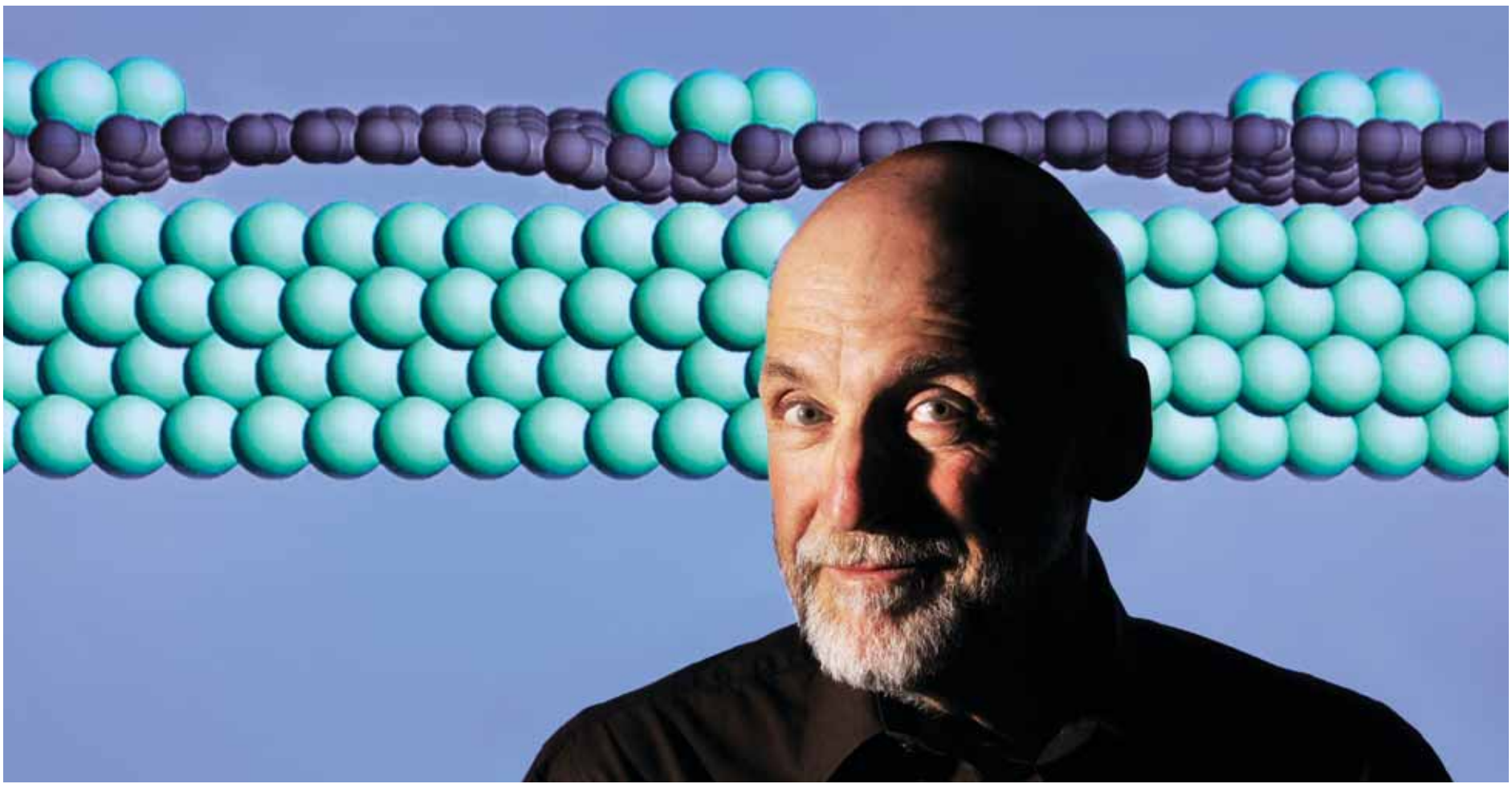

RESEARCHER PETER FEIBELMAN stands before his computational simulation suggesting an explanation for why iridium atoms (colored green) nest regularly atop a base of graphene (dark-colored atoms) grown over an iridium substrate. Graphene has proven a difficult material for researchers to tame and Peter's image of the orderly nanoscopic arrangement may provide insights to other scientists. His paper on the work was published last Thursday in *Physical Review B* online. Read Neal Singer's story on **page 4.** (Photo by Randy Montoya)

Tethered to the past

When Ed Baynes was a boy, he and his dad built and raced tether cars, tiny gas-powered vehicles that buzz around a track at 140 mph. Decades later, going through his father's estate, Ed found a set of tools that reconnected him to his boyhood and to the gifts a father gave him. Read the story on **page 12.**

Sandia LabNews

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Sandia National Laboratories

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The physics of carbon nanotubes

François Léonard writes the book on subject

By Patti Koning

Carbon nanotubes, described as the reigning celebrity of the advanced materials world, are all the rage. Recently researchers at Rice University and Rensselaer Polytechnic Institute used them to make the "blackest black" — the darkest known material, reflecting only 0.045 percent of all light shined on it.

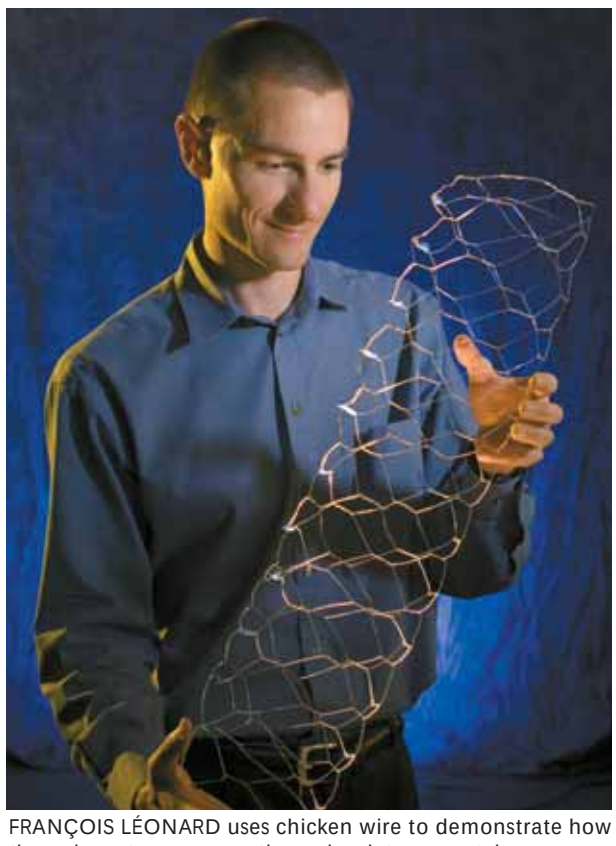
Sandia is, naturally, in on the carbon nanotube game, with research led by physicist François Léonard (8756). François has considerable experience in the subject, so much that he wrote the book on it — literally. He's the author of a forthcoming work, *Physics of Carbon Nanotube Devices*, which could become the definitive text on the topic.

François says he hadn't thought of authoring a book on carbon nanotubes until he was approached by publishers, a result of a review article he wrote. "I was intrigued," he says. "It seems like there is a need for a book like this to explain the physics behind the applications."

Carbon nanotubes are long thin cylinders composed entirely of carbon atoms. While their diameters are in the nanometer range (1-10), they can be very long, up to centimeters in length. The carbon-carbon bond is very strong, making carbon nanotubes very robust and resistant to any kind of deformation.

"Carbon nanotubes have very intriguing properties, both from a scientific perspective and for applications," says François.

(Continued on page 3)



FRANÇOIS LÉONARD uses chicken wire to demonstrate how the carbon atoms arrange themselves into a nanotube. (Photo by Randy Wong)

What's different in Sandia's HBE clinics?

By John German

If you visit one of Sandia's Health, Benefits, and Employee Services (HBE) clinics next week, the nurse will take your blood pressure, like always. Your physician will ask you whether you are allergic to any medications, like always. And that crunchy exam table paper will be there for you to sit on, like always.

So what's missing? Your medical chart.

Beginning Monday, April 28, Sandia clinics join a growing number of health clinics worldwide in replacing paper health records with electronic health records (EHRs). From now on, your physician will reference your medical chart on a computer screen rather than flip through charts kept in a brown folder.

Accuracy and automation

The change to electronic health records comes with important benefits.

For one, any medications your physician prescribes will be submitted electronically to your pharmacy. Scrawled prescriptions not only give physicians a bad

(Continued on page 4)

Augustine at Sandia

Former Lockheed Martin CEO Norm Augustine, in a recent visit to Sandia, spelled out his ideas for "reengineering engineering education." He offered 16 attributes of engineering education needed for 21st-century challenges. Story on **page 5.**

Inside . . .

Hunter in Washington

Labs Director Tom Hunter was part of an NNSA delegation that went to Capitol Hill to discuss the FY09 nuclear weapons budget with members of the Senate Energy and Water Appropriations Subcommittee. Story on **page 9.**

That's that

You can't get away with anything around here. In our last issue, I wrote a caption for a front-page photo by Randy Montoya. It showed south-heading traffic backed up on Juan Tabo Boulevard in Albuquerque with the Solar Tower gleaming in the distance. Problem is, I wrote that the photo was taken in the early morning. If I'd looked more closely, I'd have noticed, as did many of you, that the sun was obviously setting, lighting up the right sides of the cars traveling south, casting long shadows to the east. After almost a decade and a half of working with scientists and engineers, I should have known that I'd be called on this. And I was. Rightfully so.

* * *

This week's English usage lesson comes courtesy of former *Lab News* editor and Radio Sandia manager Bruce Hawkinson. Some of you may recall that a couple of issues back I talked about Randy Montoya (there's Randy again) "discretely" handing Sen. Pete Domenici some photos to share with his wife and family. Bruce, who laid down his editor's blue pencil and retired years ago, apparently can't get the editing bug out of his blood. He wrote to gently lecture me on the difference between the words "discrete" and "discreet." "Discrete," the Hawk wrote in an email, "means 'separate, distinct,' . . . while discreet means 'careful, judicious, circumspect.' He's right of course. This is Journalism 101 stuff. I must say, Bruce was very discreet in the way he took me to the woodshed; before the teaching moment on usage, he offered nice words about the column and I always like that. Now, can anyone tell me the correct usage for between and among? Anyone? Anyone?

* * *

If you're interested in New Mexico history, I'd highly recommend a new book by Hampton Sides called *Blood and Thunder*. On its very large canvas, it tells the story of the intersection of three cultures in New Mexico in the 19th century: Navajo, Hispanic, and Anglo. The primary trajectory of the story follows the parallel careers of Kit Carson (an Anglo mountain man and scout who married a Hispanic woman, lived in Taos, and spent a lifetime among Indians in peace and war) and great Navajo chief Narbona (not *the* chief, mind you, but *a* chief). The book is wonderfully readable and for Sandians has the added element of interest in that it cites our own John Taylor as an authority on Civil War battles in the state. I don't cry easily, but I must say that the last page or so of this book had me as near to tears as anything I've experienced in recent literature. It's that good and moving.

* * *

Did you go hear Norm Augustine earlier this month at the Steve Schiff Auditorium? He was there to deliver a Truman Distinguished Lecture on a topic that obviously touches close to home for a lot of us here: "Reengineering engineering education." I've written a summary of the talk in a story starting on page 5, but I'd strongly suggest you go to the video at http://ln.sandia.gov/Augustine-Apr-2008 and hear the full presentation; it's a provocative and sobering assessment of America's challenges in the 21st-century global economy and some possible approaches to meeting the challenge.

See you next time.

— Bill Murphy (505-845-0845, MS0165, wtmurph@sandia.gov)

Sandia LabNews

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Nominations sought for annual Laboratory Director's Awards

Nominations are being sought through May 2 for the Sandia Laboratory Director's Awards, which are designed to recognize Sandia project and program managers and teams that excel in all aspects of the Labs' relationship with small regional suppliers.

The Supplier Community Advisory Council (SCAC) and Sandia have sponsored the awards since 2001. The awards demonstrate a continued, high-profile recognition that regional procurement is supported from the highest levels of management at the Labs.

Award categories

These awards are presented in four categories:

• **Regionally Procured Products and/or Services**: This award is based on the project/program that achieved the largest increase (percentage or dollar increase) in the utilization of small regional services suppliers or small regional product suppliers within a project/program fiscal year.

• **Innovation in Small Regional Business Procurement:** This award is based on the project/program that reaches out to small regional suppliers to provide new/continuing opportunities, while complying with Sandia policies and procedures, above and beyond regular or standard business practices.

• **Sandia Staff Advocate:** This award recognizes an individual staff member for regional procurement accomplishments that had a significant impact on small business suppliers.

• **Sandia Team Advocates:** This award recognizes a team of Sandia employees (line, procurement, management, etc.) for regional procurement accomplishments that had a significant impact on small business suppliers.

Nomination forms with detailed instructions and submittal instructions are available at http://cfo.sandia.gov/procure/directorAwards/directorAward.htm

Final nomination forms will be reviewed by the LDA Selection Committee. The selection committee will be composed of Sandia managers, SCAC members, and at least one of the 2007 Director's Award winners. The selection committee shall review and score all nominations and then select the highest scoring nomination in each category as the 2008 winners.

SCAC will recognize the winning programs and professionals following the June 3 Supplier Community Advisory Council meeting. The ceremony and reception location will be announced at a later time. All nominees and nominators will be invited to attend.

Management promotions

Robert Hoekstra from PMTS, Electrical & Microsystem Modeling Dept. 1437, to manager of that same department.

Tom Klitsner from manager, Strategic Planning & LLT Dept. 12141, to senior manager, Computer Support Unit Services Dept. 9340.

Anthony Wingate from PMTS, Payloads Dept. 5415, to manager, Subsystem/Component Quality Engineering Dept. 12342.

Retiree Deaths

Richard A. Bice (age 90) . . . . . March 8
Leonard J. Baker (89) . . . . . March 9
Bernard O. Ellis (82) . . . . . March 10
Byron C. Coats (98) . . . . . March 11
Frank W. Corner (96) . . . . . March 13
Daniel J. Yarbrough (89) . . . . . March 15
Elizabeth Lee Frost (83) . . . . . March 17
Berry F. Estes (74) . . . . . March 19
A. Lee Jensen (67) . . . . . March 19
Margaret A. Sanders (91) . . . . . March 20
Myrna L. Walla (71) . . . . . March 20
Robert F. Knight (82) . . . . . March 21
James C. Gravlin (83) . . . . . March 24
Alfred C. Taylor (89) . . . . . March 29

Take Note

Retiring but not seen

Retiring and not seen in *Lab News* pictures: John K. H. Yip (4225), 25 years.

Nanotubes

(Continued from page 1)

Carbon nanotubes have a sort of dual personality not found in other materials made from a single element. The properties of other single-element materials are obvious — gold is a metal and silicon is a semiconductor, for example. Carbon nanotubes are special because they can be either metallic or semiconducting.

François explains that this results from the actual structure of a carbon nanotube; the way the atoms are arranged around the tube determines its electronic properties. To explain this concept to a group of undergraduates at the University of California, Berkeley, he uses three rolls of chicken wire, each cut at a different angle.

The chicken wire represents the sheet of graphene from which the nanotube is cut. The angle of that cut creates a different bond geometry along the nanotube, which results in different properties.

Working in uncharted territory

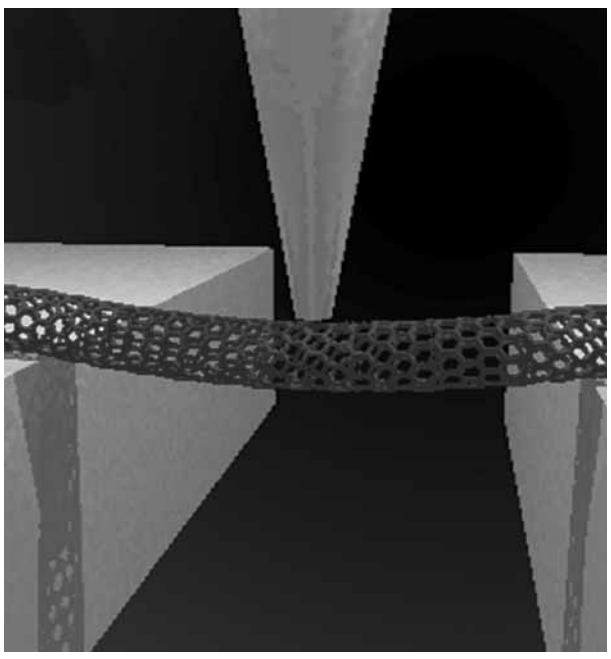
François' experience with carbon nanotubes began when the field was just emerging. While the discovery of carbon nanotubes is credited to Japanese physicist Sumio Iijima in 1991, work on applications didn't begin until the late 1990s. François was at IBM as a postdoc when researchers there built the first transistor from carbon nanotubes.

As a theoretical physicist, François was working in uncharted territory. From the beginning, he worked on modeling approaches to understand how carbon nanotubes might behave in certain applications. He joined Sandia in 2000, where he has continued his carbon nanotube research.

CHICKEN WIRE SERVES AS A METAPHOR when François Léonard explains the physics of carbon nanotubes to students. François has written a book on the subject to be published by the end of this month. (Photo by Randy Wong)

A 2007 paper that he coauthored, "Optically Modulated Conduction in Chromophore-Functionalized Single-Wall Carbon Nanotubes," received a lot of attention, including a write-up in *Nature*. The paper detailed the incorporation of a photosensitive dye with a single carbon nanotube, so that its electrical connectivity can be controlled by light. This approach allows the detection of light at intensities thousands of times less than previously accomplished.

The semiconducting side of carbon nanotubes holds a lot of promise for the development of new nanoelectronic devices. "A carbon nanotube creates a transistor that is only one nanometer wide," says François. "This makes it possible, in principle, to achieve very high device densities compared with the current state of the art." The field emission properties of carbon nanotubes are also exciting. Flat panel displays are typically made from a high density of sharp tips, to which high voltage is applied to extract electrons. These electrons strike and activate the pixels in the screen. Carbon nanotubes can serve this purpose because they are very sharp, long, and can sustain high fields and high temperatures. Recently Samsung prototyped a 40-inch color display made with carbon nanotubes as emitter tips.



SCHEMATIC OF A CARBON NANOTUBE between two electrodes and deformed by a sharp tip.

The applications just get wilder. Carbon nanotubes can convert MEMS (microelectromechanical systems) into NEMS (nanoelectromechanical systems).

'Layla' on a nanotube receiver

Researchers have demonstrated the ability to assemble such devices with a single carbon nanotube. At a recent conference, one scientist played Eric Clapton's "Layla" on a carbon nanotube device acting as a radio receiver.

Another potential use is in chemical and biological sensors. Carbon nanotubes, because of their small diameter, can serve as very sensitive detectors, with the ability to detect a single molecule of a target substance. DNA detection has also been demonstrated.

Currently, François is leading a team to develop optical detection using carbon nanotubes. The project is a partnership with Lockheed Martin under its Shared Vision program.

Unique electronic properties

"This project fits into many of Lockheed Martin's and Sandia's missions. In addition to national security applications, optical detectors are used extensively in basic science, for everything from looking at nanoscale materials to galaxies," says François.

Semiconducting carbon nanotubes have many properties that make them attractive for optical detection. They have unique electronic properties that favor light absorption. In addition, the wavelength over which light is absorbed can be controlled with nanotubes of different diameters. Importantly, the device fabrication process could be entirely compatible with fabrication processes used by the semiconductor industry.

In addition to carbon nanotubes, François is interested in electronic transport in other nanostructures — carbon nanotubes as well as nanowires and single molecules. The question, he says, is how does current pass across nanostructures? How is transport of electrons different than in conventional materials?

François' book is expected to be out by the end of April. See the publisher's website at www.williamandrew.com/title.php?id=482 for details.

Sandia CaliforniaNews

Protein purification process expected to enable discoveries in bioenergy research; will impact JBEI mission

Sandia research is having significant impact in the emerging bioenergy arena through its work in protein purification and analysis. Recent developments in this technology space were recognized in the 2008 Volume 8 edition of *Lab on a Chip* — a leading microfluidics scientific journal — that featured a Sandia paper on its front cover.

The paper is titled "Rapid, continuous purification of proteins in a microfluidic device using genetically engineered partition tags." Authored by Robert Meagher, Yooli Light, and Anup Singh (all 8321), it describes a rapid, automated microscale process for isolating specific proteins from submicroliter volumes of *E. coli* cell lysate.

High-throughput purification

"This novel approach addresses the need for high-throughput purification of minute amounts of native and recombinant proteins, which is currently necessary in drug discovery, enzyme engineering, and other life sciences," says Robert, the lead author. High-throughput screening requires availability of large numbers of purified proteins, but current purification techniques are too slow, expensive, and hard to automate.

For bioenergy research, the microfluidics-based technique is key in that it will allow for much faster enzyme purification and analysis, provide a more automated engineering method, and use smaller amounts of cell mass to produce proteins.

"It [processing of biomass] can be a difficult and often costly process, but certain enzymes have been found to efficiently break down cellulose into sugars," says Anup, senior author of the paper and manager of Sandia's Biosystems Research department. Sandia's technique, he says, combined with high-throughput cell culture methods, will allow thousands of enzymes and their variants to be purified and screened rapidly, which should significantly aid researchers as they search for the optimal enzyme to meet their processing needs.

This effort, funded by Sandia's Laboratory Directed Research and Development program and DOE's Office of Science, will have significant impact on the recently funded Joint Bio-Energy Institute (JBEI), where Sandia is contributing its expertise in science-based engineering, computational science, and microsystems. The Labs' capabilities in enzyme engineering, systems biology, membrane transport, protein expression, and hyperspectral imaging are all expected to contribute significantly to the DOE JBEI mission. — *Mike Janes*

Sandia simulations may explain nanoparticles 'pinned' to graphene

Peter Feibelman's visualization shows metallic atoms rising from substrate, like muffins in a muffin tin

By Neal Singer

Graphene flakes are notoriously difficult to work with. Still, they are stronger than diamond, better heat-shedders and conductors than silicon, and thought to have great potential in the worlds of microelectronics and sensors.

In 2005, a German team discovered a new wrinkle in the battle to harness them. A graphene flake lying atop an iridium crystal unexpectedly caused new iridium atoms, deposited on top of the flake, to arrange themselves into equally sized, equally spaced clusters. Not only that — the cluster arrays remained stable even as the temperature was raised into the 400 to 500 kelvin range.

Imagining a whole new set of possible applications, people wanted to know why.

It was hard to understand how a graphene sheet — a featureless, flat sheet of carbon atoms — lying on an equally featureless iridium surface, somehow converted itself into a kind of muffin tin that drew newly arrived iridium atoms into equally spaced, equally sized clusters ("muffins").

"At the outset," writes Sandia researcher Peter Feibelman (1130), "this seemed quite a mystery."

Sherlock Holmes himself, looking for clues to why the iridium quantum dots so mysteriously attached, would have found little to go on.

The iridium support layer was flat as could be. The same was true of the graphene layer that formed on top of it, which sported neither hooks nor ports for nanoparticle docking.

Graphite itself — merely a group of sheets of graphene — is so slippery it can be used as a lubricant. Why would nanodots attach to the completed graphene layer instead of just sliding away?

Even granted an attachment mechanism, why would newly introduced iridium atoms form a moiré — a regular, ordered array — atop the graphene instead of a planar second surface — a sandwich where the iridium was the bread and graphene the meat?

The explanation for the template effect would be almost impossible to see by direct examination.

But Peter's computational simulations, detailed in a paper published electronically last week by *Physical Review B*, produced a plausible explanation.

His work demonstrates that in regions where half the graphene flake's carbon atoms sit directly above iridium atoms of the underlying crystal, iridium atoms added on top of the graphene flake make it buckle. These regions do not occur randomly, and in fact form the regular array needed to explain the nanodot moiré.

The buckling weakens tight links between the graphene's neighboring carbon atoms, freeing them to attach to the added iridium atoms. Furthermore, buckling not only allows the carbon atoms that buckle upward to capture deposited iridium atoms, but also causes the carbon atoms that buckle down to attach firmly to the metal below, explaining the remarkable thermal stability of the nanodot arrays.

This orderly nanoscopic arrangement appeals to scientists trying to understand aspects of catalysis, Peter says. The atoms that make up tiny nanodots are expected to be in direct contact with inserted materials, important for speeding up desirable chemical reactions. The regular arrangement of the nanodots makes the science relatively simple, because every catalyst particle is the same and sits in the same environment.

"The rigorous periodicity of the nanodot arrays is a huge advantage compared to amorphous or 'glassy' arrangements where everything has to be described statistically," says Peter.

Similar quantum dot arrangements on electrically insulating graphene could keep information packets separate and "addressable" for data storage, or provide superior conditions for quantum computing.

Health records

(Continued from page 1)

reputation for handwriting, they also cause thousands of patients each year to take the wrong medications. Electronic prescriptions ensure you get the medication your practitioner intended.

If you have regularly scheduled Sandia health maintenance needs, the system will remind your physician when it is time to make an appointment. Lab test results are analyzed and results reported automatically to your doctor.

And your vitals — blood pressure, heart rate, etc. — are tracked over time for early identification of potential problems.

"It's really going to enhance patient care," says Deb Menke, manager of Healthcare & Support Services Dept. 3334.

What about confidentiality?

"In some ways, employees' records are more protected than before," says Deb. "The new system keeps an audit trail of anyone who accesses your records, with dates, times, and records viewed — so we know who touches it, when, and why."

All of Sandia's EHRs reside behind a firewall and are protected as unclassified, controlled information (UCI). Additionally, each health care provider will access the records through a secure password-protected system.

The new commercial system, called TouchWorks from Allscripts, is used by more than 30,000 physicians in 3,500 clinics nationwide, so it is tested and proven, says Rob Nelson (3330), who led the EHR team.

The HBE team plans to add an electronic personal health portal that will allow you to access your health information, update it, and have it available to provide to other physicians, he adds.

MARY MARTIN (3331) checks a patient's electronic health records. (Photo by Randy Montoya)

AAAS regional meeting in Albuquerque draws 200 papers, 350 participants

JUNHANG LUO, a graduate student from the University of Pittsburgh, shows a specialized microscope to participants in the AAAS SWARM meeting during a conference tour of the Center for Integrated Nanotechnologies (CINT) Core Facility. Luo is using the equipment available at CINT to conduct his PhD research. (Photo by Randy Montoya)

Some 350 people participated in the 83rd annual meeting of the Southwestern and Rocky Mountain (SWARM) region of the American Association for the Advancement of Science (AAAS) in Albuquerque last week.

The meeting was organized by Sandia and the University of New Mexico and held at UNM. Wendy Cieslak, senior manager of Science, Technology, & Engineering (1010), is SWARM's president. Dawne Settecerri (1010) coordinated the logistics.

The conference's theme — Meeting Today's Challenges through Collaborative Science, Engineering, and Technology — emphasized the importance of collaboration across disciplinary boundaries, says Sandia project lead Gretchen Jordan (1012).

Session themes included energy, sustainability, health, nanotechnology, collaboration, and science education.

SWARM Executive Director Dave Nash says the conference featured a good diversity of presenters, states, and topics. More than 200 people from 20 states and five countries representing 80 organizations gave presentations.

"We heard a number of times that people were finding and planning opportunities for collaboration on specific projects during the conference," says Gretchen.

Norm Augustine, former CEO of Lockheed Martin Corp. and author of the National Academies report *Rising Above the Gathering Storm*, gave a keynote address.

The award for the best nonstudent presentation went to Sameer Varma of Biomolecular Interfaces & Systems Dept. 8331 for a paper titled "Mechanisms of Ion Recognition by Biological Molecules."

The SWARM region of AAAS includes New Mexico, Arizona, Texas, Oklahoma, Kansas, Colorado, Nebraska, Wyoming, South Dakota, North Dakota, and Montana, as well as Saskatchewan and Manitoba, Canada, and Sonora, Chihuahua, and Couahuilla, Mexico.

Former Lockheed Martin CEO Norm Augustine offers prescription for 'reengineering engineering education'

Truman Distinguished Lecture addresses US competitiveness in era of 'the death of distance'

Photo by Randy Montoya

By Bill Murphy

Consider: China graduates more engineers — correction, more *English*-speaking engineers — each year than does the US. That's just one factor cited by Norm Augustine during his Harry S. Truman Distinguished Lecture April 11 to buttress his case that the US must revamp its engineering education process to remain competitive in a global economy. Augustine was hosted by Div. 1000 VP and Chief Technology Officer Rick Stulen.

Augustine, former chairman and CEO of Lockheed Martin and one of the nation's most visible champions of American competitiveness, chaired a commission not long ago that issued a report called *Rising Above the Gathering Storm: Energizing and Employing America for a Brighter Economic Future.* That congressionally mandated report calls for a comprehensive and coordinated federal effort to bolster US economic competitiveness and preeminence in science and technology, areas in which traditional US advantages are slipping away.

Employers today consider the entire planet their talent pool, while investors "pay no attention to geopolitical borders."

Speaking at the Steve Schiff Auditorium to an audience of about 300 Sandians, Augustine addressed one subset of the *Gathering Storm* report. In his talk, "Reengineering Engineering Education," Augustine laid out his view of what needs to be done to graduate more and better engineers for a 21st-century global economy. He laid out 16 attributes he believes should be part of modern engineering education, but first he sketched a picture of the global environment in which US engineers must compete (see "Norm Augustine's 16 attributes to reengineer engineering education" at top right).

The death of distance

Citing the concept of "the death of distance" (the title of a book by Frances Cairncross), Augustine noted that employers today consider the entire planet their talent pool, while investors "pay no attention to geopolitical borders."

Not so long ago, Augustine said, the impacts of globalization mainly affected assembly workers; that's not true today. Today, virtually every job is on the table.

The reasons corporations are looking at a global employment pool are compelling: They can hire nine factory workers in Mexico for the price of one American worker, 20 assembly workers in Vietnam, eight engineers in India, or five chemists in China for the price of one in America. The fact is, Augustine said, nations like China and India are turning out highly motivated and well-educated professionals who are in competition for the jobs that used to fall to Americans by default. The Saudis are entering the arena, too. Recently, Augustine noted, a new graduate research university in Saudi Arabia opened with an endowment on day one equal to what it took MIT 142 years to build.

Our ability to create jobs will be greatly dependent upon our prowess in science and engineering, particularly in basic research, most of which is conducted in our universities or in institutions such as this [Sandia]."
— Norm Augustine

It has become increasingly apparent, Augustine said, that "our ability to create jobs will be greatly dependent upon our prowess in science and engineering, particularly in basic research, most of which is conducted in our universities or in institutions such as this [Sandia]." The nation's engineering prowess has leveraged basic research to create new products and services and American entrepreneurship pushes those new products into the marketplace.

"If America is going to compete at all [in the new economy]," Augustine said, "it will be based on our ability to innovate."

Given the importance of science and engineering in driving the US economy and job creation — over the past half century somewhere between 50 percent and 85 percent of the growth in the nation's gross domestic product has been attributed to advancements in science and technology — Augustine said it is vital that the nation ensure that its engineering education is up to the task that the new times demand of it.

Augustine acknowledged that education in grades K-12 needs to be reengineered as well, observing that if you fail to connect effectively with students during those critical years, "nothing else will matter all that much." He quoted a comment from Microsoft founder Bill Gates at the National Governor's Conference in 2005: "When I compare our high schools to what I see when I'm traveling abroad, I am terrified for our workforce of tomorrow."

"I share that view," Augustine said.

Low test scores, great self-esteem

Augustine cited familiar statistics indicating that US high school students fare poorly compared to students in other countries in areas such as mastery of math and science subjects. (US students fare much better when asked where they *think* they rank in these areas — they rate themselves the best in the world.)

While emphasizing that the nation has many fine and dedicated teachers and excellent schools, Augustine said that "On average, we don't come anywhere close to average."

Norm Augustine's 16 attributes to reengineer engineering education in the US

Norm Augustine, speaking at Sandia on the subject of "Reengineering Engineering Education," offered 16 measures, or attributes, that he believes if incorporated into undergraduate engineering curricula, could begin to restore American preeminence in this vital arena. In a nutshell, here are the 16 attributes:

1. Foster an understanding of the fundamentals of physics, chemistry, and mathematics, which is the language of engineering.
2. Teach concepts that underpin design and analysis, such as parametric tradeoffs, reliability, maintainability, and testing.
3. Address circumstance of losing one-third of engineering students in the first year. Exposure to real-world design projects is an effective solution.
4. Devote a course to examining root causes of spectacular engineering failures. "Nature isn't belligerent but it's certainly unforgiving."
5. Expose students as undergraduates to rudiments of systems engineering.
6. Expose students to concepts of operations analysis and systems analysis, with an emphasis on probability and statistics.
7. Foster a working knowledge of biosciences.
8. Teach an understanding of basic economics.
9. Teach engineering ethics.
10. Include the study of public policy, history, and government.
11. Turn the clock back to the engineering education of the early 1900s, which included exposure to literature, art, and music.
12. Teach students to write and speak coherently. "On-the-job training is no better for learning to write than it is for learning neuroscience."
13. Recognize that we're in an engineering era built on large teams and teach leadership, followership, compromise, and cooperation.
14. Spend a college year abroad, because projects will increasingly be international.
15. Encourage creativity, imagination, and prudent risk-taking (the freedom to fail).
16. The balance of teaching and research at our great universities has shifted too close to the research end and requires a vernier adjustment to emphasize teaching, including when awarding tenure.

Augustine left the audience sobered by the scope of the challenge facing America, but his suggestion of 16 specifics that should be incorporated into engineering education made it plain that the challenges can be faced with tangible actions. He advocated that rather than try to squeeze a reengineered engineering curriculum into four years, it should take at least five and that the MS should be the fundamental degree for engineers. To drive home the point, he noted, "It takes more education to give my cat a vaccination than to build a bridge that thousands of people will cross."

The challenge to America is daunting but doable, Augustine said. And he ended on an upbeat note. Quoting Winston Churchill, he said, "You can always count on the Americans to do the right thing — after they've tried everything else."

Augustine asserted that if you fail to connect effectively with students in grades K-12, "nothing else will matter all that much," and cited a comment by Microsoft founder Bill Gates: "When I compare our high schools to what I see when I'm traveling abroad, I am terrified for our workforce of tomorrow."

Team developing viable biofuel for military aircraft

DARPA project focuses on the flexible conversion of bio-oil from multiple sources to Jet Propellant-8

By Michael Padilla

Coming soon: New biofuel for military jets.

That's what Sandia researchers are working on as part of a Defense Advanced Research Projects Agency (DARPA) funded team led by UOP LLC, a Honeywell company.

The team is looking at the production of military Jet Propellant 8 (JP-8) fuel based on renewable biomass oil feedstocks, including oil crops, unconventional sources like algae, and various forms of waste vegetable and animal oils.

The goal of the 18-month effort, backed by a $6.7 million project award from DARPA, is to develop, demonstrate, and commercialize a process by October to produce the JP-8 fuel used by US and NATO militaries.

Sandia researchers are working with team members at UOP and Cargill to evaluate technical, economic, and environmental interdependencies. The team is conducting comparative life-cycle analyses and trade-off assessments and assessing the scale-up feasibility of high-volume bio-oil feedstock and JP-8 fuel production from suitable oil crops and other sources.

At the same time, Sandia, UOP, Honeywell Aerospace, Cargill, and Southwest Research Institute researchers are working to evaluate, develop, and commercialize the processes and biofeedstock and biofuel production scale-up pathways needed to enable reliable, high-volume, competitively priced jet fuel production based on feedstock rather than petroleum.

A new complementary DARPA biofuel program announced in November is specifically focused on the production of JP-8 from algae and lignocellulosic materials. Sandia partnered on six different teams that submitted proposals to this program. Proposal funding decisions are expected to be made in late April, with funded projects expected to begin by late summer.

BIOFUELS FOR JETS — Ron Pate (6313) leads a Sandia team working with industrial partner UOP on a UOP-led project funded last year by DARPA's Biofuel Program to produce JP-8 aviation fuel from renewable bio-oil sources such as oil crops. Ron displays pyrolysis oil (in his right hand) derived from wood pellets (in his left hand) produced by Alex Brown (1532) and his colleagues under a New Mexico Small Business Assistance grant. Production of jet fuel from algae and pyrolysis oil derived from lignocellulosic biomass is being pursued by a new DARPA biofuel program beginning later this year. It will also potentially involve Sandia. (Photo by Randy Montoya)

Systems analysis

According to Sandia project leader Ron Pate (6313), Sandia researchers are addressing issues and options for the necessary expansion of reliable and cost-competitive oil crop production and oil feedstock processing. This includes evaluation of promising oil crops that will not directly compete with food and feed markets, can avoid the use of higher-quality agricultural land, and may also allow for reduced demand for energy, fresh water, and other inputs.

"National scale-up of oil crop-based aviation fuel production at the volumes, supply availability, reliability, and competitive costs desired is a complex and dynamic 'system of systems' challenge," says Ron. "We are leveraging our capabilities and expertise in systems dynamics modeling, simulation, and assessment to help provide insight and decision support to the project."

Several key issues and interdependencies for bio-oil feedstock and biofuel production scale-up include land use, water demand and availability, soil and climate conditions, energy, and other critical inputs.

Conversion processes under development are expected to yield high fractions of liquid biofuel product in the form of JP-8 and green diesel, along with other useful coproducts. Mass conversion yields to JP-8 are process- and feedstock-dependent, but can be well above 50 percent, says Ron.

Oils derived from plants like soy, oil palm, sunflower, and numerous others provide an easy-to-handle material with high energy density and chemical structures that can more easily be converted into high-performance liquid fuels than other forms of biomass. Production of conventional oil crops for biofuel will face limits due to competing markets for oil crop products and competing uses for the land and water required to grow the crops, Ron says.

Algae that create oil in the form of triacylglycerols (TAGs) and fatty acids have long been seen as a promising option for producing liquid transportation biofuels, Ron says. Algae can be grown using land not otherwise suitable for agriculture, and can use lower quality water sources such as inland brackish ground water, various waste waters, desalination concentrate, by-product water from oil, gas, and coal-bed-methane energy mineral extraction, and coastal sea water.

Despite the high productivity potential of algae, Sandia's preliminary techno-economic assessment reveals several major areas where innovation will be required before affordable algal biofuel production is possible.

These include less energy-intense processes associated with algal biomass harvesting, dewatering, and neutral lipid extraction. Costs of algal oil production need to be brought down by at least an order of magnitude to be competitive with other alternatives, says Ron. Currently, Sandia has several internally funded projects underway to address issues associated with algae for biofuel.

Lignocellulosic biomass represents a widely available biofuel feedstock source. Lignocellulosic materials come from forest industry residues, including sawmill and paper mill discards, municipal solid waste that includes discarded wood and paper products, agricultural residues, including corn stalks, straw, and sugarcane bagasse, and biomass from dedicated energy crops that include fast-growing herbaceous grasses and woody trees.

Outlook

Fuel produced using the new processes will have to meet stringent military specifications.

The processes are expected by the military to achieve high-energy efficiency in the conversion of renewable bio-oil feedstock to JP-8 fuel and other valuable coproducts that can include green diesel fuel and other industrial chemicals, Ron says.

The biorefinery output of high-quality biofuels and other coproducts will combine to reduce waste and production costs. UOP expects the technology will be viable for future use in the production of fuel for commercial jets.

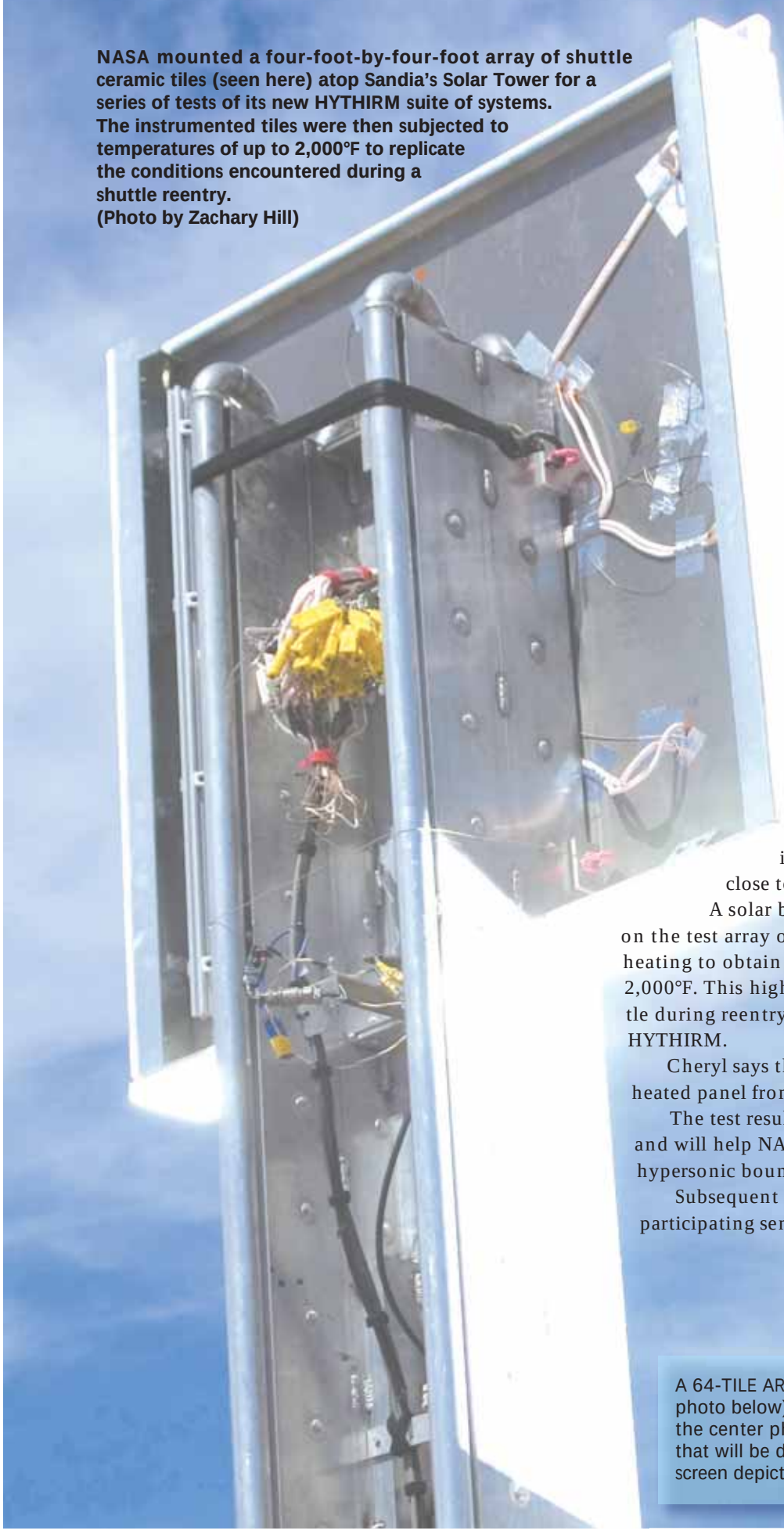
Welcome home, Col. Angelosante

TALENTINO ANGELOSANTE, an incident commander in Emergency Operations Dept. 4136, in his other life is a colonel in the US Air Force. In that capacity, Col. Angelosante recently completed a six-month deployment to Afghanistan. On his return to Albuquerque on April 18, he was greeted at the Albuquerque Sunport by members of his family, colleagues from work, neighbors, and a contingent of Blue Star Mothers. Tal expects to be back at work at Sandia by late May or early June. (Photo by Randy Montoya)

NASA tests HYTHIRM systems for thermal, optical imaging

Unique test to calibrate monitoring instrumentation for returning shuttles

By Stephanie Holinka



NASA mounted a four-foot-by-four-foot array of shuttle ceramic tiles (seen here) atop Sandia's Solar Tower for a series of tests of its new HYTHIRM suite of systems. The instrumented tiles were then subjected to temperatures of up to 2,000°F to replicate the conditions encountered during a shuttle reentry. (Photo by Zachary Hill)

NASA has once again turned to Sandia's National Solar Thermal Test Facility — aka the Solar Tower — to help evaluate new technology for future space shuttle missions. NASA's most recent testing series in early March evaluated the HYpersonic AeroTHermodynamic InfraRed Measurements (HYTHIRM) systems.

HYTHIRM is a collection of systems NASA wants to use to plan and execute missions. It includes a suite of radiometric infrared imaging systems, mission planning capabilities such as a radiance prediction methodology, and an understanding of atmospheric effects. NASA test director Kamran Daryabeigi says planners will use HYTHIRM to evaluate the performance of the participating sensor systems and associated image-processing algorithms.

Sandia test engineer Cheryl Ghanbari (6337) says NASA expects the new instruments to provide more accurate thermal and radiological monitoring data on the conditions on the shuttle's surface during reentry. NASA also hopes, Cheryl says, that these monitoring systems will help scientists understand overheating of the shuttle surface due to unexpected boundary layer transition from laminar to turbulent flow caused by anomalies (like protruding gap filler).

The Solar Tower testing involved the coordination of infrared imaging assets from five locations — three land imagers, one flown on a Navy P2 aircraft, and one space-based.

A four-foot-by-four-foot array of 64 shuttle LI-900 ceramic tiles was placed on the test arm at the top of the 200-foot-high tower, Cheryl says. Then thermocouples internally installed in some of the tiles in the array and an infrared imager located close to the test target provided actual surface temperature conditions.

A solar beam, made from reflections of 40 of the field heliostats, was focused on the test array of shuttle tiles. The array was subjected to uniform and nonuniform heating to obtain radiometric data of a known radiation source at temperatures up to 2,000°F. This high temperature, Cheryl says, simulated surface temperatures of the shuttle during reentry into Earth's atmosphere, allowing NASA to calibrate and evaluate HYTHIRM.

Cheryl says the facility provided an ideal test bed for an unobstructed view of the heated panel from the infrared imaging assets.

The test results will be used to evaluate the readiness of multiple monitoring systems and will help NASA determine their relative priority for deployment in support of future hypersonic boundary layer transition flight experiments on the shuttle orbiter in 2009.

Subsequent analysis of the imagery will be used to evaluate the performance of the participating sensor systems and associated image-processing algorithms.

A 64-TILE ARRAY of space shuttle tiles glows brightly atop Sandia's solar tower (left photo below) as a focused beam from 40 heliostats strikes it as part of a NASA test. In the center photo, Scott Splinter of NASA and JJ Kelton (6337) examine shuttle tiles that will be deployed atop the solar tower. At right, monitoring software on a laptop screen depicts the thermal response of the illuminated test array.

Photo by Michael Padilla

Photo by Zachary Hill

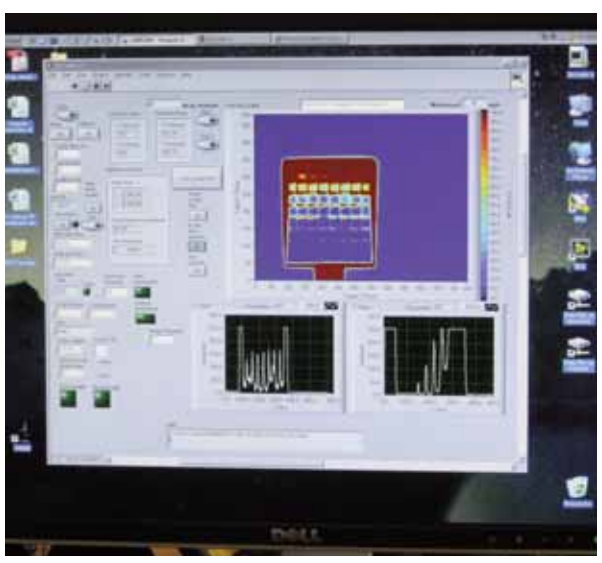


Photo by Stephanie Holinka

DENVER SKYLINE — Denver is one of the cities participating in the Solar America Cities program that Sandia is helping establish. (Photo by Matt Wright via Wikimedia Commons)

Innovative DOE program (with Sandia help) reaches out to touch you with solar

Solar America Cities program has simple aim: Solarize the US landscape

By Neal Singer

DOE photovoltaic funding for years has gone to programs that promise more efficient conversion of sunlight to electricity, or in aiding solar start-up companies. It's called "technology push."

Now for something different. For the past year, an unusually innovative DOE program called Solar America Cities has focused on reaching out to formerly ignored, sometimes low-profile city decision makers who administer large chunks of urban real estate. It's called "technology pull."

The insight at DOE management was that these key folk could purchase enough solar to make its installation as common and ordinary as curbside recycling.

DOE encouragement would include matching funds, technical support, free policy analyses, and public relations suggestions to help educate relevant political participants as well as the public.

"Tiger Teams" play a large role in underpinning the program. Personnel from Sandia, the National Renewable Energy Lab (NREL), the Florida Solar Energy Center, New Mexico State University, and private sector partner CH2M Hill aid city managers and staff with practical savvy as DOE personnel push the higher vision of "making solar mainstream."

Tiger Teams are assemblages of experts put together for a particular purpose, says Tiger Team group leader Vipin Gupta (6337). They disband once the mission is completed, only to reassemble elsewhere.

"Tigers are an appropriate metaphor," Vipin says. "Our people are independent-minded and driven. You can't just issue an order to them. They're decentralized, creative, and getting more and more disciplined."

As Tiger Team member Jeannette Moore (2734) puts it more viscerally, "People in city agencies have been talking about solar for years. Usually, they've gotten a little sleepy. Then we show up. We tell them, we're going to do solar *right now*. That wakes everyone up."

The program was conceived by DOE acting program manager Tom Kimbis in a casual drawing on a piece of paper on an airplane trip. He passed it back to a colleague who thought it was a nice idea but saw no reason why anyone would participate.

They would participate, Kimbis decided, because "Cities are strapped for cash," he said in an interview. "We'd give them money. But we'd give more than money. Two hundred k [dollars] is a lot in Ann Arbor but nothing in New York. We'd give them wording for legislation, when legislators call us for advice. A website where they could exchange ideas, so that New York could see what San Francisco was doing. And we'd give it a name — Solar America Cities — because for some reason cities like names [like Sunbelt Cities]. Amazingly, it makes people want to move there."

The remarkably energetic effort celebrated its first anniversary in Tucson April 14-16.

One-hundred twenty involved participants from 25 selected cities (chosen competitively from among 50 to 75 applicants, says Kimbis) explained or absorbed lessons of success or failure in attempts to use solar not only to save energy and lower greenhouse gases but generate low-interest loans, foster start-up companies, attract technically educated personnel, create high-paying jobs, and develop solar education courses. Other areas under discussion included solidifying local political support, writing workable inspection codes, supplying wording for appropriate legislation when asked, and choosing appropriate and sometimes "out-of-the-box" materials and locations for various forms of solar.

"I'm amazed this is a DOE project," says Mustapha Beydoun, a research scientist at the Houston Advanced Research Center. "It's so inclusive. It's good to see who's tried what and what works and what doesn't," he said of the conference, "so you don't have to reinvent the wheel. Problems often come up exactly where you never expected them to."

While from a flat financial viewpoint, the dour view is correct that solar is still too expensive to be practical — in some areas, three times the cost of generating electricity from coal — some attendees pointed out that solar power is strongest when the demand for electricity is greatest, at the hottest part of summer days. Thus, it could be used to lower the number of power plants needed to meet air conditioning and other power needs of these peak hours.

Solar electricity also requires no water to convert its fuel into electricity — a possible problem for other methods of generating power as fresh water becomes scarcer.

An oft-repeated mantra, often in the form of graphs, at the convention was that the costs of other fuels are rising while the cost of converting sunlight to electricity is declining.

Rick Scheu, CEO of Portland, Ore.-based King Solar Products, said that administrators in Germany had decided it was useless to compare the various subsidies for different forms of energy production: "About solar, they decided, 'We need it and we're putting it in.'"

Austin Mayor Will Wynn ("That's really my name. My parents did it to me,") said that city buildings will all be 100 percent alternative-energy run by Jan. 1, 2009, with 15 megawatts of solar online by 2012 and 100 solar megawatts by 2020.

DOE Vision

"DOE vision from above ('we are going to make solar mainstream'), Tiger Team technical assistance from below, your city in the middle"

Some areas in which Tiger Teams provide help:

• Tech assistance in photovoltaics, solar water heating, concentrated solar power, solar water, air heating technologies; solar resource assessment (time of year/day)

• City municipal planning: city planning, regulatory support, policy-making assistance; market analysis, consumer behavior, project financing; appropriate technology solutions, user training, monitoring.

• Architectural structural support: building codes review, architectural and structural analysis, preparation of bid specifications, outreach communications, best practices.

"I tell people that Texas was America's number-one energy state in the 20th century, and if we want to remain that in the 21st, we need to work on starting up companies that harness the sun," he said.

So the enthusiasm was there, along with more practical motives like the need to meet legislated requirements on alternative energy production, the carrot of tax incentives, and the funding and technical assistance provided by the DOE program.

The program distributed $200,000 cash to each chosen city for the execution of its developing citywide solar adoption plan, and also makes available a kind of gift certificate of $200,000 drawn on DOE that pays for work by Sandia and other labs for solar technical assistance. The cities contribute, on average, $200,000 of their own, though larger cities like Boston and New York contribute far more. The city population must be at least 100,000.

Asked by *Lab News* what will bring other cities to the table once the two-year DOE-funded program ceases in fiscal 2009, DOE program "market transformation director" Charlie Hemmeline said that the agency's solar programs weren't going away, and suggested that cities later interested in getting help to follow the path laid out by the 25 chosen cities might not find a deaf ear at DOE.

And there's more. The Solar American Showcase program and the Government Solar Installation Program are less publicized but equally real parts of DOE's solar effort.

The showcase program provides $200,000 and Tiger Team technical assistance to companies, universities, cities, or states interested in trying new solar technologies. The winners include Forest City Military Communities in Hawaii, the city of San Jose, the Orange County Convention Center in Orlando, Fla., Montclair State University in New Jersey, and a Housing Authority project in northeast Denver.

The government installation program provides solar technical assistance to federal entities.

Sandia provided two Tiger Team members for these projects last year, says Vipin: one at the Smithsonian Zoo last spring and summer, figuring out the photovoltaic needs for the elephant house (3,000 square feet of photovoltaics would do the job for cooling and lights) and for the US Capitol Building complex. "The Tiger Team did a comprehensive study there on creative ways to adopt solar without running against the stringent historic architecture restrictions there," Vipin says.

Sandia Tiger Team leads and cities

Greg Kolb (6335): Ann Arbor, Mich.
Beth Richards (6313): Madison,Wis.
Warren Cox (6335): Austin & San Antonio, Texas
Howard Passell (6313), Pittsburgh, Pa.
Vipin Gupta (6337), San Jose, Calif.
Dick Fate (6486), Houston, Texas & Sacramento, Calif.

Sandia Tiger Team members relaxing for a group shot at the 1st annual Solar America Cities meeting in Tucson are (standing, left to right) Jeannette Moore, Andrew Kazensky, Howard Passell, Vipin Gupta, Greg Kolb, and Jack Mizner. Kneeling (but ready to spring) is Warren Cox. Present but not in the photo were Sandra Begay-Campbell, Beth Richards, and Charlie Hanley. Dick Fate, another team member, was occupied elsewhere. (Photo by Neal Singer)

Tom Hunter, NNSA Administrator D'Agostino, other lab directors make case before Congress for FY09 nuclear weapons budget request


TOM HUNTER

Note: On April 16, Sandia President and Labs Director Tom Hunter joined NNSA Administrator Thomas D'Agostino, Los Alamos National Laboratory Director Michael Anastasio, and Lawrence Livermore National Laboratory Director George Miller in Washington, D.C., for an appearance before the Senate Energy and Water Appropriations Subcommittee. D'Agostino and the laboratory directors were there to discuss and to answer questions about the FY09 budget request for the DOE nuclear weapons program. Under the protocol of the afternoon hearing, each witness verbally provided a summary statement and each submitted more detailed written testimony. Tom Hunter's remarks at the hearing, based on the official transcript, are printed below. Tom's written testimony and the testimony of the other witnesses can be found at http://appropriations.senate.gov/hearings.cfm?s=erg.

* * *

Thank you, Chairman Dorgan and Sen. Domenici and Sen. Feinstein. It's a pleasure to be before you today.

Our principal mission, as you know, is to provide and support the nonnuclear subsystems for all of the nuclear weapons in the stockpile.

We also support a wide range of research and development in other areas of national security.

I presented written testimony, as you noted. I'd like to summarize a few points, perhaps some of the same points the other directors mentioned, but I'll focus on them in a little different way and then would be glad to answer questions.

Stockpile stewardship

Let me first talk about stockpile stewardship. In my view, the science in the stockpile stewardship [program] has made exceptional progress since its inception over a decade ago.

The nation asked us to stop testing, to stop development of new weapons systems, and to invest in key scientific and engineering capabilities that would allow the continued certification of the stockpile.

We've done that.

Along the way, we've been leaders in the development of many key areas of science, in particular, advanced modern supercomputing, high-energy intensive physics, advanced microsystems, and many areas of material science.

One of the areas that I'm most proud to have been associated with at our laboratory is the MESA facility, which was mentioned earlier by Director D'Agostino, when he said that we have completed it on schedule and ahead of budget.

In that facility, we build the small, little devices that can be put in nuclear weapons, and I usually like to say here we build little things you can't see that do things you can't imagine.

Annual stockpile assessment

Today, I, Dr. Anastasio, and Dr. Miller — Mike and George — continue to support the annual assessment of the safety and reliability of the stockpile.

We independently provide a personal statement of the condition of each of the systems in the stockpile. I don't think I can describe in words how significantly we take that responsibility. It means a lot to us professionally and personally. We do it each year and are in the process of doing it for this year, as well.

This annual assessment is a matter of both legislative requirement and personal accountability. Behind this stands the investment of the government, the work of many dedicated scientists and engineers, and our personal credibility and reputation and that of our institutions.

A right-sized stockpile

The stockpile needs, and will continue to need, attention. The stockpile will age. Issues will have to be resolved. As time progresses, we must remain in confidence that our deterrent is effective.

As we move forward, it is essential to recognize the need for a vital scientific foundation to support this confidence and to make wise choices about the composition of the stockpile and the nuclear weapons complex that it supports.

I believe that it is important to continue investigation of a replacement strategy for legacy Cold War-era warheads. A right-sized stockpile that is safer, more secure, has more inherent performance margins, and can be maintained more effectively should be our mutual goal.

The nuclear weapons complex must be transformed to be more effective. It must work better, operate more safely, be better integrated, and cost less.

The NNSA's program for complex transformation is very important. We've already begun at our lab. We've already completed removal of all discreet category two and category three nuclear materials from our site.

We've already achieved a reduction of 18 percent of our workforce since 2004 that supports nuclear weapons.

We're working to change our work mix at our California site. We're relooking at our approach to supercomputing.

All these transitions must be managed effectively so that our ability to effectively support the stockpile is maintained.

We must use the insight from our stockpile stewardship program to choose which infrastructure investments are made and decide when they would be made.

Capabilities have broad application

The capabilities we have developed to support our nuclear [weapons work have] allowed us to make many, many contributions in other areas of national security, from combustion science for energy efficiency to nuclear waste disposal, specialized radars for defense applications, and many more.

These applications provide great synergy and great vitality for our ability to support the stockpile.

The nuclear weapons path forward is actually just one piece, though, of a much broader nuclear future for the country and for the world. It is important to enhance our efforts in nonproliferation and help realize the full potential of nuclear power as a safe and environmentally friendly source of energy.

The budget legislation you see before you will allow that to be addressed.

Finally, I think I'd be remiss if I did not note that few threats to this country's future loom as large as our chronic lack of investment in science and engineering and the education systems that support it.

History will not judge our generation very favorably if we do not speak out, if we do not act to significantly change our lack of attention and lack of investment in one of the clear elements that made this country great.

You have my personal commitment and that of my organization to support you in addressing these important problems in the future.

Improvements planned for Sandia Science & Technology Park

Aesthetic facelift will include new streetlights, signage, streetscapes

Calling it one of his favorite places in Albuquerque, Mayor Martin Chávez last week announced a $570,000 agreement for improvements at the Sandia Science & Technology Park.

Chávez said the agreement, approved by Albuquerque's City Council and signed by him, calls for the park to build and maintain numerous features in medians, walkways, and parks along Innovation Parkway.

The improvements include streetlights, signs, and streetscapes designed to enhance and complement existing infrastructure and create an aesthetically pleasing environment for tenants, neighbors, and visitors.

Funds for construction are the result of the New Mexico Legislature capital outlay programs from 2006 and 2007. The funds were secured by Reps. Janice Arnold-Jones, Richard Berry, Larry Larranaga; former Rep. Ted Hobbs; and Sens. Shannon Robinson, William Payne, and John Ryan.

"We're most grateful to our local legislators for recognizing the extraordinary economic development potential of the park," said Sherman McCorkle, chairman of Science and Technology Park Development Corp. "The park represents a major job-producing engine for the Albuquerque community and it's great that it has such widespread support."

Construction is scheduled to begin soon, with completion expected by summer.

— Michael Padilla

ALBUQUERQUE MAYOR Martin Chavez (right) joins Sandia Science and Technology Park Program Manager Jackie Kerby Moore and City Councilor Don Harris to announce a $570,000 investment in infrastructure improvements.
(Photo by Randy Montoya)

Mileposts

New Mexico photos by Michelle Fleming


Gilbert Benavides
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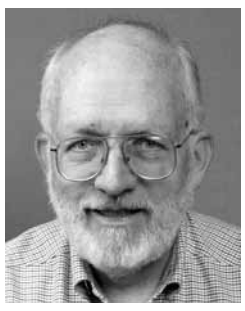
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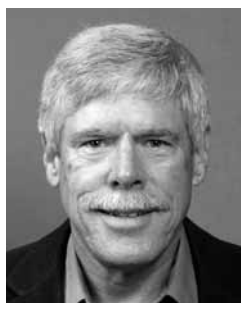
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David Tenorio
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Jose Archuleta
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William Cook
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Waylon Ferguson
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James Krupar
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Mae Lambert
25 3554


Paul Schlavin
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Charles Shirley
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Daniel Wahl
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Berniece Willeto
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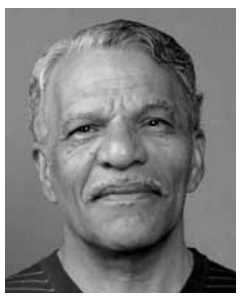
Sue Williams
25 10265

Recent Retirees


Lance Gordon
32 9335


Sandra Foster
31 9335


Joane Maese
30 3012


Lynn Washburn
25 1054


Ronald Ralson
20 5355


Denise Maestas
15 1057

This month in the past

50 years ago . . . Sandia Corporation has been assigned important roles in the forthcoming nuclear test series, "Operation Hardtack," at the Eniwetok Proving Ground. Assignments include: Design, fabricate and check fuzing, firing systems, including remote control and monitoring systems; develop and install instrumentation to measure phenomena; provide microwave and FM/FM telemetry for making diagnostic measurements of blast phenomena; and establish and supervise operation of seven microbarograph stations on islands surrounding the test area to collect data on blast pressures.


TROPICAL LIVING is found by Sandia personnel operating microbarograph stations in the Pacific in connection with Operation Hardtack.

40 years ago . . . An experiment conducted at the Atomic Energy Commission's Nevada Test Site produced a ditch — about 900 feet long, 300 feet wide, and 80 feet deep — that resulted from the simultaneous underground detonation of five nuclear explosives. The experiment was conducted as part of the AEC's Plowshare program in which excavation technology is being developed for peaceful purposes. A number of Sandians participated in the project.


PROJECT BUGGY — The ditch is three times as long as a football field and more than twice as wide. An eight-story building would stand upright in it.

30 years ago . . . A space shuttle fuel tank for the reaction motor used to control the craft while in orbit is undergoing acceleration tests in Area 3 on Sandia's centrifuge facility. The titanium tank and its intricate internal plumbing are subjected to g-forces up to 3.6. In several of the tests, flow rates in the tank will be checked while the centrifuge is spinning.


SPACE SHUTTLE FUEL TANK TEST — Test program manager Harold Rarrick and test engineer Don Fulton discuss the reimbursable project being performed for NASA contractor Martin Marietta.

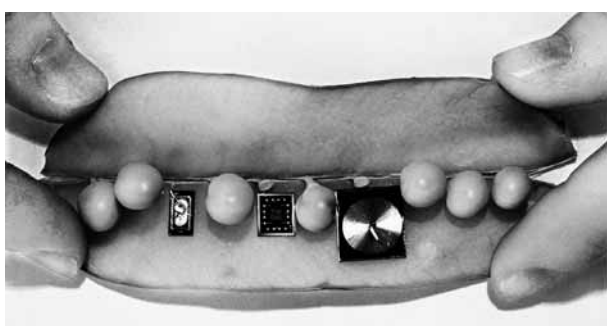
20 years ago . . . A new high-speed spin facility, which recently went on line, enables Sandia weapon developers to better duplicate the spin environment an artillery shell "sees" after it is shot from a cannon. The facility tests the electrical systems of 155-mm artillery projectiles (W82) after they have been flown at Tonopah Test Range. The goal is to see how the electrical system functions inside the artillery shell when it reaches the target.


EXAMINING THE W82 test unit suspended on the shaft from the turbine above the six-foot-deep containment tank are Pat Gildea (left) and Guy Prescott. These test units are spun up to 18,000 rpm on the spin-test device.

10 years ago . . . A team of Sandia scientists has developed a simple, inexpensive way to relieve the normal internal stresses of amorphous (noncrystalline) diamond films — a significant advance in producing wear-resistant coatings. This should mean improved protection and extended lifetimes for metal tools, auto parts, and even plastics, such as those used in biomedical devices.

DIAMOND FILMS — Tom Friedmann looks through 600-angstrom-thick membranes of amorphous diamond. The material, though ultrathin, is robust enough to be handled under quiescent conditions.


(Photo by Randy Montoya)


CHEM LAB IN A SNOW PEA POD? — The three principal components of Sandia's micro chem lab for gas-phase detection and analysis are small enough to nestle easily inside a snow-pea pod. The left-most component is the surface acoustic wave sensor array, the lab's detection mechanism. The center one is a preconcentrator that absorbs or adsorbs chemical vapors. The one on the right that looks like a tiny CD is a miniature gas chromatograph column. Together they collect, concentrate, and analyze a minute chemical sample weighing less than a single bacterium. Other Sandia microchemlabs analyze liquids.
(Photo by Randy Montoya)

Little cars and a father's unusual teaching sent senior technologist Ed Baynes on a road less travelled

By Neal Singer

The cars go by so fast you can barely see them. Maybe a foot in length, going 200 miles per hour around a 70-foot diameter track, they sound like amplified mosquitoes, or maybe like a dentist's drill hitting a soft spot on your tooth, backing off, returning, backing off, for the six times it takes to go around a competitive track of ¼ mile.

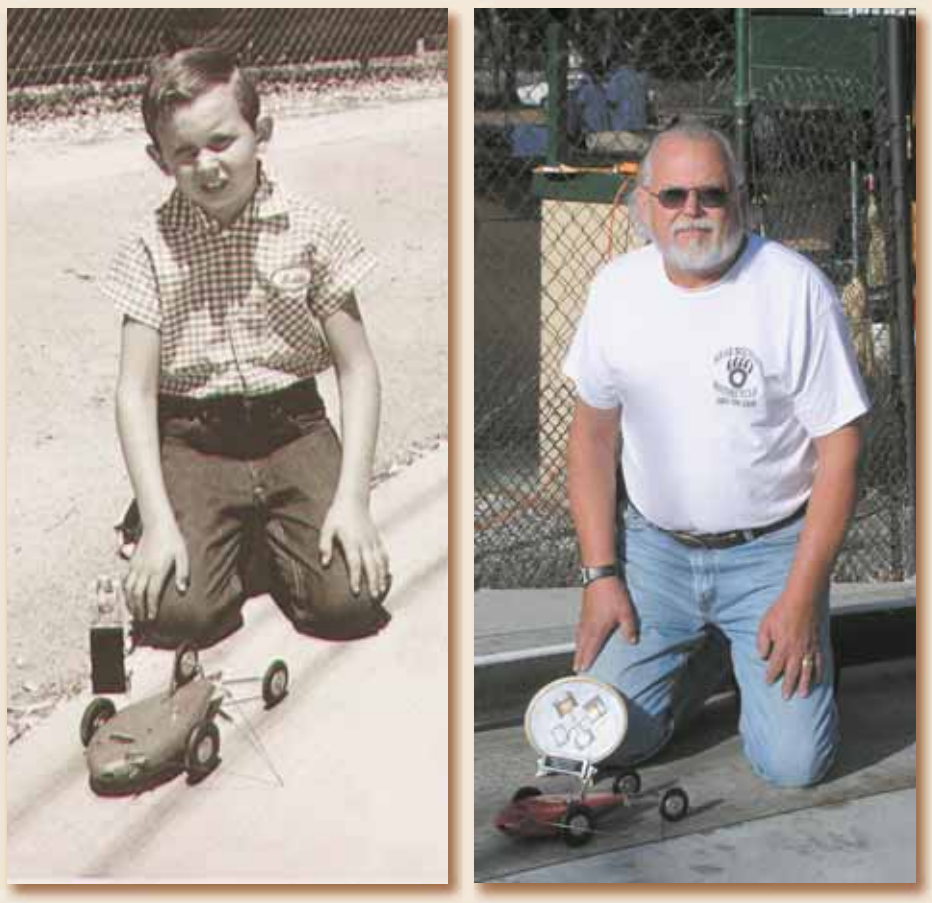
"I love the sound," says senior technologist Ed Baynes (6418). "I grew up with it. It's by the sound you know when the vehicle has reached its maximum speed. When its fuel mix is just right, that's when you start timing it."

The gas-powered cars, tethered to a central pole buried four feet in the ground, whipped around the track more slowly when Ed was a boy in Ontario, Calif., about 30 miles east of Los Angeles, in the mid-1950s.

When he worked on tether cars with his dad, they had heavier bodies — cast aluminum frames instead of magnesium, with balsa wood bodies resembling actual automobiles instead of the more streamlined cigar-like shapes of today.

Still, 140 miles per hour was pretty fast in 1955, and Ed went out with his dad to their garage or to tracks as often as he could.

"I never cared about sports," says Ed, "but if it had wheels on it, I was interested."



HASN'T CHANGED A BIT — The car is the same in these two photos of Ed Baynes — after the Nationals competition at Anderson, Ind., in 1956 and after the same event held in the same place 50 years later. Ed of today, however, demonstrates better posture and cool sunglasses, if slightly stiffer knees.

His dad, Ed Sr., was known nationally in tether car circles as a man who raced and who helped other racers. Seeing a son with an interest in things mechanical, the father had his own method of instruction.

"We bought a used bike for $10," said Ed. "My dad told me he would paint it if I took the bike apart and put it back together."

After Ed disassembled the bike, his dad painted it "a beautiful metallic purple."

When he was nine, Ed was taking tether cars apart by himself.

He owned his first full-size car at age 14, but it had no transmission.

So Ed's dad brought home a box of gears and a one-page technical drawing of a tranny.

"There it is," he told Ed. "If you can put it together."

Ed remembers, "I sat outside on Memorial Day weekend, listening to the Indianapolis 500 radiocast with all these parts around me. I had it figured out by the end of the day. It was functioning within a week."

ED SR. (second from left) and young Ed (far right) with racing buddies at the fueling bench of the Ontario, Calif., tether car race track in 1958.

His upbringing made him a believer in hands-on experience: "Developing a concept, taking it into a machine shop, and making it operate is wonderful training."

In Europe, he says, some engineering programs require students to design, build, and race tether cars. Unlike the US, where the sport now operates only three tracks nationwide, "Europe maintains a large number of tracks, some even indoors, so they can run cars in bad weather. Russia, Sweden, and Italy are very much into it," he says.

Though Ed went on to build hot rods, race cars, and motorcycles, he never earned higher than a two-year college degree.

"I was successful at everything I did," he says simply. "Maybe I never put my goals high enough."

There was at least one thing lacking from his technical toolbox, Ed says: an understanding of marriage. "It's true you learn some things by example from your parents, but I grew up more skilled in technical work than in my personal life," he says. "One of THE most crucial things you do is pick a person to marry. They taught things in school but not how to pick a partner nor how to be a parent. They didn't provide the tools."

He left California after one breakup and moved to New Mexico. He was a contractor to Sandia for 17 years before hiring on as a technologist in 1998.

But, just as he figured out mechanical things, he learned to work out relationships. They mature slowly, he found.

Six or seven years ago, he says, he started dating a newly arrived Lovelace doctor who, like himself, had just been through "a miserable divorce."

While the courtship looked exciting — the pair would ride his motorcycle to balloon fiestas and other locations — they took time to really get to know each other. Five years ago, he wed the interesting, highly educated woman 18 years his junior whose salary was much higher than his.

"A lot of men might be intimidated by a partner with a better education and higher paying job," he says, "but I don't think that's what a marriage should be based on."

When his wife got an opportunity to practice in Las Cruces, the couple moved there from Albuquerque and purchased a house that satisfied them. On three acres, there was a horse stable (Ed's Atlanta-born wife loves horses) and a shop for Ed, currently filled with old Harleys that he renovates.

Professionally, Ed put his diverse technical skills to use in the Southland for Sandia by working on border entry control and contraband detection and then on a variety of border projects related to energy and water, including supporting the DOE Solar America Cities program.

That's almost the end of the story. He had rebuilt almost everything around him needing rebuilding.

Except that when Ed's dad passed away a few years ago, Ed went west to clean out his estate. One of the few possessions he kept was his dad's balsa wood carving tools from the 1950s. They were the tools used to make the tether car bodies Ed had raced as a boy.

WHICH IS THE COPY? Ed has owned cars two, three, and four (from left) for more than 50 years. The left-most car is a replica of one owned by Ed's dad in the late 1940s. Ed did the rebuilding himself.

Though he hadn't worked with tether cars in 40 years, he found himself searching through "want ads" for one.

He removed the topside of one he bought and, using his dad's tools, carved a new body for it.

"I bought five balsa wood blocks because I figured it would take that many tries to get it right, but it was perfect the first time," he says factually.

He painted the tether car the same beautiful metallic purple that Ed Sr. had painted Ed Jr.'s bicycle as a boy — the same color as his father's own tether car, back in the 1950s. As a final touch, Ed gave the car his dad's racing number, 11.

"The car won first place in its class this fall at the Nationals," he says.

But he got most of his satisfaction from assisting other competitors.

"The nicest compliment I got," Ed says, "was from an oldtimer who said, 'Ed Junior is always helping out. He's just like his dad.'"

He pauses. He had gone a long way to come home.

"You realize later in life," he says slowly, "there's a lot of good things our parents give us."

ED READIES A TETHER CAR for competition in the moment called pushing off. The tether itself is faintly visible in the photo, attached to the frame of the car.