WINTER • 2005-2006

SANDIA TECHNOLOGY

A QUARTERLY RESEARCH & DEVELOPMENT JOURNAL
VOLUME 7, NO.4

Time traveling at Nevada Test Site

Sandia assisting NASA with space shuttle

Sandia teams win four R&D 100 Awards

Sandia National Laboratories

What is LDRD

Sandia's world-class science, technology, and engineering work defines the Labs' value to the nation. These capabilities must remain on the cutting edge, because the security of the U.S. depends directly upon them. Sandia's Laboratory Directed Research and Development (LDRD) Program provides the flexibility to invest in long-term, high-risk, and potentially high-payoff research and development that stretch the Labs' science and technology capabilities.

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When the LDRD logo appears in this issue, it indicates that at some state in the history of the technology or program, LDRD funding played a critical role.

On the Cover:

Sandia's Dan Nelson adjusts a diverter switch underground at the Nevada Test Site. The site has a storied past, but continues to be important to America's future. (See story beginning on page 2.) (Photo by Randy Montoya)

Sandia Technology (ISSN: 1547-5190) is a quarterly journal published by Sandia National Laboratories. Sandia is a multiprogram engineering and science laboratory operated by Sandia Corporation, a Lockheed Martin company, for the Department of Energy. With main facilities in Albuquerque, New Mexico, and Livermore, California, Sandia has broad-based research and development responsibilities for nuclear weapons, arms control, energy, the environment, economic competitiveness, and other areas of importance to the needs of the nation. The Laboratories' principal mission is to support national defense policies by ensuring that the nuclear weapon stockpile meets the highest standards of safety, reliability, security, use control, and military performance. For more information on Sandia, see our website at *http://www.sandia.gov*

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FROM THE *Editor*

Dear Readers,

In case you're wondering, Sandia has not yet perfected the art and science of time travel, as our lead article might suggest. Instead, "Time traveling at the Nevada Test Site" is a then-and-now look at one of America's most interesting scientific test facilities through the eyes of writer Bill Murphy and photographer Randy Montoya. The article is grounded in history through the reflections of a Cold War researcher at the site, who moved up through the ranks to become Sandia's president and director, Tom Hunter.

Jumping from time travel to space travel, science writer Michael Padilla reports on a number of projects involving NASA's "return-to-flight mission," which occurred this summer. While Sandia's orbiter inspection sensor made the news, other projects proceeded more quietly apace to help assure that future space flights, with the shuttle and with future space vehicles, are as safe as possible.

This year-end issue of *Sandia Technology* seemed a good time to brag about a number of recent awards earned by the Labs. These include four prestigious R&D 100 awards, all examples of joint Sandia-industry cooperation. The annual R&D 100 contest attempts to select the best new applied technologies from an international pool of contestants from universities, private corporations, and government labs.

Finally, seven Sandians have been recognized nationally for their contributions to science and technology. The awards — from the American Academy of Arts and Sciences, the American Association for the Advancement of Science, the American Indian Science and Engineering Society, the Hispanic Engineer National Achievement Awards Corporation, and the Federation of Materials Societies — are briefly reviewed here.

Will Keener
Editor

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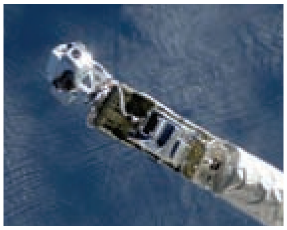
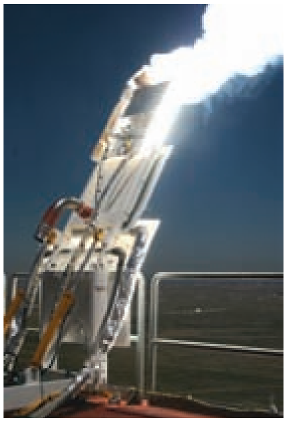
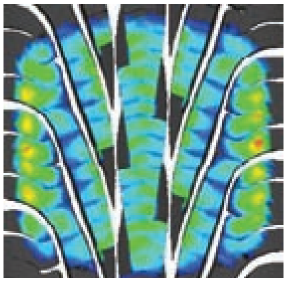






Time traveling at the Nevada Test Site

By Bill Murphy
Photos by Randy Montoya

It's easy to blow right by it when you're barreling along U.S. Highway 95 between Las Vegas and Reno. A simple sign marks the turn, offering not a hint of the mighty deeds that were carried out just over the other side of those ridges.

But you're not just any tourist heading north. You know what you're looking for, and as the odometer on the rental ticks up toward 70 miles from McCarran International Airport, you begin to pay extra attention. Then, there it is. You turn and head a few miles off the main road to Mercury, Nevada, home base for the Nevada Test Site and perhaps the nation's ultimate gated community.

Between the time it was established by President Truman in 1951 (as the Nevada Proving Ground) and 1992, when the last full-up test was carried out, some 900 nuclear tests were conducted at the site. Of those, 99 were above-ground tests, and more than 800 were underground tests.

There's a certain mining-camp ambience about Mercury, which is appropriate given the amount of digging, tunneling, boring, and excavating that has gone on in the area over the years. But, to stick with the analogy, it has the feel of one of those mining towns whose mother lode has almost played out. That's not completely fair, because important, impressive, and demanding work is still done there. But one certainly can't help but note that the town was designed to accommodate a lot more people than are now there.


Tom Hunter, today

A highway sign dating from the 1950s.

'You could dream big'

From the '50s through the '80s, Mercury was a boomtown. Tom Hunter, Sandia director and president, got his start there as a member of the Labs' Field Test group. He remembers how it was for a young engineer right out of school.

"The name of the game at the test site in the 1960s and '70s was effects testing. We had to develop at Sandia — with the other labs — the ability to do effects tests, particularly tests of components in radia-

It was a time in which you were able to dream big, and think of things thought to be impossible, and how one might do them.

tion environments. The big engineering issues for us were: one, containment of the device — could you have them go off and not get into the atmosphere? — and, two, could you in fact expose samples to the radiation environment and get back data. These were not trivial engineering challenges."

"My first job was to go in and design ways to recover samples very, very close to the nuclear devices where the fluences (quantities of radiation) were very high. ...It was a time at Sandia when you were limited only by your imagination. It was a time in which you were able to dream big, and think of things thought to be impossible, and how one might do them — and this particular challenge [getting samples from very close to a detonation] was thought to be impossible.

"So, as a young engineer, I was asked to put together a project team of folks from all over the labs to devise a way to get close-up samples."

Unique environment

Dan Bozman is the manager of the small contingent of Sandians who work fulltime at NTS, providing technical support to larger permanent and semi-permanent contingents from Los Alamos and Lawrence Livermore national labs. The Sandia team also provides administrative and logistics assistance to researchers from Sandia who come to the test site to take advantage of its unique environment, capabilities, and services.

After the introductions, Bozman gives you a quick chalk-talk about the site. Lore-rich place-names like Jackass Flats, Frenchman Flats, Yucca Flats come easily to Bozman. As he talks, the words summon up black-and-white mental pictures of mushroom clouds rising above landscapes of magnificent desolation, of flannel-shirted engineers wrestling impossibly massive pieces of hardware into submission.

Enormous scale

"In 1969 and 1971," Tom recalls, "Sandia did two tests that were 'Sandia' tests all the way. These were tunnel shots, totally designed, built, and conducted by Sandia as weapons effects tests. After the 1971 test, Sandia didn't do all-up tests on its own, but teamed with the Defense Nuclear Agency (DNA, predecessor of today's DTRA). I came in right at that transition from Sandia testing to DNA testing; in fact, my first project was a contract to DNA.

"The tunnel shots weren't about testing weapons as such; Los Alamos or Livermore

Sandia's Mercury, Nevada, staff includes, from left, Dan Bozman, Nira McCoy, Ivars Gals, Judy Schill, and Jim Metcalf.

Right: Developers of the fast-acting closure system, from left, Bob Stinebaugh, Leroy Honeyfield, an unidentified official from American Cynamide, and Tom Hunter.

Left: Gathered at a high fluence recovery station prior to a test, early 1970s. From left, Bob Stinebaugh, Art Arthur, Jerry Kennedy, Carter Broyles, Morgan Sparks, Tom Hunter, and Jerry Barr.

For their first test project, Hunter, Bob Stinebaugh, and their team perfected a fast-acting closure system — a massive, 4,000-pound steel shutter that could wink shut in thousandths of a second.

would provide a nuclear device designed specifically to produce a specific radiation environment. We weren't testing the device at all. We just needed the radiation output.

"For the tests, we built a really long vacuum pipe and installed it in a tunnel bored into the side of Rainier Mesa. The longest was some 1,800 feet long and 28 feet in diameter at one end [narrower at the other]. And it was evacuated down to near perfect vacuum.

"The pipe was brought in two-piece cross-sections — in halves — and we used the halves as garages to park out of the sun. The pipes were so big you'd just drive under them like a solid steel Quonset hut."

For their first test project, Hunter, Bob Stinebaugh, and their team perfected a fast-acting closure system — a massive, 4,000-pound steel shutter that could wink shut in thousandths of a second — to seal off the pipe to prevent blast debris from running down the tube after the test detonation. "The first we built weighed 90 tons. . . . Not only was the scale of the site enormous in landscape terms, the scale of the hardware we used was enormous."

That fast-acting closure system became a staple of the tunnel shots right through the end of the testing era.

Site tour

Dan Bozman loads you into his Ford Expedition for the grand tour of the test site, or at least part of it. There's no way to see it all in a single day. The facility is the size of Rhode Island, and driving from location to location among the far-flung assets of the site becomes a way of life.

As you head out of Mercury and crest the first ridge, an incredible vista stretches out before you, a vast, flat lakebed miles and miles across. It's here where you really "get it" about the test site. The scale of the place finally sinks in.

As he drives along offering a running commentary on the highlights of the test site history, Dan points out some highly weathered wooden benches on the left side of the road. That was the VIP observers' stand, he says, for the only atomic test shot ever fired from a cannon. The year was 1953. The actual explosion was way, way across Frenchman Flats — probably 10 miles away, but in this landscape, it's hard to gauge distances.

After crossing the immense Frenchman's Flats, the next stop is Command Post 1, or CP-1. It's from here that most of the underground tests — the shaft tests of Los Alamos and Livermore, and the tunnel shots of Sandia and DoD — were controlled.

The CP-1 team includes Jerry Chael (front), Billy Borden, Mike Burke, and Jim Jones (rear).

Los Alamos engineers monitor activity at LANL's Armando site from their control room at CP-1.

Los Alamos has developed a new mission control facility to manage its subcritical experiments in the underground mines a few miles away.

Dan takes you into the old mission control room. This is where hundreds of nuclear tests were managed. With its TV screens and phones at every seat, it has a retro future look. You can almost smell the coffee and cigarettes in the place, a time capsule from a bygone era. By contrast, down the hall from the old control room, Los Alamos has developed a new mission control facility to manage its subcritical experiments in the underground mines a few miles away. Now, that control room *is* state of the art.

Mike Burke and Jerry Chael are old hands at the Test Site, commuting every day from Las Vegas (no one really lives in Mercury — well, almost no one). They can't say enough about the field test ethic that prevails at the site.

The site has staff from the three weapons labs, from DOE/NNSA, Bechtel Nevada, Wackenhut, and DoD, Jerry says. "We're all here to get the job done. Everyone focuses on the mission at hand. There's not a whole lot of territorial stuff or turf battles here."

'Unprecedented timeframes'

Recalls Hunter: "The nice thing about the field test work — especially for a young engineer — was that you got to engage people from all over the laboratory. You dealt with component groups, groups from the other laboratories — Los Alamos and Livermore — Defense Nuclear Agency (DNA) contracts up and down the system, and you had to put together what we now call multidisciplinary approaches: structural analysis, instrumentation, and radiation effects — all of the things that go with a big systems effort. A great formative effort.

"My first systems challenge was to put all the concepts together and perform a high fluence exposure and recovery on the Dido Queen event. What I remember most about my first test as project director was that we had worked out a 15-month schedule to do the project. DNA told us, you've got 11 months, take it or leave it. We took it. Well, that was exciting. What was even more exciting was that we had a prototype experiment [to show how a critical component could survive in a ground shock environment]. It didn't survive at all. It was absolutely destroyed — and that was after a few months of the 11 months had passed.

"We realized then that we had real problems understanding how to accomplish what we had to do. We had to really rush and regroup and do a lot of calculations, scale model testing, and pulling things together, and completely redesign everything so our exposure station would have a chance to survive. We had on the order of seven months to completely regroup and do everything over again.

"The nice thing was that everyone pulled together, and we did it successfully. As a formative thing for a staff member, a project like this allows you to face the depths of apparent failure and the heights of apparent success, all in a period of a matter of months. We taxed the entire laboratory, including the procurement organization — they had to do things in unprecedented timeframes. The experience, more than any other, probably formed my impression of what it means to work at Sandia."

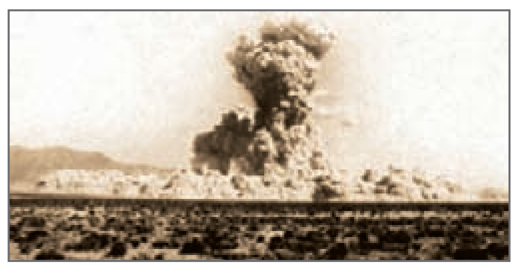
We taxed the entire laboratory, including the procurement organization — they had to do things in unprecedented timeframes.

Sedan crater

After you leave CP-1, Yucca Flats stretches out before you. Bozman tells you that when it rains, the lakebeds, like Yucca Flats and Frenchman Flats, will blossom with life: frogs, brine shrimp, and tiny fishes spawn in the precious moisture.

Bozman drives you out to a place that is, let's face it, a bit creepy — a site where houses and other structures were erected to test how they'd be affected by a nuclear blast. Here's an insight: Brick is better than wood. And another one: Farther away is better than closer.

The landscape across Yucca Flats is just peppered with the depressions, shallow bowls, and even near-craters that indicate where underground shots occurred. Time and nature are slowly reclaiming these sites, but as of today, they're still quite apparent and probably will be for a while.



The Sedan test in 1962, part of Project Plowshare, ejected soil thousands of feet into the air.

Dan Bozman, Mike Burke, and Jerry Chael 1,000 feet down.

Sandians prepping the Cygnus X-ray sources for the LANL Armando subcritical test.

Sandia has developed and is deploying a powerful X-ray source, Cygnus, which will be used to "photograph" the test in the X-ray spectrum.

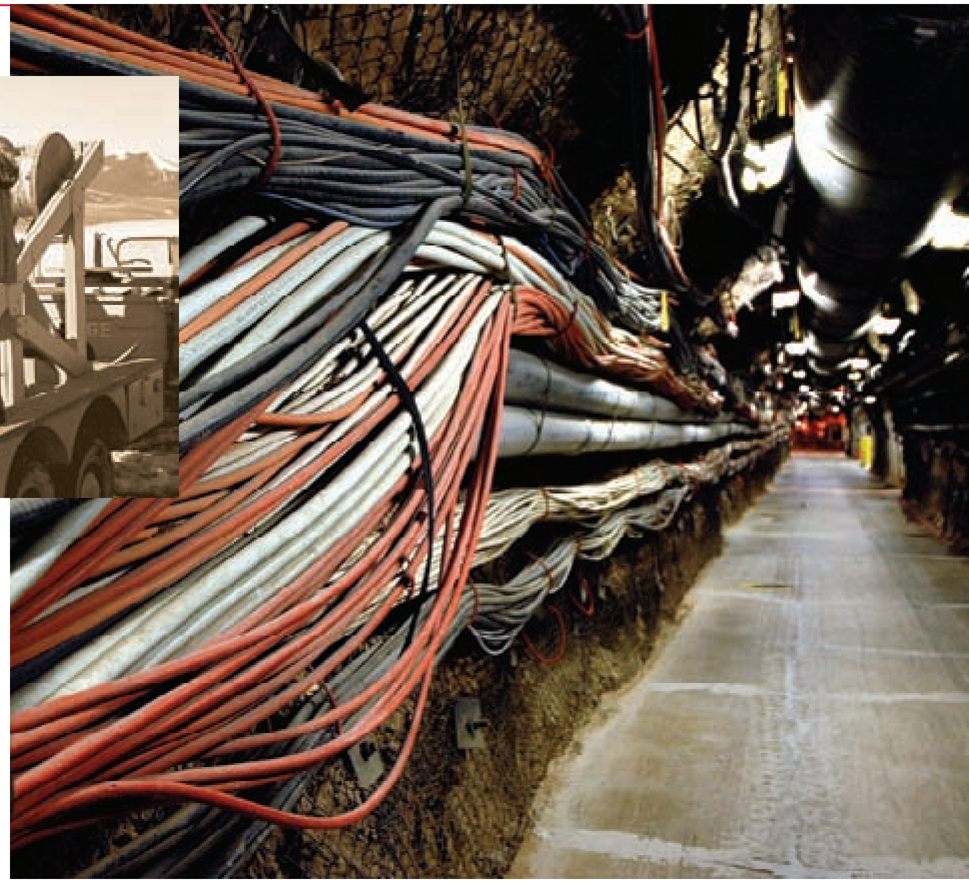
The crater formed by the Sedan test in 1962 would swallow the proverbial battleship or three. It's more than 300 feet deep and 1,200 feet across. Sedan was an excavation experiment, a part of Project Plowshare. The idea was to show how nuclear devices — not weapons, but devices — could be used in civil engineering applications like dam-building and earth-moving. The Soviets had a similar program, and, like the Americans, decided that the concept wasn't practical.

The crater, by the way, wasn't formed by an above-ground blast. The Sedan device was set off 635 feet underground and was very specifically designed to cause the earth above it to be expelled, leaving a crater that resembles a meteor impact. After Sedan, which is a good 40 miles north of Mercury, it's south again for one more stop: U1a, the access to the underground tunnel complex where a lot of the important work of the test site now occurs.

Everyone dons steel-toed boots, safety harness, hardhat, and lights for the trip underground. After watching a safety video, you head for the "man-cage" and crowd in for the nearly 1,000-foot drop. At the bottom, tunnels branch off to various work locations. (If there is a lot of driving above ground at NTS, there is a lot of walking down here. There isn't any trolley service, and the subcritical tests are conducted a long way from the vertical shaft.)

After what seems like a good half-mile hike, you get to the Armando site, a Los Alamos subcritical test. These tests use conventional explosives and small amounts — subcritical amounts — of plutonium to study phenomena in near-realistic conditions. The X-ray radiography and other data collected by various instruments are used to help fine-tune computer models used in science based stockpile stewardship.

In the no-nuclear-testing era, subcritical experiments are vital for model validation. Sandia has developed and is deploying a powerful X-ray source, Cygnus, which will be used to "photograph" the test in the X-ray spectrum. The Armando test set-up is complex: a steel sphere containing the explosive and plutonium is on one side of



Cable has always been important to testing at the Nevada site as these photos from the '60s and present day show.

There has been a cultural transition, Hunter says, and the test site is a metaphor for that transition.

a steel wall — a thick steel wall — at the far end of a spur tunnel. The Cygnus X-ray sources are on the other side. Cygnus shoots X-rays through carefully engineered "windows" (barriers transparent to X-rays) in the steel wall and in the steel sphere. A special camera box on the other side of the Armando sphere holds the digital camera that records the X-ray images.

Sandia, in addition to deploying and supporting Cygnus, provides the diagnostic instrumentation and collects the data on the machine's performance. It's a big job, and an essential part of Armando.

'a fascinating time'

"It was a very hard life — we traveled back and forth from Albuquerque to the test site a lot, often for a week or more at a time. We had our own charter flight from Albuquerque to Las Vegas; we usually stayed all week at the test site. We worked very long hours. I recall many days going into the tunnels at 7 a.m. and not coming out till 3 a.m. the next morning. That was not uncommon at all. The temperature was always the same. It all looks the same. You get used to working with people in fairly confined spaces. We got to work with the military a lot, which I found very rewarding and exciting.

"The people I worked with are largely gone now. Nobody in our Labs leadership has seen an atmospheric test, and the number of Sandians who ever worked on an underground test dwindles every year."

At the end of the hard work, and the long hours, there was the big payoff: a successful test.

"During a test, at CP-1 you could feel the ground shake. To give you an example, we had our instrumentation trailers on the top of the mesa [sitting above the tunnel, which would be bored horizontally into the mesa]. We designed those trailers so they could accommodate five feet of lift off the ground. Basically, the top of the mesa goes up and comes back down. They were on struts, like a moon lander, which had shock absorbers built in.

Ready for reentry after an early-1970s tunnel shot are Del Lawson, left, and Tom Hunter. Tom Hunter, 1974, above.

"It was a fascinating time. The fascinating thing was the excitement, the scale, the pace. Everything was done very quickly. Although, you know, it didn't seem hurried; it was just fast-paced. A lot of things got done."

There has been a cultural transition, Hunter says, and the test site is a metaphor for that transition. "It's something we did, something that was very big, that we don't do anymore. It gave rise to our work in Albuquerque with the reactors and pulsed power — all of that is the direct successor of the work we did on radiation effects with those tunnel shots."

"The role of the test site in the weapons program is essential in the area of readiness, and the importance of that can't be overstated. If the world changes, if the nation again needs to begin full testing, NTS will be ready. In the meantime, the work being done there is actively providing important data. The subcritical tests [like Armando] are very important for the stockpile program."

The role of the test site in the weapons program is essential in the area of readiness, and the importance of that can't be overstated. If the world changes, if the nation again needs to begin full testing, NTS will be ready.

(Editor's note: Since the writing of this article: Armando was successfully carried out. The data it gathered are helping the nation maintain a safe and secure nuclear stockpile.)

More to see

As you get ready to leave, Bozman invites you back. "There's still a lot you haven't seen," he says. Like the Sandia tunnel sites, which are way up to the north.

Like the nuclear rocket test stands and facilities over the ridge to the west in Jackass Flats. Like Yucca Mountain. Like the rest of the stuff going on underground at U1a. Like the Hazmat training site. And the Tonopah Test Range — a Sandia operation — is just up the road.

Bozman's enthusiasm is infectious. "I like it here," he says. "This place is unique in the Nuclear Weapons Complex and probably the world. The people who choose to be here are equally unique. They truly are exceptional and dedicated to the work being done here."

Sandia assists NASA with shuttle projects

Twenty-five Sandians worked round-the-clock shifts at the Johnson Space Center in Houston during the *Columbia* mission to provide NASA data on the condition of the orbiter's critical flight surfaces. Sandians helped staff the Mission Evaluation Room, shown here, and the Payload Operations Control Center, to support Mission Control. (NASA Photo)

Sandia interactions with NASA have grown in the time since the Columbia accident, as researchers around the country join to make sure the NASA shuttle is as safe as possible.

Several Sandia National Laboratories projects were instrumental in helping NASA with Space Shuttle *Discovery's* return-to-flight mission this summer. Projects ranged from creating an orbiter inspection sensor to analyzing sensors placed on the orbiter's wing-leading edges to providing peer review reports. Sandia also studied the vibrations caused during the rollout of the space vehicle to the launchpad, and developed an ultrasonic nondestructive inspection method. (For more, see *Sandia Technology,* Summer 2005.)

Sandia was also instrumental in analyzing the cause of the accident that destroyed the *Columbia* during reentry on Feb. 1, 2003. A Labs-wide team effort helped confirm that the accident was caused by foam from the external tank that impacted the wing leading edge on takeoff (see *Sandia Technology*, Fall 2003.)

The projects are summarized here:

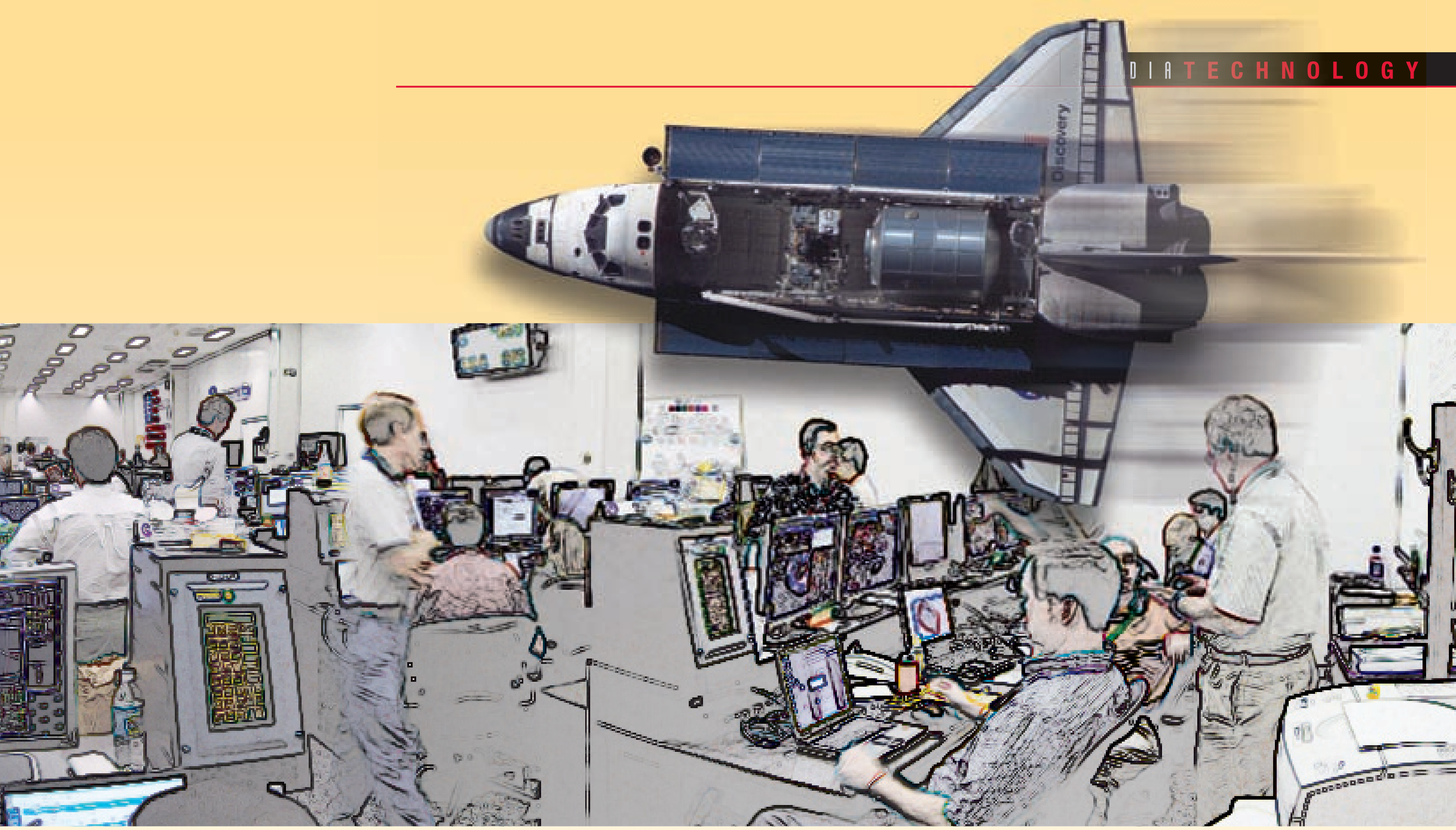
Sensor finds damage

Sandia provided the primary Thermal Protection System inspection sensor to NASA for the mission. Sandia engineers Bob Habbit and Bob Nellums led a collaborative effort of nearly 120 Sandia employees to create the sensor.

Using 3-D imaging, the sensor inspects the orbiter for critical damage during the mission and alerts astronauts if further investigations are needed to repair the damage. The crew used the orbiter's robotic arm to scan the front edge of both wings for damage as tiny as a 0.020-inch crack.

The Sandia-patented 3-D technology uses a laser illuminator coupled with a receiver to calculate time differences in reflected light to spatially locate each point in the scene.

The sensor data was relayed back to Mission Control at Johnson Space Center-Houston. A team of more than 20 Sandia employees working in the Mission



Control Center during the mission processed and reviewed the data. The processed data was provided to the NASA Mission Management Team. The Management Team, in turn, combined the Sandia data with other data to determine if it was safe for the orbiter to reenter.

The Sandia-created sensor discovered loose gap fillers on *Discovery*. The short strips of dangling material required an unprecedented repair by a spacewalking astronaut. Gap fillers are thin fabric stiffened with a ceramic material and used to plug gaps between the shuttle's tiles. One piece was sticking out 1.1 inches between thermal tiles. The other was at an angle from six-tenths to nine-tenths of an inch. One of the gap fillers kept the tiles from vibrating against each other during liftoff and had no purpose for reentry. The other was designed to prevent repeated overheating of a gap between two tiles.

Sandia's orbiter inspection sensor, attached to Space Shuttle *Discovery's* robotic arm, scans the wing-leading edge. (NASA Photo)

Habbit says once it was discovered that there was something visible, NASA took action using Sandia's Laser Dynamic Range Imager (LDRI) to characterize the protruding gap filler. The geometric data collected allowed NASA to model the effects of the protruding gap filler. The modeling indicated potentially catastrophic results if the pieces were left in place. Astronaut Stephen Robinson added a significant milestone to the history books when he removed the protruding gap fillers during the extravehicular activity, or spacewalk.

Habbit says the sensor provided hours of data, including raw video of the scans.

Sandia's orbiter inspection sensor in payload bay (right) was also used to scan tiles like those shown on shuttle surface above. (NASA photo, above; Sandia photo, right)

Given the success for the initial effort, NASA requested the Sandia-developed sensor be on the next space shuttle mission, with space shuttle Atlantis.

Once the data was processed it was given to NASA to clear *Discovery* for reentry. "We had the smallest but most capable sensor on the orbiter," Habbit says. "The LDRI was able to take enhanced 2- and 3-D images of the orbiter."

The sensor began scanning the orbiter on day two of the flight, after the robotic arm was deployed. The sensor completed wing-leading edge and nose cap scans, and focused on inspection of tile, gap filler, and the port wing.

Nellums said the team took the Sandia ethos with them to Houston. "We worry about everything and plan for the worst," he says. Given the success for the initial effort, NASA requested the Sandia-developed sensor be on the next space shuttle mission, with space shuttle *Atlantis*.

Super problem resolution team

Members of Sandia's Aerosciences and Compressible Fluid Mechanics department contributed two peer reviews of NASA's development of computational tools being used to support rapid damage assessments should anything occur during future flights.

Sandia aerospace engineer Basil Hassan serves as an external member of NASA's Engineering and Safety Center's (NESC) Flight Sciences "Super Problem Resolution Team." NESC was formed shortly after the *Columbia* accident to oversee any safety issues that might arise in any of NASA's flight programs.

Hassan and two staff members, David Kuntz and Jeffrey Payne, participated in several peer reviews as NASA prepared for return-to-flight. They were also part of a larger group of Sandia management and staff who were active in the post-accident investigation.

Two recent reviews focused on Debris Transport Review and Boundary Layer Transition Review. The Debris Transport Review focused on NASA's development of tools to model external tank foam or ice buildup that may come off during ascent and potentially hit the orbiter. While several efforts have been under way to minimize foam and ice release from the external tank, NASA wants to predict if the released debris will impact the orbiter in critical areas. NASA has used these tools to redesign parts of the external tank so that catastrophes like the *Columbia* accident will not re-occur.

The Boundary Layer Transition Review focused on reentry. During the reentry trajectory, the airflow around the orbiter will transition from laminar to turbulent flow. When the flow becomes turbulent, the heat transfer to the vehicle can increase two to four times above the laminar heating. While the thermal protection system is designed to absorb the heating rates generated by turbulent flow, damage to the system could cause the flow to become turbulent at a higher altitude. The result of this damage could mean higher localized heating rates, and

Once the data was processed it was given to NASA to clear Discovery for reentry.

ultimately higher than normal integrated heating on the orbiter during reentry.

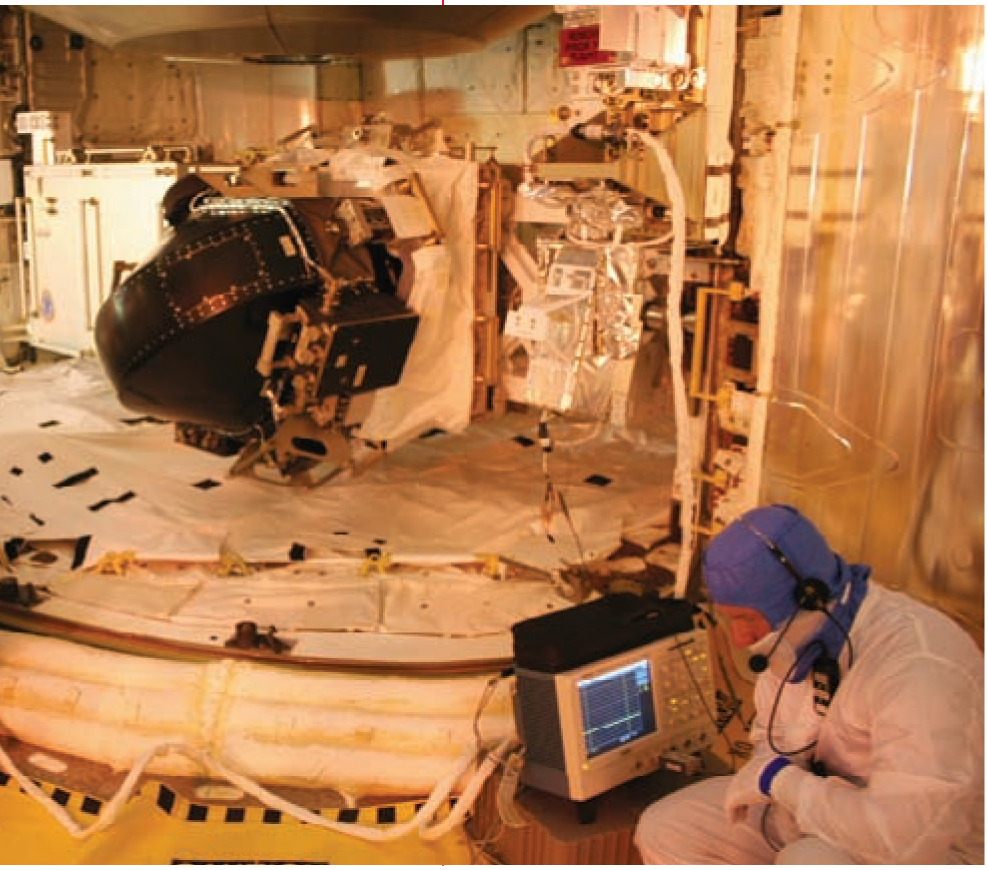
"Sandia's participation on these two review teams is one part of a larger effort of the Labs supporting a variety of return-to-flight activities," Hassan says.

Damage assessment tools

The team also reviewed NASA's rapid damage assessment tools to help the agency ensure that the codes were being applied appropriately and that the relevant assumptions in the codes were not being violated. In general, these tools make use of data from computer codes that model the fundamental physics, wind tunnel test data, and data from previous shuttle flights. Should damage occur during the ascent, NASA engineers will use these tools to decide whether the orbiter can safely return or if in-orbit repair is needed.

Sandia's David Crawford and Kenneth Gwinn analyzed tests conducted on sensors that were placed on the leading edge of the orbiter's wings. The project focused on validating NASA's Impact Penetration Sensing system wing model. The model was developed at Boeing to predict the accelerometer data collected during ascent and micrometeoroid and orbiting debris impacts on shuttle wing and spar leading-edge materials.

The sensors developed by NASA were significant to the return-to-flight effort. The addition of the sensors to the leading edge was in response to one of the prime objectives identified by the *Columbia* Accident Investigation Board. Crawford and Gwinn evaluated test data and compared it with structural models of the shuttle, assessing what the signal levels meant. Tasks included defining the forcing functions for foam, pieces of ice (from takeoff), ablator particles, and micrometeorites. Full-scale tests of foam, ice, ablator, metal particle, and micrometeoroid impacts were performed at Southwest Research Institute in San Antonio, Texas. Tests on fiberglass and RCC (reinforced carbon composite) wing panels were conducted at the White Sands Test Facility.



LDRI sensor undergoes final evaluations on launchpad in Florida. (Sandia photo)

Pre-flight process

NASA funded a Sandia team to develop an ultrasonic nondestructive inspection method (hardware, techniques, and standards) that led to a scientifically rigorous pre-flight shuttle certification process. The team investigated and proposed ways to improve nondestructive inspection (NDI) methods for certifying the flightworthiness of orbiter wing leading edges.

The team, led by Dennis Roach and Phil Walkington, initially evaluated and refined its inspection methods and hardware using carbon-composite samples with known defects created by the Sandia team. Later, as part of the selection process, a NASA engineer hand-carried orbiter wing

Extruding gap filler shown on shuttle surface and as LDRI data (in circle) from Sandia sensor. (NASA photo)

In 10 months the Sandia team developed and assembled customized hardware to produce an ultrasonic scanner system that can meet the shuttle wing inspection requirements.

samples to all the labs involved in the project and asked that each lab try to find defects known only to NASA scientists.

The team developed the revised inspection and certification protocols, and the ultrasonic scanning system was integrated into NASA's Shuttle Orbiter Processing Facility at Kennedy Space Center to monitor the health of the shuttle after each orbiter flight.

Sandia produced an in-situ ultrasonic inspection method while NASA Langley developed eddy current and thermographic techniques. These groups were the primary players on the NASA In-Situ NDI Team. The NASA In-Situ NDI Team consisted of members from all of the NASA facilities and was assembled to guide NASA as it moves to increased use of advanced non-destructive testing techniques to closely monitor the health of the space shuttle.

In 10 months the Sandia team developed and assembled customized hardware to produce an ultrasonic scanner system that can meet the shuttle wing inspection requirements. Optimum combinations of custom ultrasonic probes and data analysis were merged with the inspection procedures needed to properly survey the heat shield panels. System features were introduced to minimize the potential for human factors errors in identifying and locating the flaws. A validation process, including blind inspections monitored by NASA officials, demonstrated the ability of these inspection systems to meet the accuracy, sensitivity, and reliability requirements.

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Solar tower tests benefit future NASA space explorations

In addition to work on the shuttle, Labs researchers have been conducting tests at Sandia's National Solar Thermal Test Facility to see how materials used for future planetary exploration missions can withstand severe radiant heating.

The tests, conducted with Applied Research Associates, Inc., apply heat equivalent to 1,500 suns to spacecraft shields called Advanced Charring Ablators. The ablators protect spacecraft entering atmospheres at hypersonic speeds.

Sandia's test facility includes a 200-foot solar tower surrounded by a field of hundreds of sun-tracking mirror arrays called heliostats. The heliostats direct sunlight to the top of the tower, where the test objects are affixed.

The R&D effort is tied to NASA's plan for a future Titan mission with an orbiter and lander. Titan is Saturn's largest moon. To date, more than 100 five-inch diameter samples have been tested in the solar environment inside the tower's wind tunnel using a large quartz window.

Because the heliostats are individually computer controlled, test radiation can be a shaped pulse as well as a square wave in terms of intensity vs. time, says Sandia researcher Cheryl Ghanbari.

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Solar power heats NASA space shield material. The tests apply heat equivalent to 1,500 suns to spacecraft shields.

(Photo courtesy of Bill Congdon, Applied Research Associates, Inc.)

Sandia's Cheryl Ghanbari and Steve Moon of Gray Research look at a five-inch-diameter ablator sample that was tested in Sandia's solar wind tunnel.

(Photo by Randy Montoya)

Seven Labs researchers earn national recognition

The 213 men and women [of the American Academy of Arts and Sciences] are leaders in scholarship, business, the arts, and public affairs.

Seven Sandians have been recognized recently for their contributions to science and technology. The national awards — from the American Academy of Arts and Sciences, the American Association for the Advancement of Science, the American Indian Science and Engineering Society, the Hispanic Engineer National Achievement Awards Corporation, and the Federation of Materials Societies — are summarized here.

Julia Phillips elected fellow of the American Academy of Arts & Sciences

Julia Phillips

Julia Phillips, director of the Physical, Chemical, and NanoScience Center at Sandia National Laboratories, has been elected fellow of the American Academy of Arts and Sciences. She is among 196 new fellows and 17 new foreign honorary members. The 213 men and women are leaders in scholarship, business, the arts, and public affairs.

The Academy welcomed this year's new fellows and foreign honorary members at its annual induction ceremony on October 8 at the Academy's headquarters in Cambridge, Massachusetts. Fellows and foreign honorary members are nominated and elected to the Academy by current members — a broad-based group composed of scholars and practitioners from mathematics, physics, biological sciences, social sciences, humanities and the arts, public affairs, and business.

Phillips is also the director of the Center for Integrated Nanotechnologies (CINT), a DOE Office of Basic Energy Sciences nanoscience research center at Los Alamos National Laboratory and Sandia.

Phillips began her career at Sandia in 1995 after 14 years at AT&T Bell Laboratories. She has a Ph.D. in applied physics from Yale University and a B.S. in physics from the College of William and Mary.

Nancy Jackson, John DeBassige receive 'AISES Professional of the Year' awards

The national American Indian Science and Engineering Society (AISES) has selected Sandia National Laboratories employee Nancy Jackson to receive the 2nd Annual "Professional of the Year" award. Sandia's John DeBassige received the award for Most Promising Engineer/Scientist. The awards were presented at the AISES National Conference in Charlotte, North Carolina, in November.

Jackson is the deputy director of Sandia's International Security Center. She has served on numerous committees and boards for the national academies. The AISES Professional of the Year award is presented for overall leadership and technical achievement.

DeBassige works at Sandia's MESA (Microsystems Engineering and Science Applications) complex designing and prototyping qualified microsystem-based

Jaime Moya

The AISES Professional of the Year award is presented for overall leadership and technical achievement.

Nancy Jackson and John DeBassige

components for nuclear weapons. He participated in Sandia's One-Year-On-Campus education program, where he completed his master of science degree 10 months early. The AISES Most Promising Engineer/Scientist award recognizes his early technical contributions.

Both Jackson and DeBassige are active in encouraging young American Indians to enter the fields of science and engineering.

Jaime Moya awarded HENAAC award for Professional Achievement

Jaime Moya, a senior manager for Environment, Safety and Health (ES&H) Planning & Assurance at Sandia National Laboratories, is the winner of a 2005 award for Professional Achievement from the Hispanic Engineer National Achievement Awards Corporation. The award was presented at the 2005 HENAAC Conference in October in Anaheim, California.

Before he became a group manager in ES&H, Moya was manager for the Test Capabilities Revitalization (TCR) program at Sandia. The program's goal is to vitalize the National Nuclear Security Administration's test capabilities.

Moya recruits Sandia staff for participation in community projects such as mentorship programs, local and state science fairs, and the MANOS program, a Sandia/Albuquerque Public Schools program that seeks to introduce science and engineering concepts to middle school students.

Ken Frazier elected AAAS Fellow

Sandia Lab News Editor Kendrick Frazier, a science writer and editor for nearly 40 years, has been elected fellow of the American Association for the Advancement of Science (AAAS).

Frazier's election was announced in October. He is being honored for his "distinguished contributions to the public understanding of science through writing for and editing popular science magazines that emphasize science news and scientific reasoning and methods." He will be officially recognized in St. Louis at the February AAAS annual meeting.

Ken Frazier

Frazier has been *Lab News* editor for the past 10 years. He has also served as editor of *The Skeptical Inquirer: The Magazine for Science and Reason* since 1977. The bimonthly international journal promotes good science, critical thinking, critical inquiry, and science education. It also evaluates fringe science, pseudoscientific, and paranormal claims from a responsible, scientific point of view. He is the author or editor of nine books.

For more information about the awards:

American Academy of Arts and Sciences
www.amacad.org

American Indian Science and Engineering Society
www.aises.org

Hispanic Engineer National Achievement Awards Corporation
www.henaac.org

American Association for the Advancement of Science
www.aaas.org

The Federation of Materials Societies
www.materialsocieties.org

Tom Mehlhorn

Fusion researcher Tom Mehlhorn elected AAAS Fellow

Sandia physicist and fusion research leader Tom Mehlhorn has been elected a fellow of the American Association for the Advancement of Science (AAAS). Mehlhorn — manager of Sandia's High Energy Density Physics and ICF Target Design department — is being honored specifically "for scientific and managerial leadership in studies of high energy density physics, particularly those involving Z-pinches."

In his present position, Mehlhorn is responsible for integrated target designs for the Sandia inertial confinement fusion (ICF) program. He is leading an effort to develop a theoretical understanding of X-ray power scaling from Z-pinches for application to ICF targets and is principal investigator for the Sandia Grand Challenge LDRD project on advanced Z-pinch fusion.

Mehlhorn came to Sandia in 1978 after receiving his PhD in nuclear engineering from the University of Michigan. He was chief theorist for ion diode experiments on both the PBFA I and PBFA II pulsed-power accelerators. In September 2004 Mehlhorn received the Lockheed Martin NOVA award as manager of the team that produced thermonuclear fusion at Sandia's Z machine. He will be inducted at the AAAS Fellows Forum as part of the AAAS Annual Meeting in St. Louis in February.

Al Romig recieves National Materials Advancement Award

Al Romig, deputy director for Integrated Programs, was named recipient of the National Materials Advancement Award from the Federation of Materials Societies in October. He received the award at a reception at the National Press Club in Washington, D.C. on December 7.

The award recognizes individuals who demonstrate outstanding capabilities in advancing the effective and economic use of materials and the multidisciplinary field of materials science and engineering, and who contribute to the application of the materials profession to national problems and policy.

The Federation of Materials Societies is a consortium of technical and professional societies consisting of scientists, engineers, and other professionals active in the areas of materials policy as well as research and development, processing, recovery, and resource availability.

At Sandia, Romig's responsibilities include the leadership and management of development and engineering activities that provide science, technology, systems, and expertise in support of U.S. programs in military technology; proliferation prevention; technology assessments; counterintelligence; energy science, resources, conservation, and infrastructure assurance; and homeland security.

Al Romig

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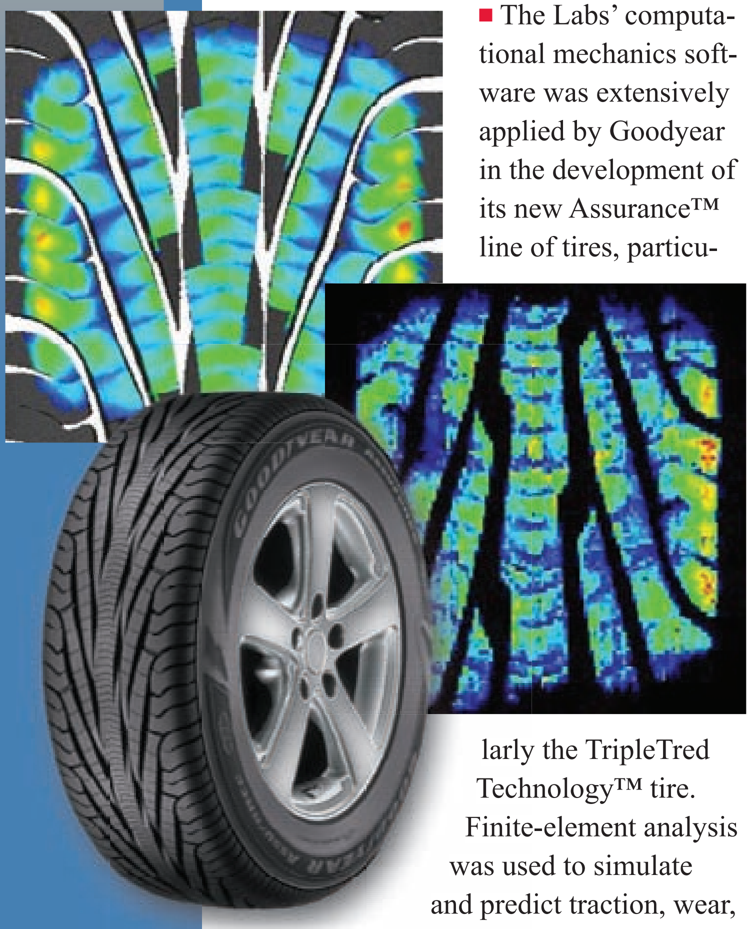
Sandia wins four R&D 100 Awards

In this year's R&D 100 awards competition—awarded annually by teams of technical experts selected by Chicago-based R&D Magazine—Sandia National Laboratories teamed with other organizations to win four awards.

Goodyear Tire & Rubber Company

■ The Labs' computational mechanics software was extensively applied by Goodyear in the development of its new Assurance™ line of tires, particularly the TripleTred Technology™ tire. Finite-element analysis was used to simulate and predict traction, wear, durability, and other performance characteristics of the TripleTred in bringing it from concept to market in less than a year.



For the Assurance TripleTred tire project, computer simulations were used to predict characteristics and then compared with actual tests—as in the case of these two footprint images—to validate the models.

Global-Link

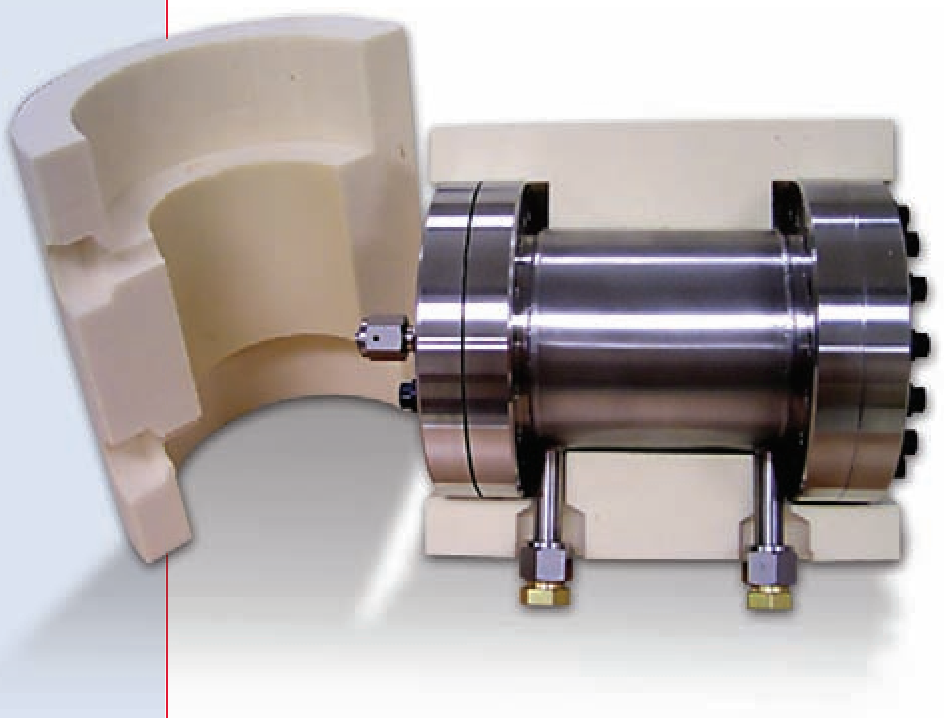
■ For another award, Sandia used innovative data compression techniques to help physicians in remote locations consult in real time over MRI images, though the amount of data transferred is normally huge and the healers may be thousands of miles from each other. Global-Link allows such rapid transmission of complex data that a doctor in the U.S. can confer with a doctor halfway around the world, viewing and manipulating 3-D images in real time directly on each doctor's computer. Similarly, petroleum explorers can confer around the globe on observed data. So can military commanders. Extremely responsive interactions between an event and a remote, secure, high-resolution display are possible using Global-Link across the Internet. Results were achieved in collaboration with Logical Solutions, Inc., which is marketing the product.

IPEM

■ Sandia earned a third R&D 100 award for the invention of a patented exploratory ion beam microscope system that does not require costly and complicated forming and focusing equipment. Joint winner Quantar Technologies is marketing this invention. The multidimensional, high-resolution analysis system is called the Ion-Photon Emission Microscope (IPEM). It allows scientists to microscopically study the effects of single ions in air on semiconductors, semiconductor devices, and biological cells without having to focus the beam. The technique determines the position at which an individual ion enters the surface of a sample; so, focusing a beam is unnecessary.

TEPIC

■ Sandia/California originally developed TEPIC—a rigid structural foam—for defense program applications. Because it is dimensionally and mechanically stable to temperatures in excess of 200 degrees C, it meets processing requirements to be used as forms for molding advanced composite materials that cure at high temperatures. Formerly, only expensive metal tooling could meet this thermal challenge. Unlike many more conventional tooling materials, it can be processed in thick sections.



TEPIC is a strong, high-temperature, low-cost tooling material for structural, resin-matrix composite manufacturing. TEPIC, shown here, was used as a high-temperature insulation for a metal powder-based hydrogen storage bed.

One hundred winners are chosen from an international pool of contestants from universities, private corporations, and government labs.

Cost and weight savings should allow smaller businesses, with less capital investment, to process new composite structures, and in general enable incorporation of advanced structural composites in aerospace, military, automotive, and other consumer product industries. Also included on this award is Scion Industries, one of two licensees of TEPIC.

The annual R&D 100 contest attempts to select the best applied new technologies. One hundred winners are chosen from an international pool of contestants from universities, private corporations, and government labs.

The sole criterion for winning, according to the magazine, is "demonstrable technological significance compared with competing products and technologies." Properties noted by judges include smaller size, faster speed, greater efficiency, and higher environmental consciousness. Winners were presented plaques at a formal banquet in Chicago this fall.

"These awards demonstrate that DOE scientists and researchers are hard at work developing the technologies of the future," said U.S. Secretary of Energy Samuel W. Bodman. "In the past, breakthroughs like these have played an important role in both our economic and national security."

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"[Testing at the Nevada Test Site] is something we did, something that was very big, that we don't do anymore. It gave rise to our work in Albuquerque with the reactors and pulsed power — all of that is the direct successor of the work we did on radiation effects with those tunnel shots. The role of the test site in the weapons program is essential in the area of readiness, and the importance of that can't be overstated. If the world changes, if the nation again needs to begin full testing, NTS will be ready. In the meantime, the work being done there is actively providing important data. The sub-critical tests are very important for the stockpile program."

Thomas O. Hunter
Sandia National Laboratories,
president and director

Sandia National Laboratories

LOCKHEED MARTIN

Sandia is a multiprogram laboratory operated by Sandia Corporation, a Lockheed Martin Company, for the United States Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000

NNSA National Nuclear Security Administration

SAND-2005-7193P

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