value of bulk data is that it can tell us when the stories are too simple, when we should look deeper and not trust our first impressions,” he says.

Mining blog posts to predict violence

Philip led the 2008-2010 Networks Grand Challenge LDRD that demonstrates the power of big data. The project dug into the question of why certain events sparked violent protests. In 2005, the publication of editorial cartoons depicting the Islamic prophet Muhammad in the Danish newspaper *Jyllands-Posten*

set off worldwide protests, violent demonstrations, and riots, which were blamed for the deaths of hundreds of people.

“This wasn’t the first or last time that these cartoons were published, so why such an extreme reaction that one time?” asks Philip. “We looked at blog postings and comments and how the information travels across the web and developed an algorithm that can predict, based on multilingual text analysis, if an event will spark deadly violence.”

The project took in a lot of data by continuously scanning blogs in multiple languages and analyzing the aggregated voluntarily public text for keywords, text clustering, and sentiment. “The prediction capability comes from looking at what is a ‘normal’ response to incendiary events in the news,” says Philip. “Our algorithm can tell us if the response will lead to violence, but it can’t tell us when, where, or by whom that violence will occur.”

Can you trust your data?

Philip has a complicated relationship with data — he doesn’t always trust it. “People can fall in love with their data, to the point that they are blind to the idea that an adversary can manipulate data,” he says.

He cites a major metropolitan police department that implemented a computer-based system to assign police officers to the neighborhoods with the most illegal drug activity. A college student arrested for possession of marijuana might not trigger an increase in police presence, but violence among cocaine dealers would. The program worked great, until police officers began seeing disparities between the computer program’s assessment of the neighborhoods and what they saw on the streets.

It turned out that a drug gang had started bribing a data entry clerk in the police department, a scheme that went undetected for a year before the gang got too ambitious. At first the clerk only flagged the arrests of the gang doing the bribing as less violent, but eventually they had the clerk flag the arrests of a rival gang as more violent.

So it soon all unraveled on the witness stand. “And it’s not like the tampering was subtle,” explains Philip. “They were able to track the problems with the data back to the very day the bribery started.”

Unfortunately, adversaries also have far more sophisticated methods of sapping or suborning the critical use of data analytics on which many research institutions, government agencies, and companies rely, including Sandia.

“Through understanding our methods, adversaries seek to produce data that is evolving, incomplete, deceptive, and otherwise custom-defined to defeat analysis,” he says. “We can’t prevent this. In fact, we frequently depend on data over which adversaries have extensive influence.”

To address this problem, Phil is now leading another LDRD project, Counter Adversarial Data Analysis (CADA), that seeks to develop and assess novel data analysis methods to counter that adversarial influence.

“We are trying to understand if an adversary can know how we are using data and if they can actually change our data,” Philip explains. “How paranoid should we be that this could happen, and what can we do to remediate the situation? The bottom line is that big data can be powerful, but only if you understand the inherent weaknesses and tradeoffs. You can’t just take data at face value.”

INTERNS

From start to symposium



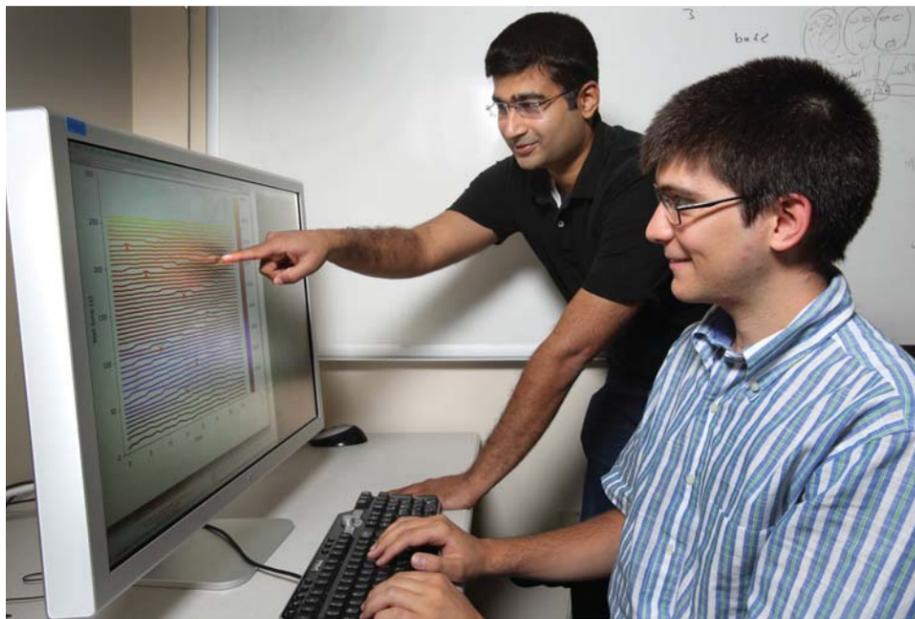
INTERN KICKOFF — The summer interns get to know each other with a good old-fashioned water balloon toss.

Photos by Dino Vournas*
**except where noted*

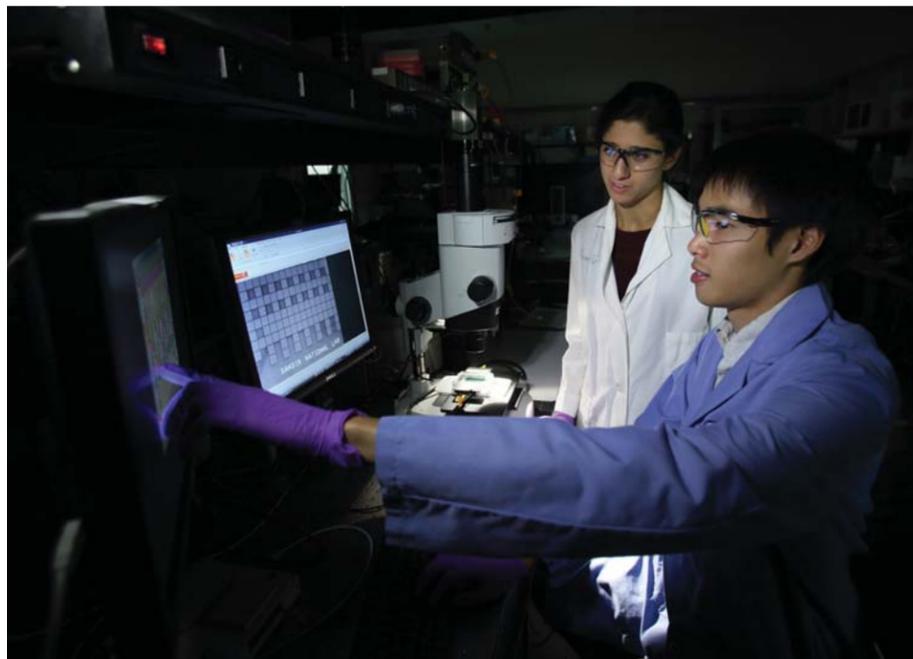
This summer, some 200 interns came to Sandia/California from high schools, community colleges, four-year universities, and graduate programs from across the country. For the first time, the Combustion Research Facility hosted two professors, four community college students, and seven undergraduate students through the Department of Energy's Workforce Development for Teachers and Scientists program. Five interns are foreign nationals — another first for Sandia. Bringing in summer interns is part of a deliberate strategy to recruit talent to Sandia. In the few months they spent on our campus, the interns interacted with many talented Sandia researchers and learned about who we are and the important work we do for the nation. From the kickoff, where the interns were welcomed, to the symposium, where they shared their learning, the interns had a positive effect on the site. As they head back to their academic lives, we will miss their enthusiasm and energy.



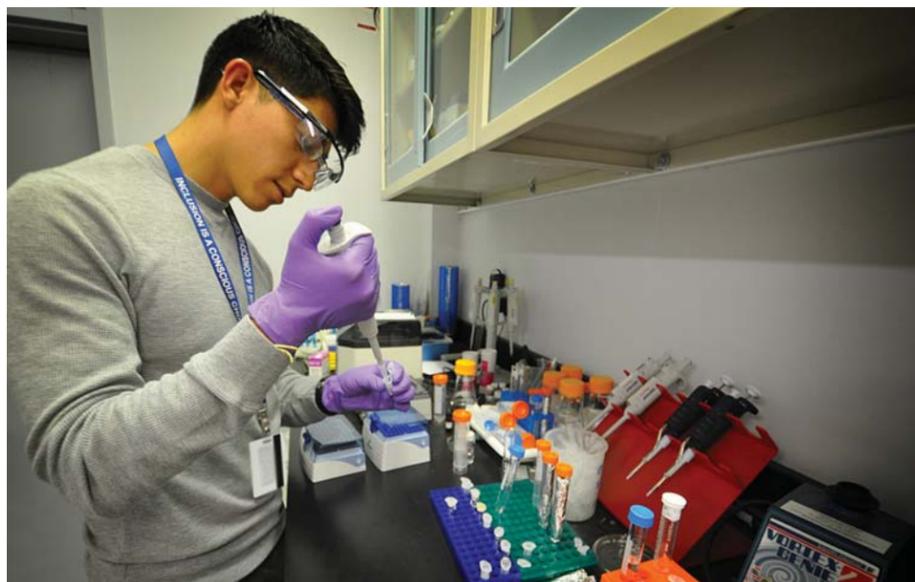
NICK WARD (8965), an intern with the Center for Cyber Defenders, teaches a programming class for high school students at the Cyber Technologies Academy .



Saurabh Hukerikar (left) and Mark Balmana (both 8953), two of Sandia/CA's first foreign national interns, discuss research aimed at increasing fault tolerance in high performance computing environments for the DHARMA (Distributed asynchRous Adaptive Resilient Management of Applications) and LFLR (Local Failure Local Recovery) projects.



Brandon Kusanto (left) and Carmen Gondhalekar (both 8353) discuss next steps for a project to automate complex sample preparation workflow for the Digital Microfluidic Hub.



At the CRF from UC San Diego, Eduardo Valle worked with mentor Carl Hayden (both 8353) to help identify novel drug discovery methods. (Photo by Daniel Strong)



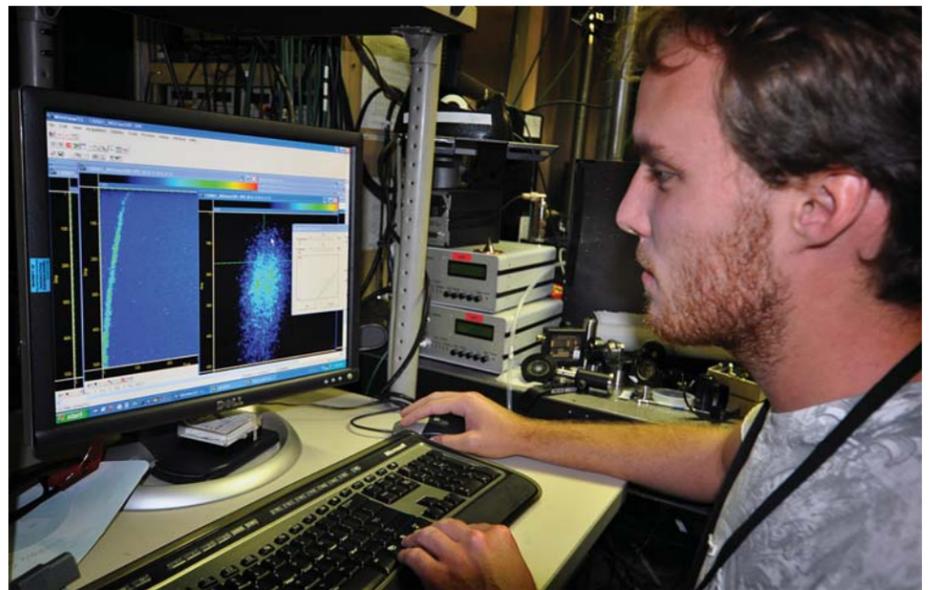
Samira Iqbal, a Las Positas College student working under mentor Ethan Hecht (both 8367), says she loves getting hands-on practice in the lab — in this case, working with a reactor that is used to characterize the oxy-combustion kinetics of pulverized coal under pressure. (Photo by Daniel Strong)



DOE Office of Science Workforce Development for Teachers and Scientists undergraduate interns with their CRF staff mentors: Kathryn Dahlgren (8351), Chuck Mueller (8362), Leonid Sheps (8353), Terry Peng (8351), Raj Kumar (8365), Samira Iqbal (8367), Eduardo Valle (8353), Alexander Delzell (8353), Emmanuel Valenton (8351), Brittany Hagler (8351), Ashley Scully (8353), Christopher Nilsen (8362), Ethan Hecht (8367), and Chris Shaddix (8351). (Photo by Daniel Strong)



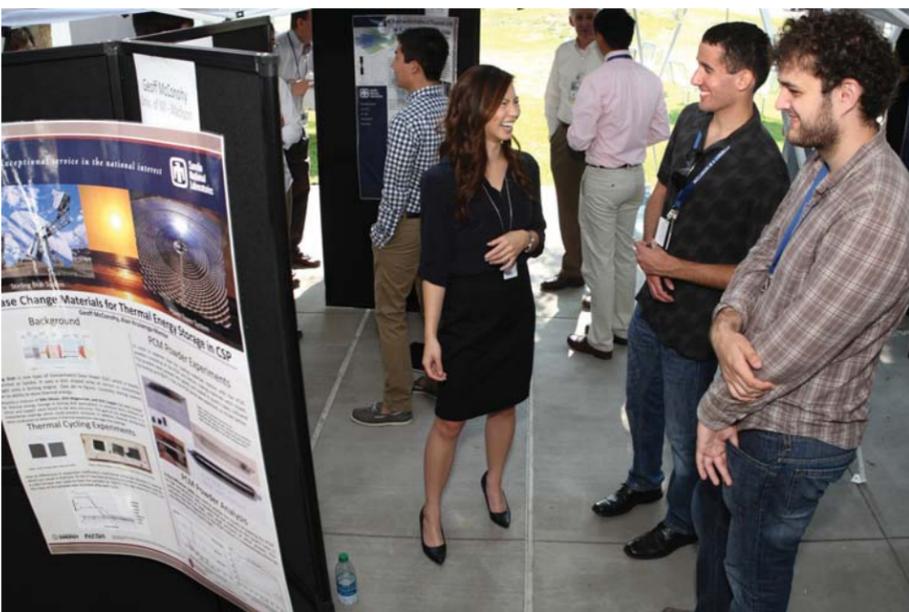
Rachelle Hamblin (left) and Samantha House (both 8623) discuss the growth of bacteria on a Petri dish while preparing for a nucleic acid purification using a 48-plex vacuum manifold.



Alexander Delzell (8353) of Santa Rosa Junior College helps bring online a new camera that will let mentor David Chandler (8300) and his team extract more accurate data from photos of experiments. (Photo by Daniel Strong)



Joseph Falcao (8256) shares his summer project, "Constructing 3D-Printed Models of Failed Tensile Specimens."



Britney Lau (8623) discusses her summer research "Phylogeny of Island Integrases," at the annual intern symposium.



Irakli Zhuzhunashvili (8954), an undergraduate at the University of Colorado Boulder, spent his summer working on a medical radioisotope application for the Technical Reachback project.

Mindfulness – a new approach to safety, security, and well-being

California pilot a success; program to expand to New Mexico later this year

By Patti Koning

One day last year, Gary Shamber (8517) attended two meetings: one on minor accidents and the other on security incidents. Despite the unrelated topics and participants, he noticed a common theme — the root cause of both problems seemed to be inattentiveness.

“The accidents were mostly trips and people bumping into stuff, just not paying attention to what they were doing. And the security incidents happened when people who knew the rules forgot one of the steps,” says Gary. “It struck me that there was a common denominator to both types of incidents: mindfulness, or really, a lack of mindfulness.”

Mindfulness had been on Gary’s mind for some time. A few years ago, he read the book *Mindfulness: An Eight-Week Plan for Finding Peace in a Frantic World* by Mark Williams and Danny Penman. The book is based on Mindfulness-Based Cognitive Therapy (MBCT), a form of daily mindfulness meditation.

“I was mostly intrigued with the title, but I found a lot that resonated with me,” he says. Gary continued reading and learning about mindfulness and made mindful meditation a part of his daily life.

“After I started experiencing some of the results, I thought what better place to apply this than in the workplace? It’s where we spend most of our waking hours and where we all have so much at stake. We can all benefit from increased clarity and concentration.”

He suggested a pilot program to Div. 8000 VP Steve Rottler, who embraced the idea.

“I was enthusiastic about Gary’s suggestion because our pace of work leaves little time to stop and think in a particular moment. He made a convincing case for this being a likely contributing factor in our accident and security incident rates,” says Steve. “We have tried multiple things to lower these rates with only limited, and often temporary, success. It struck me that an emphasis on mindfulness might be a positive way to effect change because it focuses on changing behaviors. Further, the realized benefits would not be limited to just the time we spend at work.”

Well-documented benefits go beyond safety and security

Gary, a practitioner himself, explains that mindfulness is more than just a mindset — it’s a way of relating to the world that increases awareness of the present moment. “It’s a meditative technique that you can develop just like an athletic skill,” he explains. “To realize long-term effects, you do need to practice regularly.”

A great deal of empirical literature and scientific data backs up the claims about the benefits of mindfulness. “Research [Moore & Malinowski, 2009] has consistently found that mindfulness meditation techniques result in positive cognitive, emotional, and neurophysiological changes and that these techniques may influence both attentional performance and cognitive flexibility. There is great potential to leverage these empirical findings in the workforce,” says Glory Emmanuel (1462), a cognitive psychologist in the Cognitive Modeling department.

A number of Silicon Valley companies, including Google, Facebook, and Twitter, offer mindfulness meditation as a way to improve employee satisfaction and productivity. Top-notch universities have opened mindfulness research centers and offer extensive programs to their students, like the UCLA Mindfulness Awareness Research Center.

Technology, in the form of brain imaging, helped bring mindfulness into the mainstream. “For decades, the benefits of mindfulness meditation were mostly anecdotal,” says cognitive scientist Austin Silva (1462). “With advanced brain imaging techniques, we can now see that the brain’s architecture can change with mindfulness meditation [Holzel et al., 2011].”

Gary developed a pilot program with Bill Scheinman, a meditation instructor who teaches mindfulness meditation in the San Francisco Bay Area. A Sandia team of managers and staff, including Glory and Austin, tailored Scheinman’s program to fit the Sandia culture.

Pilot program a success

The pilot Mindfulness-Based Stress Reduction (MBSR) class, held in February and March, included 30 members of the workforce and had a fairly even mix of managers and non-managerial staff. Participants attended a two-hour class each week and were given the option of joining a one-day meditation practice on a Saturday.

The pilot was very successful. The majority of the participants recommended that the program be offered again, and many said they intended to continue a mindfulness practice on their own.

Recognizing the challenge of attending a two-hour class every week for two months, a one-day crash course, “Mindfulness Essentials,” was developed and offered at the California site in July. Nancy Buckley (8531) took that class after realizing her schedule wouldn’t allow her to attend the MBSR course.

Before taking the class, Nancy says she had a misperception about mindfulness meditation. “I thought it was about emptying your mind, and I didn’t want to be in a mindless state,” she says. “But mindfulness is really about being in the present and being in touch with your entire body. You become aware of everything that is going on, your thoughts, your breath, what you feel physically. You don’t react, you are just in the moment.”

Patrice Sanchez (8523), manager of the Logistics/Transports & Assets team for the California site, enrolled in the one-day class to break the cycle of multitasking. “I would find myself multitasking to no end. I wanted to find a way to organize the collection of thoughts in my mind, focus more, and become more productive,” she says. “I learned from the class that by making a conscience effort to ‘think’ about what comes into my mind, I could enjoy, resolve, and appreciate my thoughts. By really being in the present, I’m less stressed and more productive.”

The California site will offer a second nine-week MBSR class in September and October, with a second Mindfulness Essentials class planned for late fall or early winter. The New Mexico site will pilot a nine-week MBSR class and one-day Mindfulness Essentials class this fall.

“If the pilot is a success, we hope to partner with ES&H and Corporate Learning and Professional Development to make mindfulness classes regular offerings,” says Renee Holland (3334), manager of the Healthcare & Support Services group. “A lot of our current offerings incorporate aspects of mindfulness, like Mindful Eating, but these classes will be the first totally devoted to mindfulness meditation.”

As the champion of mindfulness at Sandia, Gary is excited with the possibilities that mindfulness meditation offers the workforce, not only in terms of safety and security but also in the areas of well-being and performance.

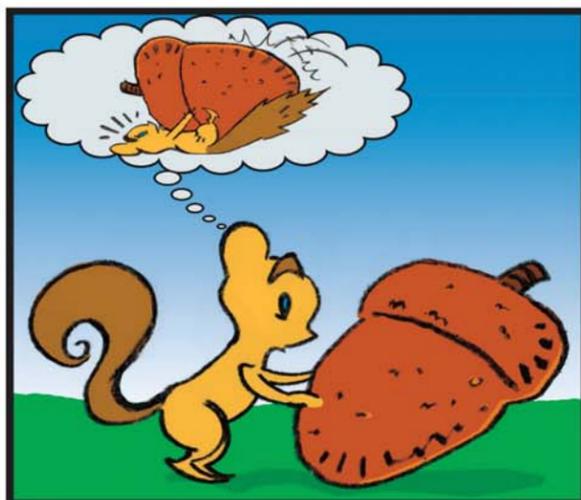
“Truly great things can be realized personally and within the workplace with increased attention to the present moment,” he says. “The present moment is all we really have; it’s where we live our lives. Building a more skillful relationship with the present can be transformational.”



BE HERE NOW — Ken Lee (8252), Kellie Ashton (85271), Emily Rada (85271), Nancy Buckley (8531), and Barbara Walker (8634) immerse themselves into mindfulness meditation during the Mindfulness Essentials class. (Photo by Dino Vournas)

Accidents Hurt. Safety Doesn't.

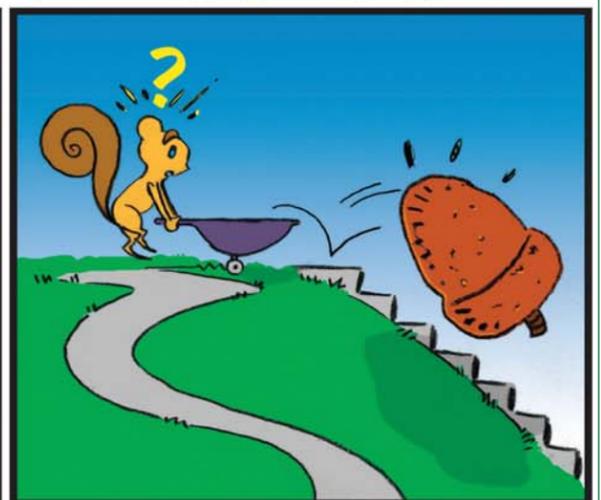
Every Day Safe



What could go wrong?



How can I prevent that?



How can I prepare for the unexpected?

ACME: Climate modeling powered by DOE supercomputers, tamed by uncertainty quantification

By Holly Larsen

Facing increasing evidence of climate change, scientists around the world are working to improve climate modeling, hoping to provide decision-makers solid projections to guide the development of mitigating policies. Khachik Sargsyan (8351) is leading a Sandia effort to strengthen climate models through uncertainty quantification (UQ) for the Accelerated Climate Model for Energy (ACME) program.

The DOE Office of Science recently launched ACME in an effort to integrate different models and ensure that modeling efforts benefit from the enormous computing power of DOE's leadership-class facility computers. This initiative is making extensive use of DOE supercomputers to consolidate several multi-lab projects into a single integrated and enhanced program.

"ACME consolidates a number of previous efforts and focuses on performing ultra-high resolution modeling of fully coupled earth-ocean-atmosphere systems to predict climate change effects out to 2050," says Christopher Shaddix (8351), manager of the Reacting Flow Research group.

Eight national labs are contributing to the effort, with a goal of developing the most accurate climate change predictions yet, as well as investigating key fundamental science questions, such as the interaction of clouds and climate and the role of secondary organic aerosols. In addition to Khachik, Sandians involved include Andrew Salinger (1442), who is providing software engineering expertise, and Mark Taylor (1446). In addition to acting as the project's computational chief scientist, Mark is supporting both the atmospheric modeling task and numerical method development, targeting high-performance computing systems.

Further, ACME research is closely related to the Intergovernmental Panel on Climate Change (IPCC) — a leading international authority on climate change established by the United Nations and World Meteorological Organization in 1988. IPCC distills the latest climate science from around the world to create reports specifically intended for policymakers. As ACME simulation results become available, they will be taken into account by IPCC and will certainly be a part of future IPCC reports.

Quantifying uncertainty to improve model predictions

Another critical DOE objective is to enhance confidence in projections by both calibrating the model against historical observations and properly quantifying prediction uncertainties. UQ is a relatively new sci-

ence — enabled by the improved computational capabilities of the last decade — of quantifying the uncertainties in model inputs and predictions. With support from colleagues Bert Debusschere and Habib Najm (both 8351) and Cosmin Safta (8954), Khachik is leading the largest UQ effort in the ACME program.

Specifically, Khachik will be bounding uncertainties in predictions from land modeling, which focuses on the physical characteristics of vegetation, soil, and other terrestrial features at risk from climate change. To explain how UQ comes into play, Khachik provides a simple example.

"A single simulation of the land model may show that in 100 years, a certain type of vegetation will vanish. With UQ, we can actually quantify how likely it is to happen."

Instead of seeking a single result, UQ explores the range of findings provided by running the model multiple times — each time with different values for key parameters. The range of results can then be plotted, as in the simple graph below. Here, the X axis shows the range of results for the outcome of interest and the Y axis shows the probability density that each of the results might occur (that is, the area under the curve shows the likelihood that the outcome will be within a certain range of results).

"It's quite easy to see that the result 5 is the mostly likely of all the results, but the grey areas under the curve add to the story. They show that there is a 25 percent probability that the true outcome is within the range of results between 4 and 6 and that there is a 25 percent chance that an outcome greater than 10 could occur," says Khachik.

In other words, the graph reveals there is a relatively low chance that the most likely outcome (or an outcome in its neighborhood) will materialize — a common result of UQ, says Khachik. "Graphs like these answer questions about the likeliness of an outcome



UNDERSTANDING CLIMATE — Habib Najm, Bert Debusschere, Khachik Sargsyan (all 8351), and Cosmin Safta (8954) compare observational data with climate land model simulation results in a weekly meeting for the ACME UQ project. (Photo by Dino Vournas)

and quantify associated risks. This information gives policymakers a very different understanding of model results, and hopefully allows them to formulate more effective policy."

This graph is one of the essential outcomes of the so-called forward UQ studies, where the variability in model inputs is propagated toward a range of variability in model outputs. The flip side of the coin is inverse UQ, in which one derives information on model input variability using actual observed historic data.

Bounded by computational costs

Khachik says UQ is needed to assess the confidence in climate simulations — at reasonable cost. "Our research focuses on developing efficient algorithms for making UQ less expensive computationally. Ideally, to get the right answer, you would run the model millions of times with millions of different input parameter settings. But given the size and complexity of climate change models, there simply isn't the budget for that," he says.

Instead, computational scientists employ advanced UQ methods to extract as much information about the model as possible, within a given computational budget. Khachik works closely with the land modeling partners from Oak Ridge National Laboratory (ORNL) to understand which parameters have the most impact on climate model outcomes and how exactly these parameters should be varied. "That way, you can run the model 100 times, rather than millions of times, and still get the answers you need to make reliable projections," he says.

With such limited model evaluations, UQ practitioners can then build a synthetic, surrogate approximation to the full climate model. This surrogate is typically computationally inexpensive to evaluate and replaces the full model with reasonable accuracy.

The UQ methods Khachik and his colleagues develop are notoriously non-intrusive — that is, they do not require programming changes to the original model (in this case, the climate model) that UQ is being applied to. Because of this important feature, UQ methods can be employed in a wide range of applications, from chemistry to materials science to nuclear engineering. It also means that previous efforts in different disciplines can expedite climate modeling UQ.

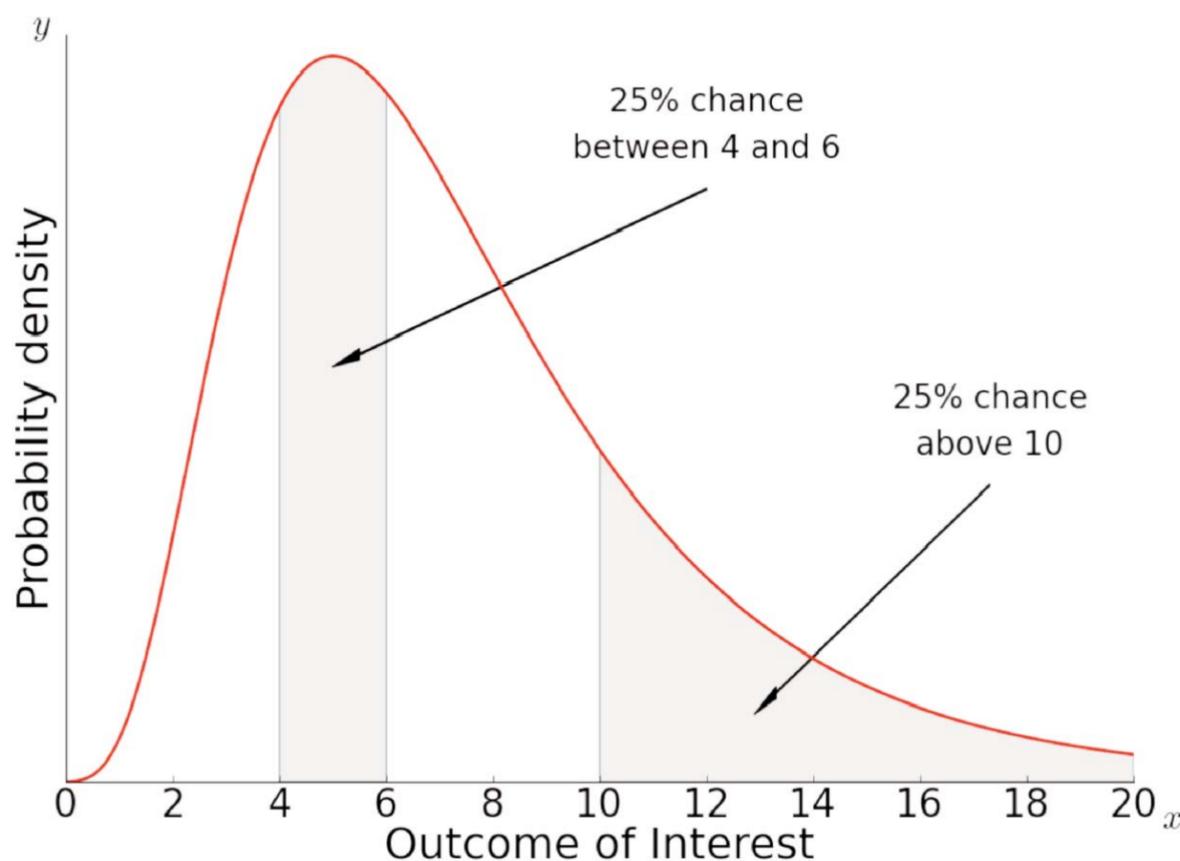
"As we grapple with climate modeling issues, my colleagues and I draw on intuition and formal mathematical machinery from previous UQ studies performed in the context of chemical models that have nothing to do with climate models," notes Khachik.

Building confidence in results

Building trust that the scientific predictions are realistic and not biased by any political or social agenda may be the most important issue in motivating people and governments to take actions to address climate change, notes Christopher.

"Sandia's work in applying UQ to predictions of climate change is critical to establishing this trust. It shows that there is significant uncertainty in these projections, but that the uncertainty is bounded by realistic levels of probability."

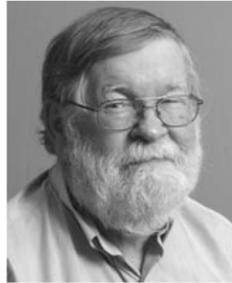
Initial funding for the effort has been provided by DOE's Office of Science.



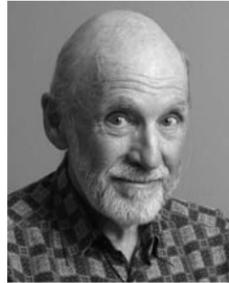
THIS SIMPLIFIED GRAPH reflects a typical uncertainty quantification (UQ) result, revealing that outcome 5 is the mostly likely outcome to occur. The graph also demonstrates that the 25 percent chance of an outcome near 5 is the same as that for an outcome of greater than 10 — defined here as a potentially catastrophic outcome.

Mileposts

New Mexico photos by Michelle Fleming



Robert Biefeld
40 1126



Peter Feibelman
40 1130



Ann Hodges
40 5212



David Sinton
35 4128



Henry Apodaca
30 432



Terry Aselage
30 1800



Thomas Davis
30 5214



Curtis Gibson
30 2627



Christopher Knight
30 4847



Michael Martinez
30 1818



Michael Meade
30 10221



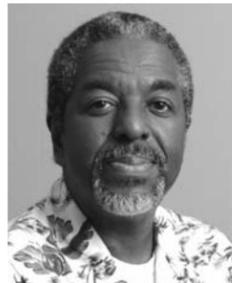
Daniel Summers
30 411



Robert Tachau
30 5753



Cathy Vortolomei
30 9518



Bob Washington
30 4844



Jay Clise
25 9542



Laura Lenberg
25 9324



Mark Martin
25 4255



Chris Mullaney
25 4236



Betsy Parker
25 9524



James Potter
25 1674



Dianne Sanchez
25 10245



Tim Wiseley
25 2994



Dick Grant
20 1819



William Rhodes III
20 6920



Ellan Anderson
15 5562



Jesse Hatcher
15 9517



Robert Hatcher
15 2712



Bernie Jokiel Jr.
15 5953



David Wick
15 7932



Site steps up to support school supply drive for military families



BACKPACK BRIGADE — Karelyn Baker (8210), Heather Egtervanwisserkerke (8511), Mark Cordes (8511), and Rachel Sowell (8200) assess the results of "Operation Backpack," a drive to collect backpacks and school supplies for children of military families at Travis Air Force Base led by the California Weapons Systems Engineering Center (8200). Thanks to Center 8200 along with Sandia veterans, security guards, and other centers at the California site, 46 children will receive brand new backpacks filled with school supplies. Several extra boxes of school supplies are being donated to the school on base and the Fisher House Foundation. (Photo by Dino Vournas)

Sandia Classified Ads Sandia Classified Ads Sandia Classified Ads Sandia Classified Ads

MISCELLANEOUS

TIRES, 2, used, 7.5X16, 8-ply, \$15 ea. Bentz, 857-0728.

LANDSCAPING ROCKS, small assortment, med. to large, you pick up, free. Smith, 440-9835, xsandysmith@gmail.com.

KITCHEN HUTCH, small, w/glass top, \$100; tall hutch, oak, for small space, \$50; folding table, antique, \$150; desk, \$30. Willis, 304-5034.

PLAYSTATION GAMES, 20, Thrillville, Shrek, Harry Potter, Ice Age, Madden, NASCAR, BMX, more. Dotson, 850-2939.

ALABAMA ALL AMERICAN TOUR TICKETS, 2, Sandia Casino Amphitheater, Friday, Sept. 12, originally \$160, will sell for \$100/ticket. Lehman, 294-5921.

RECLINER, dark blue, excellent condition, \$100 OBO; coffee table, 2-sided drop leaf, oak, \$75 OBO. Hussong, 505-332-3523.

HIGH BUNK BED, \$150; Looney-Tune golf bag, \$50; Bose speakers, \$100; barstools, 3, \$300; hanging lights, 3, \$30. Mehler, 266-6887.

BAND SAW; baker's rack; recliner; 2 patio rocking chairs; lawn mower; call for prices. Herrera, 833-5035.

DINNERWARE, Pier 1, elegant white, brand new w/tags, 12-place settings available, \$250. Burnett, 379-8066.

C4 CORVETTE TARGA TOP, removable, clear smoke color, \$1,200 new, asking \$450. Hoke, 292-4823.

SWING SET, seats 2, (not a child's swing) w/canopy, dark green, unassembled, \$120. Lewis, 323-7268.

MOVING BOXES, mostly U-Haul, extra-large, large, photo frame & lamp boxes, etc., w/white paper, \$70. Wyse, 266-6887.

TABLE, rectangular, light/med. golden brown, excellent condition, photos available, \$125. de la Fe, 903-0717.

STUDENT DESK, oak, w/oak chair, 4 drawers, 48" x 29" x 17", \$90. Sleaf, 281-4103.

DRILL PRESS, Clausing model 1670, variable speed, 3/4-hp, \$750 OBO. Laiche, 505-710-6106.

UPRIGHT FREEZER, Kenmore, 13.7-cu. ft., white, call for more info. Chavez, 864-8245, ask for Linda.

INFLATABLE KAYAK, w/extras, \$120; infl. row boat, \$40; 6' x 12', patio/RV mat, blue/beige, \$35; Forman outdoor portable gas grill, \$45. Fromm-Lewis, 220-5772.

NEW MEXICO MAGAZINE, 10 yrs., from 2003-2012, all but 4 issues, free. Pechewlys, 505-463-6767, call or text.

PING PONG TABLE, accommodates 1+ player(s), good condition, \$75 OBO; BOSU exercise ball w/video, \$40. Montoya, 342-0043.

NORDICTRACK ACHIEVER, almost used, \$200. Sanford, 856-8259.

OUTDOOR DINING SET, cast aluminum, \$300; dinnerware, hand-painted, Talavera, 6 settings, \$300; Noritake, 12 settings, \$300. Allen, 505-856-7891.

2014 FAMILY DAY CAR, TRUCK, MOTORCYCLE SHOW, Saturday, Sept. 20, 9 a.m.-3 p.m. Torres, 505-294-7273, ask for Mike.

VACATION GETAWAY, last change before the end of summer, Wyndham, \$200/night, \$1,000/wk. Garcia, 280-5815.

PIANO, Rudolph Wurlitzer spinet, w/matching bench, warm honey tone, purchased in 1982, good condition, will deliver, \$400 OBO. Cincotta, 505-306-4188.

FURNITURE: pine dresser, \$50; secretary, \$75; computer desks, 2, \$75 ea. Ethan Allen table, \$100; assorted chairs. Cordwell, 299-5026.

TRANSPORTATION

'94 4RUNNER, 5-spd. manual, great daily driver, off road, substantive new parts, pass emissions, 192K miles, \$4,000. Wolfgang, 414-1483.

How to submit classified ads
DEADLINE: Friday noon before week of publication unless changed by holiday. Submit by one of these methods:
 • EMAIL: Michelle Fleming (classads@sandia.gov)
 • FAX: 844-0645
 • MAIL: MS 1468 (Dept. 3651)
 • INTERNAL WEB: On internal web homepage, click on News Center, then on Lab News link, and then on the very top of Lab News homepage "Submit a Classified Ad." If you have questions, call Michelle at 844-4902. Because of space constraints, ads will be printed on a first-come basis.

Ad rules

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

'96 CHEVY SUBURBAN 1500, 4WD, good tires, 126K miles, runs great, \$4,000 or interesting trades considered. Weisensel, 505-366-8127.

RECREATION

'07 PIAGGIO/VESPA BV250 scooter, 6K miles, like new, \$550 in extras, 67 mpg, \$2,750. Colborg, 505-604-4915.

'12 FOREST RIVER TRAVEL TRAILER, Flagstaff V-Lite, 30WRKSS, 2 slides, 1-1/2 baths, extras, mint condition, \$22,000 OBO. Sandoval, 269-6650.

'08 HONDA GOLDWING, maroon, new tires, garaged, 16.7K miles, excellent condition, \$16,500. Kirkpatrick, 238-2288.

GO-KART, for child, gas powered, Road Rat Racer XK, www.road-ratmotors.com, \$200 OBO. Mirate, 286-2664.

'13 ZERO S ZF11.4 elec. motorcycle, up to 137 mile range, 95-mpg top speed, \$13K OBO. Delhotal, 505-659-1492.

MOUNTAIN BIKE, Santa Cruz Blur classic, full suspension, XT group, Avid disc brakes, 120 mm Marzocchi fork, \$800. Rector, 252-8799.

'11 COLEMAN ULTRA-LITE 289RL TRAVEL TRAILER, ducted AC/heat, power awning, slide out, excellent condition, \$18,800 OBO. Barrera, 505-249-9113, ask for Anthony.

REAL ESTATE

4-BDR. HOME, 2 baths, 2,425-sq. ft., 3-car garage, pitched roof, refrigerated air, close to Academy. Martin, 828-1247.

4-BDR. HOME FOR RENT, 3 baths, north Four Hills, http://goo.gl/PwAJtx, going on assignment for Sandia, \$1,400/mo. Kucera, 402-212-9690.

4-BDR. HOME, 3 baths, 4,280-sq. ft., Four Hills, wooded lot, pool, full walkout basement, \$439,900. Ramos, 505-220-5201.

4-BDR. HOME, 3-1/2 baths, 2,086-sq. ft., built 2007, beautifully maintained/landscaped, Volterra, minutes to KAFB, MLS#816122, \$250,000. Pena, 505-206-2701.

4-BDR. HOME, 3 baths, 2,521-sq. ft., new kitchen & carpet, LaCueva district, move-in ready, MLS#819530, \$364,900. Clark, 890-8108.

3-BDR. HOME, 2 baths, 1,323-sq. ft., 2-car garage, .53 fenced acres, new carpet/tile, quiet neighborhood, 25-min. commute, MLS#813765, \$154,900. Carnes, 385-0013.

3-BDR. TOWNHOUSE, 2 baths, 2-car garage, 1,611-sq. ft., NE Heights, private backyard, close to conveniences, MLS#822051, \$222,000. Gianoulakis, 505-514-6441.

4-BDR. HOME, 2 baths, 1,900-sq. ft., dining room, basement, 332 Texas NE, 5 mins. to base, \$124,750. Tafoya, 298-6208.

4-BDR. HOME, 2-1/2 baths, 2,777-sq. ft., formal living & dining, family room, loft, 2-story, enclosed hot tub, back & side yard access, will consider REC, MLS#806686, \$215,000. Maestas, 505-459-7650.

WANTED

CAPTAIN BEDS, for young boys, need two. Lovato, 836-3517.

SMALL USED CAR, Mazda 2, Kia Rio, Hyundai Accent, Nissan Versa, etc. w/remaining warranty, <\$10,000. Haase, 433-3979.

FEMALE HOUSEMATE, share 3-bdr. home, 2 baths, near Wyoming & Indian School, available immediately. Skaggs, 505-681-5585.

CELLO, for 6th grader starting orchestra, Dad couldn't convince her to play his violin. Lifke, 382-9448.

KIND WOMAN, living near Cleveland high school, to host 14-yr. old daughter after school. Passell, 505-550-5752.

LOST AND FOUND

FOUND: at 404 San Mateo NE, Sandia "challenge coin", Integrated Technologies & Systems, describe to claim. Vargo, 844-9253.

Adventures of an international security analyst

(Continued from page 12)

countering terrorism, so this delegation was sent to learn about what they did."



CAPTURING ANACONDAS — While waiting for a guide to take him into Yanomami tribal territory, Gary helped a researcher in Venezuela capture anacondas for a study of the species.

Gary was chosen for his terrorism knowledge, gained through Sandia's use control efforts, which seek to prevent the wrong people from obtaining nuclear weapons.

The delegates had unprecedented access to experts throughout Israel. "It was incredible. We met with about 40 people from various organizations, including top government officials. They were very open and shared with us extensively."

The delegation was even allowed to visit sites of very recent terrorist attacks to witness the response firsthand. "The Israelis had perspectives about counterterrorism, specialized techniques, and unique experiences that were nothing less than revelations to me."

The real lesson, says Gary, was that America had much to learn from this tiny country. "For me, it was a lesson in humility. I thought I was very knowledgeable about terrorism, but I returned with many new ideas."

Gary shared these ideas with agencies throughout the US government and in every NATO country. "You would not be able to make a direct tie between the trip to Israel and current US counterterrorism strategies. But it definitely has had an impact on the overall thinking."



TIGER TIGER — Gary went on a quest in the Bangladesh Sundarbans Wildlife Sanctuary to photograph Bengal tigers.

Retired and ready to go

Gary's decision to retire was primarily based on his desire to make the world a better place. "Even with vacations, I didn't have enough time to travel and do volunteer work." Gary is considering several possibilities, such as establishing and improving orphanages and teaching other countries techniques for clearing land mines. In the meantime, he is busy balancing personal travel and finishing work on a high-profile terrorism case with the Department of Justice.

Gary plans to fulfill a lifelong goal of traveling to every country recognized by the United Nations. He has visited 114 countries so far and is open to traveling anywhere — provided the risks are accounted for.

"In the truly dangerous places, you have to assess the risks and mitigate them, and the US government is really, really good at this. So in fact, there's no place on the entire planet I would not go — provided I had the support and weight of the government behind me."

Adventure! Travel! Sandia!

The exploits of an international security analyst



DRIVING THROUGH LAOS — On a trip to Laos, Gary walked lengths of the Ho Chi Minh trail and saw displays of US ground sensors that had been deployed there to locate Viet Cong troops during the Vietnam War.

By Holly Larsen

Two weeks in a secret underground bunker. Several months in a Siberian office that was bombed by disgruntled locals. Observation trips to sites in Israel mere hours after terrorist attacks.

Assignments in these and other exotic locales enticed Gary Richter, a recently retired international security analyst, to stay at Sandia for more than three decades. “You can work anywhere and make as much money as you want, but few career choices provide as much opportunity as Sandia,” Gary says.

Gary’s Sandia career began with a change of heart about six months before finishing his PhD in theoretical physics at the University of Texas at Austin. “I suddenly decided I wanted to get out of academia. And then a sort of panic set in. If not academia, what? So I



NOT YOUR ORDINARY HIKING TRIP — Gary spent time in the Atlas Mountains, which extend through Algeria, Morocco, and Tunisia, while studying Islam in Northern Africa.

started interviewing with any company that was hiring physicists.”

One of those places was Sandia. “I knew absolutely nothing about Sandia, but when I came out of my first interview, I realized Sandia actually did interesting stuff. What really appealed to me is that they worked on projects that were almost headline news — the hot-button issues of the day.”

In 1983, Gary entered Sandia’s Systems Analysis group, staying there for his entire career. But this longevity belies a lifelong love of travel and addiction to adventure that Gary attributes to a childhood of perusing back issues of *National Geographic*. Fortunately, only a few years into his career, Gary walked past his manager’s office at exactly the right moment — reaping his first interesting travel opportunity.

Packing for the apocalypse

“The mission involved participating in a large program to ensure the continuity of the US government in the event of global nuclear war,” says Gary. The game plan was to hide representatives from all branches of the federal government in secret nuclear-hardened bunkers at various locations. “The hope was that one or more teams would survive to rebuild and govern America.”

Realizing that the bunkers would need experts in nuclear radiation, the government turned to the NNSA labs. “Just when my manager was mulling over who to send, he caught sight of me and called me into his office. ‘Richter, you have just volunteered to represent Sandia on a new assignment.’”

That day changed Gary’s life. He was assigned to a huge underground bunker complex in a secret location. “For years, I kept a bag packed and was ready to leave home at a moment’s notice, without telling anyone where I was going.”

Shorter drills lasted a week. “But every once in a while, we had a major drill — manning the underground city for a month in two-week shifts. We practiced going in, running everything, monitoring above-ground sensors — even trying to figure out what was left of the United States.”

The project has been shut down, and one of its major sites — a giant concrete box nestled into a hillside in White Sulphur Springs, W.Va., has been opened to tourists. But the project lives on for its participants. “It was surreal. Imagining you might be one of the few people to survive a major nuclear disaster — it was truly the stuff of science fiction.”

A cold end to the cold war

Gary stumbled upon his next excellent adventure by reading the *Lab News*. “‘Wanted: Volunteers to work in Russia on a new nuclear arms control agreement.’ Unbelievable! But there it was, right between some of the most boring want ads in history. Wanted! Russia! Nukes! I was electrified.”

The government was recruiting nuclear experts to live in Siberia while overseeing parts of NNSA’s Highly Enriched Uranium (HEU) Transparency Program, which is monitoring the conversion of 500 metric tons of Russian HEU — enough material for 20,000 nuclear weapons — into low-enriched uranium for US power generation.

Riveted by a chance to experience Siberia while working on a project critical to world affairs, Gary signed up. The early interviews, which focused on the potential hardships and certain danger, fed Gary’s sense of adventure. “I wanted this assignment more than anything I had ever wanted in my life.”

For about two years — as the project’s safety details were worked out — Gary stayed enthusiastic. He was vaccinated, studied Russian, and even volunteered to live in a tent when no housing could be found. After endless delays, Gary received the call. “They suddenly wanted to leave almost immediately and spend eight weeks in Siberia with three other volunteers to get the whole thing started.”

Gary was thrilled, except for one problem. He was about to leave on a dream vacation: trekking across the jungle for several weeks and living off what he could carry, catch, or scavenge. Fortunately, a compromise — flying straight from the jungle to Siberia — meant Gary could have it all. “By that time, the aura of the whole assignment had been built up to a point where I felt like an astronaut going into outer space,” says Gary.

The hardships were real. “There was no potable water in the beginning. We filled bottles from streams flowing outside the world’s largest uranium-processing facility. There were no means to communicate back to the States; we carried one of the very bulky early-model satellite phones. We went in December, which meant only a couple hours of dim sunlight per day.”

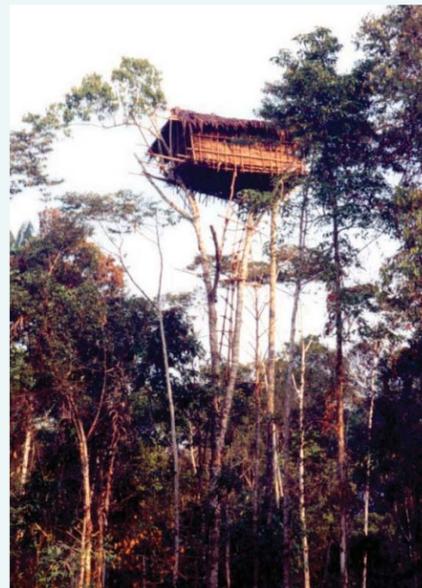
Nonetheless, Gary relished living on and off in Siberia for the next four to five years. “It was the most interesting work in every sense of the word. It was professionally rewarding. We were responsible for removing thousands of weapons from the Russian arsenal.” He also found the culture clash fascinating — even when it culminated in a bomb detonation outside one of the

American offices. “It [the bomb] did a lot of damage, but fortunately, we were all out at the time, so no one got hurt.”

Learning from a tiny country

Shortly after 9/11, Gary was sent with a small US delegation to study counterterrorism in Israel. “Americans believed that the Israelis were the world’s experts in

(Continued on page 11)



THE HIGH LIFE — This treehouse was home for two weeks during a first contact trip to a Korowai village deep in West Irian Jaya (now West Papua Province) in Indonesia.



JUNGLE TRAINING — Gary trains in the jungle to prepare for one of his riskier adventures.