



Steve Rottler tapped to head California lab

Chief Technology Officer and Div. 1000 VP Steve Rottler will become VP of Sandia's California laboratory on Feb. 1. He replaces Rick Stulen, who is retiring after 36 years at Sandia. See the story on page 3.

'Zombie' cells may outperform live ones as catalysts and conductors

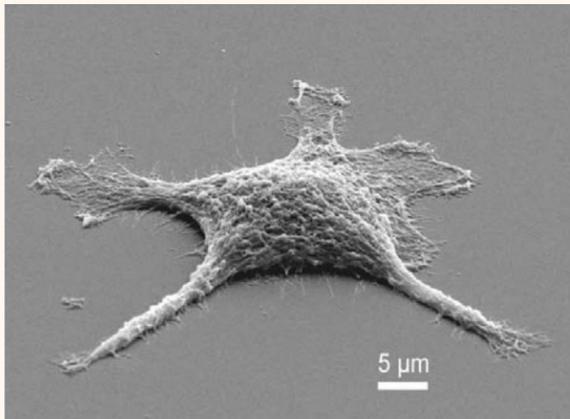
By Neal Singer

Sandia researchers have created "zombie" mammalian cells that may function better after they die. The simple technique uses a silica solution to coat a cell's insides to form a near-perfect replica of its internal structure. The process opens the door to simplifying a wide variety of commercial fabrication processes from the nano- to macroscale.

The work, reported in a fall issue of the *Proceedings of the National Academy of Sciences* (PNAS), uses the nanoscopic organelles and other tiny components of mammalian cells as fragile templates on which to deposit silica. The researchers then heat the cell to burn off its protein. The resultant hardened silica structures are faithful to the exterior and interior features of the formerly living cell, can survive greater pressures and temperatures than flesh ever could, and will function better for some uses than when they were alive, says lead researcher Bryan Kaehr (1815).

Letting nature do the work

"It's very challenging for researchers to build structures at the nanometer scale," says Bryan, who came to Sandia as a Truman Fellow. "We can make particles and wires, but 3-D arbitrary structures haven't been achieved yet. With this



ZOMBIE CELL, first stage — Only moderately heated, the cell is now pure silica, and needed to be coated in gold for a scanning electron microscope to image it.

(Image courtesy of Bryan Kaehr)

technique, we don't need to build those structures — nature does it for us. We only need to find cells that possess the machinery we want and copy it using our technique. And, using chemistry or surface patterning, we can program a group of cells to form whatever shape seems desirable."

Says University of New Mexico professor and Sandia Fellow Jeff Brinker (1002), "The process faithfully replicates features from the nanoscale to macroscale in a robust, three-dimensionally stable form that resists shrinkage even upon heating to over 500C. The refractoriness of these delicate structures is amazing."

Because a cell is populated by a vast range of proteins, lipids, and scaffolding, says Bryan, its interior is ready-made to serve as models for catalysts, funnels, absorbents, and other useful nanomachinery.

For example, he says, "Catalysts that evolve in cells are large molecules (enzymes) that have to be in the right shape for their chemistry to work. Because structure is important to their function, if we can stabilize a catalyst in the shape it evolved, that's extremely valuable. Imagine stabilizing a genetically

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Slip sliding away



Simulator teaches your muscles to catch a fall

By Nancy Salem

The human body has a pretty standard response to a slippery surface. It falls. But muscles have memory and can be trained to keep a person upright when the going gets slick.

"It's called kinetic learning, or learning by doing," says Andy Zeitler (4122), an occupational safety engineer. "The body learns very quickly and it will impact you a lifetime."

Andy is among a group of Sandians who worked nine months to bring an apparatus to the Labs to help train people to walk in slippery conditions without falling down. The Slip Simulator is a 10½-foot-high steel frame suspended over a polished, 20-foot-long tile runway. The trainee wears a harness attached to the top of the frame and walks down the 4-foot-wide path in a special shoe with furniture-moving sliders attached to the bottom.

"You're going to slip no matter who you are,"

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NO SLIP-UPS — Andy Zeitler (4122) talks about Sandia's new Slip Simulator. A team from Facilities built the 10½-foot-high by 20-foot-long apparatus in the old Disassembly and Sanitization Operation (DSO) facility in Tech Area 2.

United Way is moved by 17.1 percent boost in Sandia giving

Annual ECP campaign raises \$5.5 million for community needs

By Nancy Salem



The final numbers are in, and Sandia employees and retirees in 2012 increased donations to the United Way of Central New Mexico by 17.1 percent over the previous year, giving an "astounding" \$5,508,717 to the charitable organization.

Retirees contributed \$751,832 of the total and Sandia/California added \$236,227 through its SHARE campaign, making the total employee/retiree giving between both sites \$5,744,944. When it passed the \$5 million mark, Sandia became the first company ever to donate that amount in a single campaign to UWCNM.

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Benefits offers resources for a healthier you in 2013



See page 8

High-stakes launch

A target missile launched from Sandia's Kauai Test Facility (KTF) will fly across the sky and, if all goes according to plan, the Navy's newest interceptor missile, the Standard Missile-3 Block IB, will shoot it down. Story and photos on pages 6-7.

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That's that

Welcome back. Last year didn't end on a bad note, did it? The world didn't end on Dec. 21, we didn't go over that dreaded fiscal cliff, and the Redskins beat the Cowboys (and that's always a good thing, right?). So we have all been given dispensation to carry on for another year, to keep calm and carry on.

Have you seen those posters, by the way: the ones that say "Keep Calm and Carry On"? They seem to be showing up everywhere these days, or at least I've suddenly become very aware of them. They're striking in their simplicity: a stylized crown at the top, with bold lettering on a bright red background. As fresh and timeless as they look, the posters aren't exactly new. They originated in late 1939 when the British government's Ministry of Information printed some 2.5 million copies as part of a morale-boosting campaign at the beginning of World War II. Curiously, only a relative few were actually distributed at that time. Other posters – notably, one that read "Your Courage, Your Cheerfulness, Your Resolution Will Bring Us Victory" – were far more popular. A bookstore in the UK "rediscovered" the Keep Calm poster in 2000, and since the crown copyright on it had expired, the design was in the public domain. The bookstore owners started printing copies on demand and then in bulk as interest grew. By the end of the decade, the poster had attained that ultimate of 21st-century accolades – the parody: "Now Panic and Freak Out," "Keep Calm and Cary Grant," "Keep Calm and Rock On," (depicted with a silhouette of crossed electric guitars in place of the stylized crown), and even a parody of a parody, "Keep Calm and Rock On," with a silhouette of a child's rocking horse instead of guitars.

Some cultural observers think the new popularity of this 70-something-year-old propaganda poster is based on simple nostalgia for a certain lost "Britishness." Some think the message resonates with the current state of the economy: Times are tough, but hang in there and things will get better. There's probably something to both of those perspectives but I think, too, the poster succeeds mainly because people recognize the fundamental wisdom of the message. Panic never does any good. As the based-on-real-life surfing guru Frosty Hesson says to his young protégé in the movie *Mavericks*, fear is healthy, it keeps you alert and ready for action, but panic will kill you.

If I did New Year's resolutions, "Keep Calm and Carry On" would be about as good a goal as anything else I might choose. I like the pluck, the stiff-upper-lippedness of it. And I have learned, if I've learned anything at all over the years, that problems and challenges are almost always best addressed calmly, deliberately, forthrightly.

* * *

Had a nice interlude right before Christmas when I read that researchers have found that brown fat in the body actually accelerates the burning of white fat, the kind most of us would like to get rid of to a greater or lesser extent. With an apparent thumbs-up from the scientific community, I set about ingesting all the brown fat I could get my hands on: fudge, brownies, cakes, those marvelous concoctions called truffles, turtles, kisses . . . I know, I know – I sound like Bubba, the character in *Forrest Gump* who could rhapsodize endlessly about shrimp. I'll now pass on some hard-won, experience-based wisdom: Chocolate is, counterintuitively, not brown fat. It's plain old fat cleverly, insidiously disguised to look like brown fat. And predictably, it has the same ultimate effect as the plain old, garden variety "vanilla" kind, too. Come to think of it, if I did New Year's resolutions, maybe a gym membership would be in order.

* * *

On the subject of chocolate, there's this: My colleague Stephanie Holinka is always looking for ideas to help our media team be more effective in getting the word out about Sandia. To that end, she recently came across a web site that offered up some ideas guaranteed to generate surefire nationwide coverage. At the top of the list? Any research that shows chocolate is good for you will be picked up immediately and repeated widely across the country and around the globe. So here's a research challenge, for which you would need to get human research subject approval (but wouldn't have any problem finding volunteers!): Prove that chocolate belongs at the base of the food pyramid (the very foundation, that is) and I can guarantee that our media team will have your name in lights on Broadway within days. Prove that chocolate is, after all, brown fat, and you'll never dine alone or buy a drink again.

See you next time.

Bill Murphy (505-845-0845, MS1468, wtmurph@sandia.gov)

Employee death

A man of few words but a kind and gentle heart, James Martinez will be missed

Maybe when you first saw him, you figured James Martinez was a tough guy. It's like that sometimes with Harley riders, especially those with abundant tattoos, and James loved his Harley. But those who worked with

"He was funny; he loved to tell jokes and laugh and ride his Harley."

James knew better. He was a quiet man with a kind heart.

James, 56, died Dec. 25. The Leadville, Colo., native owned five motorcycles, including one he won in a radio contest. His bikes were very much tied up with his identity. He loved getting involved in "toys for tots" and other fundraiser bike rallies.

James came to Sandia in 2000, starting out as a custodian and then moving to the Sandia Warehouse, where he was involved in sending reusable, recyclable material to Reapplication/Reutilization.

James' team leader, Pam Mincey (4847), remembers his positive outlook on life and his humorous way of approaching things. "He shared many life lessons with us," Pam recalls, "and he was always appreciative that Sandia gave him an opportunity to work here.

"James and I shared the same birthday and we would always have lunch together on that day. This gave me a chance to see the personal side of James and to hear his perspective on things. I can honestly say that James taught me a few things about life in general based on his experiences."



KIND HEART — James Martinez donated stuffed animals at All Faiths Receiving Home. He loved to participate in motorcycle rallies to raise funds for charity. (Photo by Jennifer Standridge)

John Duran (4847) recalls that "James was a man of few words, but when he spoke, the words were always meaningful. I went to his funeral service and it was very evident to me that James touched a lot of lives and helped out so many with just his words."

James was "a good friend; I would call him a 'bro,'" says Epifaino Waquiu (10264). "His insights about life were true in his own way. His words and actions throughout the community were humbling and brought you to a true sense of reality."

Kalina Jinzo (3334) first met James five years ago at Medical. "He was a man of few words at that time, but over the years James and I become really good friends. He was no longer my patient, he was my friend."

"He was a very quiet man, kept to himself, but if you had the chance to get to really know him, he was the sweetest man with a big heart. Believe it or not, he loved to talk once he got to know you. He was funny; he loved to tell jokes and laugh and ride his Harley. I am truly going to miss his smile, his jokes, and his stories."

Speaking of that big heart, Jennifer Standridge (4847) remembers the time James came to her office one Friday. "He told me he had his back seat full of stuffed animals and wanted to know where he could donate them. I suggested he try All Faiths Receiving Home. He thought that was a great idea and he asked me if I would go with him and take a picture.

"James was a very dear friend and coworker. He was a very thoughtful, giving person and a good listener. He was there for me through some difficult times in my life. I will truly miss the many good times we shared."

"James was a man of few words, but when he spoke, the words were always meaningful."



Sandia National Laboratories

<http://www.sandia.gov/LabNews>

Albuquerque, New Mexico 87185-1468

Livermore, California 94550-0969

Tonopah, Nevada • Nevada National Security Site

Amarillo, Texas • Carlsbad, New Mexico • Washington, D.C.

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

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Lab News fax **505/844-0645**
Classified ads **505/844-4902**

Published on alternate Fridays by Media Relations and Communications Dept. 3601, MS 1468



Lab News Reader Service

The *Sandia Lab News* is distributed in-house to all Sandia employees and on-site contractors and mailed to all Sandia retirees. It is also mailed to individuals in industry, government, academia, nonprofit organizations, media, and private life who request it.

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The *Lab News* is on the external web at www.sandia.gov/LabNews. *Lab News Interactive*, accessible on the internal web, is at: www-irm.sandia.gov/newscenter/interactive.

Steve Rottler to head California laboratory as VP of Div. 8000, head of Energy, Climate, and Infrastructure Security SMU

Julia Phillips, Duane Dimos will assume acting roles as Chief Technology Officer and Div. 1000 VP, respectively



CHIEF TECHNOLOGY OFFICER Steve Rottler will become VP of Sandia's California laboratory, Div. 8000, effective Feb. 1. (Photo by Randy Montoya)

Chief Technology Officer Steve Rottler will become VP of Sandia's California laboratory on Feb. 1. Steve, currently VP of Science and Technology Research Foundations Div. 1000, replaces Rick Stulen, who is retiring after 36 years at Sandia.

In his new position, Steve also will lead the Energy, Climate, and Infrastructure Security Strategic Management Unit.

In announcing Steve's new role, Labs Director Paul Hommert said, "This management change will maintain continuity and operational stability

during the pending contract competition and help ensure a leadership team that supports the workforce as we continue to deliver on our commitments."

Steve has held a number of increasingly important leadership roles since he joined Sandia as a member of the technical staff in 1985, including VP of Weapons Engineering and Product Realization and chief engineer for nuclear weapons. He also led nuclear warhead system engineering, the integration and development of high-performance electronic systems, and organizations and programs responsible for the research, development, and application of advanced com-

putational and experimental techniques in the engineering sciences.

Steve received his bachelor's, master's, and doctorate, all in nuclear engineering, from Texas A&M University.

"Everyone at Sandia owes a tremendous debt of gratitude and appreciation to Rick Stulen for his significant contributions to the Laboratories and the nation," Paul said. "I wish him the very best in his retirement."

Steve's current responsibilities as VP for Div. 1000 and CTO will be split between Julia Phillips, currently director of Research Strategy and Partnerships Center 1900, and Duane Dimos, currently director of Engineer-

ing Sciences Center 1500. Julia will be the acting VP and Chief Technology Officer, and Dimos will serve as acting VP of Div. 1000, both effective Feb. 1.

Julia will lead Sandia's Research Foundations and take responsibility for the Laboratory Directed Research and Development Program and research strategy development and implementation. She will also lead Sandia's technology transfer efforts and the Labs' research relationships with universities, industry, and the state of New Mexico. Julia is a Fellow of the Materials Research Society, American Association for the Advancement of Science, and the American Physical Society. She received her doctorate in applied physics from Yale University.

As acting VP for Div. 1000, Duane will be responsible for delivering a full spectrum of differentiating research and development capabilities to support Sandia's mission needs — from fundamental scientific discoveries to system-level engineering solutions. He is chair of the Materials Research Society's Government Affairs Committee, is a fellow of the American Ceramic Society (ACerS), and is a past chair of the Basic Science Division of the ACerS. Duane received his doctorate in materials science and engineering from Cornell University.



JULIA PHILLIPS



DUANE DIMOS

2012 ECP giving shatters all records

(Continued from page 1)

"The results from the campaign are truly astounding," says Anthony Thornton, the 2012 Employee Caring Program campaign chair and deputy to the VP of Defense Systems and Assessments Dept. 5220. "Everyone at Sandia Labs should be extremely proud of what we accomplished together. This donation will make our community a better place and help our most vulnerable neighbors."

The 2012 ECP campaign set goals to raise \$5 million, increase participation in every division from the 2011 baseline, and engage newer employees in the Labs' culture of giving. Sandia's overall participation

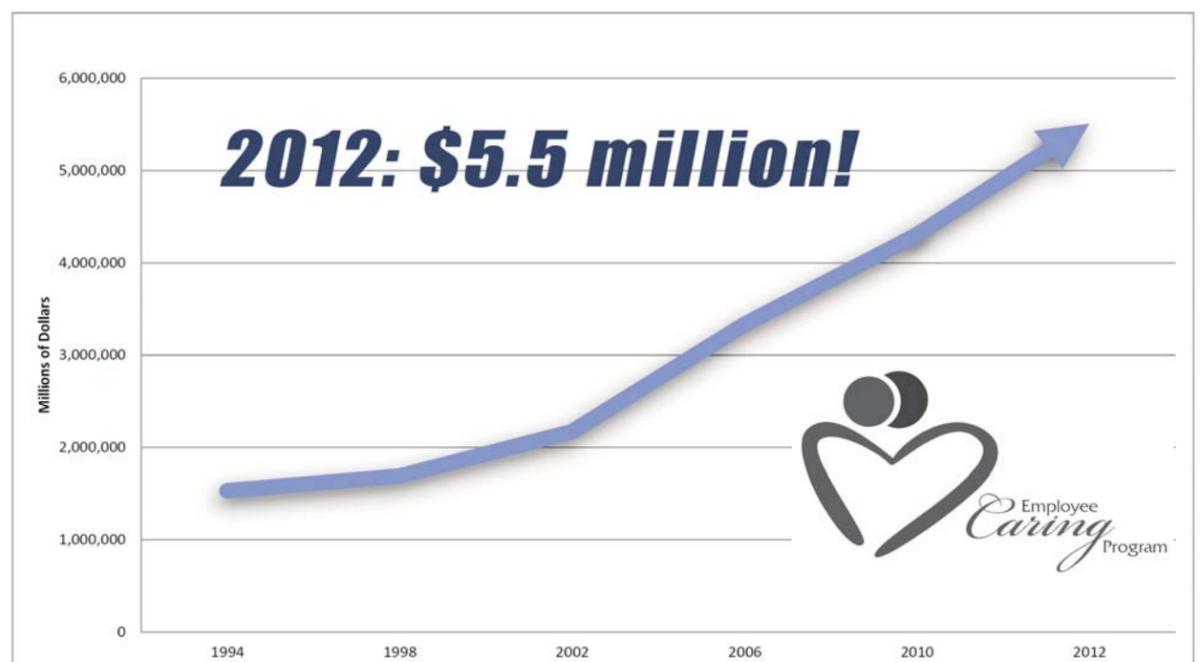
"Everyone at Sandia Labs should be extremely proud of what we accomplished together. This donation will make our community a better place and help our most vulnerable neighbors."

— 2012 ECP Campaign Chair Anthony Thornton

rose to 73.6 percent from 71.8 percent the previous year, and more than 90 percent of divisions raised their participation. New employees showed a participation increase of 5.6 percent.

Of Sandia's total giving, \$1,489,990 was designated to the Community Fund, up \$63,753 from the previous year. The fund supports a range of programs that address families, education, health, hunger, family violence, senior citizens, the homeless, and the disabled in Bernalillo, Sandoval, Tarrant, and Valencia counties.

Deputy Laboratories Director and Executive VP for Mission Support Kim Sawyer, chair of UWCNM's 2012-13 \$28.15 million campaign, says the response from Sandians and retirees this year was "absolutely fantastic."



"It continues to demonstrate our strong culture of giving," she says. "Other companies admire the generosity of Sandians and our retirees and are envious of what we have accomplished for the good of the community year after year."

Due to the UWCNM's Corporate Cornerstone program, 100 percent of money donated by individuals goes directly to help people in need. Companies can choose to donate to Corporate Cornerstone, which pays all the organization's administrative expenses. Lockheed Martin/Sandia donates \$100,000 annually as one of more than 70 Corporate Cornerstone companies.

Ed Rivera, UWCNM's president and CEO, says Sandia's generosity is "huge," and an inspiration to the

entire community. Rivera says Sandia's per capita giving ranks in the top among companies of its size nationwide. "We thank you for that from the bottom of our hearts and from all those who benefit from what you do," he says. "You will change lives."

Since the ECP was launched in 1957, Sandia has been the single largest supporter of the organization's annual campaign. Sandians have contributed more than \$76 million to the community.

"And every year it gets better. What Sandia accomplished this year is unheard of," says Randy Woodcock, UWCNM's vice president and chief strategic officer. "I've never seen a company of this size increase this much in one year."



Slip simulator

(Continued from page 1)

Andy says. "Every single person who steps out there slips a little. The body tells you this is slick and says, 'I have to change how I walk.'"

As the walker toils down the path the harness prevents a fall. "It trains you to position your body so you don't fall," Andy says. "The walker instinctively learns to straighten up, shift the center of gravity underneath the body, and take smaller steps."

The next time the person is on a slippery surface the kinetic learning should kick in automatically. "It's like riding a bike," Andy says. "There's muscle memory so you catch yourself. It's in your body and always with you. You don't have to think about it."

Slips, trips, and falls have been the No. 1 source of injuries at Sandia for years, especially during winter. Nationally, the direct cost of annual workplace injuries due to slips and falls is estimated at \$6 billion, according to a 2003 study by Liberty Mutual Research Institute for Safety.

"We often forget about the human element related to slip injuries," Andy says. "Pain, loss of mobility, and possible long-term debilitation can result from a fall and have a lasting impact on a person's quality of life."

NOT SO FAST — Kim Sawyer, Deputy Laboratories Director and Executive VP for Mission Support, navigates a super-slick surface and an obstacle as she tries out Sandia's new Slip Simulator. "It was challenging but fun at the same time," says Kim, who wore a safety harness to prevent a fall. Individuals and groups are encouraged to use the simulator to train their bodies not to fall on slippery surfaces. (Photos by Tom Wubbels)

"I strongly recommend that all Sandians try the Slip Simulator. It would provide a great experience for groups who want to emphasize safety and team building, and want to laugh a little."

— Executive VP Kim Sawyer

The Slip Simulator got a lot of visibility after United Parcel Service started using one. The average UPS driver makes more than 100 deliveries a day in sometimes wet and/or snowy weather or on slippery floors. Training on the simulator resulted in a significant drop in on-the-job falls.

Sid Gutierrez, director of Radiation Protection, Waste Management, and ES&H Center 4100, heard that Los Alamos National Laboratory had a Slip Simulator. He sent a team to LANL to check it out. "Everybody fell in love with it," Andy says. "The Slip Simulator has the potential to greatly improve the safety culture at Sandia while teaching folks to walk safely on slippery surfaces."

LANL sent design drawings and specs. ES&H ordered materials and a team from Facilities built the simulator

in the unused Disassembly and Sanitization Operation (DSO) facility in Tech Area 2.

It was unveiled in mid-December and one of the first volunteers was Deputy Laboratories Director and Executive VP for Mission Support Kim Sawyer. "I thought it would be a breeze to cross through," Kim says. "I quickly discovered that the surface was almost like glass. The first time across was a piece of cake. I was then challenged to perform some everyday things — holding a phone, a package, wearing a backpack. Clearly, this made it more difficult."

Kim's muscle memory kicked in and she took small steps and focused on the path. "It was challenging but fun at the same time," she says.

Starting in February, Sandians will be able to sign up for a simulator session on a special website. Andy says sessions will be offered most days. Each individual session runs about 10 minutes. He says people should aim to use it once a year to continue to improve their slippery-surface walking skills.

"It's just phenomenal that Sandia has something as awesome as this," Andy says.

Kim agrees. "I strongly recommend that all Sandians try the Slip Simulator," she says. "It would provide a great experience for groups who want to emphasize safety and team building, and want to laugh a little."

Zombie cells

(Continued from page 1)

designed biocatalyst at its most optimal shape and then using it in a 200 degree Celsius reaction in which it otherwise would have no chance of surviving." The hardened silica would stabilize and protect the still-present protein as it did its work.

In its simplest, most immediate use, says UNM post-doctoral student Jason Townson, silicification may be the simplest, best method of preserving the structure of organic materials for imaging. "Formerly, for internal preservation and subsequent imaging, a cell would be fixed in formaldehyde or some other preservative. But many of these methods are labor-intensive. This method is simple. The preserved cells will never get sloppy in decay. And when we cracked open the resulting structure, we were blown away by how well the cell was preserved, down to the minor groove of the cell's DNA."

Like a Madame Tussauds wax portrait

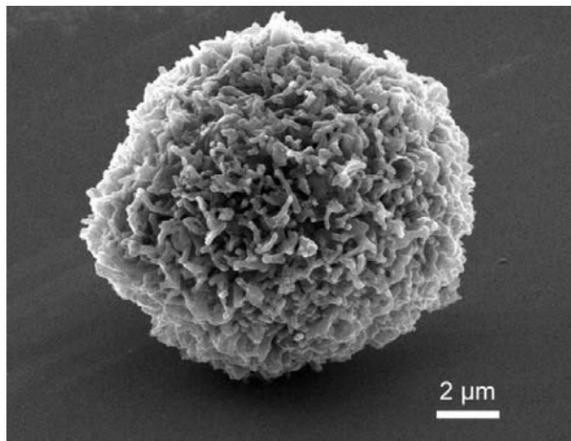
Heating the cell to still higher temperatures, greater than 400 C, evaporates the organic material of the cell — its protein — and leaves the silica in a kind of three-dimensional Madame Tussauds wax portrait of a formerly living being. The difference is that instead of modeling the face, say, of a famous criminal, the hardened silica-based cells display internal mineralized structures with intricate features ranging from nano- to millimeter-length scales.

Construction occurs like this: Take some free-floating mammalian cells, put them in a Petri dish, and add silicic acid.

Through the action of methanol, a byproduct of the acid, the cell's lipid layers — the protective casings that keep the cell intact — are softened and made porous enough for the silica to flow in at about the temperature of the human body.

The silicic acid, for reasons still partially obscure, enters without clogging and in effect embalms every organelle in the cell from the micro- to the nanometer scale.

If the cell isn't heated, the silica forms a kind of per-



ZOMBIE CELL, advanced — The cell was pyrolyzed to 900 C in the absence of oxygen, leaving a cell of graphitic carbon and silica. Because carbon is conductive, the cell — practically identical to its protoplasmic original — doesn't need to be coated in gold to produce an SEM image. (Image courtesy of Bryan Kaehr)

meable armor around the protein of the living cell. This may support it enough to act as a catalyst at temperatures and pressures undreamed of by nature.

"Once we've stabilized the cellular structure, it can still carry out reactions and more important, that reaction is stable enough to work at high temperatures," Bryan says. "It's a means to take a soft, potentially valuable biological material and convert it to a fossil that will stay on our shelves indefinitely."

Ordinarily, preserving something organic means freezing it, which is energy-intensive, he says. Instead, "We're doing rapid fossilization: quickly converting a protoplasmic cell into a hard structure that will stand the test of time."

The unusual but simple procedure may serve as a model for creating harder classes of nanoscopic products.

Experiments showed the cell can be used as a reverse mold from which, at 900 C, a porous carbonized structure results from heating cell protein in a vacuum. (Put in ordinary terms, burning wood in air leaves a residue

of structureless soot. The zombie heating method results in a high-quality carbon structure.) Subsequent dissolution of the underlying silica support decreased the cell's electrical resistance by approximately 20 times. Such materials would have substantial utility in fuel cells, decontamination, and sensor technologies.

Going beyond large sponges

That such extraordinary results can be achieved by silicifying cells indicates, according to the technical paper, that many soft cellular architectures could be "feedstock for most materials processing procedures, including those requiring high temperatures and pressures."

Other porous material structures, relying on titanium instead of silica, have been formed using the organic template technique. Other metal oxides, says Bryan, are a possibility. These would have advanced structural functions or could serve as catalysts.

The work follows the efforts of a number of scientific groups, including Bryan's, that have built gel-like structures, copied them with silica, and then burnt off the gel to create, in effect, large sponges.

"Now we can change the biological shape and calcify (heat) it, so for the first time we get new irregular structures," Bryan says.

In the PNAS paper, Bryan's team used dissociated cell culture from various human, chicken, and mouse organs as starter material. Grown in flasks, these are soft, delicate objects that normally would eventually exist in a multicellular structure like a person (or a chicken or mouse).

"Since then we have found that the procedure can silicify an entire organism — in this case, a chicken embryo — which is somehow creepy," says Bryan. "But it proves that larger-order animal forms (that is, humans) can, in principle, be glassified just like single cells using this technique."

The work was supported by DOE's Office of Science. Other authors of the technical paper are Jeff Brinker (1002 and UNM), Brian Swartzentruber (1131 and the Center for Integrated Nanotechnologies), Robin Kalinich (2501), and Darren Dunphy and student Yasmine Awad of the University of New Mexico.

Looking for nefarious intent in the cyberworld

By Sue Major Holmes

The weakest link in many computer networks is a gullible human.

With that in mind, Sandia researcher Jeremy Wendt (5632) is trying to figure out how to recognize potential targets of nefarious emails and put them on their guard.

He's working to reduce the number of visitors that cyberanalysts have to check as possible bad guys among the tens of thousands who search Sandia websites each day.

His ultimate goal is to spot spearphishing. Phishing is sending an email to thousands of addresses in hopes a few will follow a link and, for example, fall for a scam offering millions of dollars to help a Nigerian prince wire money out of his country. Spearphishing, on the other hand, targets specific email addresses that have something the sender wants. "Spearphishing is scary because as long as you have people using computers, they might be fooled into opening something they shouldn't," Jeremy says. Even if an outsider gets into a Sandia machine that doesn't have much information, that access makes it easier to get into another machine that may have something, he says.

Jeremy has been working on algorithms that separate web crawlers from people using browsers, and he has been able to split those groups. He believes the work to date will help security because it allows analysts to look at groups separately.

Identifying malicious intent

Cybersecurity's Roger Suppona (9317) says the ability to identify the possible intent to send malicious content might enable security experts to raise a potential target's awareness. "More importantly, we might be able to provide sufficient specifics that would be far more helpful in elevating awareness than would a generic admonition to be suspicious of incoming email or other messages," he says.

Jeremy, in the final stretch of a two-year Early Career Laboratory Directed Research and Development grant, presented his work last year at a Sandia poster session.

He has been looking into behaviors of web crawlers vs. people browsing to see if that matches how computers identify themselves when asking for a webpage. A browser's computer generally says it can interpret a particular version of HTML — HyperText Markup Language, the main language for displaying webpages — and often gives browser and operating system information. Crawlers identify themselves by program name and version number. A small number Jeremy calls "nulls" offer no identification, perhaps because the programmer omitted that information, perhaps because someone wants to hide.



JEREMY WENDT is sharpening the tools needed to foil nefarious spearphishers. (Photo by Randy Montoya)

What Jeremy is looking for is a computer that doesn't identify itself or says it's one thing but behaves like another and trolls websites in which the average visitor shows little interest.

Going to an Internet site creates a log of the search. Sandia traffic is about evenly divided between web crawlers and people browsing. Crawlers tend to go all over; browsers concentrate on one place, such as jobs.

Crawlers, also known as bots or robots, are automated and follow links like Google or Bing do. "When we get crawled by a Google bot, we aren't being crawled by one visitor, we're being crawled by several hundreds or thousands of different IP addresses," Jeremy says. An IP or Internet Protocol address is a numerical label assigned to devices on a computer network, identifying the machine and its location.

Distinguishing bots from browsers

Jeremy wants to distinguish bots from browsers without having to trust they are who they say they are. He expects some are lying, so he looked for ways to measure behavior.

The first measurement deals with the fact bots try to index a website. When you type in search words, the web crawler looks for pages associated with those words, disregarding how they're arranged on a page. That means a bot pulls down HTML files far more often than other things.

Jeremy first looked at HTML downloads. Bots should have a high percentage. Browsers pull down smaller percentages.

More than 90 percent of the nulls pulled down nothing but HTML — typical bot behavior.

A single measurement wasn't enough, so Jeremy devised a second based on another marker of bot behavior: politeness.

Bots could suck down webpages from a server so fast it would shut down the server to anyone else, Jeremy says. That might prompt the site administrator to block them.

So bots take turns. "They say, 'Hey, give me a page,' then they may crawl a thousand other sites taking one page from each," Jeremy says. "Or they might just sit there spinning their wheels for a second, waiting, and then they'll say, 'Hey, give me another page.'"

Browsers go after only one page but want all images, code, and layout files for it instantly. "I call that a burst," Jeremy says. "A browser is bursty; a crawler is not bursty." Bursts equal a certain number of visits within a certain number of seconds.

What 'bursty' behavior indicates

Ninety percent of declared bots had no bursts and none had a high burst ratio. Sixty percent of nulls also had no bursts, lending credence to Jeremy's belief they're bots.

But 40 percent showed some bursty behavior, making them hard to separate from browsers. However, normal browsers behave predictably. When Jeremy combined both metrics, most nulls fell outside those parameters.

That left browsers who behaved like bots. "Now, are all these people lying to me? No. There could be reasons somebody would fall into this category and still be a browser," Jeremy says. "But it distinctly increases suspicions."

So he also looked at IP addresses. Unlike physical addresses, IP addresses can change. Say you plug your laptop into the Internet at a coffee shop, which assigns you an IP address. After you leave, someone else shows up and gets the same IP address. So an IP address alone doesn't necessarily distinguish users.

There's another identifier: a particular browser on a particular operating system, which leads to what's called a user agent string. There are thousands of distinct strings.

IP addresses and user agent strings can collide, but Jeremy says odds are dramatically lower that two people will collide on the same IP address and user agent string within a short period such as a day. That tells him they're probably different people.

Now he needs to bridge the gap between splitting groups and identifying targets of ill-intentioned emails. He has submitted proposals to further his research after the current funding ends this spring.

Carrying the fire: Sheldon Tieszen honored for passion to fire sciences

By Sue Major Holmes

Sandia President and Labs Director Paul Himmert says he wishes there were a magical way for new hires to have known the late Sheldon Tieszen as a mentor and to have seen the passion with which he pursued his work and interacted with others.

"I would just say to them, 'Be like that,'" Paul says.

Paul and Engineering Sciences Center 1500 Director Duane Dimos credit Sheldon for the vision that became Sandia's high-tech Thermal Test Complex.

Sheldon, who retired from Sandia on Christmas Eve 2011, died of a brain tumor Sept. 28 at age 54. Paul talked with Duane when they heard about Sheldon's death and both felt Sandia should do something to recognize the debt of gratitude it owed him.

Sheldon's friends and colleagues collected funds to honor him with a plaque that now hangs in the Thermal Test Complex. The metal plaque, unveiled at a half-hour ceremony at the complex Dec. 13, reads, "To our friend, Sheldon R. Tieszen, for his dedication and leadership to engineering sciences and his contributions to the field of fire sciences." The plaque features an engraved picture of Sheldon backed by a panoramic view of the Sandia Mountains where he loved to hike.

'Not too many dry eyes'

More than 85 friends and Sheldon's wife, brother, and sister attended the ceremony. Duane, who says Sheldon often talked about how he had been mentored when he first arrived at Sandia, says the gathering represented a room full of people Sheldon mentored in his nearly 30 years at the Labs. Paul, who spoke at the event, says it was a reflection of how people felt about Sheldon and that as people talked about him, "there were not too many dry eyes in the place."

Sheldon, who worked in the organization Paul headed in the 1990s, presented

his idea back then for an experimental fire facility. Paul acknowledged thinking the facility wasn't mainstream enough and there was little chance for it, but he told Sheldon to go for it. When Paul returned to Sandia after leaving for a time, the Thermal Test Complex had become reality.

Chief Technology Officer and Div. 1000 VP Steve Rotler told the gathering, "Sheldon's work on the effects of fire was an essential contribution to nuclear weapon safety."

The test complex, opened in 2005, is aimed at fundamental understanding of fire science, heat transfer, and thermal science. It provides a controlled environment to test the performance of components and assemblies, subjecting them to temperatures up to 2,200 C with a simulated setup that allows a "dial-a-fire" approach.

"He will always be thought of as the guy who had this real vision for that facility, and someone who wouldn't give up that vision," Duane says.



DEDICATED TO A FRIEND — Pat Tieszen, wife of the late Sheldon Tieszen, reacts as Engineering Sciences Center 1500 Director Duane Dimos unveils a plaque last month honoring Sheldon's contributions to fire science and the creation of Sandia's Thermal Test Complex. Sheldon died in September, less than a year after retiring from Sandia.

(Photo by Richard Simpson)

High-stakes countdown:

Kauai Test Facility launches target missile to help assure national defense



LAUNCH OPERATIONS BUILDING — Called the LOB, this is the center of activity for Kauai Test Facility (KTF) during the practice countdowns and the launch. Makaha Ridge provides a natural backdrop. (Photo by Heather Clark)

Story by Heather Clark

In the Pacific Ocean, some sailors will be tested. A target missile launched from Sandia's Kauai Test Facility (KTF) will fly across the sky and, if all goes according to plan, the Navy's newest interceptor missile, the Standard Missile-3 Block IB, will shoot it down in an operation similar to defending the US from an offensive missile attack.

Past test operations have been described as hitting a bullet with a bullet.

Most people think of countdowns as the television voiceover saying, "10, 9, 8 . . ." but they are much more.

Days and weeks before the launch, Sandia employees arrive at KTF, a 132-acre launch site at the Pacific Missile Range Facility (PMRF) on the western tip of the Hawaiian island of Kauai, to support the test of the US Missile Defense Agency's Aegis Ballistic Missile Defense Program.

At the PMRF gate, drivers are told to go "right at the stop sign and all the way down." The remote spot is no accident: it has little interference from the radio frequencies found on the East and West coasts; there's an expanse of ocean to work in and it's near the Pacific Fleet, says Vince Salazar, senior manager of Sandia Missile & Air Defense (5410).

Test targets arrive at the Missile Assembly Building, which contains a 30-by-70-foot high bay with 10- and 20-ton cranes and office space, where they are assembled and tested, manager Steve Lautenschleger (5419) says.

Nearby, two white canvas "clamshells" on wheels protect two large rail launchers, which are used to launch both guided and ballistic missiles, from the weather, Steve says. Nearby are a vertical stool launcher, which will be used for this missile, and a universal rail launcher.

Across from the vertical launcher is the bunker-like Launch Operations Building (or LOB, pronounced el-oh-bee), the site's communications hub, topped by 15- and 20-foot white dish antennas that will receive telemetry from the missile.

Reuben Martinez (5419), the test director for this mission, first came to KTF as the "computer guy." He explains that thousands of data points will be analyzed and turned into graphic displays that help controllers quickly determine whether the test missile is flying along its intended flight path. They use that information in real time to make recommendations about whether to continue the mission. It's also used after the flight for further analysis or making changes when things don't go the way they should, he says.

Sandia employees and contractors begin their three practice countdowns with the arrival of Uncle Tom Takahashi, an 81-year-old elder (kapuna) from a local church who blesses the missile.

"Sandia, her name is," he pauses, then, "Uilani," which means beautiful heaven. The Navy missile is named "Keiki ale ale o kekai," which means choppy water of the ocean, describing the condition of the Pacific in recent days.

The practice countdowns include: an internal readiness test, the first time everyone comes together for the mission; a dry run, to verify the countdown is correct; and a dress rehearsal, when the aircraft and ships participate so they understand the timing and the countdown must be finalized, says Margaret Scheffer (5419), the Sandia test officer. Margaret will communicate with PMRF, the lead range on launches from KTF. Reuben will be responsible for all the intrarange issues involving the missile, launch pad, and all the KTF launch assets.

"It's high pressure in the terminal countdown, so it's important to have these practice countdowns," Reuben says.

Launch day

When employees arrived at KTF, the smell of smoke hung in the air from a wildfire on nearby Makaha Ridge.

Reuben arrives from PMRF's Range Operations Control Center (ROCC, pronounced rock) and says the launch is a go.

Notices already have been sent to ships and aircraft, telling them to avoid the Notice to Mariners/Notice to Airmen (NOTMAR/NOTAM) area surrounding the potential debris field. On launch day, the area is again checked for "range foulers" that haven't heeded earlier warnings, Margaret says.

Along the raised concrete platform that connects the white 40-foot trailers that house staff and customer offices, Margaret walks to the LOB. Is she nervous ahead of the launch? "Not yet. I don't get nervous until the last 30 minutes."

During three practice countdowns, Margaret has demonstrated nerves of steel under pressure, seasoned by the dozens of countdowns she has run. She is an aeronautical engineer who worked on Sandia's Strategic Target System (STARS) and other missiles.

Reuben and Margaret sit down behind a bank of video and computer monitors, keyholes, knobs, and switches on a raised platform in the center of the LOB to start the countdown. Three large video screens show the launch pad and the test missile's sides, graphics of the flight path once the test missile is launched, and pictures from the rocket's on-board camera.

A large digital clock with red numbers ticks away the hours at the left-hand side of the room.

T minus 06:00:00

"T minus six hours," an automated voice says.

This is the countdown's unceremonious start. The KTF team must complete more than 500 steps to launch the 42-foot-tall single-stage guided missile. Each step is listed on a spreadsheet that Reuben has tweaked to perfection in the late night hours during the three practice countdowns.

If the on-screen boxes containing each step turn yellow, Reuben and Margaret state the task hasn't been completed within one minute of its scheduled time. After 60 seconds, the print turns red and remains so until the task is completed and checked.

T minus 05:33:03

One of the first major steps is to verify the launch pad and missile are ready for launch. The latter involves turning on and verifying you can receive telemetry from the equipment, and confirming that the systems are working.

After Margaret receives a series of numbers from PMRF, an expert in the field radios to say several numbers are unusually low.

Reuben considers the problem, leaning forward in his chair and then pacing. He asks whether one of the doors on the vertical launch tower hadn't been opened properly and saturated the radio signal, but the response from the field was that the door was fine.

The wheels turn in his head as he ticks off what could be causing the odd readings: Are the PMRF antennas turned in the correct direction, he asks. Sure enough they were pointed the wrong way. Problem solved.

"You need to have situational awareness," Reuben says. "When something doesn't look good, you have to figure it out on the fly."

T minus 05:00:00

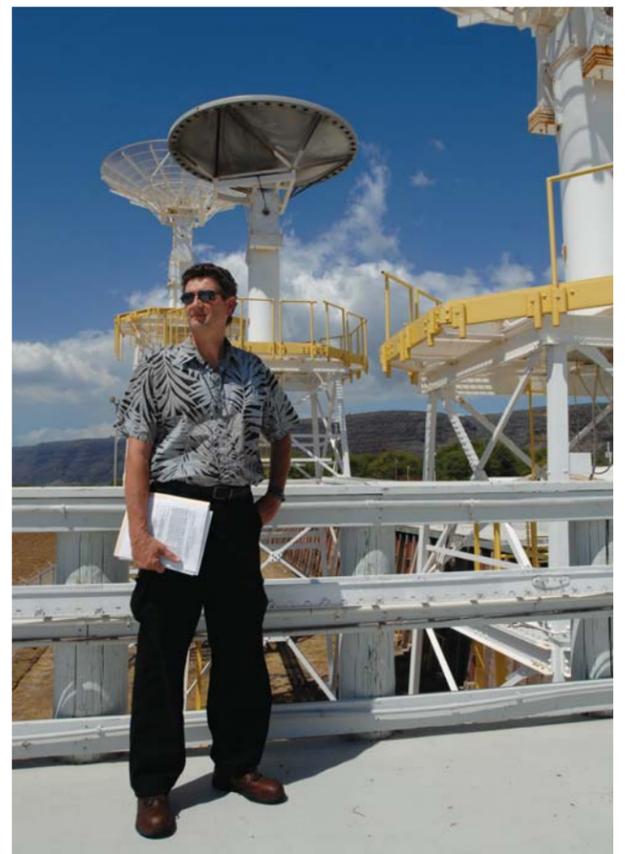
"T minus five hours," drones the automated voice.

Reuben's and Margaret's jobs are stressful and involve major multitasking. Imagine monitoring 15 communications networks, or loops, chattering all at once, having to problem-solve within seconds or risk delaying a launch, and working and communicating with multiple agencies to make the launches happen.

"It's a stressful job, but it's exciting," says Reuben, who has been test director for five launches and recently also became KTF's site manager. "Margaret and I are a good team. We'll get in a groove, and I know what she's going to do and she knows what I'm going to do."



DRESS REHEARSAL — Margaret Scheffer, left, the Sandia test officer for this launch, and Reuben Martinez (both 5419), the test director, work through a six-hour dress rehearsal, ahead of the final countdown. (Photo by Michael Bejarano)



ATOP THE LOB — Manager Steve Lautenschleger (5419) explains the layout of KTF from the rooftop of the LOB. (Photo by Michael Bejarano)



READYING EQUIPMENT — Scott Walkington, left, and Michael Bejarano (both 1535) run through pre-launch checks of their photometrics equipment near the vertical launcher during a practice countdown. (Photo by Heather Clark)

As they work, many times a single utterance or a nod indicates who's going to handle which task and they often cover for each other like clockwork.

Employees then verify that the Flight Termination System (FTS) works. This missile contains an FTS, which could be triggered remotely to destroy the vehicle if it flies off course before it hits something it shouldn't, Steve says.

A large white weather balloon is tethered to the 80-foot tall launch tower to provide a PMRF team a visual on the vehicle pad location. This gives the PMRF team a line of sight to verify how the rocket leaves the launch pad in the brief period before it's high enough to be detected by radar, Margaret says.

The balloon is the same as the five or six weather balloons Sandia contractors at KTF launch to 100,000 feet to measure high altitude weather conditions, such as the jet stream, say mechanic Charlie Vegas and groundskeeper Michael Mier (both 5419-1).

"In the beginning, we didn't get involved with the launches. Now we've gotten involved with pretty much everything they do," Charlie says.

Ken Dama (5419-1) agrees that the local contractor staff is an integral part of KTF, in day-to-day operations and mission support.

Today, the weather balloon above the launch pad accidentally gets wrapped around a lightning tower and partially deflates. Steve

is concerned that the balloon could interfere with the launch tower being pulled away from the missile.

"There's always some kind of unplanned event," Reuben says. During a practice countdown, four chickens scurried across the launch pad and pigs once ran across the launch pad during an actual countdown.

Steve decides the balloon must be cut down, and confers with Wayne Itokazu (5419), who is responsible for the weather balloon launches and data acquisition.

"I like these types of crises better than when a target missile doesn't work," Steve says. "This is not so bad."

Safety risk analysis

Terry Jordan-Culler (5422), an aerospace engineer, calls from Sandia/New Mexico to give a real-time flight safety risk analysis using weather balloon data.

Should the report be negative, the launch could be scrapped, Reuben says.

While the support Terry gives from Sandia is just one example, Vince says Sandia's involvement in KTF pre- and post-launch and during the mission operations is key to KTF's success, particularly when Sandia-developed rockets and payloads are launched.

"Sandia is what makes KTF unique. It is Sandia doing the technical work, developing the target missile systems and also having major responsibility for the payloads that were out there," Vince says. "You get to see the countdown and liftoff of these experiments. It is sealing the deal."

Suddenly, 13 steps on Reuben's and Margaret's screens turn red. Employees are on the launch pad arming the mis-

sile, but another group needs to start its work.

Calls are coming in from the ROCC asking when the next task will start, as the entire screen goes red. The tension in the room rises slightly, as Steve and Margaret discuss how to keep the launch moving forward, but about an hour later PMRF puts a planned two-hour hold into effect, KTF suddenly catches up, and faces show relief all around.

With the missile now prepared for launch, all non-essential personnel are cleared out of KTF, in case of an accident, to watch the launch from a nearby field.

Employees take the arm plug, a red canister about the size of an egg, and remove the green safe plug to make the connections on the launch pad necessary for the launch, a task simulated during the practice runs. The plugs are kept safely in a lock box behind the central operations desk.

There are about 22,000 pounds of explosives on the target missile, so safety is paramount, Steve says.

T minus 00:15:00

With about 15 minutes to go, Steve and Reuben say the LOB becomes very still as everyone focuses on their jobs.

"No one's talking about their weekend or cracking jokes," Reuben says. "When you get to the 10-minute mark, you think, 'This is serious. We're probably going to go. We're not turning back now.'"

T minus 00:05:00

"The three-word hold is in effect," comes over the radio.

Reuben explains that anyone who sees any reason to hold the launch can say "hold, hold, hold" into the radio and everything is halted. During the dress rehearsal, two holds were called outside KTF as last-minute checks were made, but so far the real launch has had none.

A set of keys used to initiate the launch were handed out to controllers early in the countdown. The keys are turned after each person's steps are completed, so along the way, anyone can delay turning their key to hold the launch. There's also a big black "HOLD" button on the test director's display.

"If we're going to hold, this is when it's going to happen," Reuben says.

Margaret adds: "There are so many ways to hold and only one way to launch."

T minus 00:01:43

"Final clearance to launch," Margaret confirms with PMRF, her voice tense, but controlled. "Launch enable."

During the last minute, Reuben explains a day later, his heart is pounding. He takes his hand off his mouse so he doesn't accidentally click a step before it's complete.

An automated voice indicates 90 seconds, then 60 seconds to go.

A display in the corner of Reuben's monitor shows six of seven mandatory interlocks for launch are green, then the last one is checked by Booster Control, Rod Stanopiewicz (5419), with 17 seconds to go. Voices from the communications networks are heard repeating that the launch is a go.

An automated voice counts down the final seconds: "10, 9, 8 ..." Sound familiar?

Lift off!

And with an orange blaze the target missile moves slowly off the launch stool and into the night sky.

In a field about two miles away, a crowd of Sandia employees and contractors, Orbital Sciences staff (Orbital Sciences supplied the missile), and the military waits in the dark.

From behind a line of trees a whitish-orange glow lights up a half circle of the dark sky. Silently a brightly glowing orange oval rises slowly above the trees. Then the sound hits, first a rumble, followed by a metallic roar that lasts for nearly a minute as the oval becomes smaller and smaller, until it is a tiny orange ember among the stars.

A small cheer and a sense of relief washes over the LOB, Reuben says.

The target missile transmits telemetry to KTF, where Ed Mader (5419) is splitting his time between operating the tracking antennas and monitoring the computer room with Steve Sanchez (5419). Wes Crownover (5419), who records all data, but uses Best Source Selector equipment to determine the data with the least errors caused by the transmission and routes it to Sandia and Orbital Sciences.

Across the LOB, Larry Young (5422) generates displays on computers that translate telemetry within milliseconds into graphs on 17 monitors that show whether the target missile is flying along its intended path, viewed as a green line within an orange corridor. Larry says the guided missile should fly along the green line. Should the missile move outside the orange corridor, the Navy would abort its launch to avoid wasting a missile.

Sitting yards away from Larry is Tom Johnson of the Johns Hopkins University/Applied Physics Laboratory, who studies the graphs to tell PMRF whether it's a good target.

On this test, Johnson has a 15-second window to make the call, which he says is a "leisurely pace," compared to as little as 5 seconds he sometimes has on other flights. Today, the rocket flies straight.

The voice of Eric Hedlund, test director of the US Missile Defense Agency's Aegis Ballistic Missile Defense (BMD) Program, is heard from the ROCC: "Good target, good target."

"Confirm," comes the answer, which means the Navy can try to intercept the incoming missile.

"Eagle away!" The Navy is ready to launch its interceptor. All eyes are on the front video screen, watching as two yellow lines grow longer and longer and intercept at a yellow dot.

In the field, the missile sparks orange as the interceptor flying from the Navy ship in the Pacific Ocean hits it. An excited voice says "Mark India!" on the radio.

"Whoo hoo!" People shout through the dark. "Congratulations!"

Back in the LOB, the control desk is quiet because it's unclear whether the interceptor hit its target, Steve says. But Wes, the telemetry expert, sees his data go dark, so he and a few others know the mission is successful. Their joy quickly spreads across the room.

One contractor exits the LOB with a huge smile across his face.

Steve looks happy and relaxed. The launch was "smooth ... very smooth" and no holds were called in the final minutes.

"I really like this job. You really feel like you're doing something important," Reuben says. "I bet the president knows we did this tonight."

Margaret adds: "You feel instantly excited that it's over. Then you can breathe. Then you start thinking about starting work on the next one."



TELEMETRY WATCH — During a practice countdown, Larry Young (5422) checks a bank of computer screens in the LOB that display telemetry from the missile within milliseconds to show whether it's flying on its intended path. (Photo by Michael Bejarano)



LIFT OFF — A target missile is launched into the night sky from a vertical launcher at Pacific Missile Range Facility tenant, KTF. (Photo by Scott Walkington)



BE A BETTER HEALTHCARE CONSUMER

New Healthcare Consumerism Microsite Saves Time, Money, and Stress

Two years ago Sandia introduced Sandia Total Health, a consumer-directed health plan that encourages healthcare consumerism while improving overall health through an integrated approach to health and wellness. This includes a focus on prevention and healthy lifestyle factors, the management of chronic conditions, and behavior modification aimed at changing risk factors. Sandia is pleased to introduce another tool in your toolkit to help you be a better healthcare consumer, thus maximizing your Sandia Total Health benefits.



Healthcare Consumerism website

The Sandia Healthcare Consumerism website features a bevy of tools and resources to help you become a savvy healthcare consumer. You can get to the site by going to hbe.sandia.gov and clicking on the Your Healthcare Consumer Toolkit logo (pictured here).

This new site offers you a variety of tools you can use to help find good quality health care, make wise health care decisions, and stay informed health care consumers. Check out all the following sections for more information on:

- **Know Quality Health care** — Some doctors have higher quality standards than others. Finding quality health care can help you recover quickly from illness and stay healthy.
 - **Take Care of Yourself** — Your doctor is a partner in helping you stay healthy. As a partner, you too should be involved in making decisions that affect you. The more you know about your condition, the more confident you can be in discussing treatments with your doctor.
 - **Watch Your Dollars** — Spending your dollars on quality care can save you and Sandia money. With your doctor's help, you can identify medical issues early and potentially avoid costly treatment later.
 - **Use Resources You Can Trust** — Certain websites can offer accurate health information, backed by medical research. There are a number of things to look for to make sure a site is reliable.
 - **Choose Health Services Onsite** — As a Sandia employee, you have access to certified medical professionals, right here at work, through HBE's Health Services Onsite, all at no cost to you.
 - **Compare the Plans** — Any time you make a significant investment, like buying a home or automobile, there are steps you take before you decide. You should also be a smart consumer when deciding which administrator to choose for your Sandia Total Health plan: Blue Cross Blue Shield of New Mexico, UnitedHealthcare, or Kaiser in California.
 - **Focus on Health & Benefits** — Updated monthly with news and information about particular elements of Sandia Total Health and how you can maximize the benefits of your plan.
 - **Article Library** — Visit this area to peruse previous HBE articles written about your health benefits, Sandia Total Health, and the Sandia Health Partner Network.
- To learn more and see the full website, visit hbe.sandia.gov and click on the Your Healthcare Consumer Toolkit logo.

BE A BETTER HEALTHCARE CONSUMER

Show Your New Medical and Rx ID Cards in 2013

All Sandia Total Health Blue Cross Blue Shield of New Mexico and UnitedHealthcare (UHC) members should have received new Express Scripts ID cards. This new Express Scripts ID must be shown to pharmacies when you are filling your first prescriptions of 2013. If you have not yet received your Express Scripts ID card or if you have any other questions about your prescription drug benefits, contact Express Scripts at 877-817-1440 or visit www.express-scripts.com.

Additionally, all Sandia Total Health UHC members should have received new UHC medical ID cards. UHC has issued new cards because they changed the name of the network from UnitedHealthcare Options PPO to UnitedHealthcare Choice Plus. The providers in the network are not changing; only the name is changing. When you first visit a medical provider in 2013, you must indicate your insurance has changed and show the provider your new ID card. If you have not yet received your UHC ID card, or have any other questions about your medical benefits, contact UHC at 877-835-9855 or visit myuhc.com.



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on your Virgin HealthMiles (VHM) page.

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Comet explosions did not terminate ancient Clovis culture

Mark Boslough, coauthors find fault with theory

By Neal Singer

Rebutting a persistent academic hypothesis that comet explosions and impacts changed Earth's climate sufficiently to end the Clovis culture in North America 12,900 years ago, lead author Mark Boslough (1465) and researchers from 14 other institutions assert in a technical paper that other explanations must be found for the apparent disappearance.

"There's no plausible mechanism to get airbursts over an entire continent," says Mark. "For this and other reasons, we conclude that the impact hypothesis is, unfortunately, wrong."

In the American Geophysical Society's *Geophysical Monograph Series*, published in December 2012, the researchers point out that no appropriately sized impact craters from that time period have been discovered, nor have any unambiguously "shocked" materials been found.

In addition, according to the paper, the fragmentation and explosion mechanism proposed for some of the impact-hypotheses versions "do not conserve energy or momentum," a basic law of physics that must be satisfied for impact-caused climate change to have validity.

Also absent are physics-based models that support the impact hypothesis. Models that do exist, write the authors, contradict the asteroid-impact theorists.

The authors also charge that "several independent researchers have been unable to reproduce reported results." Worse, samples presented as supportive of the asteroid impact hypothesis were later discovered by carbon dating to be contaminated with modern material.

The Boslough trail

Mark has a decades-long history of successfully interpreting the effects of comet and asteroid collisions.

His credibility was on the line on a July afternoon in 1994 when he saw *Eos*, the widely read newsletter of the American Geophysical Union, in his mailbox. There, on the front page of the biweekly publication, was the prediction by a Sandia team, led by Mark, of what would happen a few days later when comet Shoemaker-Levy 9 was to strike the planet Jupiter.

Along among the world's scientists, the Sandia team — Mark, Dave Crawford, Allen Robinson, and Tim Trucano — stated that under certain conditions, plumes from the collision would be visible from Earth.

"It was a gamble and could have been embarrassing if we were wrong," says Mark. "But I had been watching while Shoemaker-Levy 9 made its way across the heavens and realized it would be close enough to the horizon of Jupiter that the plumes would show." His reasoning was backed by simulations from the world's first massively parallel processing supercomputer, Sandia's Intel Paragon.



STORMCLOUDS OVER CLOVIS — Mark Boslough and coauthors are challenging a theory that asserts that an asteroid impact-caused change in climate led to the demise of ancient Clovis culture. (Photo by Randy Montoya)

On the one hand, it was a chance to check the new Paragon's logic against real events, a shake-down run of the defense-oriented machine. On the other, it was a hold-your-breath prediction, a kind of Babe Ruth moment when the Babe is reputed to have pointed to the spot in the bleachers he intended to hit the next ball. No other scientists were willing to point the same way, partly due to previous failures in predicting the behavior of comets Kohoutek and Halley, and partly because most astronomers believed the plumes would be hidden behind Jupiter's bulk.

That the plumes indeed proved visible started Mark on his own trajectory as a media touchstone for things asteroidal and meteoritic.

Indiana Jones and Tom Sawyer?

It didn't hurt that when he stood before television cameras to discuss celestial impacts, his earnest manner, expressive gestures, and extraterrestrial subject matter made him seem a combination of Carl Sagan and Luke Skywalker, or perhaps Tom Sawyer and Indiana Jones.

Standing in jeans, work shirt, and hiking boots for the Discovery Channel at the site in Siberia where a mysterious explosion occurred 100 years ago, or discussing it at Sandia with his supercomputer simulations sliding in bold colors on a big screen behind him, the rangy, 6-foot-3 Sandian vividly explained why the mysterious explosion at Tunguska that decimated hundreds of square miles of

trees and whose ejected debris was seen as far away as London most probably was caused neither by flying saucers drunkenly ramming a hillside (a proposed hypothesis) nor by an asteroid striking the Earth's surface, but rather by the fireball of an asteroid airburst — an asteroid exploding high above ground, like a nuclear bomb, compressed to implosion as it plunged deeper into Earth's thickening, increasingly resistive atmosphere. The governing physics, he says, was precisely the same as for the airburst on Jupiter.

Mark also was the Sandia component of a National Geographic team flown to the Libyan Desert to make sense of strange yellow-green glass worn as jewelry by pharaohs in days past. Mark's take: It was the result of heat on desert sands from a hypervelocity impact caused by a bigger asteroid burst.

In the present case

In the Clovis case, Mark felt that his own ideas were taken further than acceptable when other researchers claimed the pur-

ported demise of Clovis civilization 12,900 years ago in North America was the result of climate change produced by a cluster of comet fragments striking Earth. In a widely reported press conference announcing the Clovis comet hypothesis in 2007, proponents showed a National Geographic animation based on one of Mark's simulations as inspiration for their idea.

Indiana Jones-style, Mark responded. When confronted by apparently hard asteroid evidence, as well as a *Nova* documentary and an article in the journal *Science*, all purportedly showing his error in rebutting the comet hypothesis, Mark ordered carbon dating of the major evidence provided by the opposition: nanodiamond-bearing carbon spherules associated with the shock of an asteroid's impact. The tests found the alleged 12,900-year-old carbon to be of very recent formation.

While this helped raise red flags to critics, "I never said the samples were salted," Mark said carefully. "I said they were contaminated."

That find, along with irregularities reported in the background of one member of the opposing team, was enough for *Nova* to remove the entire episode from its list of science shows available for streaming, Mark said.

"Just because a culture changed from Clovis to Folsom spear points didn't mean their civilization collapsed," he said. "They probably just used another technology. It's like saying the phonograph culture collapsed and was replaced by the iPod culture."

National FLC award goes to Sandia technology used at Fukushima

Lab Consortium honors crystalline silico-titanates in tech transfer category

By Nancy Salem

Sandia and UOP, a Honeywell Company, are being honored by the Federal Laboratory Consortium (FLC) for their work to transfer an innovative technology to the private sector.

The 2013 national Award for Excellence in Technology Transfer recognizes the team behind the development and commercialization of crystalline silico-titanates (CSTs). The award goes to employees of FLC member laboratories and non-laboratory staff who do outstanding work in transferring a technology developed by a federal laboratory to the commercial marketplace.

The Sandia honorees included business development specialist Bianca Thayer (8539), researcher Tina Nenoff (1114), Geochemistry Dept. 6915 researcher Jim Krumhansl (retired) and manager Mark Rigali.

"We are extremely proud when Sandia's technology transfer initiatives have a major impact. In this case, the impact is international," says Jackie Kerby Moore, manager of Technology and Economic Development Dept. 1933 and Sandia's representative to the FLC.

CSTs are inorganic, molecularly engineered ion exchangers that can remove high-level radioactive contaminants such as cesium from wastewater. Honeywell UOP licensed the Sandia technology in the mid-1990s and revised the license last year to become the exclusive US manufacturer of CSTs.

The company worked with Sandia through a cooperative research and development agreement (CRADA) to produce a commercial-scale manufacturing procedure for the technology.

CSTs came to mind when the Fukushima Daiichi nuclear power plant outside Tokyo was damaged in an earthquake and tsunami in March 2011.

Mark says seawater was pumped in to cool the reactors. The water was contaminated with cesium, a common fission product in reactor fuel, and could not be released back into the ocean. "The Japanese were looking for a way to clean up the water," Mark says. "That's where the CSTs came in."

But it wasn't known if the technology worked in seawater.

DOE called on Tina at the end of March 2011 to test CSTs for removal of cesium in concentrated seawater, due to her extensive experience in both developing and working with CSTs in the 1990s. Tina and Jim worked around the clock for 10 days. "There was a sense of urgency," Tina says. "We compared CSTs against commercially available zeolites, mineral zeolites, and some clays. We found that the CSTs outperformed the other materials for cesium removal from seawater under these conditions."

Mark says other materials can capture cesium, "but there's nothing out there that works as well as a CST. It's tough to beat."

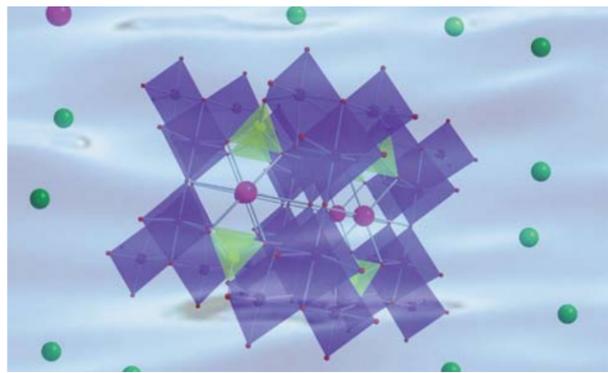
Honeywell UOP, which was in contact with Sandia and doing its own tests, came to the same conclusion. The company asked to renegotiate its license with Sandia to become the exclusive manufacturer of CSTs.

Honeywell UOP products with CST technology have successfully treated more than 40 million gallons of contaminated water at Fukushima.

Mark says it was exciting to be part of an effort that addressed a challenge like the Fukushima cleanup. "It's the kind of thing that sends a chill," he says. "Wow. We've helped really make a difference in the world. These are the kinds of successes we want to see with all our intellectual property."

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

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



CSTs, SHOWN IN THIS SANDIA ILLUSTRATION, are inorganic, molecularly engineered ion exchangers that can remove high-level radioactive contaminants such as cesium from wastewater.

Mileposts

New Mexico photos by Michelle Fleming
California photos by Randy Wong



David Dell
35 5953



William Pregent
35 6524



Bernie Bernal
30 8537



Gary Zender
23 1822



Jerome Cap
30 1527



Ann Gutierrez
30 810



Michael Irwin
30 6623



Don Joe
30 5211



Anthony McDonald
30 1114



Paula Schoeneman
21 10656



Peggy Underwood
18 3520



Tim Moss
30 6123



Daniel Naru
30 753



Gary Polansky
30 5424



Kenneth Reaves
30 2992



Walt Rutledge
30 5423



Michael Swanson
30 5339



David Gardner
25 5434



Bill Klein
25 9542



Martha Trujillo
25 11100



Tom Wunsch
25 2546



Cynthia Burns
20 10507



Nancy Clise
20 853



Karen Conley
20 10650



Jim Green
20 10222



Margaret Mora
20 4236



Elizabeth Schexnayder
20 2553



Norman Schwers
20 1383



Cassandra Shaw
20 711



Kathy Silva
20 35031



Karla Simoes
20 10668



Olga Spahn
20 1742



Joel Stevenson
20 9326



Renee Urquidez
20 10503



Richard Baird
15 9542



Michael Collins
15 5635



Phillip Cox
15 9317



Richard Drake
15 1443



Eric Eidson
15 6925



Colin Joseph Hamman
15 413



Clinton Hobart
15 6532



Robert Knowlton
15 6632



Carlos Lopez
15 6233



Tony Perea
15 5516



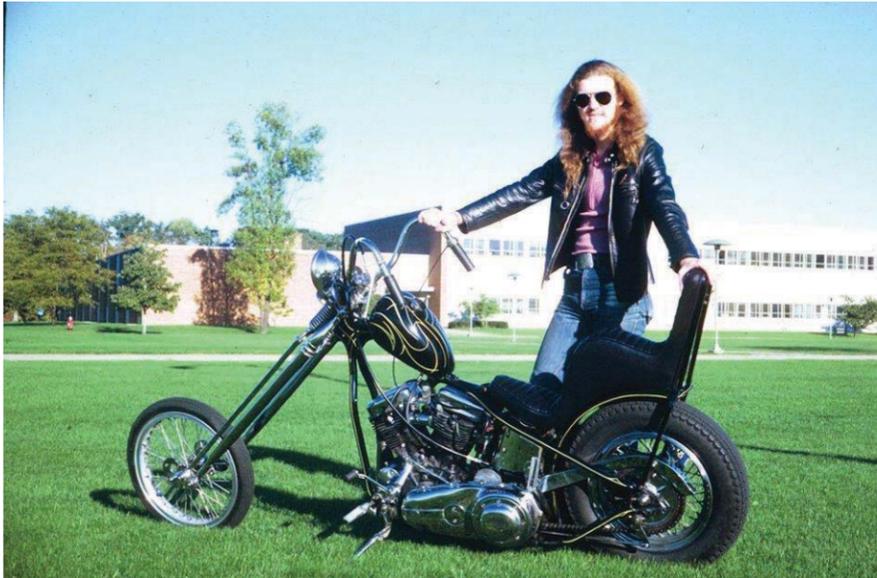
Catherine Putelli
15 10628



Lisa Shannon
15 8112

Recent Retirees

More than meets the eye: A family legacy on two wheels



SAME GUY, SAME BIKE — Dennis Beyer (8537) in 1972 and today with his baby, a 1954 Harley Davidson Panhead Bobber. The bike has gone through a lot of iterations since it came into the



Beyer family in the 1960s, and so has Dennis. The Beyer brothers, Dennis, Dave, and Don, are all into bike restoration. (Right photo by Dino Vournas; left photo courtesy of Dennis Beyer)

By Patti Koning

On warm and dry Fridays that he's in the office, Dennis Beyer (8537) rides a vintage 1954 Harley Davidson Panhead Bobber motorcycle to work. Sure, it's a beautiful bike, but this Bobber is also a piece of living history, part of the Beyer family legacy.

Dennis was about 16 years old the first time he laid eyes on this motorcycle. "My brother Dave brought it home one day, much to the chagrin of our parents. I thought it was pretty cool," he recalls. "He then sold it to me when he was shipped off to Vietnam a few years later."

As a mechanical engineering student and self-described tinkerer, Dennis started working on the bike. "It was a passion for a number of years," he says. He put the Panhead through a series of chopper versions with modifications to the frame and gas tank, switching up the seat, fender, sissy bar, and paint job along the way. The Panhead moved with Dennis from Michigan to California in 1976 when he graduated from the University of Michigan and began working at Sandia.

Then he put the bike aside in 1981 as work and family began to fill up more of his time. For the next 20 years, the bike was relegated to the back of the garage. "I kept seeing it there and began to wonder if I could get it running again," Dennis says. "I always enjoyed working on the bike — it exercises my hands and it's both fun and challenging to see if you get and keep a machine that's nearly as old as me running. But it's also a huge time sink."

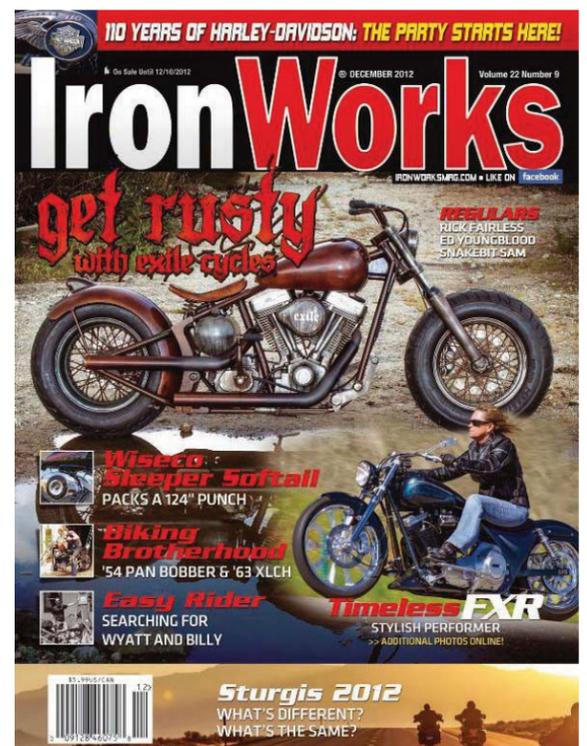
Sandia California News

A family tradition

The bike turned out to be in relatively good mechanical shape, so in 2003 Dennis decided to restore it. "Before, budget had always been a constraint and I bought the parts I could afford," he says. "This time, I was determined not to let cost be a factor and create the bike it could have been when I stopped working on it, a period Bobber."

Sourcing parts was the easy part. Dennis eventually had to completely rebuild the engine to address several mechanical issues. "I'm pretty proud of how it turned out," he says. "This is the only bike I've ever owned."

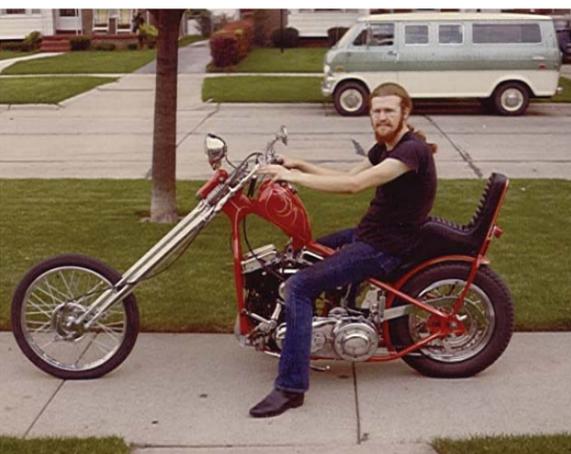
Vintage motorcycles are a family tradition for Dennis and his two brothers. After Dave sold the Panhead to Dennis, he bought a 1970 XLCH Sportster for himself that was featured in a 1976 issue of *Easyriders* magazine. Eventually, Dave dismantled that bike and repurposed many of the parts, but kept the frame hanging in the back of his garage. Don, the youngest of the three brothers, later bought that frame from Dave and with a basket case Sportster, painstakingly restored it as a 1963 Street Tracker. Dave is now busy working on a 1952 Harley K Model. The Beyer brothers and their bikes were featured in the December 2012 issue of *IronWorks* magazine (see magazine cover at right).



Dennis says he's now getting the itch to work on another motorcycle. "I'm keeping my eyes out for the right one," he says.



HEAD OUT ON THE HIGHWAY — Dennis Beyer and his Harley in 1970 (above) and 1973. (Photos courtesy of Dennis Beyer)



Rep. Swalwell visits California lab



REP. ERIC SWALWELL, D-CALIF., newly elected to California's 15th district and a member of the House Homeland Security and Science committees, visited the site on Jan. 11 and toured various labs. Here, he talks with Tom Kroeger (right, 8965) and Bob Hutchinson (left, 8960) about Sandia's cybersecurity efforts. (Photo by Dino Vournas)