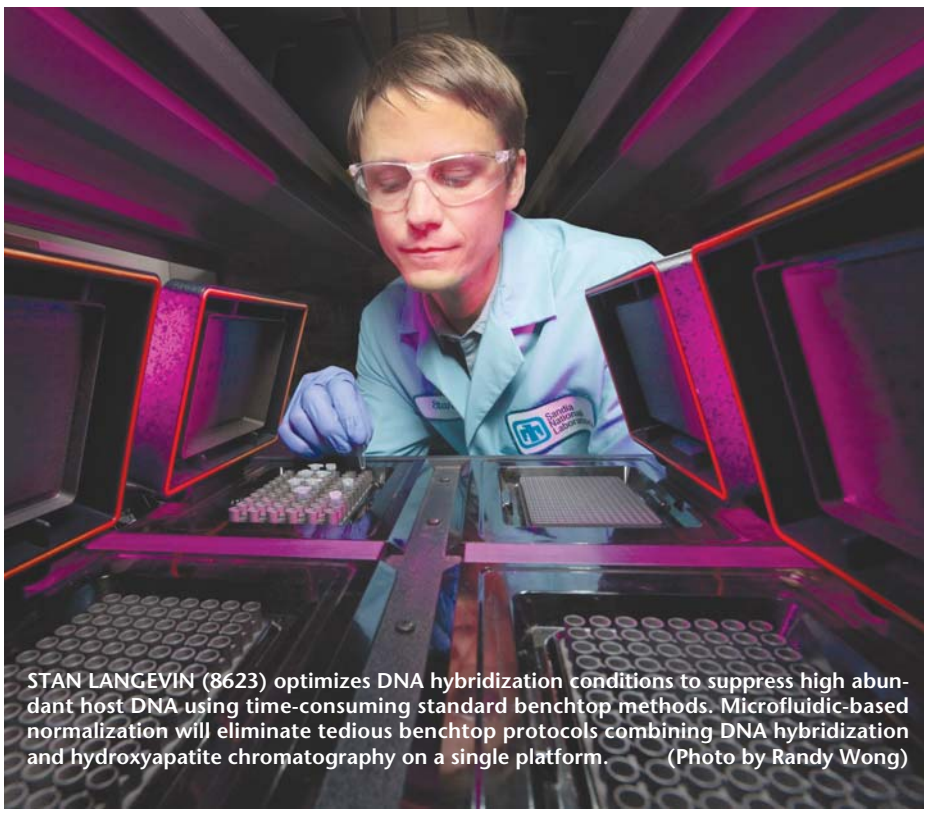
RapTOR seeks to quantify 'unknown unknowns'



STAN LANGEVIN (8623) optimizes DNA hybridization conditions to suppress high abundant host DNA using time-consuming standard benchtop methods. Microfluidic-based normalization will eliminate tedious benchtop protocols combining DNA hybridization and hydroxyapatite chromatography on a single platform. (Photo by Randy Wong)

By Patti Koning

The world of bioterrorism is filled with scary stuff — anthrax, smallpox, and ricin, to name a few pathogens. And those are just the agents we know about. There is also a whole other realm of "unknown unknowns," lethal agents that could be weaponized from ordinary viruses or disguised to look harmless.

USING PATHOGEN DETECTION and characterization technologies developed under the RapTOR Grand Challenge, Sandia researchers will study algal pond collapse, a phenomenon that stands as a major roadblock to widespread use of algae in biofuel applications. See **page 4.**

The RapTOR (Rapid Threat Organism Recognition) Grand Challenge seeks to solve the "unknown unknowns" problem by developing a tool to rapidly characterize a biological organism with no pre-existing knowledge.

"We've been thinking about this threat space for years," says Todd Lane (8623), the project's principal investigator. "Taking advantage of rapidly evolving molecular biology technology and the advent of ultra-high-throughput DNA sequencing, we are re-engineering time-intensive benchtop methods to be faster, easier, and automated."

Todd divides the biological threat spectrum into three categories: traditional agents such as anthrax; enhanced agents that have been genetically manipulated for increased virulence, drug resistance, or to evade detection; and advanced agents — the unknown unknowns. "An advanced agent could start with a benign organism that we'd have no interest in from a national security perspective and manipulate it into a virulent pathogen that is difficult to detect with current systems," he says.

Unlike known threats such as anthrax or smallpox, detection of an advanced agent would only occur when people begin showing symptoms. Every day that treatment is

(Continued on page 4)

Workforce Appreciation Day

Earlier this month, about 250 members of the workforce and their families gathered at the Robert Livermore Community Center for the third annual Sandia/California Workforce Appreciation Day. Story and photos on **page 6.**

California Sandia LabNews

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Sandia National Laboratories

DHS/S&T, Sandia developing new technical capability for emergency exercises

By Mike Janes

The Department of Homeland Security's Science and Technology Directorate (DHS/S&T), working with researchers at Sandia, is developing a new software architecture that will help emergency incident planners and responders from around the country more effectively use and integrate advanced simulation models.

The software package, known as the Standard Unified Modeling, Mapping & Integration Toolkit (SUMMIT), will help a range of exercise professionals from the federal, regional, and local levels tap into existing models to ensure consistency, accuracy, and robustness when exercise scenarios are developed and played out. Work on SUMMIT is the central focus of the DHS-directed Integrated Modeling, Mapping, and Simulation (IMMS) project, now in its second year.

SUMMIT is not a new modeling or simulation tool, but rather is meant to take advantage of the significant investments that DHS and others have made through-

(Continued on page 5)

Sandia CaliforniaNews

IT'S BECOME an August tradition. For the fourth consecutive year, this special edition of the *Lab News* is dedicated largely to the work being done today at Sandia/California. The issue's guest editors are Mike Janes and Patti Koning (above). (Photo by Randy Wong)

Tritium thermoelectric generator prototype nears completion

By Patti Koning

Early last year, the tritium thermoelectric generator (TTG) was a concept that existed only on paper. Over the last 16 months, a cross-divisional team has been working to deliver an initial prototype by the end of the fiscal year. This project, funded by NNSA, is being led by Power Sources Component Development Dept. 2547 and includes staff from multiple departments in New Mexico and California.

"Recognizing that this could be a very critical component and have a significant impact on future nuclear weapon designs, this project brought together nuclear weapons engineers, materials scientists, and Sandia's modeling and simulation capabilities," says Terry Johnson (8365). "Early on, we also began working with the Kansas City Plant, which potentially will manufacture the part, and Savannah River, which would load the tritium, to ensure an efficient design process."

The TTG emits a low but steady level of electricity to provide a long-term, unmaintained power source for small electronics. Potential applications include nuclear weapons, as well as satellites, space probes, and unmanned remote devices.

ALF MORALES measures the electrical transport across a thermoelectric sample. This data is used as input for engineering and aging models used to validate the design of the tritium thermoelectric generator. (Photo by Dino Vournas)

The TTG design integrates several new technologies. These include a new tritium-based heat source (led by Andy Shugard, 8224), a new thermoelectric module (led by Dan Wesolowski, 2547), a highly efficient thermal management design (led by Terry), and power management electronics (led by Phil Zablocki, 8226). The thermal management design uses a number of techniques to minimize heat loss: vacuum insulation, a low-emissivity gold-electroplated coating, radiation heat shields, and titanium spokes to mount the heat source. Significant science and engineering hurdles were overcome to achieve these advancements.

To use vacuum as insulation, the entire thermoelectric module has to be vacuum-compatible. "That's a pretty significant challenge because the device has to stand alone. You can't pump on it to create the vacuum," explains

(Continued on page 5)

Inside . . .

That's that

By Rick Stulen, Div. 8000 VP

In last year's "all-California" edition of *Lab News*, I discussed my intent to engage more with the Golden State's congressional delegation, the importance of community and civic outreach, and a host of other long- and short-term goals designed to help support the Laboratory's mission in nuclear weapons and broader national security. While the challenges of leading Div. 8000 continue to be substantial, I'm happy to report on some early successes that have Sandia's California site on the right path.

RICK STULEN

One of the most exciting developments continues to be progress on the Livermore Valley Open Campus (LVOC), which you'll read about in this edition of *Lab News*. The LVOC will offer the Labs a streamlined approach to engage with the international science community, and will also provide a pipeline for the next-generation workforce into all our key mission areas (both classified and open).

Regarding government outreach, we've taken demonstrable steps to more effectively leverage Sandia's California presence by building lasting relationships with the California congressional delegation.

In December, we built upon the success of Sandia's 60th anniversary events in New Mexico and Washington, D.C., by hosting some 50 regional VIPs, including eight congressional staffers, the governor's staff, several state legislative employees, county officials, local mayors, city council members, and others here in California. This was both a reminder of the support this community has for our mission, as well as an opportunity to educate our elected officials about our history and current national security responsibilities.

Many offices have requested follow-up briefings. Most importantly, we have become a trusted, unbiased resource for our legislative delegations.

We've hosted or met with many California congressional staffers, including people in the offices of Speaker Nancy Pelosi, Sens. Dianne Feinstein and Barbara Boxer, congressmen John Garamendi, Jerry McNerney, and more. We've also met with numerous California state officials, ranging from state legislators to the California Energy Commission. For each of these offices, we have been honored to become an ongoing source of analysis and information to assist with state and federal policymaking decisions.

Our relationship with the Livermore community gets stronger every day. The initiative known as iGATE (the state innovation hub awarded to Livermore by the State of California), for instance, is a direct result of a partnership between Sandia/California and the city of Livermore, with a number of other local collaborators.

Likewise, momentum continues to build with the LVOC, the success of which, like iGATE, will ultimately depend on partnerships we forge with industry players, academia, and other scientific institutions. With strong existing ties to organizations such as Las Positas Community College, General Motors Co., and our neighboring national laboratories, we've got an excellent head start.

Education continues to be the focal point of our local community activism, particularly with K-12 schools. This past year, we conducted Family Science Night events at some 26 elementary schools, up from just four in 2004, and we've now reached roughly 35,000 students over the years and continue to help foster an interest in science with local elementary school-aged children.

This year, Sandia/California hosted its 19th consecutive high school regional DOE Science Bowl competition and the 5th consecutive one for middle schools.

Since 2008, we have recognized exemplary teachers from the Livermore Valley Joint Unified School District for their work in science, engineering, mathematics, and technology education. Each year we present a $500 Excellence in Teaching Award to three deserving teachers.

By "sharing the science of Sandia," our vision and passion is to use our science, technology, engineering, and math resources to be an active part of the solution with science literacy and education. The ultimate goal, of course, is to strengthen our nation's science workforce into the future.

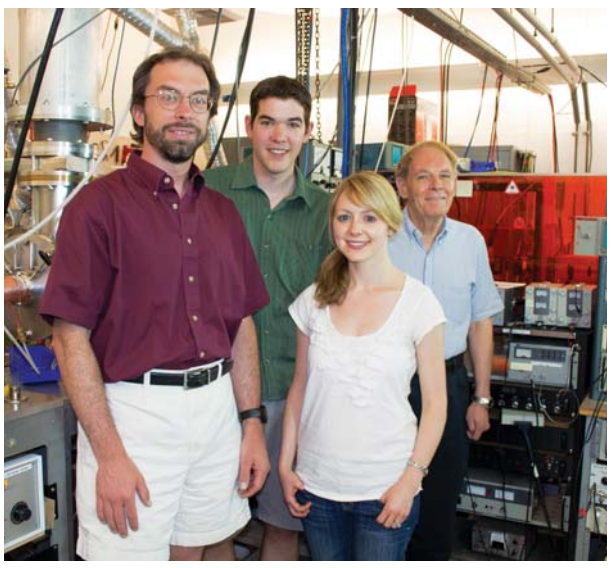
Sandia/California's outreach to government, industry, the community, and our schools is important in and of itself. But it is worth repeating that those activities are primarily designed to support and enhance the Laboratory's broader technical mission.

This special edition of *Lab News* offers insight into the important work taking place at Sandia/California to support our Strategic Management Units and national security mission, and it includes stories on pathogen detection research, the tritium thermoelectric generator, the integrated modeling, mapping, and simulation (IMMS) project, our ongoing partnership with General Motors, and several human interest stories that depict the people and flavor of Sandia/California. Enjoy!

— Rick Stulen, Div. 8000 VP and California Laboratory Director

CRF's David Osborn concludes four-month JILA assignment

David Osborn (8353), a physical chemist in Sandia/California's Combustion Research Facility (CRF), is completing a four-month appointment as a Visiting Fellow at JILA, a joint institute of the University of Colorado, Boulder, and the National Institute of Standards and Technology (NIST). David began the fellowship in April and returns to Sandia in early September.



PAUSING FOR A MOMENT from their work at the JILA laboratory in Boulder, Colo., are, from left, David Osborn (8353), Scott Wren, Kristen Vogelhuber, and Carl Lineberger. David is wrapping up a four-month appointment as a visiting fellow at JILA, one of the nation's most highly regarded research institutes in the physical sciences.

JILA was founded in 1962 as a joint institute of CU-Boulder and NIST-Boulder. JILA is located at the base of the Rocky Mountains on the CU-Boulder campus in the Duane Physics complex. The facility brings together scientists in chemical physics, quantum physics, biophysics, frequency metrology, cutting-edge laser development, and astrophysics. David's CRF colleague, Craig Taatjes (8353), previously served as a JILA Fellow in late 2004.

Expanding formidable talents

"David's appointment as a visiting fellow at JILA provides him the opportunity to expand his already formidable experimental talents by working at one of the leading institutes in the world in laser spectroscopy and chemical physics," says Andy McIlroy (8350), senior manager of chemical sciences at the CRF. "I expect that he will return from JILA with new skills and ideas that will enable our combustion chemistry program to maintain its position at the cutting edge of the field."

At the CRF, David studies the kinetics and mechanisms of chemical reactions in the gas phase through a variety of highly multiplexed techniques he has developed.

During his JILA fellowship, David has been working with JILA Fellow W. Carl Lineberger to investigate the vibrational and electronic structure of the elusive propargylene biradical (HCCCH). A 2005 paper by CRF scientists showed that propargylene is the dominant isomer of C3H2 in many hydrocarbon flames, and may be a precursor to soot formation. In addition to combustion, there is great interest in isomers of C3H2 in interstellar chemistry, where the cyclic isomer of this species, known as cyclopropenylidene, is the most abundant cyclic hydrocarbon known. Propargylene can rearrange to form cycloprenylidene.

David also has been exploring frequency comb spectroscopy with JILA Fellow Jun Ye. A frequency comb laser, for which JILA Fellow John Hall received the Nobel Prize in 2005, provides the equivalent of tens of thousands of single-frequency lasers evenly spaced in frequency (like the teeth of a comb). They hold great promise as a new approach for time-resolved studies of chemical reactions, complementary to the techniques David has developed at Sandia.

Sandia LabNews

Sandia National Laboratories

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Retiree deaths

Frank Koletar (age 92) . . . . . May 14
Joan E. Hodges (93) . . . . . June 1
Bruno D. Navalesi (86) . . . . . June 9
Gerald Stuart Roudabush (56) . . . . . July 10
Nicholas S. Perea (85) . . . . . July 19
Irving Auerbach (91) . . . . . July 21
Gilbert Ramirez (82) . . . . . July 23
Joseph Lawrence Torres (59) . . . . . July 25
Mary F. Baca (65) . . . . . July 30
Gene Harold Romero (90) . . . . . July 31
Robert C. Colgan (80) . . . . . Aug. 1

New Labs Director Paul Hommert tells business community about priorities: Nuclear weapons work, managing diverse Labs

MAKING HIS POINT — Sandia Labs Director Paul Hommert discusses Sandia's priorities during a luncheon meeting of the Greater Albuquerque Chamber of Commerce. (Photos by Randy Montoya)

By Heather Clark

Sandia's nuclear weapons work and effective management of a laboratory that is growing increasingly diverse and answers to a variety of customers are priorities over the next five years to a decade, Sandia President and Labs Director Paul Hommert told the Albuquerque area's business community.

Paul told hundreds of Greater Albuquerque Chamber of Commerce members and guests at an Aug. 10 luncheon that Sandia also expects a net gain of about 300 employees this year. The Labs hopes to hire 700 new employees, and expects about 400 people to end their employment through retirement or other transitions.

Paul called nuclear weapons work the "core of our mission responsibility." He said a national focus on reducing nuclear weapons while maintaining the safety, security, and effectiveness of the deterrent has put Sandia "square in the sights of the national enterprise because we will be the predominant mission activity in terms of some of this life extension work on the stockpile."

New tools in computing and basic science must be used to more rapidly and more effectively support the stockpile in the future, he said.

"Those innovations and that ability to turn product out even quicker is a great challenge. This is also a tremendous attractor to new talent at the Laboratories because there is a lot of innovation opportunity that is here," he said.

Paul described Sandia as having moved from its historical infrastructure supporting only nuclear weapons work to becoming a multimission laboratory that works on a diversity of research areas, including energy, defense, antiterrorism, nonproliferation, and cybersecurity.

Paul said now that 60 percent of Sandia's work falls outside its historical nuclear weapons mission, the Labs needs to focus on managing how it invests in new buildings, new capabilities and science. Sandia also will focus on its operational management, including safety, security and environmental responsibilities, he said.

"Five years from now, I'd like anyone to come to our laboratory and say — in terms of a national laboratory that operates in the national security space like we have to — they're seeing a laboratory that's a paradigm of efficiency, of effectiveness, of interactions with its community and with the national organizations at the highest levels possible," he said. "I think we do an exceptional job of that today, but the bar just keeps getting raised higher."

In response to a question from the audience, Paul said Sandia could be doing more nuclear power work in the future. Since the 1970s, the Labs' work in this area has included risk assessment, small reactors that would reduce capital costs, and research on nuclear waste repositories.

"In our role of trying to reduce technological impediments (to nuclear power) and let others work out the policy and economic framework, we see a number of ways for somewhat of a renaissance of our work in this area," he said. "It's active and we think it should be more active going forward."

Sandia NewMexicoNews

Labs leaders, NNSA officials, elected leaders launch new Ion Beam Laboratory

Photo by Darrick Hurst

Sen. Jeff Bingaman, fourth from left, Rep. Martin Heinrich, fourth from right, and Albuquerque Mayor Richard Berry joined Labs and NNSA officials last week to mark the opening of Sandia's newest research facility, the state-of-the-art Ion Beam laboratory (IBL). Pictured from the left are Berry; Sandia President and Labs Director Paul Hommert; Div. 1000 VP and Chief Technology Officer Steve Rottler; Bingaman; Executive VP and Deputy Labs Director for National Security Programs Jerry McDowell; IBL lab director Barney Doyle; Div. 4000 VP Mike Hazen; Heinrich; NNSA HQ Assistant Deputy Administrator for Infrastructure and Construction Michael Thompson; NNSA Sandia Site Office acting Deputy Manager Mike McFadden; and Executive VP and Deputy Labs Director for Mission Support Al Romig.

The IBL's structure will contain six accelerator systems capable of generating ions of every element in nature from one electron volt (eV) to 400 million electron volts (MeV), and at intensities ranging from just single ions to trillions of ions per second. One eV is enough to ionize a single atom or energize a single photon; 400 MeV will accelerate the heaviest ions to 7 percent the speed of light.

Among the uses for the building's high-energy beams is rapidly analyzing materials. A low-energy ion implantation beam then modifies the materials. (An ion is an atom with too few or too many electrons.) This artificial condition helps improve predictions about the corrosion of materials used in electronic components that permeate military and civilian life.

Other research areas at the IBL are uniquely owned by Sandia in the DOE complex. They include microscopic diagnostics of radiation sensitivity of integrated circuits, simulating the effects of the enormous fluxes of neutrons associated with nuclear detonations, to provide data that will help protect US electronics against such an occurrence. The beams also aid calibrations and certifications for the nuclear stockpile.

The 27,000-square-foot building, constructed and expected to be equipped at a cost of $39.6 million, is on track to be significantly under budget and completed approximately six months ahead of schedule.

RapTOR

(Continued from page 1)

delayed, the lethality of the attack goes up exponentially. "If a novel attack occurs and our detection systems fail, we have limited time in which to identify and characterize the organism to be able to offer effective treatment," says Todd.

History shows that identifying and characterizing a naturally occurring unknown organism is very difficult. The 1970s outbreak of Legionnaires' disease took six months to characterize; nearly 30 years later, it still took weeks to characterize Severe Acute Respiratory Syndrome (SARS). Conventional DNA sequence-based detection systems failed to identify a recent outbreak of Ebola in Uganda because the virus had changed so much it was unrecognizable.

Lowering the bar to bioweapons

The same advances that make the RapTOR concept feasible also have lowered the technical bar for creating a bioweapon. "The research I did in graduate school for my dissertation is now being taught in high school," says Todd. "It is now possible to completely synthesize bacterial genomes. Bioweapons have become a potentially low-cost weapon of mass destruction and it's a very risky situation."

Sequencing the human genome took 10 years and hundreds of millions of dollars. With ultra-high-throughput sequencing, that same work can be accomplished for about $10,000 in a week or less.

But ultra-high-throughout sequencing only addresses part of the problem. As Todd explains, in an outbreak scenario there would be a large number of samples from people manifesting symptoms of the disease and the worried well.

"The more samples you can sequence, the better chance you have at identifying and then characterizing the organism. But sequencing a clinical sample provides a lot of information that is not of interest," he says.

For example, 99 percent of the DNA in a blood sample is the human genome. DNA in a nasal swab is 90 percent human-derived and much of the rest is garden-variety bacteria. "You need to quickly eliminate the 'human flora' before sending a sample to ultra-high-throughout sequencing," says Todd. "We aren't exactly looking for a needle in a haystack — we're looking for multiple needles and each one is different."

VICTORIA VANDERNOOT (8125) performs capillary-based hydroxyapatite chromatography to reduce high abundance host DNA, leaving rare DNA sequences, such as from a pathogenic infection, behind for ultra-high-throughput sequencing. (Photo by Randy Wong)

A better analogy is a jumble of 100 different disassembled pocket watches, with one of the original pocket watches representing a pathogen. "You have to sort through the watch parts to identify and discard everything you recognize. You have to simplify the mixture so there are more parts of significance to the pathogen," he explains. "It's not enough to just identify those parts that are unique — you also have to reassemble the pathogen watch."

Molecular biologists employ a number of methods to prepare samples for ultra-high-throughput sequencing; the challenge for the RapTOR project is adapting those methods to a portable, automated platform. Todd explains that these methods require days of work by a highly trained scientist on the bench.

"Our overall goal is a 24-hour turnaround. An end user would inject a sample of blood into the system, which then runs the sample through a number of molecular biology manipulations and sends it off to a DNA sequencer," says Todd. "The sequencer provides enriched information that the user sorts through to identify and characterize the sample."

The team already has succeeded in adapting one method to a microfluidic platform: normalization, which removes high-abundance genetic material from a sample, leaving a small, representative amount of all of the genetic material found in a sample. Currently, normalization is performed using an enzymatic digestion process that relies on enzymes from Siberian Kamchatka crabs.

A faster, cheaper, and simpler method

To re-engineer normalization, the researchers looked back 20 years to hydroxyapatite chromatography, a resin-based method that was discarded because it was difficult to reproduce. "Modern resins are commercially available and well-defined, so hydroxyapatite chromatography is relevant again," says Todd. "We created a capillary-based system to perform hydroxyapatite chromatography. It's a faster, cheaper, and simpler method that doesn't destroy the material in the process."

In the traditional, benchtop normalization process, double-helix DNA is heated to separate the two strands. As the DNA cools, the genes that are expressed in high abundance will find their partner strands more quickly than those expressed in low abundance. A researcher stops the cooling sequence, adds the crab enzyme to remove the double-stranded DNA, and with some additional manipulation, the resulting DNA all appears in low abundance.

Hydroxyapatite chromatography follows the same process, substituting a phosphate buffer for the crab enzyme to remove the double-stranded DNA without destroying any of it. The entire process can be automated.

The RapTOR normalization method is now being tested against human clinical samples for "fevers of unknown origin" that did not develop beyond mild sickness. "These are outbreaks that get ignored because they are self-limiting, but the samples are a perfect test of our system," says Todd. "If we can handle a small outbreak, we can handle something larger."

The RapTOR normalization method has caught the attention of sequencing companies and government agencies that Todd says are very interested in helping bring such a device to market. He expects a prototype to be ready in the fall.

RapTOR must do more than just normalize samples, so the researchers are turning their attention to other DNA manipulation methods such as ligation (linking two small pieces), digestion (cutting a larger piece into fragments), and size-based separations. Adapting some of these methods will prove simpler than others. Sandia's microfluidic platform was developed for proteins, which are far more complex than DNA samples.

The LDRD project brings together a broad distribution of technical disciplines, unusual for a Grand Challenge but well-suited for Sandia's capabilities. "Everyone has to work together, the microfluidicists, the microbiologists, and the bioinformaticists," says Todd. "As we process samples, the data analysis and knowledge discovery group will provide feedback on the quality of the information being produced. The upstream process is tunable."

RapTOR is designed to be a public health tool applicable for day-to-day work. "If you develop a tool like this, you need to regularly apply it to real-world scenarios. You can't put it in a glass box and wait for the horrible attack," says Todd.

The tool will have other applications in other fields as well, such as environmental detection. Todd explains that RapTOR could be used to take regular atmospheric samples and analyze their genetic makeup to develop a baseline. This application has garnered interest from the Defense Threat Reduction Agency, DoD, and DHS.

RapTOR will never eliminate the problem of unknown unknowns, but it will make the path from unknown to known faster and simpler, says Todd.

RapTOR for algae: Understanding pond collapse

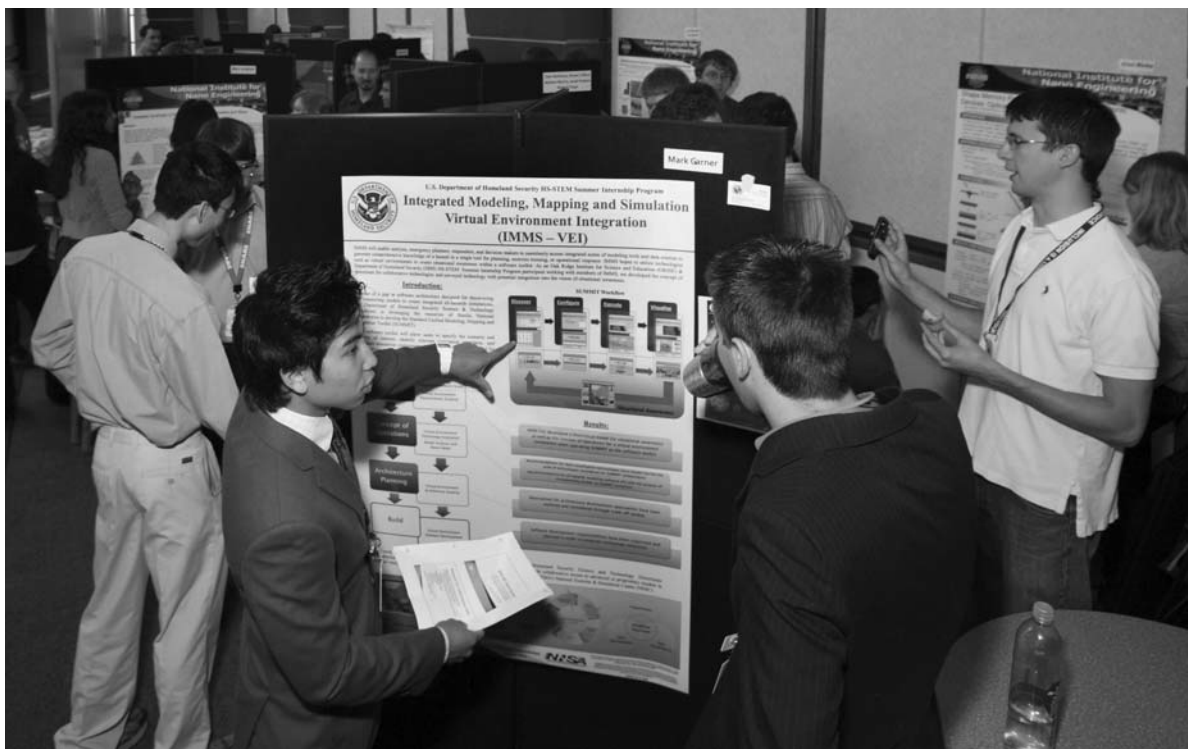
Last month, Todd Lane (8623), Jeri Timlin (8622), and Ben Wu (8125) received $800,000 in funding over two years from the DOE Biomass Program for their proposal "Pond Crash Forensics." Using pathogen detection and characterization technologies developed under the RapTOR Grand Challenge, they will compare the environmental conditions and metagenomes of algal samples taken from normal ponds to those taken from ponds that have undergone collapse.

Algae are widely viewed as a potential source of renewable fuel, but the technology to mass-produce fuel-grade algae is still in the early stages. A major roadblock, says Todd, is the inability to produce large amounts of algae.

Algae are commonly grown in raceway ponds, large, shallow, artificial ponds that serve as fields for algae crops. "Pathogens and viruses fall into these ponds and can crash a pond overnight," says Todd. "No one has identified many of the agents that are causing these pond crashes. You can't develop countermeasures without understanding why something is happening. This is a complex problem with a lot of factors at play."

He adds that this is a mostly unexplored area because growing algae is closer to farming than biotechnology. "This is a good application for RapTOR because, like clinical blood samples, there is a lot of naturally occurring stuff to sort through before you can find the pathogen or virus," says Todd. "It's a really good niche for Sandia, to provide a service that will be of great benefit to the algal biofuel industry that will in turn greatly benefit the nation."

Student symposium sums up a summer of hard work



SHOWING THEIR STUFF — Sandia/California's annual summer intern symposium gives a high-tech twist on the age-old fall question: how did you spend your summer vacation? Mark Garner (8116), an intern in the systems modeling and software engineering group, explains his summer research for the Integrated Modeling, Mapping, and Simulation Virtual Environment Integration (IMMS-VEI) to intern Jacob Pagliocca (8527). A total of 27 interns presented posters and 16 gave oral presentations. (Photo by Dino Vournas)

SUMMIT

(Continued from page 1)

DRY RUN — Zach Heath (8958), Stephen Mueller (8116), and Christine Yang (8958) are part of a Sandia team that has helped develop the SUMMIT software tool, which links together various models that are used by exercise planners at the federal, regional, and local levels. (Photo by Dino Vournas)

out the years, explains Jalal Mapar, the DHS/S&T program manager.

"The departments of Energy, Defense, and Homeland Security — among others — already do a lot of modeling and simulation," says Jalal. "What is urgently needed, then, is not a whole new set of models, but an easy and user-friendly way to access and link together the most appropriate models for a given emergency drill."

Though current modeling tools are effective on their own, says Jalal, they all incorporate different assumptions that currently require a large amount of time, resources, and human effort to properly synchronize each model's output.

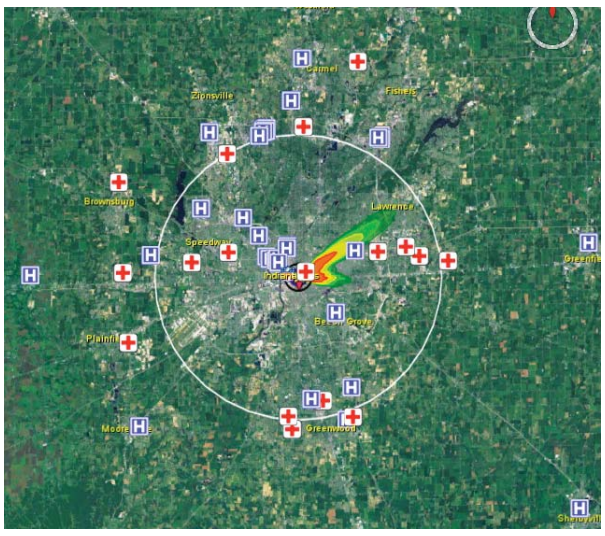
For instance, an exercise scenario might involve an improvised nuclear device blast in a large midwestern American city. The exercise planners, in order to create the most accurate and effective scenario, need to know details on the device, blast effects, numbers of immediate casualties, information on damaged buildings and infrastructure, radiation exposure to citizens, and other key pieces of information. While current models exist to provide the information in piecemeal fashion, there is no automated method for sharing information among the various models.

"You can't really calculate infrastructure impact until you know the technical details of the blast," says IMMS principal investigator Karim Mahrous (8116), pointing out the dilemma in having separate data sets that don't "talk" to one another. "We need a technical solution for linking the models together instead of having humans do the expensive and time-consuming interpretation themselves."

SUMMIT, says Karim, does not require exercise planners and participants to be experts in modeling and simulation. Instead, they merely would input the information they need for a particular scenario, and then allow SUMMIT to process the information.

"With minimal user input, the system links to the appropriate models, takes the information the planner has given it, pushes it out to the models in the proper format, does any necessary translations to make sure everything is consistent, then brings back an integrated story that can be used in the exercise," Karim says. The SUMMIT system will work with as few as two models, or it could involve many. "It will be largely invisible to the user," says Karim.

The broader goal, says Jalal, is to make the SUMMIT capability a pervasive part of preparedness and response for emergency managers, responders, and exercise teams in federal, state, and local governments.



RESULTS FROM RUNNING the SUMMIT template (screenshot above) provide an integrated picture of what has occurred in the simulated scenario. Results of interest include plume dispersion and the location of hospitals and urgent care facilities. Associated medical resource needs are shown in tables and plots.

Deployment at FEMA exercise provides real-world learning for SUMMIT developers

FEMA's National Level Exercise 2010 (NLE-10), which took place earlier this spring, had a new twist this year: the presence of DHS/S&T's Integrated Modeling, Mapping and Simulation (IMMS) team. Specifically, the team was there to test-drive its Standard Unified Modeling, Mapping & Integration Toolkit, or SUMMIT.

"This was SUMMIT's first foray into a real-world environment, and the lessons we learned will now be folded back into the ongoing architecture development process," says Lynn Yang (8114), a systems analyst who works on the IMMS project team.

To run this year's national exercise, FEMA's National Exercise Division designed a scenario focused on the federal government's ability to function while required to move its operations to contingency locations outside of Washington, D.C. The threat involved the detonation of an improvised nuclear device. More than 60 federal agencies participated in the exercise.

SUMMIT's role during the exercise's planning stages, says Lynn, was to provide a small part of the overall "ground truth" data to the simulated scenario created for the event, including information on casualties, weather, resource requirements, and demographics in various regions (most of the data was produced by other DOE and DHS modeling and analysis centers).

During the execution phase of the exercise, SUMMIT integrated a "medical surge" model from the Department of Health & Human Services with other modeling tools, such as those used to model plume dispersions, population, and infrastructure ("medical surge" generally refers to the ability to provide adequate medical evaluation and care during events that exceed the limits of the normal medical infrastructure of an affected community). When combined and effectively integrated by SUMMIT, models like these can be quickly and easily brought to bear for analysis purposes, such as real-time exercise scenario adjustments.

"SUMMIT essentially acts as the 'glue' that allows the emergency management community to bring models together and talk to each other," says Lynn. "SUMMIT offers the ability to bring credible, yet disparate, models together and easily integrate them with other modeling and simulation efforts." Though SUMMIT had a limited role in the NLE-10 exercise, she says, the IMMS team saw glimpses of how the software tool will allow exercise planners to quickly discover existing models and run them side-by-side with others.

"We've just scratched the surface, and look forward to seeing the full impact that SUMMIT will have," says Lynn.

Tritium

(Continued from page 1)

Terry. "It's a passively pumped vacuum system, using a getter. We have to ensure the environment only contains gas species that the getter will soak up, and still minimize those as much as possible."

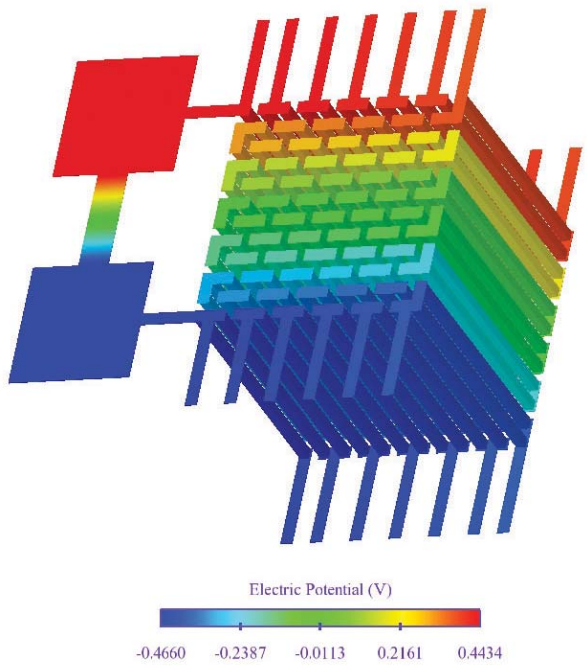
Validating the design

Modeling and simulation was crucial for studying the materials and the design as a whole. Dean Dobranich (1516) created a full 3-D model of the system that included an exact design of the thermoelectric module with all the thermoelectric properties. "The modeling effort went a long way toward validating the design and showing what efficiencies we could achieve in converting thermal energy from the tritium decay into electrical energy," says Terry.

A second modeling and simulation thrust, led by Nathan Spencer (8249), looked at the response to the shock and vibration environments. "You're talking about a device made of a bunch of tiny beams of a very brittle material. It can't take a lot of force, so part of the design is to use a soft mount with maximum compliance," says Terry. "We used the model to understand the magnitudes of the transferred shock load."

Alf Morales (8223) heads up the materials science side of the project. "Standard thermoelectric modules aren't designed for use under these conditions, so the power sources group took the lead in developing a module that would meet the TTG requirements," he says. "The TTG has to operate unattended for a long period of time under fairly stringent environmental requirements in terms of temperature, shock, and vibration. The materials science challenge resides in understanding the materials being used — how they behave at a range of temperatures, in vacuum, and over many years."

The TTG is all about heat — producing heat and turning that heat into electricity — and anything heated undergoes change. Alf likens it to a brand new engine in a car. "If you took microscopic pictures before you drove the car and then after 30,000 miles, the difference is huge — it's going to look so bad you might not want to drive the car again," he explains. "But the parts have big tolerances and even if they aren't pretty, they are safe and functional. The science here is to discover the changes and if they matter or not to the performance of the device."



MODELING AND SIMULATION are essential to developing the TTG. Shown here is a simulation of the temperature distribution across a TTG thermoelectric module. High-fidelity simulations allow Sandia engineers to predict power output levels for different potential component designs. (Courtesy of Dean Dobranich and Bryan Sanchez)

Answering the burning questions

With the goal of having an integrated prototype next year, Alf is developing a large study to determine how the device's aging will affect performance and how much tritium needs to be added to compensate. "This is an engineering design project, so we need to answer the burning questions as soon as possible," he says.

Anticipating burning questions that could arise during production, project lead Chris Apblett (1815-2) brought the Kansas City Plant and Savannah River Site into the project early. Tritium has never been used in this application, so Savannah River gave input on design changes to facilitate the loading process.

The subtleties of manufacturing

"We were able to understand some subtleties of the manufacturing and loading process and bring that knowledge back into the design," says Terry. "It was definitely a worthwhile process to have these discussions early."

After replicating Savannah River's loading manifold setup, Andy discovered a small modification to the loading manifold was necessary to ensure that the bottle temperature was uniform during tritium loading. Loading tests at Sandia/California used an oil bath, which provided very uniform heating; the Savannah River loading manifold used a resistive heating mantle. The bottle's location in the heating mantle and the heater control affected the bottle temperature and thus the loading rate.

Bringing together so many different players early in the project, he says, has been a real benefit and enabled the team to move through the Technology Readiness Level quickly."Within a very short time, we've accomplished a lot," he adds. "I think it's due to Sandia's science-based engineering approach coupled with materials science expertise, computer modeling and simulation, and experimentation. It's the reason we got this project."

Workforce Appreciation Day is all about building bridges

Story by Patti Koning
Photos by Dino Vournas

On Saturday, Aug. 7, about 250 members of the workforce and their families gathered at the Robert Livermore Community Center for the third annual Workforce Appreciation Day presented by the Division Diversity Council (DDC). The event's purpose is to promote diversity, unity, and team building across the Sandia/California site, as well as give thanks to members of the workforce and foster Sandia's mission of unity and community.

"I've been fortunate to attend all three Sandia Workforce Appreciation Days, and each one has been very special. It's been wonderful to connect with people from work in a relaxed, social setting. It has also been great to meet friends and families. The DDC has done a terrific job in sponsoring such a fun event," says Pat Smith (8500), director of site operations.

Ed Allen (8243) organized the first Workforce Appreciation Day in 2008 after attending an NNSA conference on diversity. "It's a chance to rub shoulders with people you might never talk to at work. When you share personal experiences outside of work, playing bingo or baseball for example, you build bridges and that builds inclusiveness," he says.

Members of the workforce brought their significant others, children, parents, friends, and pets to the picnic. Everyone enjoyed a delicious barbecue lunch, volleyball, baseball, balloon animals, board games, karaoke, raffle prizes, and, of course, bingo. Special guest Marie Brown (3512) from the Diversity and Inclusion Program Office at Sandia/New Mexico served as the moderator for the bingo games and raffle.

Livermore Valley Open Campus

Initiative moving forward with master planning, lane construction

By Mike Janes

MAKING THE GRADE — Lane changes near the CRF will help facilitate access to LVOC as that project matures.
(Photos by Dino Vournas)

The Livermore Valley Open Campus (LVOC), an initiative embraced by NNSA and the DOE Office of Science since 2009, continues to make progress.

Sandia and Lawrence Livermore National Laboratory (LLNL) are working collaboratively to create an open national security research and development campus that facilitates ready access to NNSA expertise and facilities.

As currently envisioned, the Open Campus initiative will consist of an approximately 110-acre parcel along the eastern edge of the LLNL and Sandia sites bordering Greenville Road. The LVOC will be modeled after R&D campuses found at major industrial research campuses and other DOE laboratories with graded security, and a set of business and operating rules devised to enhance and accelerate international scientific collaboration and partnerships with US industry and academia.

In the spring, Sandia and LLNL announced Flad Architects as their selection for a $500,000 architectural and engineering contract to perform design and master planning services for the project. Flad, says Brian Damkroger (8300), has developed several design options and continues to work with both labs' LVOC management teams to identify the most effective, long-range master plan for the campus.

The motivation for the LVOC stems from future national security challenges that require increased coupling with the private sector in order to understand threats and deploy solutions in areas such as energy, cyber security, high-performance computing, and nonproliferation. NNSA Administrator Thomas D'Agostino and DOE Under Secretary for Science Steve Koonin signed a mission needs concept for LVOC in 2009, and last summer a $3 million expenditure of laboratory overhead was approved. This allowed the labs to move forward on the conceptual development of design alternatives required to reconfigure the existing laboratories into a more open layout.

Flad is a Madison, Wis..,-based architectural, engineering, planning, and interior design firm with offices in San Francisco and five other locations. The firm was unanimously selected by a team of Sandia and LLNL program and operations specialists. Flad has done other campus master planning projects at Oak Ridge National Laboratory and Brookhaven National Laboratory.

Among the issues Flad has been looking at are land density and the "zones" that might make up the open campus.

"One of the fundamental issues they're examining is the open campus land and infrastructure, and the best way to utilize it," says Brian.

The designated space offers considerable room for future growth. Planners, however, want to avoid creating a campus that resembles a vacant lot, with no sense of place, Brian says. The open campus needs to have a degree of denseness, but a design that accommodates ample parking space, is walkable, and makes sense from a programmatic standpoint, he says.

One of the initial design concepts the LVOC management team is looking at, says Brian, is a so-called "string of pearls" that takes a page from the famed Googleplex in Mountain View, Calif. The campus might feature several "mini-centers," each with a mission or technical theme, such as an "energy corridor," followed (a block or two away) by a "biology neighborhood," a "cyber center," and so on.

Program areas that could have a presence in the LVOC include high-performance computing, transportation energy, cybersecurity, biosciences, materials science, high-energy-density science, and various homeland security activities. The open campus could also house amenities and features such as conference space, collaboration facilities, a visitors center, and food services to support tenants and lab workers.

In addition to proposed development zones on the open campus, Flad is conducting market studies that examine opportunities for industrial and academic tenants, and results from interviews with laboratory managers and staff to help define specific program requirements for the LVOC. Berkeley-based Economic & Planning Systems (EPS) is leading the market studies portion of the work.

In parallel with the master planning, construction has begun on a new vehicle lane on East Avenue that will allow visitors to Sandia's Combustion Research Facility (CRF) to access that portion of the site from the east (Greenville Road). The CRF is considered one of the main anchors for the LVOC. The opening of the new lane, expected to take place by early-October, will come with a number of new features along the eastern end of East Avenue meant to accommodate the new access while keeping the remainder of the site secure. Newly installed features will include new directional signage and automated gates.

In addition, with the closing of the "Sandia hill" popular with Sandia and LLNL recreational walkers, a pedestrian pathway is being constructed near the CRF (parallel to East Avenue) out to Greenville Road. This feature, says Doug Vrieling (8512), is designed to provide lab members of the workforce with a safe and convenient connection to Greenville for jogging and walking.

Sandia and LLNL are preparing a report on LVOC development options that will be delivered to NNSA for review by the end of September.

This drawing represents what a future "build-out" of the LVOC could look like. A series of small villages or "mini-centers" could house various program elements (energy, biology, cyber, etc), stretching from the CRF complex in the southwest corner to LLNL's National Ignition Facility (NIF) to the far north. Included in the drawing are several proposed parking structures (P1, P2, etc) as well as potential buildings.

MOVING THE FENCE — Workers prepare to set fence poles during construction related to the evolving LVOC project.

A visit to the Antarctic this winter?

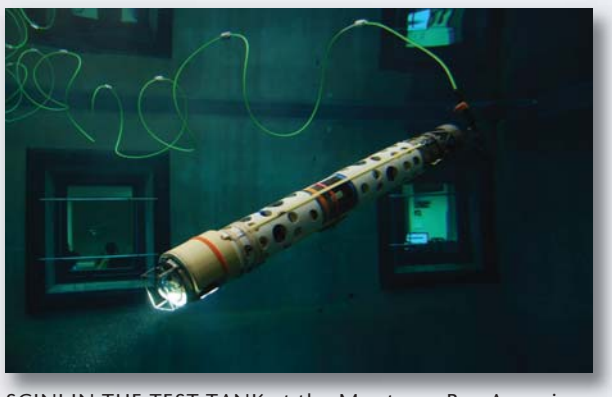
Count me in, says California researcher

Photos courtesy of Moss Landing Marine Labs

By Mike Janes

While most people are dreaming of Florida beaches during the chilly winter months, David Burnett (8136) apparently likes to go against the grain.

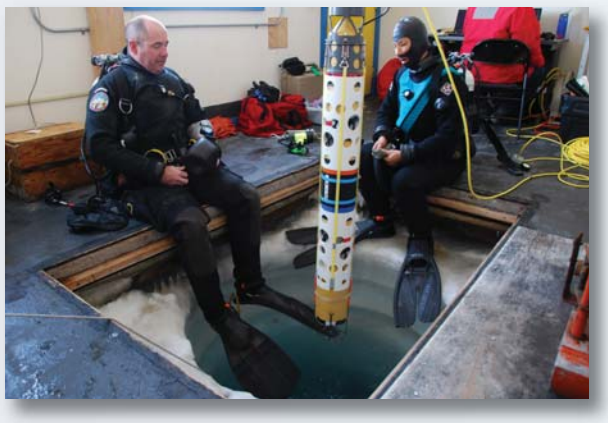
David, an electrical engineer who works in the Protection Technologies & Systems group at Sandia/California, will travel to Antarctica in October for a two-to three-month work assignment paid for by the National Science Foundation (NSF). The trip is in support of a project led by Moss Landing Marine Labs, which is developing a robotic device known as the Submersible Capable of under Ice Navigation and Imaging, or SCINI.



SCINI IN THE TEST TANK at the Monterey Bay Aquarium Research Institute

SCINI is an underwater robot specifically built to complete science missions beneath the frozen surface of the ocean in Antarctica. Such ecological research is important, David says, since the seafloor and marine organisms found in this part of world are essentially untouched and remain largely unexplored.

For more than 200 years, the United States has played an active role in exploration of the Antarctic, and that history has led to a continuous US presence there since the 1950s. Current federal policy, according to the United States Antarctic Program (USAP), "suggests continuation into the foreseeable future of a strong US government capability to support Antarctic scientific research."



DURING INITIAL FIELD TESTS, divers in the water observed the ROV control.

SCINI, outside the tent over mission control, ready to deploy.

SCINI is funded by a three-year NSF grant that started in 2007. Development of the device takes place in Moss Landing's Benthic Lab. Annual field deployments during Antarctica's summer season (fall and winter in the US) are based out of McMurdo Station, an American Antarctic research center located on the southern tip of Ross Island on the shore of McMurdo Sound in Antarctica.

David's involvement in the project was a classic case of serendipity. He learned about the work through his peer network and, as luck would have it, his most recent Sandia projects were winding down, offering a gap in his schedule. In June, he started lending his talents to the team at Moss Landing and has been focusing his efforts on the SCINI device's power and camera systems.

The SCINI device is operated remotely, allowing its pilot to view previously impenetrable parts of the ocean seafloor via a camera mounted on the device. A SCINI pilot utilizes a video game controller to direct the device (similar to those found on an Xbox), and a computer flat screen shows not only the seafloor, but also the device's status array and engineering diagnostics.

David points out that the work, to date, is not currently part of any sponsored Sandia project. His expenses for the Antarctic trip will be covered by Moss Landing Marine Labs' NSF funding. But he and other Sandia managers firmly believe the SCINI device could have wide-ranging benefits to laboratory mission areas, including assessing the ramifications and recovery of the Gulf oil spill. He suggests that climate modeling and sampling, as well as general ecological studies, would all benefit from a flexible robotic device.

"David's role has clear ties to Sandia's interest in robotics and teleoperated systems and a broad range of sensing capabilities, including potential future projects at Sandia," says Will Bolton (8136), acting manager of the Protection Technologies and Systems Department.

More information on the SCINI project can be found at www.iceaged.info. The site describes both the science mission SCINI is serving and the engineering behind the project.

LAUNCHING SCINI through a small hole in the ice.

A SCINI TEAM MEMBER sits in the open as he analyzes data from the innovative submersible probe. Usually, the team has a tent enclosing the mission control area.

Reinvigorated CCD taking shape at California site

Successful cyber program 'ready for a transition' at place where it all started

By Mike Janes

Sandia's well-known Center for Cyber Defenders (CCD) initiative, which has enjoyed a long track record of success in Albuquerque and California, has seen its impact as an employment pipeline and developer of qualified cybersecurity professionals decrease in the Golden State in recent years.

But things are about to change.

Bob Hutchinson (8960), manager of the computer sciences and information operations group, has set a robust goal for Sandia/California's new CCD effort: 50 students in the summer of 2011, with a long-term objective of 100 or more students in the summer and perhaps as many as 50 students year-round. Bob and director Len Napolitano (8900) envision a CCD in California that is grounded in science and engineering, with a solid understanding of cyber vulnerabilities.

Though the CCD started at Sandia/California in the 1990s and enjoyed a good deal of accolades and success, the number of interns began to slow when the academic world "caught up" with the Labs' original vision, says Bob.

"The original CCD concept was born out of necessity," he says. "It was quite simple: We needed to develop employees who could work in computer security, and no one else was doing this sort of thing at the time. We exposed them to projects and research and concepts in information security so that they could get a sense for whether it was the right career for them.

"It was a tremendous success," Bob continues. "But then universities started developing coursework in computer security, cryptography, the fundamentals of information assurance, and even digital forensics. So once there was no longer a need for us to inform the students of what it would be like to work in this field — a need that was suddenly being met by the universities — the CCD program in California became less of a factor."

The CCD program in New Mexico, says Bob, has continued to thrive with a project-based framework, one in which students can help Work for Others (WFO) sponsors with specific information security challenges.

But a strictly project-based format may not continue to work as well into the future, says Bob, since the attractiveness of having student interns versus regular staff executing a project will naturally diminish as "digital natives" become the norm in the workplace and replace their "digital convert" predecessors.

(Generally speaking, a digital native is someone who was born after the emergence of digital technology and, as a result, has a lifetime of familiarity with computers, the Internet, mobile smart phones, and other digital devices.)

The appeal of bringing in new students will eventually fade, Bob says, since the expertise they now offer will become routine.

Instead, Bob says, a more suitable role for Sandia is to transition the CCD from what is today an art and a practice of cybersecurity into one that is more based in engineering and science principles. This would include fundamental issues associated with the security of systems and the vulnerabilities inherent in computer systems.

"Ultimately, it is people who attack computer systems," says Bob. "So we need individuals who are trained to understand the cognitive and social science aspects of computer security." Bob muses that the CCD might even be able to publish a book one day on the theory of vulnerabilities that serves as the basis for producing more robust computer systems.

> *"Ultimately, it is people who attack computer systems, so we need individuals who are trained to understand the cognitive and social science aspects of computer security."*
>
> **— Bob Hutchinson**

The revamped CCD in California also want students who are more proof-and-reason based, Bob says, individuals who want to take on the hard task of structuring and developing experimental science around cybersecurity and information technology.

The driving force behind the CCD continues to be the federal government's need to have a hiring pool of cybersecurity professionals to draw upon. "We need to help the government acquire a supply of high-quality labor," Bob asserts. "They need to be threat-informed, and they need to have the skills and tools that can wipe out classes of vulnerabilities, as opposed to today's model, which is very much a 'find-a-vulnerability, fix-a-vulnerability' model," he says.

In addition to project work and ongoing access to a pool of cybertalent, a key part of the CCD's value in California will be to deliver positive publicity for sponsors. "A sponsor's involvement in the CCD demonstrates that they're investing in people, in the development of a workforce, and that they're committed to making the US stronger through its educational programs. It shows that they're forward-thinking," Bob says.

DIGITAL NATIVES like Jon Avery, Ben Schmoker, and Steve Cramer are among a new crop of Sandia/California student interns taking part in the Center for Cyber Defenders. They and future CCD interns in California are expected to take on the hard task of structuring and developing experimental science around cybersecurity and information technology.
(Photo by Dino Vournas)

In developing the program, Sandia is exploring a variety of funding sources and potential partners, including universities. "We may even need to create relationships with schools that are willing to assign course credit for coming here and working," Bob says.

He acknowledges that he's less familiar with industry models for talent acquisition yet is still optimistic that valuable relationships can be forged. "Maybe we can provide value by saying, 'You want to develop this type of a software security product, and through our internship program, we can mentor students to help develop the concepts and the product,'" Bob says. "Or an industry partner might be persuaded to send its new employees to our program to quickly develop an elevated threat awareness and build a peer network."

For now, Bob says he and his colleagues are developing a compelling value statement for government and industry sponsorship and identifying the many tasks and activities that need to be completed prior to the CCD's doors being thrown open next summer.

"The biggest problem with cybersecurity today is that it's been over-admired," Bob concludes. "Go online and look at cybersecurity, and what you'll find is a wealth of analysis and papers out there, and every one of them describes the problem a little better than the previous one.

"But where are the solutions going to come from? They're going to come from people conducting experiments and reasoning, developing a theory of vulnerabilities, then taking that theory and moving it into real applications. Sandia's CCD is here to provide those solutions."

Sue Downes finds 'dream job' in Motor City

Sandia researcher heads to Detroit via unique exchange arrangement with General Motors

By Mike Janes

Entering a new phase in the longstanding relationship between Sandia and General Motors Co. (GM), the Labs and the giant automaker have initiated a "liaison" program — essentially, a swapping of researchers — meant to support and strengthen the organizations' strategic alliance.

SUE DOWNES

That alliance, says Art Pontau (8360), is focused on advancing automotive technologies such as clean, super efficient engines, electric vehicles, and smart cars. Sue Downes (8360), selected as the Sandia liaison, began her two-year stint with GM in June and is expected to relocate to the Detroit area by this fall.

"This is my dream job," says Sue. "I love working with the private sector and helping solve big problems through these kinds of partnerships."

Sue says her primary job at GM will be to look for ways for the two organizations to collaborate on broad projects and to ensure that the processes for doing so are clear and streamlined. Technical work will also be part of the assignment, she says, but the scope of that work has not yet been defined.

Sue, who has worked at Sandia for 15 years, holds degrees in environmental engineering and industrial engineering. She began her Labs career in Carlsbad by building simulation models for nuclear waste transport systems, then moved on to Albuquerque to work for the National Infrastructure Simulation and Analysis Center (NISAC), where she continued to hone her skills by "looking at a whole bunch of infrastructure systems instead of just one." During her most recent NISAC assignment, she served as the primary subject matter expert and project lead on chemical infrastructure systems.

Sue readily admits, however, to having little or no knowledge of cars or the automobile industry. So why was she selected for the GM assignment?

"Sue possesses a very strong foundation in systems analysis, which is one of the key topics that GM and Sandia are interested in exploring together," says Art, noting that advanced combustion and electrical energy storage are two other technical areas that the two organizations share particular interest in. In addition, Art says, Sue's experience working with industry will prove invaluable, as she's adept at understanding a company's "big picture" needs.

Sue acknowledges that it's her "soft skills" that make her particularly well-suited for the job, particularly those gleaned during her tenure with NISAC.

"A big part of the job when working with chemical companies was the need to speak and understand their language, then to translate back to Sandia researchers and government sponsors," she says. "There was a lot of interface. I needed to be able to understand the technical side of the chemical industry, then effectively communicate Sandia's capability in a way that met the industry's real-world problems. I expect this assignment to be similar in that respect."

Sandia continues to forge a unique partnership with GM that goes far beyond mere licensing agreements or singular projects.

"We're charting a new approach for national labs working with industry, and our alliance with GM serves as a great working model," Art says. "Rather than just piecemeal technology transfer, we're building a broad, deep-rooted partnership where we understand each others' strategic intent and can identify and respond to challenges and opportunities as a team."

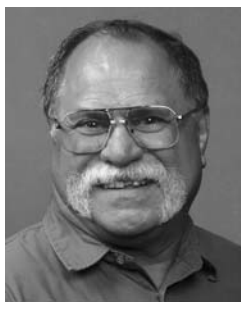
Sandia and GM are, for instance, able to quickly and effectively take action when a call for proposals is issued that aligns with both organizations' mission and goals. The key to success, says Art, has been establishing strong personal relationships between individual researchers and management teams of both organizations. Even with the recent bankruptcy turmoil surrounding GM and many personnel changes in both organizations, the institutional relationship is stronger than ever.

"If Sandia is truly responsible for exceptional service in the national interest, then we need to be able to partner with other entities," Sue adds. "The world continues to become global-dependent, and we can no longer solve big problems by ourselves unless we want to take decades to do it. We can tackle them together, though, and solve problems much faster."

Tang-Wei Kuo, a thermoscience researcher, is the GM liaison to Sandia. He has begun his assignment at Sandia/California's Combustion Research Facility. Watch for a story in a future edition of *Lab News* profiling Tang-Wei and his work.

Mileposts

New Mexico photos by Michelle Fleming
California photos by Randy Wong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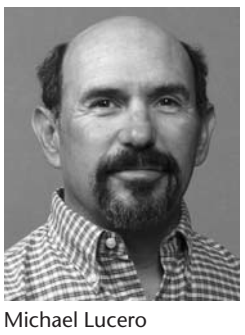
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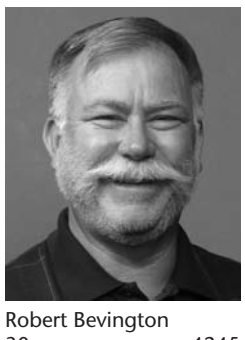
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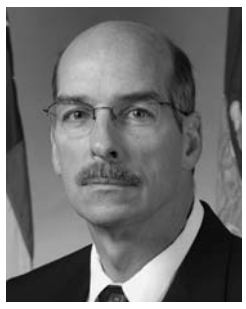
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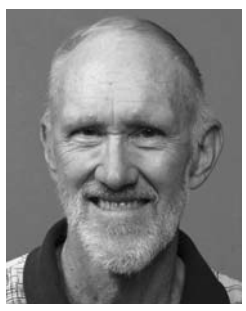
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Scott Keith
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Bill Richmond
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Gail Simon
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Brian Thomson
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Sherrie Trezza
20 1382

Julia Phillips
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Sarah Renfro
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Christopher Shaddix
15 8367

Peggy Underwood
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Rebuilding Haiti

Steve Orth lends a hand in the building of a new church in Petit-Goâve

Story by Patti Koning

In April, Steve Orth (8517) and his 20-year-old son, Austin, witnessed firsthand the devastation of the magnitude 7.0 earthquake that struck Haiti last January. For about a week, Steve and Austin worked with 18 other volunteers to build a new church in Petit-Goâve.

Located about 42 miles southwest of Haiti's capitol Port-au-Prince, Petit-Goâve is one of the oldest cities in Haiti and has a population of about 12,000. On Jan. 20, it was the epicenter of a magnitude 5.9 aftershock.

TENT CITIES, like the one shown here, popped up all over Haiti in the aftermath of the earthquake. Steve says many people he encountered were afraid to sleep inside even if their homes encountered no damage.

Steve has undertaken more than 20 such trips in the last 25 years, traveling to Ecuador, Swaziland, Peru, and Mexico to help build homes for the poor through Livermore's Discovery Church of the Nazarene. Each year he leads a group of high school students to Mexico, just past the California border.

A sense of adventure — Steve is an avid backpacker — and desire to help others in keeping with his Christian beliefs drove him to set out on his first humanitarian mission to Ecuador in 1985. Two years later, he traveled deep into the Andes Mountains to build homes and meeting houses for a community of Aguarunian Indians. He describes this trip, on which he enjoyed local delicacies like baked monkeys and cooked buzzards, as one of his favorites.

"I don't know if you could find a place like that today, so untouched by the rest of the world," says Steve. "It was an amazing experience."

Another favorite trip was to Pucallpa, Peru, in 2007. Joining Steve on that adventure were Austin, his daughter, Mackenzie, and his father, Roland. To read his blog from that trip, visit http://www.discovery-livermore.com/Peru2007.html.

Last spring's trip to Haiti was the first Steve has taken in response to a natural disaster. "My son was the driver behind this trip," he explains. "After the earthquake, he really wanted to go to Haiti to help with the recovery. Through another church member, we were able to join a group from Findlay, Ohio."

The Nazarene church projects are typically planned well over a year in advance, to allow time to fundraise for project materials. Last year, the Findlay church had already committed to work with the Nazarene College in Haiti to build a new church in Petit-Goâve that would replace the community's old, smaller church.

"The earthquake destroyed the old church. Not a wall was left standing," says Steve. "In Haiti, churches play an important role in the community. It's a meeting place that is used every day for many different purposes."

In April, Steve, Austin, Dan Dague from Discovery Church, and 17 members of the Findlay church headed to Haiti with the goal of finishing the Petit-Goâve church and helping the machine and carpentry shop at the Nazarene College prepare for future recovery projects.

"When we flew into Port-au-Prince, my first thought was that the landscape looked like Los Angeles, with blue swimming pools visible everywhere," says Steve. "As we got closer, I realized those weren't swimming pools, they were blue tarps being used as tents all over the city."

As they drove from the Port-au-Prince airport to the Nazarene College, there were two constants: rubble from earthquake damage and tent cities in every imaginable place. One tent city was erected in the median of a busy four-lane highway, bordered with 50 mile-per-hour traffic on both sides. "It was freaky seeing little kids playing in front of the tents and ramshackle structures with cars just whizzing by," says Steve.

STEVE and his son Austin in front of the church they helped build in Haiti.

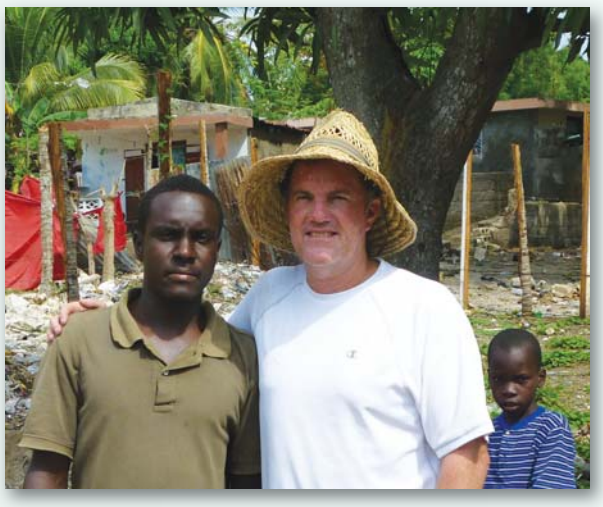
The group stopped at the Nazarene College where they spent several days making roof trusses, frames for bunk beds, and benches for church pews. Taking advantage of the metalworking skills of several members in the group, the Nazarene College had them churn out building materials for future work groups — enough to build another six to seven churches, says Steve.

They next journeyed onto Petit-Goâve, where local workers paid by the Nazarene Church had already poured the foundation for the church and built the floor and walls. In three busy days, the American group put on a roof, installed pews, and painted the entire building.

"The whole community got really involved because they knew what this church would mean for them," says Steve. "One night we went to sleep around 10 p.m. to a lot of noise and activity. When we woke up early the next morning, the locals had constructed the sidewalk from the church to the street."

He left Haiti satisfied that he'd done something, however small, to make a difference to one community. "There was a lot of sadness, because everyone you talked to had lost a family member or friend to the earthquake. And around Port-au-Prince there were all these flattened buildings where people were likely crushed," he says. "At the same time, it was uplifting to see how well the Haitian people coped with the devastation and that they are able to move on with life."

IN 2007, STEVE traveled to Peru with his son, daughter, and father to build a church in Pucallpa, Peru. Shown here, Austin, Mackenzie, Steve, and Roland take a break from work to visit Macchu Picchu, the "lost city of the Incas."



STEVE WITH NIKKO, one of the local Haitians who helped build the church in Petit-Goâve.

STEVE'S DAUGHTER, Mackenzie, and his father, Roland, lay bricks for a wall of the church in Pucallpa.

REFUGEES moved into tent cities amid the rubble in the aftermath of the devastating earthquake.