Cool flames for better engines

Sandia researchers use Direct Numerical Simulations to enhance efficiency, reduce pollution in diesel engines

By Sarah Sewell

"Cool flame" may sound contradictory, but it’s an important element of diesel combustion—one that, once properly understood, could enable better engine designs with higher efficiency and fewer emissions.

Sandia mechanical engineer Jackie Chen and colleagues Alex Krisman and Giulio Borghesi recently identified novel behavior of a key, temperature-dependent feature of the ignition process called a cool flame in the fuel dimethyl ether.

(Continued on page 5)

Painless microneedles extract fluid for wearable sensors for soldiers, athletes

By Mollie Rappe

T he lab is calm and quiet, clean and well organized; boxes of tiny needles and sample tubes are neatly stacked above a pristine paper-covered countertop.

This is a far cry from the hectic emergency room, dusty battlefield, or sweaty training center Sandia and University of New Mexico researchers hope will soon host their microneedle-based sensors.

I am here, at this UNM lab, to participate in a research study to help these microneedles make that leap from basic research to helping soldiers on vital missions.

Ronen Polsky, a materials scientist who leads the design of the microneedle sensor, says the technology is the first way to extract large volumes of pure interstitial fluid for further study. In September, Ronen presented his vision and hopes for the microneedle-based sensor system at the Albuquerque TEDx conference.

Microneedles are a few hairsbreadths wide and can sip the clear fluid between cells in the middle layer of skin. This is below the topmost layer of dead skin cells and above the layer of skin where veins and nerves

(Continued on Page 4)

FAREWELL, PETE.
FORMER LABS DIRECTOR and Sandia President Ementius C. Paul Robinson shares memories of working with New Mexico Sen. Pete Domenici, who passed away Sept. 13. Page B.
That's that

The first time I met Pete Domenici, I was 18 years old. “Met” may be too grand a word for our encounter, but I always remembered it — there was something compelling, something charismatic about the man that stuck with me.

I was a student at the University of Albuquerque, a school Domenici himself had attended when it was called College of St. Joseph on the Rio Grande, which is now the campus of St. Fina X High School. I had enrolled in what at that time was an innovative between-semesters interdisciplinary course about the challenges of urban planning in late 20th century America. One of the speakers was an energetic young guy named Pete Domenici, who was chairman of the Albuquerque City Commission — the equivalent level of office before Albuquerque restructured its city government.

I don’t remember much about what Domenici had to say that day back in January 1969, although I’ll never forget his remark that Albuquerque didn’t have a smog problem — smog was a big concern in Los Angeles and other auto-centric coastal cities at the time — but a “smust” problem. Smart, he noted, was a combination of smoke and dust, a situation that could be addressed by parking more street cars on the fringes of the growing city. What I really came away with was a lasting impression about the way his conviction that smart policy can make a real difference in the quality of life in a community. His message wasn’t that he could solve Albuquerque’s problems but that “we” could.

And at my tender age, I knew Pete Domenici was destined to be somebody. At that point, in fact, I would have been happy to see him elected as president. He was that impressive to a young man looking for inspired national leadership.

Now, fast forward six years. I was living out in the far reaches of the Washington, D.C., metro area, riding the Amtrak train into D.C. every day where I was working on a personal project at the Library of Congress. I’d left New Mexico a few years before, but as a political junkie I was quite aware that the impressive young Pete Domenici had been elected to the US Senate in 1972 from what was still my favorite state.

Anyhow, on the first day of what would end up being about a six-months-long daily commute, I noted that when the train made a stop somewhere in Montgomery County to pick up passengers, one of the first people to get aboard was Sen. Pete Domenici. And he was still impressive, just for anything he did that day, but for what he didn’t do. He didn’t act like he was something special. Quite the contrary. Like every other busy commuter with a demanding job, he took a seat, opened his trilectric, and began going through papers, organizing, and informing himself for the day ahead. I saw Sen. Domenici pretty much every day for the next several months, both of us just going to work.

When my wife and I moved to New Mexico in the early 1980s — for me it was a most welcome return — I read about Sandia from time to time (this was years before I was lucky enough to get a job here). The thing is, whenever I heard anything about the Labs, there was always some sort of connection to Sen. Domenici. He was very effective — and very vocal — at making the case for the Labs and smart policy to make that energetic young mayor of Albuquerque who made such an impression on me all those years before was still at work for the people of New Mexico and the nation.

My first reflection about Sen. Domenici is perhaps the most personally meaningful. A couple of years ago, the phone rang in my office. I picked it up and a voice I thought familiar said, “Hello, Bill, this is Sen. Pete Domenici. Do you remember me?” Of course I did; he’d retired a few years before but how could I, or anyone in New Mexico, forget?

He asked if I’d be interested in an essay he proposed to write exclusively for the Lab News about the importance of government investment in basic scientific research. I can’t tell you how gratified I was that energetic former senator, who was now a senior fellow at the non-partisan Bipartisan Policy Center, turned to the Lab News to publish his thoughtful piece (read it in the May 15, 2015, Lab News at http://tiny.sandia.gov/jfsal).

In tribute to Sen. Domenici, we’ve asked former Labs Director C. Paul Robinson to share his perspective on Domenici’s contributions to Sandia and his ongoing relevance in providing exceptional service to the national interest. Read Paul’s essay, accompanied by a selection of Sandia and its ongoing relevance in providing exceptional service to the national interest. Read Paul’s essay, accompanied by a selection of photos by Randy Montoya, on pages 8-9.

I’ve been inspired by his national leadership.

— Bill Murphy (ND 1668, 505-845-0845, wtmurph@sandia.gov)
Three men armed with rifles take hostages at Sandia’s California laboratory. You and your team have exactly 70 minutes to get as much information as you can about what’s happening and safely defuse the situation. How would you respond?

That is the question participants in this year’s Urban Shield emergency response exercise had to ask themselves. The event is part training, part competition among 35 local, state, national, and international SWAT teams. This year’s exercise included groups from Taiwan, the Netherlands, the Department of Homeland Security, California Highway Patrol, and 28 Bay Area SWAT teams.

Over the course of 48 hours starting Sept. 9, the teams rotated continuously through each of 36 emergency simulation events set up at locations across the Bay Area, including one at Sandia’s laboratory in Livermore.

Emergency Management coordinator John Norden describes Urban Shield as a test of stamina as well as decision-making, communication, and coordination skills. “At hour 40 into this event teams are still expected to make intelligent decisions. This is important training given that hostage negotiations can take that long,” he says.

Even though teams used different tactics, Sandia emergency planner Rob Pedersen says the overall response to the Sandia active shooter scenario was admirable across the board. “All the teams moved quickly as soon as they heard the sound of gunshots. They did not hesitate — they were ready to go. A good thing, since excessive caution could cost lives.”

Other scenarios included a hazardous materials emergency, a bomb scare, and tests of fire response, urban search and rescue, and emergency medical skills. The Alameda County Sheriff’s Office hosted the teams and arranged logistics for the entire event.

Coordinating with local law enforcement is especially useful for Sandia’s Protective Force, according to emergency planner Anthony Trimble. “The planning process during Urban Shield is important for building relationships, so when an emergency really does happen on our site, we are not seeing each other’s faces for the first time,” he says.

This year, event observers named Sacramento Police Department SWAT as the top response team, followed by Oakland and San Francisco police teams in second and third place, though all teams showed a high level of preparedness.

In addition to the important coordination and response work, the many volunteers who act as victims help make the scenarios feel more realistic. Anthony says he hopes that next year more members of the workforce will opt to participate in Urban Shield and in the other emergency response exercises conducted on campus. If you would like to get involved, contact John Norden or anyone on the emergency management team.

By Jules Bernstein
Photos by Dino Vournas

CENTRAL California SWAT team members include police officers from San Ramon, Martinez, and Walnut Creek.

HAYWARD POLICE navigate the entrance of a building involved in a simulated active shooter incident.

HAYWARD POLICE SWAT team evacuates “hostages” inside the building.

UNIVERSITY OF CALIFORNIA, Santa Barbara police are searched prior to entering the exercise “hot zone.”

UNIVERSITY OF CALIFORNIA, Santa Barbara police take down two hostile intruders.
Microneedles

(Continued from page 1)

The microneedles can contain minuscule sensors or extract the interstitial fluid for further testing. Because microneedles are tiny and don’t go very deep, they’re practically painless. When five microneedles clasped in a 3-D printed holder were inserted into my forearm, I felt a little pain. It was less than a standard needle prick and faded quickly.

For the study I participated in, the needles were left in for 30 minutes and three different lengths of needles were tested to determine the proper length to extract interstitial fluid from me.

Since the needles are painless and minimally invasive, they could be left in for hours or even a whole day without irritation, allowing constant monitoring, says Ronen. Continual sampling of important biomarkers in this interstitial fluid could help monitor and diagnose many diseases and disorders. These markers include electrolytes, salts such as potassium and sodium that get out of balance during dehydration; glucose, a sugar that diabetics need to monitor constantly; and lactate, a potential marker of physical exhaustion or life-threatening sepsis.

Diabetes, dehydration, and exhaustion biomarker detection

A small, wearable sensor that can monitor these markers could have many uses. It could help endurance athletes meet their training goals without plunging into dehydration or severe exhaustion. Tracking their physiological conditions would aid soldiers on strenuous missions, alerting them before they get so exhausted it could compromise their objectives. Ronen suggests that the microneedle sensor could also be part of a sense-and-respond device that detects high glucose levels and automatically delivers insulin.

“To move toward something that is market-ready, you need to start adding components that make it a bit more user-friendly and increase the reproducibility of the readouts,” says Philip Miller, a Sandia biomedical engineer also involved in designing the sensor. Or the sensors could be used in emergency rooms and critical care facilities to determine which salts are out of balance in cases of severe dehydration or track the response of a septic patient to a course of antibiotics, says Dr. Justin Baca, assistant professor of emergency medicine at UNM who leads the human testing of the sensor.

“There are a lot of great uses for these microneedle sensors,” says Baca. “They have the ability to help a lot in the medical sphere and in national security, but they could also be something that’s useful to somebody who’s just trying to improve their performance as a cyclist.”

1.5-millimeter-long needles extract interstitial fluid

The goal of the first research study in humans was to determine the best length of needle to extract the most interstitial fluid from healthy volunteers and then compare the composition of the interstitial fluid to blood.

“Now we have a pretty good sense of what the average length we should use for most people, but some people’s skin is a little thicker or a little thinner in that area and the flow rate may be decreased,” says Baca. Typically the best microneedles are 1.5-millimeter long, about as long as a US penny is thick. I’m pretty thin-skinned and this study proved it. The 1.5-millimeter-long needles extracted more interstitial fluid from me than the 1.5- or 0.1-millimeter long needles.

In addition to the salts and sugars with well-studied roles in physiological monitoring, interstitial fluid contains many proteins and exosomes, free-floating balls carrying genetic information including cancer markers.

More research is needed to incorporate these components can signal, but Ronen says he hopes some day interstitial fluid will join blood and urine as a fluid doctors routinely test for their clinical diagnoses. That’s the focus of the study I participated in.

After Robert Taylor, a postdoctoral fellow who works with Baca at UNM, cleaned my forearm with an alcohol wipe, he pressed the third five-needle holder into my arm. There was a brief jolt of pain and pressure similar to tagging on strands of hair. Then, except for the fact that I was asked not to move my hand and someone was pressing a finger-sized piece of plastic against my arm, I hardly noticed it. Future sensor systems will be set up to be simpler to use, says Taylor.

After about 10 minutes, I saw clear, water-like liquid seeping out of my arm, into tiny glass straw-like capillaries. In 30 minutes, the five microneedle-capillaries collected about 2 microliters, or 1/30 of a drop.

Weary sensors, early cancer detection, bright future of microneedle-based sensors

For many applications the researchers envision, the biomarker sensors would be on the very tip of the microneedle to allow continual detection of the conditions inside the body. Future studies will use larger needle arrays to increase sample volume. For other applications, such as early cancer detection, collecting the interstitial fluid may take longer than a standard blood draw, but could provide different clues.

Future work includes testing the tip-based sensors in people — they’ve already shown it works well in simulations — and then monitoring the fastest levels in people undergoing strenuous exercise.

In June, the researchers announced interest in business partners to help integrate the microneedle sensors into a self-contained device. The ultimate goal of commercialization or a partnership with industry would be to get the technology to the market in a way that benefits the public.

The initial work on the sensor was funded by Sandia’s Laboratory Directed Research and Development program. The US Defense Threat Reduction Agency is funding the human studies.

After four 30-minute interstitial fluid collections, my part is done. The red marks from the needle head fade after a few hours but the satisfaction of helping science lasts much longer. Baca’s team will conduct various tests on my interstitial fluid, bringing them one step closer to microneedle-based sensors for patients, soldiers, and athletes.
Cool flames

(Continued from page 1)

The team's research has shown that during autoignition (the spontaneous ignition of injected fuel in a combustion engine), cool flames accelerate the formation of ignition kernels — tiny localized regions of high temperature that seed a fully burning flame — in fuel-cell regions. The work was performed at Sandia's Combustion Research Facility using Direct Numerical Simulations (DNS), a powerful numerical experiment that resolves all turbulence scales, and was published in the proceedings of the Combustion Institute with Alex as the lead author. The work was supported by DOE's Office of Basic Energy Sciences.

Guillou further extended the cool flame DNS study by performing a three-dimen-
sional study on n-dodecane, a diesel surrogate fuel that has been the recent focus of Sandia's Engine Combustion Network on spray combustion in diesels (the study that Alex authored with dimethyl ether, a 'fueler, was in two dimensions). Guillou's paper is pending publication. Taken together, both Alex's and Guillou's papers will form a comprehensive study of low-temperature chemistry in autoignitive flames at different stages of ignition.

Cool Flames Can Improve Engine Design

The details of starting an engine often are taken for granted. Unlike a gasoline engine, in which the fuel-air mixture is ignited with a spark plug, in a diesel engine the fuel must auto-ignite when it is injected into the hot, compressed air that is in the piston at the top of the piston stroke. As the fuel is inducted into the engine cylinder, rapid mixing and combustion combine to burn the fuel and drive the engine. While this lasts mere fractions of a second, the condition of the flame that start this powerful process are crucial for improving engine efficiency and minimizing pollution formation.

In a diesel engine, the fuel-air mixture is far from uniform, with some regions hav-
ing high fuel concentrations and low temperatures and other regions having low fuel concentrations and high temperature. In other words, the in-cylinder condition is highly stratified. Alex and his coworkers discovered that stratification, combined with the complex ignition chemistry of the diesel-like fuel, create a fast-moving cool flame that controls the overall ignition behavior.

The rapid movement of the cool flame decreases the time needed for ignition, which is important when operating an engine with significant flue gas recirculation, a technique used to decrease soot and nitrogen oxide emissions and increase engine efficiency.

Alex says the cool flame triggers the hot ignition, “This causes the hot igni-
tion timing and location to be markedly different to what would be otherwise expected.”

This discovery should improve our understanding of the very complex diesel ignition process.

DOE INCITE computational grant (Innovative and Novel Computational Impact on The-

tory and Experiment). Computations using some of the world's largest supercomputers, such as Titan, are required to produce an accurate and detailed calculation of the auto-

ignition process.

“Combustion processes are challenging to study because the fuel itself is quite complicated,” says Guillou. “Fuel oxidation chemistry consists of hundreds of species and thousands of chemical reactions. A realistic simulation of diesel combustion needs to capture this complex chemistry accurately in an overall model that includes turbulent mixing and heat transfer.”

As part of the DOE Exascale Computing Program, the team collaborates with out-
side institutions including NVIDIA, Lawrence Berkeley National Laboratory, National Renewable Energy Laboratory, Stanford University, Oak Ridge National Laboratory, Argonne National Laboratory, and Los Alamos National Laboratory to develop perfor-

mance-portable algorithms to enhance the computing efficiency for DNS combus-

tion studies.

Future Work

In the future, the team would like to investigate basic questions about the speed and structure of flames at diesel engine conditions and study the relationship between spray evaporation, ignition, mixing, and soot processes associated with multi-component fuels. These basic questions will contribute to studying the cool flame's crucial role in engine energy production and exercise the valuable capabilities of DNS running on exascale supercomputers as a highly precise and detailed numeri-

cal simulation method.

Sandia’s Stewart Silling to co-edit new technical journal

By Sue Major Holmes

Standard equations for solid mechan-
ics aren’t well-suited to complex prob-
lems such as modeling cracks in mate-

tials. So Sandia’s Stewart Silling

generated the theory and its applications and it

has now become the editor-in-chief of a new journal that developed from an idea that began at Sandia “doesn’t happen every day,” Stewart says. He explains that Madenci proposed the idea.

A pioneer in peridynamics

Stewart started working on peridynamics in 1998, making him a pioneer in the field. He spent a year at Caltech as a visiting faculty member on temporary assignment from Sandia, which gave him time to develop a general-

ized theory. He published his first peridy-

manics in 2000. The United Association for Computational Mechanics awarded him the Belytschko Medal in 2015 for outstand-

ing and sustained contribution to computa-

tional solid mechanics.

Peridynamics is useful for such areas as structural mechanics, impact and penetra-

tion mechanics, shock waves, predicting materials failure, fracture, and composite materials. “The theory is being applied to problems as diverse as additive manufac-

turing, fragmentation of munitions, aging of concrete structures, bird strike on aircraft, erosion of high-temperature ceramics, cracking of car windshields, and even the spread of cancer cells,” says Stewart.

Sandia’s David Littlewood and Michael Parks serve on the journal’s editorial board.
The Sandia Gives Campaign is the Labs’ annual opportunity to come together and act with the common goal to help our communities through the United Way. For more than 60 years, Sandians have generously volunteered their time and given of their resources to change lives and help our local communities in profound ways.

The United Way of Central New Mexico’s Community Fund helps those most vulnerable through program grants to qualifying health and human service agencies. The Community Fund supports programs that advance education, health, and self-sufficiency, improving the lives of more than 250,000 of our neighbors. The grants currently support 104 projects and programs, totaling $3.6 million. APS Clothing Bank, NMCAN, and the Rio Grande Food Project are just a few of the programs that are able to provide life-improving services because of Sandia’s contributions.

Albuquerque Public Schools Clothing Bank provides clothes, shoes, socks, and underwear to students in need so they can focus on learning.
Shovel-ready: Upbeat groundbreaking for multi-petaflop computing center

By Neal Singer

Under gray skies, on a graveled lot enclosed on three sides by chain link fences and, on the fourth, a 30-foot-high wall of aluminum siding, a group of perhaps 30 Sandians and a few outside contractors listened expectantly as Tom Klitsner of Sandia’s mission computing organization and computing research center director Scott Collins described benefits from the ultra-modern computer annex expected shortly to be erected there.

"Thanks for joining us on this great occasion," said Tom. He went on to invoke a Sandia benchmark of note — the Red Storm supercomputer, built and housed in the early 2000s in the building behind the aluminum wall.

"It was one of the most influential supercomputers ever. It was copied many times over, and its design changed the way supercomputers were built. We believe this new facility will [house machines similarly influential], not just for Sandia but for the HPC community in general," Tom said.

Said Scott of the multi-petaflop computer the facility is intended to contain, "We refer to it as a prototype but it’s also going to be a large system, as much as a hundred times faster than Red Storm in performing large-scale weapons simulations."

The building will house all future Sandia high-performance computing systems.

Funded institutionally, the building is expected to be completed in the summer of 2018 at a cost of approximately $10 million.

New building technology, based largely on techniques explored by Sandia data center engineer David J. Martinez and collaborators, is expected to use the most advanced tools to minimize water and energy use. Green-building construction and an external solar panel field, are expected to be good enough to achieve LEEDS certification.

At the ceremony’s close, rather than champagne toasts, the researchers — most dressed “engineer-casual” in jeans and short-sleeve shirts — and executives picked up 12 gold-painted shovels to displace a pile of dirt and by doing so, signify their intent to mold the vacant lot to their vision.

Carol Meincke, who five years earlier began assisting Tom with initial planning of the project, called to the audience, “Let’s start digging before it rains!” It was a happy beginning.

"[Red Storm] was one of the most influential supercomputers ever. It was copied many times over, and its design changed the way supercomputers were built. We believe this new facility will [house machines similarly influential], not just for Sandia but for the HPC community in general."

The building will house all future Sandia high-performance computing systems.

Funded institutionally, the building is expected to be completed in the summer of 2018 at a cost of approximately $10 million.

New building technology, based largely on techniques explored by Sandia data center engineer David J. Martinez and collaborators, is expected to use the most advanced tools to minimize water and energy use. Green-building construction and an external solar panel field, are expected to be good enough to achieve LEEDS certification.

At the ceremony’s close, rather than champagne toasts, the researchers — most dressed “engineer-casual” in jeans and short-sleeve shirts — and executives picked up 12 gold-painted shovels to displace a pile of dirt and by doing so, signify their intent to mold the vacant lot to their vision.

Carol Meincke, who five years earlier began assisting Tom with initial planning of the project, called to the audience, “Let’s start digging before it rains!” It was a happy beginning.

"[Red Storm] was one of the most influential supercomputers ever. It was copied many times over, and its design changed the way supercomputers were built. We believe this new facility will [house machines similarly influential], not just for Sandia but for the HPC community in general."
A transformatve experience at Sandia

Pete Domenici was a great American and in my relationship with the senator he was a man who cared very deeply for our nation and gave seemingly more than 100 percent each day so to work on it behalf.

From the very first time I met him it was clear to me he was driven by a tireless desire to help shape a better future — for state and nation alike. He worked very hard on each issue and always asked tough questions about long term results: “Where do you think this could lead? Tell me if you think I’m taking the right view of this.”

He was devoted to improving the future for all. Once, on one of his visits to the Laboratory, with the prior consent of our highest DOE official, who would be coming along with Pete on the visit to Sandia, I got approval to “read in” Sen. Domenici into one of our closely held programs. The senator’s reaction was transformative: “My God, I knew you people did important work, but I never could have guessed that it was something like this.”

In the years that followed, he would remind me of how thankful he was that we had communicated such information to him, saying, “I always held you folks in high esteem, but I take so much more pride now in knowing how valuable you can be to all of us — and knowing what it really means to have supported you so strongly over the years.”

That is the memory of “St Pete” that I will always carry.

— C. Paul Robinson

Photos by Randy Montoya
Back to the Canyon

Sandia team continues to quantify fatigue using wearables

This is the second story in a series about the R2R WATCH (Rim-to-Rim Wearables at the Canyon for Healthy) study, a collaborative project between Sandia and the University of New Mexico (UNM). The interdisciplinary project, led by Glory Emmanuel Aviña from Sandia and Jon Femling from UNM, weaves cognitive science, emergency medicine, systems biology, data science, and sensor technology together to examine early predictors of health events. Lab News reporters Patti Koning and Michael Padilla returned to the Grand Canyon, this time to focus on the results of the R2R WATCH team’s partnerships and to see how the team is quantifying performance and fatigue.

By Patti Koning and Michael Padilla

It’s 27 degrees at the South Kaibab Trailhead, and a set of hikers marvels at the fresh snow visible on the opposite side of the Grand Canyon as the sun peeks just above the horizon. By the time the hikers reach the bottom of the canyon four to six hours later, the snow will be long melted, and the temperature will be at least 30 degrees hotter.

The hikers are ready for the physical trial that lies ahead: 21 miles from rim to rim, including a one-mile change in elevation, extreme swings in temperature, and the mental challenge of the uphill second half. But for the hikers who have volunteered to be in the R2R WATCH study, the first step is to check in at the R2R WATCH tent near the entrance of the south trail. The Sandia and UNM teams collect vital health information from the volunteer hikers, administer cognitive tests, and outfitt them with wearable fitness devices. These devices will provide a window into the hikers’ physiological changes during their rim-to-rim trek.

This is the second R2R WATCH data-collection study at the Grand Canyon, part of a three-year effort funded by the Defense Threat Reduction Agency (DTRA). The Sandia team is once again collaborating with UNM and the National Park Service (NPS), forming a unified R2R WATCH team that is merging multiple data streams to answer a single question: “What indicators predict the early onset of declines in performance or health?”

Project team members have been at the South Rim since 2 a.m., preparing to greet the first set of hikers, a military group that arrives at 3 a.m. Each study participant is fitted with a wearable device, receives a smartphone for cognitive assessments, has a few teaspoons of water, and cognitive markers to rim-to-rim hike performance,” says Cathy Branda, the Sandia project manager. “We can also compare military study participants to civilian volunteer hikers, a comparison of great interest to DTRA.”

According to Glory Emmanuel Aviña, Sandia’s principal investigator for R2R WATCH, identifying which physiological and cognitive markers are most important for predicting performance and fatigue poses a scientific challenge. To then wrap those markers with their different sensor technology requirements into a single wearable device will be a future engineering feat.

“One of our long-term objectives is real-time data analyses,” glory says. “Right now we collect data, download data after the hike, and then analyze it. But what if you could analyze the data in real time and identify health concerns before someone had a severe decline in performance? Those predictors could be physiological, like heart rate variability, but they could also be cognitive or genetic.”

Strong partnership

Sandia’s R2R WATCH study began in 2016 in response to a DTRA call for proposals to evaluate commercial and government off-the-shelf wearable devices. R2R WATCH is an extension of a previous UNM/NPS study — launched in 2015 by Emily Pearce, a former Grand Canyon park ranger — that focused on the nutritional intake of rim-to-rim hikers.

“Everyone brings a unique contribution to the table,” says glory. “UNM has years of experience in emergency response, clinical populations, bloodwork, and nutritional data, enabling us to create a one-of-kind, world-class dataset that capitalizes on the UNM infrastructure for collecting physiological data. We are also thankful that the National Park Service allowed our study to take place in the Grand Canyon, which offers both a controlled environment and an ideal setting for studying performance and fatigue since the hikers have to come back up after descending into the canyon depths.”

Sandia provides expertise in collecting data from the wearable devices, as well as fusing the multiple data streams such as wearable devices, cognitive tests, biomarkers, and blood samples and teasing out meaningful trends. Sandia’s advanced capabilities in computational analysis are crucial to solving this part of the problem. Dr. Jon Femling from UNM says the strength of this partnership goes beyond the considerable expertise of the team.

“Our collaborative study design will allow us to improve Grand Canyon visitor experiences, enhance military capabilities, expand our knowledge of exercise physiology and improve the care of patients,” says Femling.

The data generated by military personnel in the study is analyzed to understand performance decline in national security settings.

Dr. Argenta, Science & Technology manager for DTRA’s Chemical and Biological Technologies Department, says the project will enable DTRA to use real-time data collection and quantitatively show how markers relate to a non-laboratory, mission-relevant performance task. Findings on individual markers also inform which wearable devices are most useful both in the attributes they measure and the logistics of use.

“The partnership between Sandia and UNM has benefitted DTRA tremendously,” he says. “The Sandia team has provided strong connections with military communities of interest and has recruited individuals to participate in the data collection events. The data collected is critical for analysis and algorithm development, which Sandia is managing and performing as well.”

Argenta says UNM has provided subject matter expertise on the medical perspective and brought innovative ideas to the project, benefiting the project’s data package and subsequent analysis.

“Overall the entire team has been great to work with and our department looks forward to continuing the partnership with Sandia and UNM under this effort,” Argenta says. “The goal of developing an early warning to a biological or chemical exposure capability for our warfighters is important. Without great partners it will not come to fruition.”

Reaching the North Rim

At the North Kaibab Trail on the North Rim of the Grand Canyon, a pair of hikers appear wearing the red wristbands that identify them as participants in the R2R WATCH study. Victoria Newton, a core member of the study team, congratulates them on finishing the arduous journey.

The hikers flop into camp chairs in front of the R2R WATCH tent and gladly accept some soft drinks. After giving the hikers a few minutes to rest, the researchers spring into action, removing and cataloging the wearable devices. A UNM student administers a survey of questions about their hike. When asked if they’d choose the same hiking companions again, the two hikers laugh and answer affirmatively. They then take the last round of cognitive tests.

Next, the hikers are handed off to other team members who repeat the early-morning data collection tasks first performed at the South Rim. The researchers weigh the hikers and their backpacks, record their pulse and blood oxygen levels, measure their BMI and body fat with a bioelectrical impedance analysis device, and collect blood samples. This data will be used to quantify the hikers’ performance and fatigue, as well as associated indicators.

“We were able to collect a lot of useful data, especially because a lot of the volunteer hikers agreed to wear devices, do cognitive tests, and have blood drawn,” says Victoria. “The hikers willing to do R2R or R2R2R are incredibly inspiring. It was fun to see the hikers cheering each other on as they reached the top of the Rim and then to how seriously the same hikers took the cognitive tasks. Some got pretty competitive.”

(Carried on next page)
Quantifying fatigue

Fatigue is defined as extreme tiredness, typically resulting from overexertion — either physical or mental — or illness. We easily recognize our own fatigue when it hits, but the cause and seriousness are often unclear. If you wake up feeling fatigued, does that signal an impending illness, a poor night’s sleep, or excessive stress? Will you shake off that fatigue as the day progresses, or will it continue to wear you down?

“We sometimes sense that we are about to get sick or that external stress is beginning to affect our health,” says Glory. “With this study, we hope to identify predictive signatures for fatigue and quantify the type of fatigue. Is it manageable, meaning your body can recover if you remove the cause, or indicative of a potentially catastrophic health outcome?”

The range in outcomes is clear in the study volunteers after completing the hike. Some are so exhausted they can’t speak when they first approach the R2R WATCH team. Another pair debates hiking back to the South Rim — 21 more miles! They decide to take a shuttle only after realizing that the return hike would stretch into the early hours of the morning—they were worried about being cold, not tired.

Understanding fatigue could have broad impact. “For the military or other physically demanding professions, being able to discern the level and effect of fatigue could be life-changing. For example, when someone is fatigued, can that person keep going or is the fatigue at a level that endangers the individual, mission, or both?” says Cliff Anderson-Bergman, lead project statistician.

Results

Preliminary results have shown a decline in cognitive scores as fatigue sets in. Functional clustering methods also suggest differing effort profiles across subjects, which likely affected fatigue in different ways. Further planned analyses include examining how accurately heart rate variability captures the onset of fatigue and matching different effort profiles to the effects on the metabolic panel data collected before and after the hike.

Up next

The team will continue to analyze the data and plans on collecting more R2R WATCH data in October. “Like other human-subjects studies, the R2R WATCH study is a balancing act between pursuing science and being considerate of the study participants,” says Glory. “Thousands of hours are spent preparing for data collection. We can’t just throw devices on a person and stick them with a needle. You have to balance caring about a person’s rim-to-rim hiking experience with collecting solid, unbiased data that answers key research questions. That’s a balance that we continue to work toward.”
SANDIA LAB NEWS  •  September 29, 2017  •  Page 12

51 individuals, 72 teams

Labs Director’s Awards

For the first time, the Employee Recognition Awards include the Sandia Labs Director’s Award.

From the 123 winning ERA nominations, each division selected one to be considered for the award. Nominees were considered in the categories of Safety & Security, Quality, Collaboration, Efficiency, Technical Excellence, and Leadership.

“I am pleased to announce that there will be two recipients of the Laboratories Director’s Award this year—one for an individual and one for a group,” wrote Labs Director Stephen Younger. “Ashley Allen won the individual award for her leadership in transitioning battery technologies to partnering organizations. Ashley drive this project forward while maintaining a constant focus on safety.

“The group award goes to the Harding team that developed a new platform for inertial confinement fusion and high energy density physics on the Z-machine. This team, which included Matthew Martin, Eric Harding, and Paul Schmit, combined plasma theory, computer simulation, and experiments on Z to create a novel and exciting target concept for pulsed power.”

LABS DIRECTOR Steve Younger presents the first-ever Laboratories Director’s Awards to Ashley Allen, left, for her leadership in transitioning battery technologies to partnering organizations, and the Harding Team, which developed a new platform for inertial confinement fusion and high energy density physics on the Z-machine. (Photos by Lonnie Anderson)

Program honors teams, individuals for exceptional contributions to Sandia

Sandia’s Employee Recognition Awards are presented to individual employees and teams nominated by their peers and chosen by a division selection committee with final approval by the division ALD/SO for their accomplishments during the past year.

ERA awards underscore the importance placed on individual and team contributions to Sandia mission success. ERA categories include, for individuals, exceptional service, leadership, technical excellence, safety, and Sandia values, ethics, and integrity. Teamwork awards recognize technical, administrative, and support accomplishments and team safety accomplishments.

Sandia this year recognizes 51 individuals and 72 teams for their outstanding contributions to mission success.

Individual winners

Robert Abbott
Technical Excellence

Ashley Allen
Exceptional Service

Kendrew Au
Exceptional Service

Mark Bruhike
Exceptional Service

Jose Castillos
Technical Excellence

Anthony Colombo
Technical Excellence

Nathan Crane
Exceptional Service

Sandra Duran
Safety Leader/Change Agent

Richard Elliott
Exceptional Service

Juanita Evans
Exceptional Service

Adam Flynn
Technical Excellence

Christine Ford
Exceptional Service

Jamie Garner
Exceptional Service

Nathan Glenn
Leadership

Team honorees

Division 1

National Security Leadership Development Program (NSLDP) Team

The team successfully executed a redeployed National Security Leadership Development Program, providing critical training for Sandia’s future leaders during a time of unprecedented leadership transitions.

SF6 Emission Working Group

The Sulfur Hexafluoride (SF6) Emissions Working Group successfully identifies and implements solutions for reducing SF6 emissions from Sandia operations. SF6 is an extremely potent greenhouse gas that is critical to Sandia’s mission.

Technical Advisory Group

The Counterintelligence Office strategically teamed with technical SMEs in various programs and emergent R&D technologies. The group’s efforts have significantly helped protect national security.

Division 1000

Avondale Intelligent Web Crawler

The Avondale intelligent Web-Crawler efficiently and rapidly analyzes and synthesizes millions of web pages in a couple of days to enhance analyst decision-making.

First Tritium Shot on Z Team

For careful planning and execution of the first tritium experiment on the Z pulsed power facility.

Harding—a new ICF and HED science platform

For inventing, designing, and demonstrating a novel concept for inertial fusion and high energy density science experiments on Sandia’s Z machine.

REDACT Development and Test Deployment Team

REDACT is a multi-DOE-laboratory effort with the goals of developing new RF sensing capabilities and analytic techniques to advance global security. This year, the team successfully completed a critical field test to prove the capabilities.

With ALT 370 Neutron Generator Neutrons/Gamma-Ray Development Test Team

The team successfully field-tested extensively fielded stand-alone candidate neutron generators in the high-radiation environment created by the ALT open at peak power, contributing significantly to the qualification of the NCGS for the ALT 370 system.

(Continued on next page)
SANDIA LAB NEWS  •  September 29, 2017  •  Page 13

Sandia honors 2017 award recipients

Exceptional Service

Leann Jenkins
Robert Kapler
Lennie Klebanoff
Garrett Kliec
Sharlotte Kramer
Timothy Lambert

Technical Excellence

Mark Kiefer
Lori Mann
Karli Massey

Health and Safety Excellence

Sarah Leming
Maria Logan
Jeremy Pacheco
Jason Plake

Leadership

Robert Meagher
Jessica Mazzie
Elizabeth Quinley
Don Shoemaker
Mohan Sarovar

Michael Meagher
Lance Lippert
Steve Morrison
Malia Orr
Aaron Thompson

Exceptional Service

Robert Meagher
Mohan Sarovar
Elizabeth Quinley
Don Shoemaker

Division 2000

AED/DO Team

This team created and implemented a process to improve the rigor of all AH Electrical Product Definition during the transition from development to production. B61-12 LEP Phase 4: 6-Up Run Milestones

This work lays the foundation for our risk-informed stockpile evaluation plan.

Mk21 AFA Thermal Qualification Team

The team completed a series of testing, analysis, and computational simulations providing significant evidence for the AFA R&D. Contributions included thermal performance and thermal cycling data, abnormal thermal environments response, and a validated thermal model.

N-Ray Image Analysis Team

This RTG sub-component team balanced accelerated S&T with mission effectiveness and efficiency information to meet the NA-50 Deep Dive initiative that they described as setting a very high bar.

W88 ALT370 FIRING SUBSYSTEM PRODUCT REALIZATION TEAM

The Thermal Battery Test System Design Team has supported Thermal Battery Test activities while continuing to deliver on new system design and development to meet new testing requirements

Tonopah Test Range Mission Team

The team accomplished major systems, facility, infrastructure, and operational safety enhancement upgrades in the award period enabling the B61-12 and W88 ALT370 Blank Tube Test Teams to achieve the milestone.

Virtual Tours Team

Using dynamic panoramic photos, vibrant videos, and captivating dialogue, the Virtual Tours tool offers new-hires, potential employees, long-time employees, and cyber visitors a glimpse of Sandia facilities and advanced technologies.

Division 3000

M60 Contract Transition Communications Team

A communications team proposed Sandia's communications products for the new operator and planned an all-hands meeting and news conference to introduce the new leaders to employees, the community, and stakeholders on their first day.

Facilities Deep Dive Team

In support of a federal directive for real property asset management and Sandia Strategic Objective 2, this team committed to successfully reducing Sandia's deferred maintenance by $26 million, with a budget of $37 million.

Facilities Deep Dive Team

The Facilities Deep Dive Team compiled corporate and DOE facilities data with mission effectiveness and efficiency information to meet the 60-50 Deep Dive initiative that they described as setting a very high bar.

The Personnel Security Team, to include the Clearance Office, Badge Office, (Continued on next page)
Division 6000

Counter Unmanned Aerial Systems Testing Evaluation Team

Supporting NASA’s OAS T&E Program in pursuit of identifying suitable systems, while addressing technology gaps with innovative HIL solutions that meet the desired performance requirements for deployment and achieve the NASA OAS goal.

Division 5000

C MOS Device, Design, and Hard-FPGA Team

For exceptional technical leadership in rapidly developing and demonstrating the CMOS process and test chip, and developing the radiation hardened FPGA IP and layouts, including the complex licensing agreement with a commercial FPGA partner.

Electronic Production Control System (EPCS) MESA NW ASIC/HBT team

For 227 process improvements and reduced acceptance inspection time by 90%.

File Configuration Management Board Methodology

To recognition of developing outstanding methodology for the configuration management of classified networks in the Facility Intelligence Network Environment (FinEN) computing environment.

ITUS Intelligent Transceiver for Universal Signalling

The Sandia Intelligent Transceiver for Universal Signalling team was identified as the most sophisticated counter (Unmanned Aerial System (UAS) detection, localization, and operation at a system of the world’s largest joint aero/ground/HUMINT exercises.

Navy Flight Experiment 1 Software Development Team

For developing a prioritized list of security projects to refresh those systems.

Navy Joint Radar Laminar MEMS Substrate Team

Demonstrated laminar substrate technology, design, materials, and processability in 10 months for the joint Radar Multi-chip multiplexer for 10 programs, reducing MP execution risk and achieving significant cost savings.

Photovoltaic System Improvement Team

For identifying the cause (triboelectric charging in a wafer washing tool) of reduced yields in all NW ASIC product and CVV wafers. More specifically, developed a mathematical software solution to an urgently needed NW-based problem.

Promising Propulsion Team

For exceptional technical skill and critical support of complex satellite payload testing and characterization activities.

Red Tide

The Red Tide team completed a comprehensive test and evaluation of the Office of Naval Research’s Tactical Cloud Implementation deployment in the test system environment US Navy ships, on schedule and under budget.

T3 Excellence Testing Team

For excellence in software operational execution of a critical national security exploits experiment which changed community-wide understanding of a specific exploitation phenomenon.

Ten Year Refresh Plan for NNSA Nuclear Facilities

For Ten Year Refresh Plan analysis and the existing infrastructure and physical security systems across the NNSA nuclear weapon complex, then developed a prioritized list of security projects to refresh those systems.

TRENDO

For successful one-time and under-budget delivery of TRENDO tournament that met all requirements for use in a unique, high-visibility, high-impact simulation situation—on the radiation detection equipment for the New START treaty.

Division 8000

Advanced Mathematics

The Advanced Mathematics team provided a creative advanced mathematical software solution to an urgently needed NW-based problem.

Advanced Nuclear Physics Team

For development of a new process decreasing product acceptance errors, eliminating redundancy, and simplifying the closeout process.

AutoCAD and Enterprise Geographic Information System Development - Florida Division

For the design, development, and implementation of a mobile device reporting environment. This tool is designed to help users find reports more efficiently using modern technology.

B61-12 FASTER 2.0 Data Recorder Team

For delivering a high-impact application using an existing service-based architecture that transforms NW business, processes, and IT efficiencies, meeting a sandia level-5 milestone commitment to NNSA.

BPRM Project Team

For creating a successful pilot the first phase of the Weapon Response Analyst Training and Qualification Program, aimed at building Weapon Response Analyst competencies to improve the safety of nuclear explosive operations.

Division 10000

Enterprise Business Intelligence Development Team

For developing a new process decreasing product acceptance errors, eliminating redundancy, and simplifying the closeout process.

Enterprise Geographic Information System Development - Facilities and Asset Management Systems

For the design, development, and implementation of a mobile device reporting environment. This tool is designed to help users find reports more efficiently using modern technology.

Enterprise Systems Engineering Team

For exceptionally skilled technical engagement and critical support of complex satellite payload testing and characterization activities.

Enterprise Geographic Information System Development - Nevada Sites

For achieving the cause triboelectric charging in a wafer washing tool of reduced yields in all NW ASIC product and CVV wafers. More specifically, developed a mathematical software solution to an urgently needed NW-based problem.

Enterprise Geographic Information System Development - Division 6000

For the design, development, and implementation of a mobile device reporting environment. This tool is designed to help users find reports more efficiently using modern technology.

Executive Business Intelligence Development Team

For the design, development, and implementation of a mobile device reporting environment. This tool is designed to help users find reports more efficiently using modern technology.

Exceptional technical team delivering a high-impact application using an existing service-based architecture that transforms NW business, processes, and IT efficiencies, meeting a sandia level-5 milestone commitment to NNSA.

Financials and Procurement

For development of a new process decreasing product acceptance errors, eliminating redundancy, and simplifying the closeout process.

procurement

For exceptional technical engagement and critical support of complex satellite payload testing and characterization activities.

Procurement Guideline Reengineering

For developing a high-impact application using an existing service-based architecture that transforms NW business, processes, and IT efficiencies, meeting a sandia level-5 milestone commitment to NNSA.

Procurement

For development of a new process decreasing product acceptance errors, eliminating redundancy, and simplifying the closeout process.

Procurement

For development of a new process decreasing product acceptance errors, eliminating redundancy, and simplifying the closeout process.

Procurement

For development of a new process decreasing product acceptance errors, eliminating redundancy, and simplifying the closeout process.

Procurement

For development of a new process decreasing product acceptance errors, eliminating redundancy, and simplifying the closeout process.

Procurement

For development of a new process decreasing product acceptance errors, eliminating redundancy, and simplifying the closeout process.

Procurement

For development of a new process decreasing product acceptance errors, eliminating redundancy, and simplifying the closeout process.

Procurement

For development of a new process decreasing product acceptance errors, eliminating redundancy, and simplifying the closeout process.

Procurement

For development of a new process decreasing product acceptance errors, eliminating redundancy, and simplifying the closeout process.

Procurement

For development of a new process decreasing product acceptance errors, eliminating redundancy, and simplifying the closeout process.

Procurement

For development of a new process decreasing product acceptance errors, eliminating redundancy, and simplifying the closeout process.

Procurement

For development of a new process decreasing product acceptance errors, eliminating redundancy, and simplifying the closeout process.

Procurement

For development of a new process decreasing product acceptance errors, eliminating redundancy, and simplifying the closeout process.

Procurement

For development of a new process decreasing product acceptance errors, eliminating redundancy, and simplifying the closeout process.

Procurement

For development of a new process decreasing product acceptance errors, eliminating redundancy, and simplifying the closeout process.

Procurement

For development of a new process decreasing product acceptance errors, eliminating redundancy, and simplifying the closeout process.

Procurement
How to submit classified ads

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

Submit one of these methods:
- EMAIL: Michelle Fleming clavined@sandia.gov
- FAX: 990-4045
- MAIL: 90140 (Dept. 3051)
- INTERNET WEB: From Techweb search for ‘NewsCenter’, at the bottom of the page choose to submit an ad under, ‘Submit an article’. If you have questions, call Michelle at 844-4902.

Because of space constraints, ads will be printed on a first-come basis.

Ad rules:
1. Limit 18 words, including last name and phone number. No abbreviations.
2. Include organization and full name with the ad submission.
4. Type or print ad neatly; use accepted abbreviations.
5. First ad per issue.
6. We will not run the same ad more than twice.
7. No "for rent" ads except for ems.
8. No commercial ads.
10. We reserve the right not to run ads, even if accepted.
11. Work Wanted ads limited to students of employ- age.
12. We reserve the right to post a notice that may be consid- ered offensive or on our editorial.

REAL ESTATE

4-25 ACRES, currently categorized as agricultural. Jarales NM.
Park, 505-433-7405, ask for Lorraine.
3-BDR. HOME, 2 baths, deep garage, quiet Tramway/Corpus neighborhood, new appliances, Mastercool, etc., MLS#91173, $146,500. Carter, 505-681-6312.
NOB HILL CONDO, modern, gal- ted, natural lighting, covered parking, walking distance to shops, restaurants, 79,000 OBO. Corona, 294-4268.
3-BDR. HOME, 2 baths, 1,900-sq-ft., solid and updated, tile floors throughout, new countertops, new bathrooms, 1 block from La Cueva High. Francs., 505-553-2431, ask for Linda.
3-BDR. HOME, 2 baths, 1,760-sq-ft., lots of updates, large backyard, Holloman area, MLS#89559, $199,000. Crawford, 505-263-0376.

WANTED

GAZELLE Exercise Equipment.
Bar, 505-385-0137.
BOOKS ON ROAD ENGINEERING, w/ special interest on roads in mountainous environs. Menicucci, 235-8501.

Misclassified Ads

JITTERBUG FLIP PHONE, barely used, w/car charger, $7.5. McAllaster, 270-8920.
FORMING DINING TABLE, w/chairs, regency-style, mahogany, brass inlay on legs, $700. OBO. Asford, 505-286-2528.
BOOKCASES, 2, 4' x 3', w/matching 2-drawer executive file cabinets (2), solid oak, good condition, $150. Wells, 292-0179.
SONY RECEIVER, JCVCasse player, $100 both. Dreibing, 293-3315.
PURSE, Dooney & Bourke, tan, new, $50. OBO. Craft, 505-501-0792.
BOOKS ON ROAD ENGINEER-

GAZELLE EXERCISE EQUIPMENT.

NEW MEXICO CAMPAIGN:

505-228-2669.

DEADLINE: October 2-20.

ED COLE 30 Linda Wajer Barratt 25
LINDA KROUNER 15 15 Jeanette Orona 25
Lisa Teraji 25 25 Pin Yang
Charles Eberle 15 Benjamie Commons 15 Eugene Ormond 15 Lisa Teraji 15 George Wang 15

New Mexico photos by Michelle Fleming California photos by Randy Wang

SANDIA NEWS • September 29, 2017 • Page 15
More than 200 Sandia staff and visitors celebrated Hispanic Heritage Month last week with speeches, good food, delicious paletas, music, and dancing.

Events were organized by HOLA — Hispanic Outreach for Leadership and Awareness — and sponsored by DOE/NNSA, Kirtland Air Force Base, and the Sandia Zero Waste program. HOLA leaders Rita Garcia and Keith Vigil and a cadre of volunteers labored for months to stage the event, which included a student art contest, a Diversity Cinema showing of The Latino List and entertainment at Hardin Field.

Month officially established in 1968

Labs Chief of Staff Pablo Garcia handled emcee duties, telling the crowd that Sandia sees the month-long celebration as muy especialmente. He added that President Lyndon Johnson began the tradition in 1968 to “recognize the contributions of Hispanic and Latino-Americans to the country’s heritage and culture.” Pablo thanked HOLA volunteers Catalina Acosta, Erin Akinikawke, Emily Baca, Veronica Barraza, Miquella Carion, Doreen Chalasumphon, Daniel Cordova, Theresa Cordova, Liz Gallegos, Joshua Herrera, Riley Jordan, Guadalupe Masoth, Juan Molinar, Lyndsy Ortiz, Stefanie Portillos, Roberta Rivera, Daniel Sandovol, Lisa Sena-Carian, and others.

Associate Labs Director of Mission Services Scott Aeilts told attendees that he’s honored to serve as executive champion for HOLA. In nearly three decades of service to the Labs, he said, the organization has helped place qualified Hispanics in Sandia jobs, promoted awareness of career opportunities for local Hispanic youth, and fostered mentorship opportunities.

Other VIP speakers included NNSA Sandia Field Office Manager Jeff Harrell and USAF Col. Michael Harner, 377th Mission Support Group commander at Kirtland. Finally, Bernalillo County Commissioner Steven Michael Quezada, one of the stars of TV’s Breaking Bad series, gave a funny, piquant keynote address about growing up in Albuquerque, his Chicano identity, and his work to reduce gang violence through Youth Development Inc.

The crowd then enjoyed musical stylings and the high (alternative) energy of The Solarez Band, Sandia staff members from the National Solar Thermal Test Facility.