

Reducing the cyber threat to the nation's electrical power grid



Photo by Randy Montoya

International cyberterrorism remains a highly credible threat to the US and vulnerability to attack lies in the nation's increased reliance on automation, information, and communications technologies.

By Darrick Hurst

In August 2003, approximately 50 million people in the United States and Canada were plunged into darkness as the Northeast coast's power grid experienced a massive failure. The region's water supply, transportation, communications, and industry were all directly affected by the power loss, and some areas suffered looting during the blackout.

While the widespread North American blackout of 2003 was the result of human error and not terrorism, it illustrates the kind of disruptions that could be caused by malicious cyberterrorists. That's why laboratory researchers are partnering with private industry to protect America's electrical power grid.

The rationale behind the work is that international

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Changing nature of employer total benefits plans

Survey says: As costs go up, Sandia's package still rates high

Cost-competitive, high value, and top quality. Three traits often hard to achieve in one equation. But a national health benefits program expert says that's what Sandia provides to its employees — and continues to do so even with costs of health care regularly increasing for both employers and employees.

"Over the past several years, Sandia has maintained overall health care plan benefits that are competitive," says Brad Cornish, a Mercer actuary and principal. "This allows Sandia staff and retirees to continue to receive excellent value in their benefits while experiencing lower-than-normal increases in their healthcare premiums."

Mercer (www.mercer.com), a subsidiary of Marsh & McLellan, conducts an annual "National Survey of Employer-Sponsored Health Plans," which provides one of the most comprehensive looks at health care trends and costs.

Q&A about new retirement benefit that takes effect for new hires after Dec. 31. See page 4.



It also provides a Sandia-commissioned edition that compares the Labs' total benefits package offerings with the entire group of 2,945 companies that Mercer surveys each year.

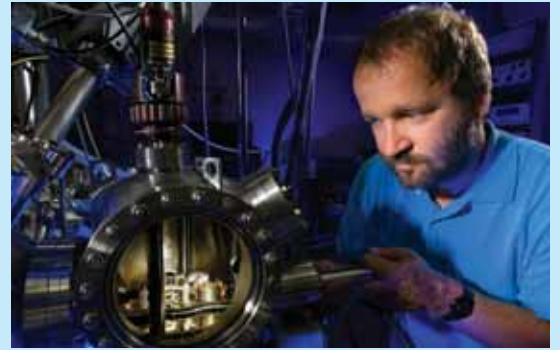
Mary Romero Hart, manager of Benefits Dept. 3332, recently received her copy of the latest report. Although the health care plan business is complex, she immediately came up with several first impressions about the health care situation as a whole after digesting the report and other factors:

- 60 percent of surveyed employers plan to shift additional costs to employees in 2008.
- Only 21 percent of surveyed employers still offer retiree medical benefits to Medicare-eligible retirees. Sandia is in that small and shrinking group of employers offering this benefit.

- Sandia's internal accounting system shows the Labs' health care costs decreased 2.5 percent between FY05-07, while nationally costs for employers increased 12.5 percent during the same period of time. (The Labs' most recent significant cost increase occurred between 2004 and 2005.)

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Inside . . .



California researchers crack some of the persistent mysteries of ice. See story on **page 5**.

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Senate committee headed by Sen. Jeff Bingaman holds field hearing at Sandia on energy options



SEN. JEFF BINGAMAN, D-N.M., makes an opening statement at a Senate Committee on Energy and Natural Resources field hearing in Albuquerque. Bingaman chairs the committee, which conducted the hearing — focused on renewable energy options — at the request of Sen. Bernie Sanders, I-Vt. (left). At right is ranking member Sen. Pete Domenici, R-N.M.

(Photo by Randy Montoya)

By Chris Burroughs

Calling the American Southwest the "Saudi Arabia of solar energy," Sandia researcher Chuck Andracka (6337) was one of five experts to testify during a field hearing of the US Senate Committee on Energy and Natural Resources July 2 at the Labs' International Programs Building.

Chuck spent several minutes describing the benefits of concentrating solar power (CSP) — it's highly scalable, makes grid-ready AC power, it's a proven technology, and it can incorporate storage. He also talked about some of the barriers to deployment of CSP, primarily that it takes a large capital investment upfront and proposed large deployments present technological and financial uncertainty.

"CSP has the potential to meet a large fraction of

our energy needs," he said. "It should be part of a portfolio with other leading renewables."

The hearing was requested by Sen. Bernie Sanders, I-Vt., a proponent of renewable energy sources, and conducted by Sen. Jeff Bingaman, D-N.M., committee chair. Sanders and Bingaman were joined at the hearing by Sen. Pete Domenici, R-N.M., former chairman and ranking Republican on the panel. In addition to Chuck, others who testified were Fred Morse of Abengoa Solar Inc., Michael Daly of Mesa del Sol, Alex Marker of Schott Solar Inc., Fong Wan of Pacific Gas & Electric, and Gary Nelson of PNM.

In introductory remarks, Bingaman talked about the need for more alternative energy sources.

"Today's focus is on the issue of generation of

(Continued on page 3)

That's that

Have you noticed that this place is going to the dogs lately – or at least to the coyotes? A couple of Fridays back, I was sitting in my office trying to come up with a few pearls of wit and wisdom for this column when, right outside my window, I see a coyote loping by like he owns the place.

This wouldn't be a big deal, I guess, if I was out in some remote site (like Coyote Canyon?), but I'm not. I'm in Bldg. 811, which is just north of Bldg. 800, about as busy and populated a spot as you're going to find at Sandia.

It so happens that we do have a lot of rabbits around here and always have had. They feast on the lush green grass in front of Bldg. 800 – and make little rabbits. Obviously, that coyote had discovered that the pickins were pretty good around here.

Anyhow, after admiring the coyote's audacity (the audacity of hoping for a rabbit?) for a couple of minutes, I didn't give it another thought until, about a week later, Rochelle Lari from our Diversity Office sent us a photo taken by John Campisi (12870). The picture is of a coyote lying down on that narrow swath of grass by Sandia's medical facility . . . eating a rabbit.

Via email, I asked Steve Cox, a wildlife biologist in Org. 4133, what's going on. He wrote: "Coyotes are adaptable scavengers/predators and are tolerant of human activities, [adapting] rapidly to changes in their environment. The biggest problems occur when people feed coyotes – either deliberately or inadvertently." Besides not feeding coyotes ("Don't lead them into temptation," says Steve), he says we should make sure coyotes know they're not welcome around people.

The good news is that coyote attacks on humans are rare. However, they're not unheard of. So if you do come across a coyote while you're walking around the tech areas (or anywhere else for that matter), it's a good idea to chase it away. Steve says to make a loud noise, yell at it, or clap your hands. That'll typically send the coyote running. Whatever you do, don't start grazing on the lawn. Some coyote might get the wrong idea. After all, as Woody Allen, a notorious naturephobe, once said, "It's a restaurant out there."

* * *

These days, workplace benefits seem to be a hot topic of discussion, not just at Sandia, but around the country. The American workplace is changing and so are the benefits packages that go along with it. We're doing our part at the *Lab News* to join the discussion; our page one story talks about benefits trends around the nation and how Sandia's own benefits package stacks up by comparison. For what it's worth, I've always considered our package pretty darned generous, but that's a personal assessment and others may have a different idea.

While doing some online research about benefits issues, I have to admit I got a bit jealous when I came across a Scripps Howard News Service item about benefits among some Internet companies. According to the article, a lot of Silicon Valley companies, with Google leading the way, are providing free lunches (and sometimes free breakfasts and dinners) for all their employees. The news story goes on to say that one gaming company even has a team of employees that tries out sushi vendors. Hey, somebody's gotta do it.

See you next time.

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

Creating teacher scientists

Hands-on research a highlight of DOE program for teachers

By Amy Tapia

Where and how do kids make a decision to enter the sciences or engineering?

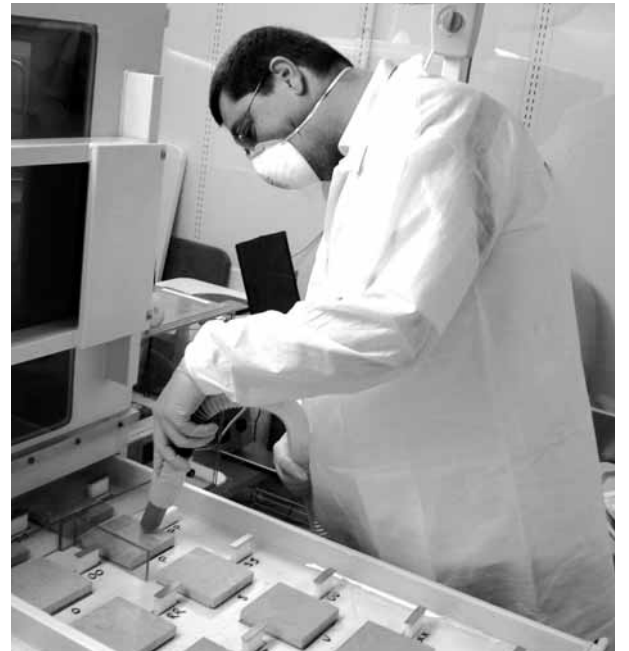
Their parents, of course, play a huge role. But so do teachers. In fact, recognizing the pivotal role teachers play in influencing students' career choices, DOE's Office of Science is funding a new program called ACTS, "Academies Creating Teacher Scientists."

DOE supports the three-year program at several of its laboratories, including Sandia. The goals of ACTS are to:

- Enhance teachers' science-related content knowledge
- Expose teachers to real-life research in an effort to assist them in teaching applied science
- Better prepare teachers to encourage students to pursue science, technology, engineering, and math careers
- Encourage teachers to become science leaders in their schools and districts.

For the past two summers, 10 middle school teachers (from Albuquerque, Rio Rancho, Kansas, Oregon, and Pennsylvania) have spent the month of June at Sandia.

Last summer's program focused on water treatment technologies including arsenic removal and desalination. This summer, the program focused on energy technologies including photovoltaics, solar, wind, coal, nuclear, and geothermal.



JOEL WICKERT, Hayes Middle School teacher, participates in Sandia's ACTS (Academies Creating Teacher Scientists) program. (Photo by Matt Tezak)

Community Involvement Dept. 3652 partners with Energy, Resources, and Systems Analysis Center 6300 to provide a research experience for the teachers to increase their science content knowledge, as well as provide new ideas for sharing science/engineering applications with their students.

The unique research component of the program has been embraced enthusiastically by participating teachers.

"Margaret Welk [6338] was able to involve us in every aspect of research as we took part in the setup, calculations, running of experiment, data gathering, and conclusion — all in one week!" says Dennis Newell, a middle school teacher from Emporia, Kan.

In addition to the research experiences, the teachers hear from speakers and participate in a variety of tours at Sandia, the San Juan Generating Station, Sandia's Tribal Energy Program, and the New Mexico Wind Energy Center in Tucumcari.

"The contrast of the San Juan Generating Station with the solar installations on the reservations will stay with me and I'll share this with my students," says Steve Kaestner from Jefferson Middle School in Albuquerque.

The final component of the program is building a community of teachers around the country who support each other to develop lesson plans and effective teaching strategies based on their summer experiences.

"The teachers come from different schools and have varying teaching backgrounds," says Community Involvement Manager Bruce McClure (3652). "One of the most rewarding aspects is providing an environment where they can exchange ideas."

Teachers receive a \$3,200 stipend for their work in the program. They are also eligible to receive up to \$2,000 in classroom materials and up to \$2,000 for professional development activities during the following school year. The teachers plan to present their experiences at the National Science Teachers Association meeting in November.

Sandia LabNews

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Retiree deaths

Martha E. Sterling (age 65)	May 1
Marie M. Ream (97)	May 3
A. J. Brouillard (78)	May 7
L. C. Trujillo (78)	May 10
Donald D. Richardson (89)	May 12
Merton M. Robertson (83)	May 13
Robert G. Marmon (74)	May 13
Rogelio G. Gonzales (84)	May 14
George Voids (91)	May 14
Marlin C. Klemm (93)	May 15
John A. Brammer (64)	May 15
Donald K. Hoffheins (80)	May 16
Joe D. Hankins (80)	May 19
Ernest Watson Hall (92)	May 20
Carlotta L. Fugazzi (75)	May 28
Aurelio R. Teta (82)	May 31
James Howard Davis (81)	May 31
Russell W. Foster (89)	May 31
Clifford K. Diem (75)	June 1
Vernon M. Brewster (84)	June 2
Billy B. Asher (83)	June 2
Wilber G. Grisham (87)	June 3
Victor W. John (79)	June 3
William D. Wing (91)	June 3
Lucille H. Cafferty (81)	June 4
Norman F. Sinnott (86)	June 5
Ralph O. Pena (77)	June 8
Ruth L. Lindquist (95)	June 12
Richard S. Claassen (86)	June 16
Ralph W. Carter (92)	June 24
Willie D. Servis (85)	June 25

Retirements

Retiring and not seen in *Lab News* pictures: **Ronald E. Loehman** (1815), 27 years.

SCADA

(Continued from page 1)

cyberterrorism remains a highly credible threat to the US and that vulnerability to attack lies in the nation's increased reliance on automation, information, and communications technologies.

No enemy has yet successfully attacked the US power grid control network, but if it were to happen, it could be catastrophic. North America has more than 211,000 miles of high-voltage electrical transmission lines, carrying a net summer capacity of nearly 830 gigawatts (830,000 megawatts) to the customers of 3,100 electric utilities. These utilities have become more vulnerable as they have become more dependent on open information technology standards for their grid control systems.

Ethernet, TCP/IP, and web technologies are increasingly being used to manage power transmissions through supervisory control and data acquisition (SCADA) systems, many of which were originally designed and installed before modern IT systems were adopted.

These control systems, if not adequately protected, present potential opportunities for cyberterrorists to exploit. An assault on one part of a system will almost surely affect the operation of another part and the problem could propagate across the system.

A growing concern

Cyber attacks on IT systems are becoming increasingly more common. According to one expert estimate, there were 37,000 reported penetrations of government

and private systems during fiscal 2007. Others estimate the numbers are much higher depending on the measured magnitude of the attacks, acknowledging that we may not know about all penetrations.

Additionally, information disclosed by a CIA analyst in January 2008 at a conference held by the SANS Institute reported that cyber attacks have successfully disrupted power equipment in several regions outside the US.

When the blackout of 2003 affected eight US states and the province of Ontario, it did so at a cost of \$4 billion to \$10 billion, which illustrates the importance of anticipating, detecting, and correcting disruptions in energy distribution systems spread across the nation.

Energy security experts point out that the 2003 blackout — one of several that occurred worldwide that year — could be replicated by cyberterrorists. Any system that relies on highly automated control networks can become the target of an intentional attempt to affect the operation of the devices and communication networks required to run the nation's power system.

Investing in cybersecurity

Without a history of cyber attacks to provide object lessons, it is difficult for utilities to justify investments in additional protective measures. While the need for standardization became evident after the 2003 blackout, it is for the most part yet to be achieved. The slow pace of cybersecurity investment is of considerable concern to DOE and other organizations dedicated to the security of critical infrastructures. One of the goals of the DOE/industry programs is to develop secured interoperability among the various protective systems now on the market, so that as the utility corporations decide to invest in them, the security technology will be ready.

At Sandia, Robert Pollock (5633) is program lead for

DOE's Office of Electricity Delivery and Energy Reliability (www.oe.energy.gov) has a key mission to enhance the security and reliability of the nation's energy infrastructure, which includes oil and gas providers.

the National SCADA Test Bed (NSTB), and Ronald Halbgewachs (5633) and Jason Stamp (6332) are analysts for the Open Process Control System Security Architecture for Interoperable Design (OPSAID) part of NSTB. The group is part of a Sandia-based team that is working with colleagues at Pacific Northwest, Idaho, Oak Ridge, and Argonne national laboratories.

The National SCADA Test Bed is charged with identifying and solving SCADA vulnerability issues, testing new and existing equipment, and developing next-generation architectures and technology advances. In accordance with the emphasis on creating interoperability between security services for different vendors/systems, the NSTB program has developed the installation of crypto-security boxes as "bumps in the wire" that protect key components of transmission lines.

The OPSAID project, which began as a Sandia Laboratory Directed Research and Development project, is part of NSTB and provides a design basis for vendors such as Schweitzer Engineering Laboratory to build security devices that can be installed in control system networks.

The addition of these devices can increase the strength of security in older systems, while providing a foundation for the development of secure process control system elements in the future. In contrast to some security solutions, the OPSAID effort is based entirely on open-source software and standardized hardware, using an open architecture.

Senate hearing

(Continued from page 1)

electricity," he said. "Since 1978 the government has encouraged use of renewables. Frankly, the truth is we haven't made much progress. Currently about three percent of our electricity comes from nonhydropower renewables."

He added that wind generation has been growing at a rapid rate in recent years, which is encouraging. CSP,

he said, is also an alternative energy source with real potential.

Domenici, who also serves on the Senate appropriations panel that funds Sandia and its solar research, noted how Sandia has been working on CSP "for a long time." He recalled visiting the Labs early in his Senate career when work on solar was in its infancy.

"More energy from sunlight strikes the Earth in one hour than all the energy consumed by human activity on our planet in one year," Domenici said. "New Mexico is truly blessed to have this abundant, carbon-free source of energy, if we can effectively harness it."

Domenici spoke of the need to increase domestic

production of traditional fossil fuels for the short term. "This oil production in the near term will provide us with a bridge to a long-term clean energy future with an economy driven by clean energy technologies like solar," he said.

Following the testimony, Sanders said that the hearing "reinforced my view that there is extraordinary potential for concentrating solar in helping us reverse global warming, break our dependence on fossil fuels, and create hundreds of thousands of good-paying jobs."

"We have optimum solar resources in the United States and we have to take advantage of it," Sanders said.

Chuck Andraka further defines concentrating solar power in written testimony presented to Senate committee

In written testimony that Sandia researcher Chuck Andraka (6337) provided to the US Senate Committee on Energy and Natural Resources, he describes concentrating solar power (CSP) as a "suite of solar technologies that uses mirrors and thermodynamic processes to develop grid-ready electricity."

"Mirrors on tracking structures concentrate sunlight, producing high temperatures, which then drive conventional or novel engine cycles that in turn drive a generator to develop electricity," he says in the report. "CSP technologies do not depend on strategic or high-tech materials, but rather are based fundamentally on glass and steel structures. The collected energy can be stored as thermal energy, an inherent advantage of CSP over photovoltaic solar and wind electrical generation."

"While CSP technologies are not as recognizable as photovoltaic technologies, there are nearly 450 MW of CSP generation currently operating in California and Nevada, with additional planned deployments of over 3,000 MW in the Southwest United States."

He notes that CSP "has the potential to supply a large fraction of US energy needs, although prime generation sites exist primarily in the Southwest. Working in conjunction with other renewable



CHUCK ANDRAKA (6337) testifies during a Senate field hearing on various renewable energy options. (Photo by Randy Montoya)

resources established in other parts of the country and with improvements to the grid infrastructure, the future of CSP in the nation's energy portfolio is indeed bright."

In both his written and oral testimony, Chuck credited the DOE national laboratories — particularly Sandia and the National Renewable Energy Laboratory — as playing a crucial role in existing CSP deployments.

"The historical and ongoing technical achievements at the laboratories have been and will continue to be a cornerstone of successful cost reduction, performance enhancement, and deployment success," he said. "The test capabilities at Sandia are unmatched worldwide and provide a great resource to industry partners." — Chris Burroughs

Benefits

(Continued from page 1)

"So although we are encouraged by how Mercer — and other benchmarking measures — compare our total benefits package with peer groups," Mary says, "we all must remember that each year the American worker is being asked to open up their wallets a little wider for the full range of health benefits and that employers are rethinking major parts of their plans, for example, retirement savings plans for their employees."

"At the same time, our overall health care programs continue to feature some pretty special offerings," Mary adds. For example, the Labs' on-site health clinic is a cost-saving mechanism for employees burdened with rising out-of-pocket health care costs. During the past year, more than 6,000 Sandians used the Labs' on-site facilities rather than having to reach into their pockets for a visit to a physician's office.

The special Sandia edition of the Mercer report also provides what Cornish says are some true apples-to-apples comparisons: Sandia vis-à-vis a transportation/aerospace peer group of 35 companies (among them Astronautics of America, Boeing, Lockheed Martin, and Northrop Grumman) and a high-tech group of 150 companies (among them IBM, Intel, and Microsoft).

The Mercer report, for example, compares "average total health benefit cost per employee" between Sandia and its transportation/aerospace and high-tech peer groups. Simply put, this cost-per-employee figure of \$9,200 is the combined total of what both Sandia and the individual covered employee pay in premiums (but not out-of-pocket expenses) for the breadth of offered medical, dental, prescription drug, vision, and other coverage.

The comparable 2007 survey figures for the peer groups:

- Transport/aero — \$9,058
- High tech — \$9,024

The fact that Sandia's costs for this comparison are slightly higher than the peer groups could suggest the

(Continued on next page)

Benefits

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Labs has not been able to control costs as well as peer-group companies.

"However," Cornish explains, "there are demographic factors that push Sandia's costs to that slightly higher level. One of those is the average age of the populations — 47 years for Sandia, 42 for transport/aero, and 41 for high tech."

Research shows that health care costs increase about three percent for each year a person ages. Therefore, the Sandia population would be expected to have costs — including base premiums — that are 15-18 percent higher than the peer groups' populations simply

because of its higher average age.

Sandia also carries a higher number of dependents per covered employee than the peer groups. "You have about 2.6 covered individuals per employee," Cornish says, "while average groups have about 2.3 covered per employee. Because of this factor, we can estimate that Sandia will have costs about nine percent higher than the peer groups."

Next Cornish offers a bit of math. "If we adjust Sandia costs for age and dependent content in order to compare on a level playing field versus the peer groups, normalized Sandia costs [remember that's the combination of Sandia's and employees' share of premiums] are $\$9,200 \times (1-.15) \times (1-.09) = \$7,116$, which is well below the peer group averages."

Some other Sandia-to-peer group comparisons of health care plans contained in the 2007 Mercer survey:

- Average total health benefit cost incurred by on-roll employees as a percentage of Labs' payroll for 2006: Sandia — 6 percent; transport/aero — 16.5 percent; high tech — 13.5 percent.

- Average contribution for family coverage (percent of premium paid by employee): Sandia's Preferred Provider Organization (PPO) participants — 18 percent; transport/aero PPO participants — 19 percent; high tech PPO participants — 26 percent.

Cornish sums up his analysis of what the Labs' Benefits Department (3332) has accomplished. "Everybody in the world wants 100 percent coverage but the fact is that no employer provides that," he explains. "You've got to look at how your company does things in terms of its peer groups — what are the benchmarks? And in every way I can score it I say, 'Job well done for Sandia.'"

Although none affect current Sandians

People want to know more about retirement benefits changes: A Q&A

The Sandia Board of Directors has already approved a change in the retirement benefits provided to nonrepresented employees who begin work at Sandia in 2009 (see June 6, 2008, *Lab News*).

Quite simply, these new or rehired employees will participate in an enhanced defined contribution plan rather than participating in a defined benefit pension plan. This change reflects what employers are doing across the country.

The Center for Retirement Research at Boston College recently reported that "total pension coverage has remained stagnant while the nature of coverage has continued to shift to 401(k), or defined contribution plans.

"The growth in defined contribution plans outpaced defined benefit plans on every major measure of comparison between 1980 and 2004: assets, benefits paid out, active participants, and contributions," the center's report continued.

The report also warns that the move to defined contribution plans — and 401(k)s in particular — places much of the responsibility for retirement savings in the hands of the employees, who must make decisions about whether to participate, how much to contribute, where to invest, how to rebalance their portfolio, and whether to cash out when changing jobs.

With news about initiation of a new retirement benefit strategy for future Sandia employees came a variety of questions from on-roll Sandians about this change and how — although they aren't affected now — they might be in the future.

Mark Biggs, senior manager of Pension Fund/Savings Plan Management Dept. 10520, addresses some of those questions below:

Q: Will these changes affect current employees?

A: No. The changes are focused on the retirement benefit strategy provided to

employees hired in the future. Current employees will continue to participate in the Retirement Income Plan and will be eligible to continue their participation in the Savings and Income [401(k)] Plan.



Q: Are Sandia's recent changes consistent with other NNSA labs?

A: We believe the resulting benefits for newly hired employees at Los Alamos National Laboratory, Lawrence Livermore National Laboratory, and Sandia (those hired in 2009 and beyond) are very comparable. Los Alamos and Livermore national laboratories instituted similar benefit structures for newly hired employees. In both cases, new hires are excluded from the defined benefit pension plan, are provided with an enhanced defined contribution retirement plan, and are eligible for retiree medical benefits without any company cost subsidy.

The enhanced defined contribution plan adopted by both sites provides a 100 percent employer match on the first six percent of employee contributions, and an automatic service-based company contribution of 3.5 percent for the first nine years of service, 4.5 percent for 10-19 years of service, and 5.5 percent for 20 or more years of service. Based on this approach, a newly hired LANL or LLNL employee with no prior service would receive company contributions to the new defined contribution plans of 9.5 percent of pay if he or she contributes at least 6 percent of pay. Sandia's recent changes also will exclude employees hired after Dec. 31, 2008, from our defined benefit pension plan, offer them an enhanced defined contribution plan, and provide them with access-only retiree health care. Sandia's enhanced defined contribution plan provides a two-thirds company matching contribution on the first six percent of employee contributions, and an automatic service-based contribution equal to six percent of pay for the first 14 years of service and seven percent of pay for 15 or more years of service. A newly hired Sandia employee without any prior service will receive company contributions of 10 percent of pay if he or she contributes at least six percent of pay to our Savings and Income Plan. That compares with the 9.5 percent in company contributions a newly hired employee of LANL or LLNL will receive if he or she contributes at least six percent of pay.

Q: Why aren't current employees being offered an opportunity to switch to the defined contribution plan? It seems that has occurred at other DOE facilities.

A: Offering a choice of retirement plans — the current defined benefit pension plan or the ability to freeze that benefit and join the new enhanced defined contribution benefit plan — was under very serious and lengthy discussion by Sandia's senior management, the Labs' Board of Directors, and NNSA. In fact, that discussion pushed back final approval by several weeks. In the end, however, the parties agreed that offering choice would have been administratively challenging and exposed Sandia to potential legal and financial risks. The choice options that some other DOE facilities have employed is not apples-to-apples comparable with our situation. For example, both Los Alamos and Lawrence Livermore national laboratories experienced M&O contractor changes when they permitted their employees to choose benefit structures.

Q: Are there other benefits impacts that employees hired or rehired after Dec. 31, 2008, encounter?

A: Yes. The new retirement strategy also affects retiree health care benefits for new and rehired employees. New hires and rehires after Dec. 31, 2008, will have access to Sandia's retiree health care providers if they meet age and service requirements at retirement, but they will be required to pay the full cost of that coverage.

Q: How will offers made to new employees be handled when the offer is made before the transition date but they begin work after the transition date?

A: It is imperative that such offers, and any discussions held with prospective employees, be honest and complete. Additionally, Sandia must properly portray current Labs' programs and initiatives, along with programs and initiatives that could affect individuals after they join the Labs. Any new employee or rehired employee starting after Dec. 31, 2008, will be eligible for the enhanced defined contribution plan. Those with a start date before Dec. 31, 2008, will be provided the current defined benefit pension plan, along with the current 401(k) plan. Detailed materials will be provided to the recruiting office to ensure that offers made to prospective employees clearly explain this situation.

Q: Will employees be asked to contribute to the Retirement Income Plan (RIP) defined benefit pension plan in the future?

A: Sandia is not actively considering this change; however, it is prudent that employee contributions be discussed periodically. Employees made regular out-of-pocket contributions to the plan from 1950 to 1975. Resuming employee contributions is always a possibility.

'Heart of Diversity' program brings Sandia Secretary of Energy EEO & Diversity Best Practices Award

By Iris Aboytes

"The most touching Heart of Diversity Award given was to a group of individuals whose coworker was diagnosed with terminal cancer," says Rochelle Lari (3552). "Her coworkers not only covered her workload, but together provided selfless care. Their actions to prepare meals, spend time with her, take her to doctor appointments, etc., went well beyond the workplace. Their compassion, dedication, and love were her source of strength."

Sandia's "Heart of Diversity" program was recently awarded a 2007 Secretary of Energy EEO & Diversity Best Practices Award. "Your unique program is clearly deserving of this recognition," says a letter to Sandia President and Labs Director Tom Hunter from Theresa Alvarill-Speake, DOE's director of the Office of Economic Impact and Diversity. The letter explains the award was designed to recognize new and innovative initiatives that support DOE Secretary Samuel Bodman's commitment to EEO and diversity at DOE.

"In 2000 we realized that we didn't really have a corporate award process for recognizing significant positive actions taken by individuals to address workplace diversity and inclusion issues," says Rochelle. "When we talk about diversity issues and inclusion, it takes acknowledgement, understanding from the heart, and courage by action, to engage in dialogue and effect positive change. Often these people are the unsung heroes who make our workplace and day-to-day work life better. This award program is bureaucracy-free and doesn't require pages of documentation."

The program's vision is to advance a dynamic, inclusive work environment that respects the individual and capitalizes on differences and similarities to increase productivity at all levels.

The program has been shared with Lockheed Martin colleagues from several business units as a best practice.

Anyone can nominate a person by contacting their division Corporate Diversity Team member. To date more than 155 awards across all divisions have been awarded.

A list of team members and more information can be found at www-irn.sandia.gov/hr/diversity/cdt.htm



SANDIA DIVERSITY officer Rochelle Lari and Div. 3000 VP John Slipke display award presented to Sandia from Energy Secretary Samuel Bodman.

(Photo by Randy Montoya)

Cracking the secrets of ice

By Patti Koning

Imaging ice only a few nanometers thick as it forms bulk ice was supposed to be impossible. A scanning tunneling microscope (STM) shouldn't work with ice because STMs create images by relying on conducting current, which runs contrary to one of ice's basic properties — insulation.

But no one told this to Sandia physicists Norm Bartelt and Konrad Thürmer (both 8756). Actually, everyone did, but they didn't listen. Experience and a bit of stubbornness resulted in what Konrad describes as the “most important scientific accomplishment of my career.”

The images captured by Norm and Konrad show ice sheets growing one molecular layer at a time. These images also reveal some new truths about ice and solve a decades-old mystery about why ice grows in cubic form at very cold temperatures, as opposed to the expected hexagonal form that leads to the six-fold symmetric snowflake shape. By combining their talents and experience — Norm is the theorist and Konrad is the experimentalist — these two physicists made a discovery they hadn't dreamed was possible.

Science always builds on past discoveries. Norm's and Konrad's research was inspired by Peter Feibelman's (1130) research in water-solid interactions. In 2002, Peter achieved a major breakthrough in interpreting water-solid interactions (Jan. 25, 2002, *Sandia Lab News*). His research explained why an initial layer of water molecules lies flat on the precious metal ruthenium.

Peter says that Norm and Konrad's work shows Sandia research at its best.

“A gifted experimentalist determined to solve a problem as hard — and important — as how ice grows on a metal crystal contrives to make a scanning tunneling microscope take pictures that, because ice is a good insulator, no one imagined could be taken. Then working closely with a theorist known for a deep understanding of the forces that drive film growth, he concludes that the structure of the imaged ice film is not what thermodynamics would favor, but instead reflects the growth process. So, pictures ‘impossible’ to take yielded a lesson no one had imagined,” Peter says.

Norm and Konrad published their work in a paper, “Growth of multilayer ice films and the formation of cubic ice imaged with STM,” that was published in *Physical Review B* in May. The paper has generated excitement in the physics world and accolades for the researchers.

“How water interacts with solids is extremely important,” says Norm. He points to the design of fuel cells and water purification systems as two areas that could benefit from new STM information. “Getting direct information is difficult, so imaging how small ice crystals grow on solid surfaces is an important advance. This is solid information that allows basic theories to be verified. This was our goal — to provide unambiguous information.”

Ice cubes or snowflakes?

The ice-growth images answer a fundamental mystery about ice: Snowflakes form in the classic six-sided symmetrical shape, but at low temperatures, ice grows in a cubic form. This phenomenon is something that has puzzled scientists for 60 years.

Norm and Konrad discovered that when an ice film is extremely thin, measuring an average of about 1 nanometer thick, the water molecules form little islands of crystalline ice. Once the thickness reaches 4 or 5 nanometers, the ice islands join together and start to form a continuous film.

In the *Physical Review B* paper, the researchers showed that cubic ice forms when the ice crystals merge. Because of a mismatch in the atomic step heights of the platinum substrate relative to ice, the coalescence often creates screw dislocations in the ice. Further growth occurs by water molecules attaching to the steps that spiral around screw dislocations, creating cubic ice in the process.

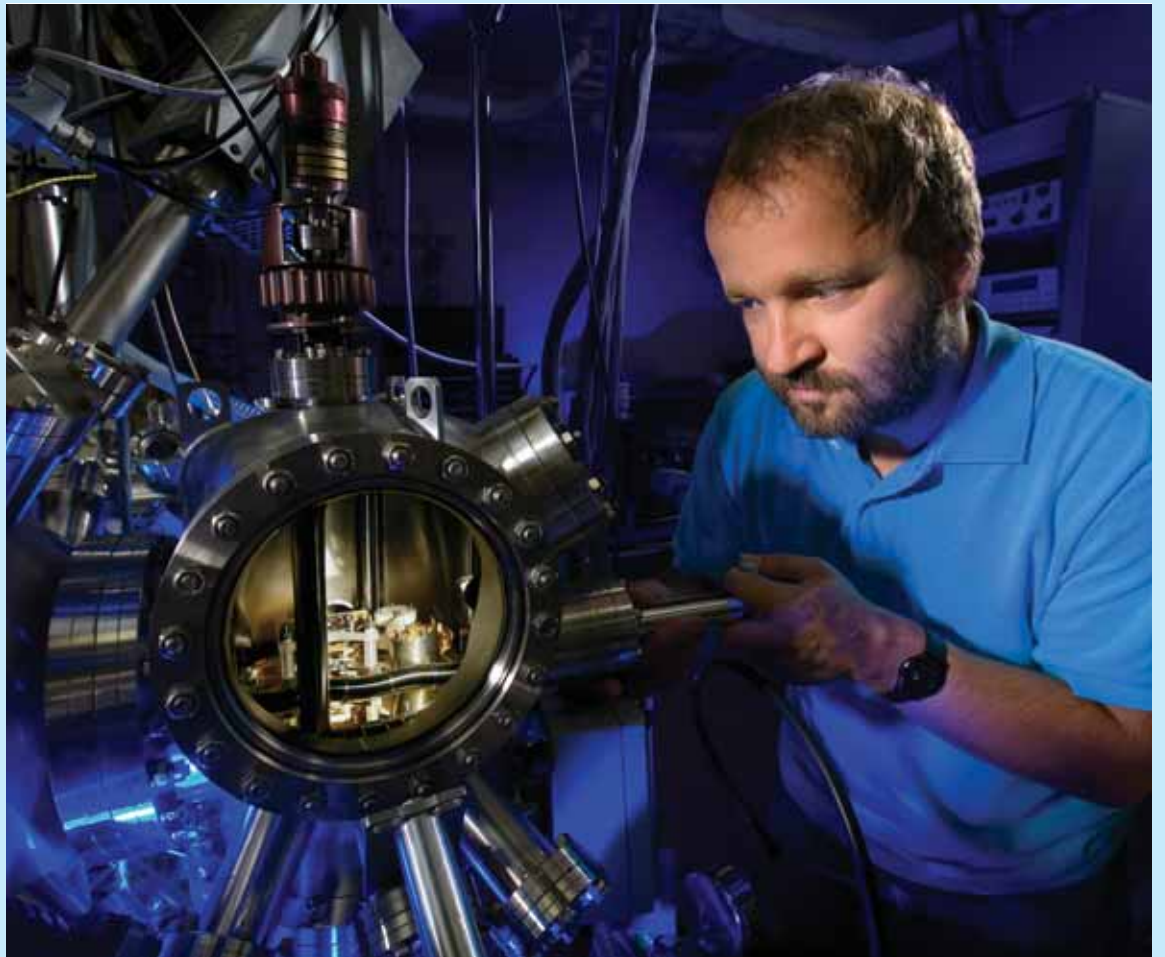
“In retrospect, this process might seem obvious, but it was not anticipated. The ability of microscopy to directly observe ice growth allowed us to solve this very old problem,” says Norm.

Pushing the boundaries of STM

The STM is a notoriously finicky piece of scientific equipment, and working with ice only increased the difficulty. An STM functions by positioning a narrow needle tip near the sample and then allowing a tiny electrical current to flow across the gap. As the tip of the STM is scanned across the sample surface, the voltage required to position the scanner is used to form an image of the sample.

“Typically, an STM only works if the substrate is conductive,” says Norm. “Through persistence and patience, Konrad learned that to image ice, one needs a very small current — three orders of magnitude smaller than what had previously been tried.”

It was Konrad's intuitive decision to change the STM's parameters, namely those for voltage and current, that made imaging ice crystals feasible. Basically, Konrad



WITH PERSISTENCE AND FINESSE, Konrad Thürmer (shown here) and Norm Bartelt pushed the boundaries of scanning tunneling microscopy (STM) to image ice — a material believed to be unsuitable for STM because of its insulating nature. (Photo by Randy Wong)

Sandia California News

found the sweet spot where none was believed to have existed.

The STM was developed in 1981 and earned its inventors, Gerd Binnig and Heinrich Rohr, a Nobel Prize for physics in 1986. “The discovery caused a rebirth of surface science and completely changed the field, but until now, people had not been able to apply it to ice,” says Norm. “The fact that we can apply these same methods to ice is very exciting.”

STM requires artistry and intuition on the part of the scientist. Konrad jokes that he has been working with STM for his entire life (actually, it's been 15 years).

“STM is an experiment that doesn't always work. Because you are trying to get atomic resolution, a few atoms on the apex of the tip can completely throw off the experiment,” says Norm. “If you are not getting an image, you don't know if your tip is bad or you are choosing the wrong parameters.”

This means that experiments have to be repeated over and over. “It's like fishing in the dark,” says Konrad.

In fact, the two physicists never expected that they could image thick ice films; they were hoping for a few molecules. Konrad explains that even after he began imaging thicker ice films, he didn't trust the results. Instead, he thought they were just very misleading artifacts of the measurement approach, which have fooled other scientists to the degree of publishing results based on such artifacts.

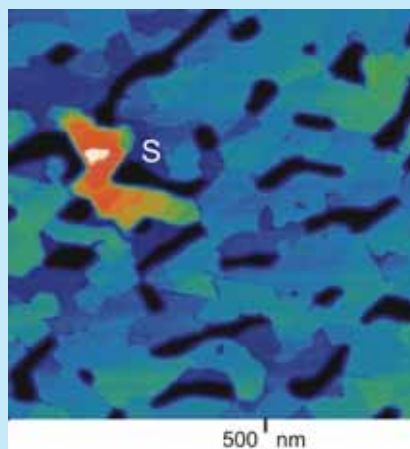
Because Konrad only expected to see films a few molecules thick, he had the STM tip set too close; it was shaving off the top of the films. “For about a month, we thought the films were not really as high as they seemed. We thought the insulating quality of ice made them appear to be higher,” he explains. “I increased the voltage, and the ice appeared to really pop out. Still, I thought it was just a really striking electronic effect.”

However, the researchers could not come up with another explanation for why the films appeared so high. Konrad then purposely grew very thick films and reversed the polarity on the STM, which resulted in an ice carving that proved the thickness was, in fact, real.

Norm and Konrad credit Peter's work plus 10 years of basic energy science research at Sandia for laying the foundation for their breakthrough. “Sandia has been studying metal epitaxy for the last 10 years; we've gained a thorough understanding of the physics of the very early stages of crystal growth,” says Norm. “We've also developed a strong modeling capability, so we could immediately begin working with the images.”

The two Sandians are not resting on their initial success; in fact, they say they are working to build on their breakthrough. Future experiments include putting salts on an ice crystal to see how salts change the crystal's growth and depositing molecules that react with water, such as atomic oxygen, to determine the exact point on the surface where water dissociates.

“Our ability to image these ice films opens the door to a multitude of exciting new experiments,” says Konrad.



A TWISTED MYSTERY — Konrad Thürmer's images reveal that ice grows faster around screw dislocations leading growth spirals (labeled “S”), where cubic ice is being produced.

Homeland Security Workshop gives students experience in complexity

Second year of program builds on high school campers' experiences

By Stephanie Holinka

Leadership demands many things depending on the circumstances: strength, intelligence, persuasiveness, perseverance. High school students attending the second annual Homeland Security Workshop in Roswell this summer learned a bit about leadership and those other qualities in the week-long camp — and perhaps a lot about themselves.

John Taylor (0303), director of the program, says the objective of the workshop, held in late June at the New Mexico Military Institute (NMMI), is to enhance student leadership and complex thinking skills using homeland security and emergency response as a content vehicle.

Last year, the first conference was held over a weekend in Albuquerque. During the weekend, students shared their experiences, visited various homeland security-related projects at Sandia, and worked on problem solving.

"There was little or no formal instruction," says John.

The 2008 workshop built on the experiences students gained in programs they completed at their own schools over the past year. John says the Roswell experience provided a sequential process of learning and applying lessons, both hands-on and in-classroom. In addition, John says, "We built in opportunities to apply the lessons directly in the complex problem-solving, ethics, and tabletop exercises."

Lori Parrott, who led the discussion on complexity in problem-solving, says, "I wanted to introduce students to the idea that complex systems problems are different than just big and hard problems."

During the complexity workshop, students were given fact sheets on complex social and environmental issues and were asked to discuss them. Lori says the nation's educational system, its professional rewards system, and sometimes even our political processes "all drive us to try to jump into solutions too quickly."

"I wanted students to understand that with really complex problems, like those in homeland security," Lori says, "it takes discipline to learn to approach the problems with the right mental framework and get the right people, representing diverse areas of expertise, engaged. And it's vital to identify the right tools that will help you understand the dynamics of a problem before you decide on overly



IN CLASSROOM exercises, students explore concepts of complexity in solving thorny problems.



A HAND UP — High school students learn decision-making and teaming skills at NMMI's leadership reaction course.

"In this day and age," Anita adds, "it is extremely important that the public becomes aware of emergency preparedness — the sooner the better." As a result of the workshop, she says, the participating students "are more aware of the dangerous possibilities and as a result will be vigilant members in their communities."

In addition to intellectual challenges, students were also challenged to solve problems on the ropes course and leadership reaction course at NMMI. The instructors, who typically deal with cadets in these team-building and problem-solving activities, demand each student look past discomfort and shyness and focus on the problem at hand.

Eric Davidson, director of NMMI's ropes course, says it helps students look beyond their limitations and attempt to solve problems using what they are given. He points to his own childhood as "a skinny guy" as an example of how people have to look for solutions that match their skills and abilities. "I am a skinny guy and a mountain climber. The solutions that a football player might use wouldn't work for me."

John says the students came away with a better understanding of themselves as leaders and an appreciation of the complexity of leadership and problem-solving challenges entailed by national security/homeland security problems.

In the future, John says he hopes to accommodate more students and offer a greater variety of experiences.

simplistic — and thus usually less than fully effective — solutions."

Lori says she wanted students to walk away from this camp experience as more intelligent consumers of information about homeland security. She also says she hopes the students will understand the kind of infrastructure the country has in place to prevent or deal with problems. In addition, she says she thinks some of the students may even decide to pursue further study in homeland security-related fields.

Anita Romero, Sandia's Emergency Public Information program manager, assisted in the emergency scenario where students took the roles of various local and state groups that would be involved in a large-scale emergency incident. Anita says the workshop's homeland security drill is similar to those done by city officials all over the country.

"They experienced firsthand what it's like to delve into complex problems that defy simple solution," Anita says.



WALKING THE LINE during the high school-oriented Homeland Security Workshop in Roswell.

First Earth, Wind, and Sun conference set for July 23-24

Conference designed to make people more aware of conservation and alternative energy sources

By Chris Burroughs

Living a greener life by conserving and using alternative energy sources will be the focus of the first-ever Earth, Wind, and Sun conference July 23-24 sponsored by Sandia's Environmental Planning Dept. 4131 and Energy Management Team. The event is open to all Sandians.

"In light of increasing gas and electricity prices and global warming, this seemed like the right time to have this kind of conference," says Jack Mizner (4131), who is involved in planning the two-day conference. "We will have workshops, tours of Sandia's environmentally friendly buildings, and speakers."

July 23 events

The first day will feature keynote speaker Ed Mazria, an internationally recognized architect, author, and educator who will talk on "Buildings and Climate Change: Energy Conservation, Solar and Daylighting Design." Mazria, who is speaking at 11 a.m. in the Steve Schiff Auditorium, most recently has reshaped the national and international dialogue on climate change to incorporate building design and the building sector. Mazria, who has been called a visionary on environmental issues, is the founder of Architecture 2030, an innovative and flexible research organization focused on protecting the global environment.



ED MAZRIA

Also on July 23 from 10 a.m.-3 p.m. more than 30 exhibitors from Sandia, the city of Albuquerque, state of New Mexico, and private and nonprofit organizations will display products and services and share information in a tent outside the auditorium. The exhibits will present information related to energy, water, and other environmental topics.

Other July 23 events include:

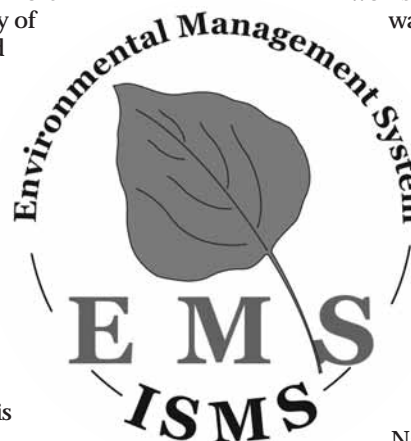
- 1-2 p.m. — "Greening Your Life" workshop where people will learn how to become greener, more sustainable individuals with energy, water, and material-saving advice that is practical and easy to adopt.
- 1-4:30 p.m. — Green building and LEED® (Leadership in Energy and Environmental Design) building certification workshop.
- 2:45-4:15 p.m. — "Support the Environment and Save Money Too: Rebates and Tax Incentives" workshop where people can learn how to apply the various city, state, federal, and other incentives to their home and life. A panel of experts will provide an overview of rebates, tax credits, and resources available to homeowners and citizens.

July 24 events

On July 24 events shift to the Rio Grande Community Center at F Street and Texas on Kirtland Air Force Base. The day starts at 8:30 a.m. with a renewable energy plenary session featuring a panel consisting of Charlie Hanley (6335), who will discuss solar energy; Daniel Laird (6333), wind energy; Ron Pate (6313), biomass; and Doug Blankenship (6331), geothermal. They will give brief presentations and answer questions.

Other July 24 workshops include:

- 10:30 a.m.-noon — "Solar Basics for Albuquerque"



workshop where people will learn innovative ways to reduce home energy use and save money on energy costs from simple insulation techniques to more involved photovoltaic installations.

- 10:30 a.m.-noon — "Remaking Sandia," a workshop aimed at gathering a group of Sandians from all organizational and management levels who wish to work toward remaking Sandia as a national leader in energy conservation.
- 1-2:30 p.m. — "The Ecology of National Security" workshop where discussions will center around how an ecosystem decline may be one of the greatest threats to national security. Attendees will learn the potential causes of decline, possible outcomes, and recommended solutions to this looming problem.

• 1-2:30 p.m. — "PV Installation" where people will learn the basics of photovoltaic installation taught by Marlene Brown (5715), member of the New Mexico Solar Energy Association.

• 2:45-4:15 p.m. — "Eco Footprinting" workshop where attendees will gain a general understanding of the ecological and carbon footprint concepts through interactive participation and the opportunity to experiment with different footprint calculators.

• Two tours — Sandia's green buildings from 10:30 a.m.-noon and Sandia's solar tower from 1-2 p.m. People are required to register for workshops and the tours. They can just show up for the keynote speech, plenary session, and booths.

Registration is done through the Environmental Management website (www-irm.sandia.gov/esh/ems/) in the Integrated Laboratory Management System (ILMS).

The teachings of Don Wati still inspire

By Iris Aboytes

It is plain and simple. Jesús Martínez (4225) loves science and makes no bones about it. Maybe it happened when Chuy, as young Jesús was called, was five or six years old growing up in Chihuahua, México.

One day Chuy accompanied his dad, who moonlighted as a shoemaker, to deliver huaraches (sandals) to Tarahumara Indians in the Sierras. To reach the villages, they had to take a series of different rides. At one of the drop-off places, an old Tarahumara Indian named Watimosín (Don Wati), who had been in the same vehicle, walked over to the river that flowed alongside the road. Chuy's dad and others in the group stayed and waited for the next ride. They cautioned Don Wati not to go far. The old Indian was considered very wise by the traveling group. Jesús called him Don as a sign of respect.

Intrigued, Chuy followed him, and sat beside him at the river. "I wondered what he was up to," says Jesús. They did not engage in conversation but shared lots of thoughts in silence as Jesús watched Don Wati toss small pebbles into the water. "He would toss one and look up at me with a question in his gaze," says Jesús. "I did not feel compelled to speak. The silence seemed to be guiding my own thinking. I wondered if the pebble was going to sink. Don Wati must have read my mind, because he finally asked what I was wondering. After launching several pebbles Don Wati asked me how much I thought one of the pebbles weighed. He picked up a smaller and still smaller pebble and asked me the same question. Finally, he asked me, 'Have you ever watched logs come down the river? How much do you think they weigh? How is it that they are so heavy and yet they don't sink to the bottom the way the little pebbles sink?' He proceeded to explain that pebbles sank because they were made of smaller and smaller pebbles that packed together much tighter than the splinters of which the logs were made."

Their ride came and Jesús and his father continued on to the village. Jesús started school in Chihuahua and continued in El Paso, where the family moved when he was nine. Jesús did a lot of daydreaming as he gazed at a NASA poster in the classroom. He tried dropping out of school. Bilingual education was not available at the time, and he had vision problems that he hid. He was expelled from public school. He thought he would pick cotton all his life.

Mother Basila at Incarnate Word Catholic School rescued him. She discovered he had a vision problem and arranged for him to be fitted with glasses — for free. Jesús told her that when he grew up he wanted to build bilingual schools and find a cure for measles. She convinced him that in order to do that he would have to read a lot more. So Jesús read and studied, and studied some more. He passed all his exams. It no longer mattered if the tests were on the bulletin board, Jesús could see.

He attended Jesuit High School. Brother Murphy cultivated his passion for books. He told Jesús that Jesuits prepared people to change the world. He told him they had prepared Fidel Castro. Jesús argued with Brother Murphy, "Look at what the changes got us!" Brother Murphy replied, "We cannot guarantee the changes, we just educate people to create change. Now you be careful what changes you bring about."

Jesús had been a migrant worker throughout high school and looked forward to becoming a farmer in Oregon. His father, a laborer and janitor, had other plans. Jesús would go on to college. In an argument with his father, his father's convincing words were — what about the changes?

Jesús attended the College of St. Joseph on the Rio Grande. Sister Rosalie, his organic chemistry professor, molded his experiences into a dream that included graduate school. The Vietnam conflict was going on and Jesús was drafted. Graduate school was set aside for almost two years. Later, using the GI Bill, he continued his education and earned his PhD in chemistry from New Mexico State University. His parents were ecstatic; they had the first *catedrático* (PhD) in the family.

His 32-year career at Sandia has involved six assignments. Jesús' passion for sharing science has kept him involved with education. His outreach activities have included being a science advisor, being part of Sandia's old SCIAD (Science Advisor) program, and creating entrepreneurial workshops for engineers to transfer technology.

Jesús developed an approach called "Gaining Access to Natural Abilities in Sciences" (GANAS) to apply multiple intelligences (see "Multiple intelligences" at right) for teaching science. "My GANAS approach keeps infecting my job assignments," says Jesús.

For the recent Sandia Safety and Security Fair, he developed a way to increase learning by introducing

fun and games. He engaged everyone with his Classification Guide for Confectionery Hotness, which served to highlight the importance of derivative classifiers at Sandia. He often sings a line or two from his "Friends in Classification," to the tune of "Friends in Low Places," (a song by Garth Brooks) as he conducts his briefings in SEC150.

Jesús has developed bilingual skits or plays as well as cuentos (stories) to help both students and teachers develop a love for science at an early age. In one play Pepito is taking a test in Mr. Skully's class on bones. It is Ribs, his horse, who helps him understand. In "The Little Atom Who Couldn't Bond," Dr. Ganas talks about chemical elements.

Jesús has never forgotten his time with Don Wati and uses his approach to explain density. "Now I know that this man who was not a scientist — or was he? — introduced me to the concept of density," says Jesús. "I wonder if Don Wati knew about molecules?"

"I guess my quest," says Jesús, "is to help people grow. I try to motivate them to do more — more research, more experimenting, have more questions. What a special world they will discover."



JESÚS AND GARRET head home. (Photo by Esperanza Vigil-Martinez)



AS DON WATI taught Jesús Martínez about density, so Jesús teaches his five-year old grandson, Garret. Garret already knows that everything is made up of smaller parts called molecules. (Photo by Esperanza Vigil-Martinez)

Multiple intelligences

The theory of multiple intelligences was developed in 1983 by Howard Gardner, professor of education at Harvard University. Gardner proposes eight different intelligences to account for the broad range of human potential in children and adults. These intelligences are:

- Linguistic intelligence (word smart)
- Logical-mathematical intelligence (number/reasoning smart)
- Spatial intelligence (picture smart)
- Musical intelligence (music smart)
- Interpersonal intelligence (people smart)
- Intrapersonal intelligence (self smart)
- Naturalistic intelligence (nature smart)

Bobby Baca wins North American One Arm Golf National Championship



GOLF MADE EASY — Bobby Baca (2712) just wanted to be the best golfer he could be, like Tiger Woods, only with one arm, as he won his first North American One Arm Golf National Championship held at Fuzzy Zoeller's Covered Bridge Golf Course in Sellerburg, Ind., July 1-3. This is Bobby's first national title. "The golf course was a challenge, with thick rough, narrow fairways, water everywhere, and very fast greens," says Bobby. "It tested your golf ability and course management." Bobby obviously passed the test. Bobby is seen here practicing his swing at the Tijeras Arroyo Golf Course. (Photo by Doug Carlton)

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LIFT AND HOLD THE LOAD CLOSE TO YOUR BODY. TAKE SMOOTH SHORT STEPS. IT'S ALMOST LIKE DANCING!

SHE NEEDS TO GET OUT MORE!

