



A SANDIA RESEARCHER holds a military GPS unit. The Labs’ researchers have spent more than a decade developing technology which helps make military GPS units more robust and reliable in the 21st combat environment. (Photo by Randy Montoya)

Sandia searches for unexploded ordnance

Team discovers remains at old Kirtland bombing site as part of national program

By Michael Padilla

It’s a local twist to a nationwide problem: potential unexploded ordnance (UXO) at old bombing ranges. Several intact 250-pound bombs were recently discovered during a construction project at the old Kirtland bombing range near Double Eagle Airport on Albuquerque’s West Mesa. Since then the bombs have been safely removed from the area. A complete site survey was conducted after excavation of a new sewer line turned up the 250-pound bombs. Expansion of the Eclipse Aviation facility near Double Eagle Airport has also necessitated adding water and power lines. The survey of the Kirtland site, one of the national Wide Area Assessment (WAA) sites, was initiated and funded

(Continued on page 5)

National Engineers Week



As part of its observation of National Engineers Week (Feb. 18-24), the *Lab News* asked Sandia engineer and local historian John Taylor to write about some of the notable contributions engineers have made to our way of life. John chose to write about the Information Age, but from a unique perspective: In his story beginning on **page 6**, John tells us about the founding fathers of the age, beginning with a most significant breakthrough by a eunuch in the court of Chinese Han Dynasty Emperor Ho Ti almost 2,000 years ago. For more about local Engineers Week activities, see **page 2**.

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Status report: Managed Workforce Transition makes headway, but hard work remains

John Stichman to make decision soon about next steps

Three months after Sandia began the FY07 Managed Workforce Transition process — an accelerated approach to moving people to work and work to people within the Labs — many of the division staffing targets are met, says Esther Hernandez (3010), Deputy to the VP for Human Resources, who headed the team that created the new process at the request of the Executive Office. In particular, programs in the Integrated Technologies and Systems (ITS) Strategic Management Group (SMG) and the Laboratory Directed Research and Development (LDRD) program office are getting needed reinforcements, especially from the indirect-funded areas. These transfers are driving efficiency improvements. At this point, Nuclear Weapons staffing is a bit below its target level, so further net movement

“Right now the staffing assessments provided by the division offices are being evaluated in HR to identify where we still need to move people to work and work to people.”

from this area is not being sought. In addition, more than 120 people have retired since Nov. 16, almost double the number over the same period last year. An overall FY07 hiring program of about 300 people — a number comparable to FY06 — is planned.

Hard work ahead

But some of the hardest work remains to be done, says Esther. Staffing surpluses remain in certain areas, especially

in the Integrated Enabling Services (IES) organizations where managers are having difficulty placing employees elsewhere in the Labs. These may be the toughest issues to resolve, she says. “Right now the staffing assessments provided by the division offices are being evaluated in HR to identify where we still need to move (Continued on page 4)



Hey, kid! You stole my dog!

How do you get kids excited about science? Tim Boyle and his team have perfected one way: Get the kids together in a lab and accuse them of stealing your dog. Then, using techniques you might see on a “CSI” TV program, lead the kids through a series of experiments using the scientific method to figure out who really stole the mutt. Read all about the program in Neal Singer’s story on **page 12**.

What’s what

With my colleague Howard Kercheval visiting family and sailing the Gulf for a couple of weeks, I’m filling in for him with this column . . . and that got me thinking about John Candy.

Back in the 1970s, there was a “Saturday Night Live”-like TV show called “SCTV,” a Canadian sketch comedy program with a raft of memorable performers. Among the stars of the ensemble cast was a young John Candy. One of his funniest recurring riffs was playing the part of a talk show sidekick a la Ed McMahon whose primary role was to laugh at everything Sammy Maudlin, the show’s host, says. In one episode, the Candy character gets a show of his own, something he’s convinced will be easy as pie to do, since he’s watched the master at work for so long. When the camera starts rolling, of course, about all Candy can do is tell painfully unfunny jokes and then laugh his trademark sidekick laugh. The audience, which loved him as a second banana, isn’t amused, and the show is a disaster. Candy finds out the hard way that what Sammy Maudlin does so effortlessly, what looks so easy, isn’t a bit easy. Not at all. So here goes . . .

* * *

Every now and then since I became editor of the *Lab News*, someone will ask me how I like my job. The short answer is: A lot. But there are frustrations, of course. One of the biggest frustrations in the newspaper business – and the *Lab News* fits that description in this context – is that you know you’re never able to tell the full story, paint the full picture of any given event or situation. There’s always more nuance, another dimension or a different perspective. You just do the fairest, most complete job you can with the time and resources available. At the *Lab News*, we’re certainly aware that we provide a snapshot of Sandia at any given moment, with more left out of the frame than we put in it. We do hope that over the course of time we offer enough snapshots to convey the breadth and depth of what goes on here.

There’s one area, though, that we’ll never talk about: our classified work. In many ways, that work represents the very heart of our mission, our reason for being. While the majority of us spend entire careers rarely coming near classified matters, hundreds of our colleagues apply all their gifts to work that will never be recognized publicly, never be lauded in this – or other – publications, never even be bragged about to loved ones. These colleagues, more than any of us, truly embody the idea of exceptional service in the national interest. They are most worthy of our gratitude and our admiration.

* * *

I see where we’re about to move away from using Social Security numbers for a lot of our Sandia business. That’s probably a good thing, but I have to admit, I’m a bit ambivalent about it. It’s just one more number we’re all going to have to commit to memory. Let’s see: I have PIN numbers, Kerberos numbers, passwords galore. I have landline numbers, cell phone numbers, pager numbers, fax numbers. I have email names, user names on PayPal, on eBay, on Amazon. And, oh, a Social Security number.

I know. I know. Years ago we used Sandia ID numbers, and folks seemed to manage; I’m sure we’ll learn to manage again. Don’t get me wrong: I’m as concerned as the next guy about privacy issues and identity theft. It’s just that there’s so much information about all of us out there anymore that I wonder if this measure will really make us any safer.

– Bill Murphy (845-0845, MS 0165, wtmurph@sandia.gov)

Igal Brener named fellow of Optical Society of America

Igal Brener (1727) has been named one of 58 new fellows of the Optical Society of America. In making the announcement last month, the Optical Society cited Igal for “contributions to the fundamental understanding of terahertz generation, coherent phenomena, and terahertz near-field imaging.” Igal has been involved in the terahertz LDRD Grand Challenge at Sandia.

Fellows of the Optical Society are selected based on a variety of criteria, including the record of publications related to optics, service to the society, achievements in optics, or management ability. The number of fellows is limited by bylaw to 10 percent of the organization’s 70,000 members worldwide.



IGAL BRENER

Igal was born and raised in Uruguay. He earned a BS in electrical engineering, a BA in physics, and a PhD in physics, all from the Technion in Israel. He spent two years as a postdoc at Bell Labs before becoming a member of its staff in 1993, researching ultrafast lasers and the spectroscopy of semiconductors, terahertz phenomena, fiber optical communication, nonlinear lithium-niobate waveguide devices, gallium-nitride lasers, and semiconductor heterostructures.

Igal left Bell Labs in 2000 to advance his research activities in the private sector. He joined Sandia in 2004, where his research has focused on the interface of optics, biology, and chemical/biological sensing.

Igal holds 13 US patents and has authored more than 120 journal and conference papers. He has been involved in leadership roles in several professional organizations and conferences.

Igal participates in several Sandia-sponsored science outreach programs in elementary schools and volunteers with MANOS, a minority outreach program for middle school students in Albuquerque. He currently mentors a number of students from UNM.

Local Engineers Week activities scheduled

The New Mexico Society of Professional Engineers is sponsoring two events marking National Engineers Week, scheduled this year for Feb. 18-24.

On Thursday, Feb. 22, the society is hosting a family event and reception at the National Atomic Museum, 1905 Mountain Rd. NE, from 6-8 p.m.



On Friday, Feb. 23, several classes and a luncheon will be held at the Albuquerque Marriott Pyramid North, 5151 San Francisco NE.

NMSPE professional development hours (PDH) credit will be awarded for the classes on Friday. Classes include tracks on human resources and employment law; emergency preparedness and response; and a discussion/presentation about the vertical axis wind turbine.

After a luncheon featuring keynote speaker Justin Rattner, Intel’s chief technology officer, a class on engineering ethics will be offered, also for PDH credit.

A tour to Intel’s Rio Rancho facility will be conducted from 9-11 a.m. on Friday (25 spaces available).

Registration for all events is required. For information, call Karen Ohlendorf Prinke at 284-9717 or 980-1400.

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There’s gold (plating) in them thar hills (of Livermore)!

California site’s materials manufacturing labs are multitalented, and green, too

By Patti Koning (8528)

Often, it’s the things behind the scenes that are crucial, like the airbags hidden beneath the dashboard in your car or the hydrogen getter that keeps your waterproof flashlight from exploding. The Center 8700 materials manufacturing labs have been in the business of making hidden — yet essential — devices since Sandia has been in Livermore.

researcher LeRoy Whinnery, has received a great deal of public attention for its applicability to the surfboard “blank” industry.)
Foam, in fact, shows up in a lot of places where you might not expect it. There are foams sandwiched in some armor plating for blast mitigation and shock isolation, for instance. Foam has also proven to be an excellent means of large-scale decontamination of physical structures, as demonstrated in Sandia’s licensed foam technology.

year. This getter, while small in size, is a crucial safety feature.
Environmental advances in batteries eliminated most of the toxic mercury, making batteries greener, but created a problem of hydrogen buildup, especially in sealed waterproof devices. If enough hydrogen builds up, the gases can explode. The Sandia-invented getter effectively scavenges undesired hydrogen, thus eliminating the hazardous properties of trapped hydrogen.
More than 10 million of these getters have been produced in the last 10 years and are found worldwide in commercial products.
The plastics lab also supports hydrogen getters for the stockpile and provides rigid foam for fixing components within devices. Just as the components of a printed circuit board are fixed together, the internal “guts” of weapons systems are potted to prevent damage to crucial elements.
Another important lab at Sandia/California is the composites lab, which is capable of producing a full range of composites structures. A recent, significant composite is TEPIC, a tooling material that won an R&D 100 award in 2005.

Sandia CaliforniaNews

The characteristics of TEPIC — high-temperature stability, low cost, and high strength, to name a few — make it ideal for processing advanced composites. TEPIC solves a common manufacturing difficulty, replacing composite parts when tooling no longer exists or only the old, possibly broken part remains. The casting characteristics of TEPIC permit the fabrication of tooling directly from an existing structure. The dimensional and feature fidelity of the resulting mold is sufficient to permit the use of the mold with minimal additional machining.
The production of composites and foams sounds very messy, but all these labs are designed for minimal environmental impact. The plating shop sits on a big catch pan, which collects all the waste water for recycling. Most discarded paper, metal, and empty reagent containers are also recycled. “The goal is to impact the environment as little as possible,” says Tim.



KAREN KRAFCIK and John Hachman (both 8778) review the electroplating program on an automatic plating system. (Photo by Jeff Shaw)

The materials labs boast a full range of capabilities. The plating shop, plastics lab, and composites shop churn out devices of practically any size, shape, material, or function. In addition to manufacturing, Sandia researchers use the capabilities of the materials labs to look for new solutions to science and engineering problems.
“At Sandia, we always do things a little differently. Sometimes it’s because of classification, sometimes because off-the-shelf products just don’t fit our needs,” says Tim Shepodd (8778). “We need a strong scientific and manufacturing base to make things happen, and the materials manufacturing labs are a key element of this capability.”
Tim is manager of Materials Chemistry Dept. 8778. The department’s plating shop recently had a breakthrough in the development of gold-plated items.
“We’ve hit the gold standard on gold plating,” Tim says. “We’re making devices with emissivity that matches commercial calibration standards.”
Low emissivity requires a fine grain structure. The plating baths for the ultrafine grain-size gold were developed for the LIGA program and now enable plating for heat flow control devices.
While gold plating is common with simple shapes — think of fireplace doors or jewelry — applying gold to Sandia geometries while maintaining uniform low emissivities is a challenge. The breakthrough came in collaboration with Gas Transfer Systems Dept. 8224. In terms of controlling heat-flow, Sandia has taken gold plating to the limits of physics.
The plastics lab at Sandia/California creates a full range of materials in polymer science. The lab’s capabilities in foam production range from energy-absorbing devices to structural materials; some are strong enough for tools, and others for lightweight materials, like a surfboard core. (TuffFoam®, developed in the plastics lab by

If you own a waterproof flashlight, there’s a good chance it is embedded with a device that originated in the Materials Chemistry department. A Sandia-licensed hydrogen getter, developed by the plastics lab staff, is now used by a major battery manufacturer in millions of flashlights every



JOHN HACHMAN (8778) inspects the low-emissivity gold plating on a model cylinder. (Photo by Jeff Shaw)

Workforce

(Continued from page 1)

people to work and work to people,” she says. “Based on these evaluations, [Labs Deputy Director] John Stichman will decide what the next step is.”

Says John: “So much of this is about establishing an intentional, managed approach to aligning the workforce with the work to be done. I am very pleased with our progress in aligning staff in Nuclear Weapons, ITS, and LDRD. We still have a very crucial task in making a net movement of staff from indirect activities, like IES and center support, to direct program work.”

One option, if John sees the potential for matchmaking across divisions, is a senior manager “brokering” meeting, at which opportunities to move individuals to activities needing people are identified and transfers are made.

However, employment separation could become necessary in the event that an employee’s skills do not match current or foreseeable mission needs. Every year a few people are terminated for this reason. The future is expected to be no different, says Esther.

This year differs from past years in that the budget-workload-staffing mismatches were more pronounced than usual, and the MWT process is being used at the Labs-wide scale to adapt quickly to changing mission requirements, a function Sandia will need to get better at as the Labs’ mission evolves more rapidly, she says.

“The vice presidents have asked for a process

Congratulations to all on a job well done



LABS DIRECTOR Tom Hunter (center), Executive VP John Stichman (right), and Chief Financial Officer Frank Figueroa hosted a celebratory get-together earlier this month to personally congratulate Sandians — including VPs, directors, managers, and staff — for their collective efforts in earning an “outstanding” rating in the 2006 Performance Evaluation Report, or PER. The PER is issued annually by NNSA as a report card on Sandia’s performance in executing the terms of the management and operations contract. The outstanding rating for 2006 reflected a marked improvement in the Labs’ operational accomplishments and a continuing outstanding performance in mission-related work. (Photos by Randy Montoya)

that meets their needs and that is synched to their annual budget cycle as well as to the new-hire recruiting season on college campuses,” says Esther. “MWT is designed to be a sustained

process that can be applied in future years as needed.”

Watch the *Lab News* for more about next steps in this year’s MWT process. — John German

You be the judge

Intel International Science and Engineering Fair looks to Sandia for judges for mid-May event

Sandia employees are encouraged to volunteer as judges for the 58th Intel International Science and Engineering Fair (ISEF), to be held May 13-19 at the Albuquerque Convention Center and Tingley Coliseum. The annual weeklong event is the world’s largest precollege celebration of science and engineering. ISEF brings together approximately 1,500 high school student finalists from more than 47 countries, regions, and territories to compete for more than \$3 million in scholarships, tuition grants, internships, and scientific field trips. The top winners receive \$50,000 college scholarships.

Grand Award judges must have a minimum of six years of related professional experience beyond receiving their BA, BS, or master’s degree or must have a PhD, MD, or the equivalent.

About 1,200 judges will be needed to assess the quality of research done by the students. The hosting community is responsible for securing the required judges. Albuquerque was selected as host in part because of the large number of potential judges in the area.

Each year, more than 1,000 professionals including university faculty, medical researchers, industrial scientists, engineers, and representatives of private and federal research centers volunteer their time to interview and reward the participating high school students at the ISEF.

The ISEF has a tradition of attracting extraordinary talent. At the 57th Intel ISEF held in Indianapolis, Ind., for example, 329 of the 1,470 registered finalists were seeking patents.

To become a Grand Award judge, complete the online form at www.intelisef2007.org/judges.asp to provide the information on your area of scientific expertise, any specialized area of concentration, and some personal information that will help officials to assist you while you are at the fair.

Sandians are also encouraged to sign up as category cochairs who will recruit Grand Award judges in their categories and manage/facilitate category Grand Award judges during the two judging days May 15 and May 16. Cochairs are needed in the following categories: biochemistry, materials and bioengineering, energy and transportation, microbiology, physics and astronomy, and animal and plant sciences. Cochairs can go to www.intelisef2007.org for more information.

Sign up as early as possible so that you can guarantee a spot as a judge in your subject of expertise.

— Erin Gardner



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UXO team

(Continued from page 1)

by DoD’s Strategic Environmental Research and Development Program (SERDP) and the Environmental Security Technology Certification Program (ESTCP).

However, the main result of the survey by this team showed no evidence of any target areas south of the runways.

“This southern portion of the site completely encompasses the area in which Eclipse Aviation is expanding, so good news for them,” says Sean McKenna (6313), project team leader. “We did identify several other potential target areas north of the airport; some of these turned out to be geological noise such as magnetic rocks. About three of them turned out to be legitimate potential ordnance target areas.”

Site characterization

Sandia, along with members from Pacific Northwest National Laboratory (PNNL), used lidar (light detection and ranging) imagery to remotely characterize the Kirtland site. The imagery revealed several features indicative of UXO targets. The lidar provided a high-resolution topographic map of the area and focused on old targets such as concentric circles, a ship outline, and other areas of interest, Sean says.

The entire site was characterized using two complementary geophysical techniques: magnetometers and electromagnetic induction. The techniques were run simultaneously on a specially designed trailer pulled by a dune buggy. This technique, done by Geo-Centers (now SAIC), is known as Vehicular Simultaneous Electro-magnetic Induction and Magnetometer System or (VSEMS). In addition, a helicopter-mounted magnetometer was used to survey the entire site, including some areas south of the Double Eagle runways that were not surveyed with the VSEMS.

“These geophysical tools don’t have the discrimination power to identify UXO versus scrap metal, but they do a good job of identifying locations with relatively larger concentrations of metal in the ground,” says Sean. “Typically, these areas are the target locations we’re interested in.”

Project conception

Research on the development of the project techniques was funded by SERDP beginning in

Typical site characterization work flow

- Site owners and the Corps of Engineers meet to develop a conceptual model of how the site in question was used as an ordnance testing facility. Discussion includes types of ordnance used, results from previous surveys including lidar imagery, whether removal was done in specific areas, and future site plans.
- Once the conceptual model and types of sensors to be used have been determined, the team designs geophysical survey transects using the tools developed by PNNL.
- Data is collected along the transects and the location of every metal anomaly detected above some noise threshold within the area surveyed. The data comes to Sandia for evaluation. Typically only 1 percent or less of the site area is surveyed with the transects.
- Sandia uses the data to create spatial estimates of the anomaly density on a fine grid across the site as well as the probability of the anomaly density exceeding a background threshold value. These results provide the boundaries of the target area(s) at the site. Estimates are also provided of the total number of anomalies expected within each target area.
- Site owners decide what to do with the results.



SEAN McKENNA AND BARRY ROBERTS in the wide open spaces on Albuquerque’s West Side just south of Double Eagle Airport, check data that confirms the location of metal fragments associated with the old Kirtland bombing range. The range, abandoned decades ago, was used for bombing practice during and right after World War II. (Photo by Randy Montoya)

2000. Work funded by SERDP focuses on basic research. The ESTCP subsequently funds initial field application and verification of technologies developed under SERDP funding.

Sandia received ESTCP funds for initial “field” testing that involved application of algorithms to simulated sites; no field sites had been adequately characterized and excavated to a point where they could be used for validation. Characterization of the simulated sites was successful.

ESTCP recently organized a set of wide-area technology assessments and demonstrations. These wide-area studies involved testing and evaluating a number of UXO technologies at a

given field site. The field sites for the wide-area assessment have been chosen based on visibility and urgency of the need to remediate the land. Urgency is generally driven by someone else wanting to use the land.

Sandia has been involved with various WAA research sites including the Pueblo site in southeast Colorado; Toussaint River, an underwater site in Lake Erie off the north shore of Ohio; the Victorville site in southern California; and the Camp Beale site north of Sacramento.

“The reason for the different sites across the country is to test the different technologies on various topography, soils, site areas, expected number of target areas, and anomaly densities,” says Sean.

Overall, as much as 20 million acres of land in

the US — that’s about half the size of Maine — could possibly contain UXO. The unexploded ordnance is left over from wars as well as from decades of live-fire training and practice in the US. “UXO presents a discrete and acute health hazard, but not the same as the land-mine problem,” says Barry Roberts (6313), a member of the team. The Kirtland site was used for training during and after WWII.

In addition, data collected from known historic target sites at Laguna and Isleta pueblos have been used for development of various research techniques. The data sets, funded by SERDP, were mainly collected to test the helicopter-mounted magnetometer being built by Oak Ridge National Laboratory. “We also used the data for the statistical algorithm development work, but did not complete any reports regarding the two sites,” Sean says.

Work in progress

Currently the team is writing up final reports for the Pueblo, Victorville, and Kirtland sites. The Sandia team has completed work on the conceptual model for Camp Beale and worked with the Corps of Engineers and PNNL to come up with a transect design for that site. The ground magnetometer surveys will begin there this month.

This year, ESTCP has funded Sandia and PNNL to develop a training course for state and federal regulators and contractors involved with site characterization and cleanup using these methods. The first course will be offered in August.

SANDIA/PNNL PARTNERSHIP: The Sandia team members include Sean McKenna, Barry Roberts, and David Hart (all 6313) and Victoria Cruz (10730). Hirotaka Saito and Roger Bilisoly, no longer at Sandia, were also part of the team. PNNL participants include Brent Pulsipher, John Hathaway, and Brett Matzke.



RECOVERED BOMB PARTS from the old Kirtland bombing range near Double Eagle Airport. (Photo by Randy Montoya)



A DUNE BUGGY and trailer, towed across target areas looking for unexploded ordnance, use a technology called VSEMS, for Vehicular Simultaneous Electromagnetic Induction and Magnetometer System. Here, the innovative technology is being put through its paces in Colorado. (Photo by Barry Roberts)

ENGINEERING THE INFORMATION AGE

Information availability — Ts'ai Lun (ca. 105 A.D.) and Johannes Gutenberg (ca. 1400-1468)

The first transformational developments on the road to the Information Age were those that broadly demonstrated the power and utility of information.



TS'AI LUN

Ts'ai Lun, a eunuch in the court of the Han emperor Ho Ti, was the first to manufacture paper. Although writing and printing on papyrus, vellum, and silk were already well established, Ts'ai Lun developed a cheaper, more transportable, more available, and more flexible alternative. The discovery brought him great wealth, but also led to his suicide to avoid the consequences of a palace intrigue.

German goldsmith **Johannes Gutenberg** invented neither the printing press nor movable type. His contribution was as a systems engineer — combining modern inks, metal type, a new press, and new processes to produce the first practical printing system. This system is widely credited with enabling the Reformation, among other major cultural shifts, as texts became widely disseminated and accessible to any reader.

Despite his systems insight, Gutenberg was not a good businessman. He became embroiled in several lawsuits, lost money on his printing system, and was forced to forfeit his equipment to his business partner.

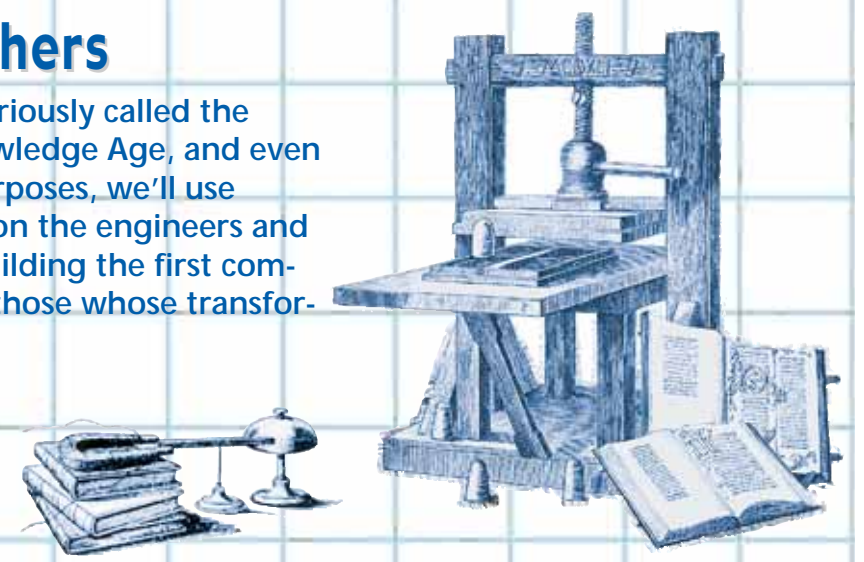
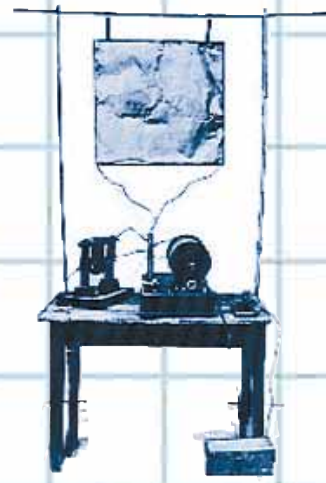


JOHANNES GUTENBERG

The Founding Fathers

We are living in an epoch that has been variously called the Information Age, the Digital Age, the Knowledge Age, and even the Post-Information Age. (For present purposes, we'll use Information Age.) This article focuses not on the engineers and scientists who introduced this epoch by building the first computers and inventing the Internet, but on those whose transformational insights enabled these advances.

By John Taylor



Opening the microworld — Zacharias Jansenn (ca. 1580-ca. 1638) and Antony van Leeuwenhoek (1632-1723)

The fifth transformation provided access to the micro world.



ZACHARIAS JANSENN

Without any formal training in optical engineering, **Antony van Leeuwenhoek**, a minor functionary in the town of Delft, Netherlands, perfected the lens grinder's art and improved Jansenn's system of lenses to obtain magnifications up to 270X.

Although Leeuwenhoek is remembered for discovering the world of microbes, the scaling laws and miniaturization in solid-state electronics and integrated circuits envisioned by modern-day engineers such as Robert Dennard would not have been possible without van Leeuwenhoek's breakthroughs in microscopy.



ANTONY VAN LEEUWENHOEK

Capturing and controlling electrons — Alessandro Volta (1745-1827) and Thomas Edison (1847-1931)

A second revolution transformed electricity from a laboratory curiosity to power for the world. From earliest childhood **Alessandro Volta** had a passion for electricity. When he was a boy, electricity was just a laboratory curiosity, known primarily through lightning and static electricity captured in Leyden jars. In 1800, Professor Volta's "voltaic pile" combined zinc, silver, and brine into the first true battery, demonstrating the ability to store electrical charge and generate a steady current. Volta's portrait adorns the Italian 10,000 lira bill.



ALESSANDRO VOLTA

American **Thomas Edison** received more than a thousand patents, doing so with only three months of formal education. In fact, one of his teachers said that poor Tom had an "addled brain." Best known for inventing the light bulb (which he actually only improved, having purchased the patent from two Canadian inventors), Edison-developed concepts for providing electricity to homes and businesses changed the way the world functioned. Although his DC concept ultimately yielded to AC, a system proposed and refined by the likes of George Westinghouse and Nikola Tesla, electricity was now controlled and available to the public.



THOMAS EDISON



JOSEPH HENRY

Universal connectivity — Joseph Henry (1797-1878) and Guglielmo Marconi (1874-1937)

The third critical transformation enabled the global telecommunication infrastructure, leading to ubiquitous, near-instantaneous transfer of information.

In 1830, **William Henry**, the first Director of the Smithsonian and one of the founding members of National Academy of Sciences, demonstrated telegraphy, the use of electricity (actually electromagnetism) to provide signals at a distance. Although best known for his invention of the electric motor, Henry's foundational contribution to telecommunications, later improved by men like Samuel Morse and Alexander Graham Bell, may have been even more important.

Italian **Guglielmo Marconi**, inspired by Heinrich Hertz's confirmation of the existence of electromagnetic radiation, patented the first practical radio system in 1896.

Although early radio communications used Morse code, wireless voice communication arrived in 1906, leading to commercial radio in the 1920s. Marconi continued his work in shortwave and microwave communication until his death in Rome in 1937. Henry's telegraph proved that instantaneous communication over distances was possible; Marconi made it wireless and gave it a voice.



GUGLIELMO MARCONI

Electrons in solids — Michael Faraday (1791-1867) and Carl Ferdinand Braun (1850-1918)

The sixth transformation was the discovery and application of the peculiar electrical properties of semiconductors.

English chemist and physicist **Michael Faraday** started out as an apprentice book-binder. Largely self-educated, he became fascinated with electricity after attending a lecture by Sir Humphry Davy. Best remembered for demonstrating the relationship of electricity and magnetism, Faraday's observation of the effect of temperature on the conductivity of silver sulfide was the first purposeful demonstration of semiconduction in materials.



MICHAEL FARADAY

In 1874, German **Carl Ferdinand Braun**, a professor of physics at the University of Strasbourg, developed the first practical semiconductor device, the "cat's whisker diode." He also built the first cathode-ray oscilloscope (1897) and shared the Nobel Prize in physics with Marconi (1909). Braun died in the US in 1918 while attempting to protect German interests in a radio station from commercial assaults by the then-British-controlled Marconi Corporation. The invention of the transistor by Bell Labs researchers in 1947 can be directly linked to the transformational insights of Faraday and Braun.



CARL FERDINAND BRAUN

Enabling visualization — Louis Daguerre (1787-1851)

The fourth transformation was the ability to image the real world in real time.

Louis Daguerre, a French artist well known for spectacular panoramas, capitalized on the earlier work of Johann Schultz (who discovered the light sensitivity of silver salts) and of his own colleague, Joseph Niepce (who produced the first photographic image in 1820), to produce the first practical camera system in 1837.



LOUIS DAGUERRE



JOHN TAYLOR

JOHN TAYLOR, a nuclear engineer by training and a veteran of 32 years at Sandia, is the manager of ITS Strategic Planning Support Dept. 303. He has a passion for history and has authored or co-authored two books on the Civil War in New Mexico and one on the history of Catholicism in the Rio Abajo. He was also the technical editor of "A History of Exceptional Service in the National Interest," the 1997 Sandia history, as well as two detailed examinations of specific national security programs at Sandia. He is also one of the principals in Sandia's Personal History Project.

The Information Age dawned in the middle of the 20th century. Demands for data processing, driven by the Manhattan Project and advanced aircraft designs, began to be satisfied by ENIAC, Mark I, and commercial mainframe computers. The invention/creation/introduction of the transistor in 1947 enabled power, size, and heat loads to be drastically reduced, enabling the PC. Intensifying requirements for real-time battlefield situation awareness and threat assessment following the launch of Sputnik drove DoD to the first computer networks in the late 1960s and gave rise to the full-blown Internet a few decades later. The rise of PCs and the Internet led to an increasing demand for real-time information, including graphics and images. Each of these innovations has its origin in the transformational insights of one of the "founding fathers," discussed here, who created the expectation that information should be shared and could be made accessible. Absent their contributions, the Information Age would have dawned much later, if at all.

All illustrations from public domain sources

Automating computation — Charles Babbage (1792-1871)

A final foundational enabler is the ability to manipulate numbers automatically.

Charles Babbage, professor of mathematics at Cambridge, was something of an eccentric. He loved fire and once had himself baked in an oven at 265 degrees F for five or six minutes, just to see the effect. He also hated music and was followed by people in the street who "tormented him with songs and fiddling."

Babbage's analytical engine, first conceived in 1834, had essentially all of the capabilities of a modern electronic calculator. In developing the analytical engine, Babbage stood on the shoulders of the unknown Greek who developed the Salamis counting board (ca. 500 B.C.); John Napier, who publicly propounded the concept of logarithms in 1614; and William Schickard, who developed the first adding machine (called the Calculating Clock) in 1623.

Babbage's creation was lost to history until 1937 when Harvard graduate student Howard Aiken rediscovered the work. There is a spirited debate about who really built the first modern computer. Some argue for Aiken, who developed Mark I with IBM in 1943. Others argue for Konrad Zuse, who developed the first programmable system in 1941. Still others argue for John Vincent Atanasoff, whose Atanasoff-Berry Computer (1937-1942) first used a binary structure and electronics. However, Babbage is generally credited with the seminal idea.



CHARLES BABPAGE

The black experience is part of the larger American experience

Texas Prairie View A&M President George Wright inspires, motivates at Black History Month kickoff

By Bill Murphy

The answer to George Wright’s rhetorical question was probably a foregone conclusion, but how he arrived at the answer caught and held the attention of an audience of about 100 Sandians and students at the Steve Schiff Auditorium last week.

Wright, president of Prairie View A&M University, was invited by Sandia’s Black Leadership & Outreach Committee (BLOC) to help launch Black History Month at the Labs this year. Wright has been involved personally and professionally in Black History Month activities since the 1970s.

The middle school and high school students in the audience were at the Labs to participate in an awards ceremony for an essay contest sponsored by BLOC. Wright specifically addressed many of his comments to the young people in attendance.

In his comments, Wright, who said he feels like “a history teacher masquerading as a college president,” asked, “Is Black History Month still necessary?”

By tapping into that latent history teacher within, Wright laid out the story of Black History Month from its inception and demonstrated why it is still relevant today.

Do we need to move on?

His remarks, while serious, did not lack a lighter side. Wright noted that he once had a white student who said that if black Americans had their own month, why shouldn’t there be a white history month.

“And I told him,” Wright said, “‘Every month is white history month. I thought you knew that.’ We have taken February. The shortest month.”

But is it still necessary? “Given all the changes that have occurred in this society over the past 90 years [since the month was first observed], is it still important? Is it still necessary? Do we need to move on to something else?”

In answering, Wright turned to the Bible, citing the first verse in Isaiah, Chapter 51. “Hearken to me, ye that follow after righteousness, ye that seek the Lord: look unto the rock whence ye are hewn, and to the hole of the pit whence ye are digged.”

The verse, Wright said, tells him that “All of us need to know our past; all of us need to know where we came from — it’s a guide to where we’re going.”

Started at the nadir of race relations

Wright said Black History Month started in the early 1900s during a period that he called the nadir of race relations in the US. That period, from roughly 1890 to 1930, marked a time when the entire apparatus of government was engaged

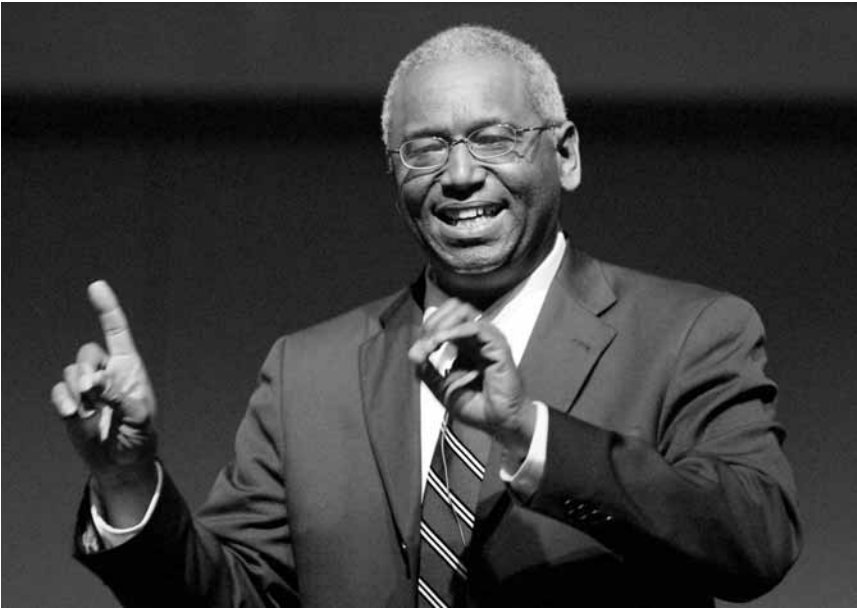
in systematic discrimination of black people.

During these bleak years, he said, Black History Month was created to achieve two goals: to inform black Americans of the achievements of their own people; and to convince white Americans of the contributions that black Americans had made to the founding and growth of this country.

“The first goal was successful,” Wright said. The second goal — raising awareness among whites — was less so.

“Whites for the most part ignored Black History Month. I know there were exceptions, but it was largely ignored by white America.” In contrast, Wright recalled that when he was in school in Kentucky in the 1950s, observance of the month was very important in his segregated school.

And Wright reminded his audience — especially the students — of the price black Americans have paid to be full citizens. As a student studying



Photos by Randy Montoya

involved in the NAACP from the very start. White and black attorneys working together, for example, won great legal fights that led to constitutional recognition of the equality of the races.

Whites involved in struggle, too

“My point is that Black History Month reminds us that it was not just black folk who were involved in the struggle, but a wide range of white Americans as well.”

It is only together, Wright suggested, that progress is possible.

“So let me come back to my question: Is Black History Month still necessary?” He ticked the answers off on the fingers of his hand.

It’s important, because it reminds white Americans that other whites have consistently championed the cause of black Americans. “And if you look closer,” Wright said, “you’ll discover that Black History Month says to whites that you can’t be neutral in the area of race. If you are silent, if you are passive, Wright suggested, you allow bad people to hold sway.

He noted that late in his life Dr. Martin Luther King said that “the most troublesome adversary [of the Civil Rights movement] is the white American who is more devoted to order than to justice; the white man who tells the black man to wait for a more convenient

season to protest.”

Black History Month reminds black people that their ancestors made tremendous accomplishments against incredible odds.

“All of my life I have met black people — they could be a schoolteacher, they could be a janitor, they could be anything — who have overcome so much. They are to be admired; they are to be respected. If we understand the problems they had, it makes our problems seem shallow by comparison.

A need to look inward

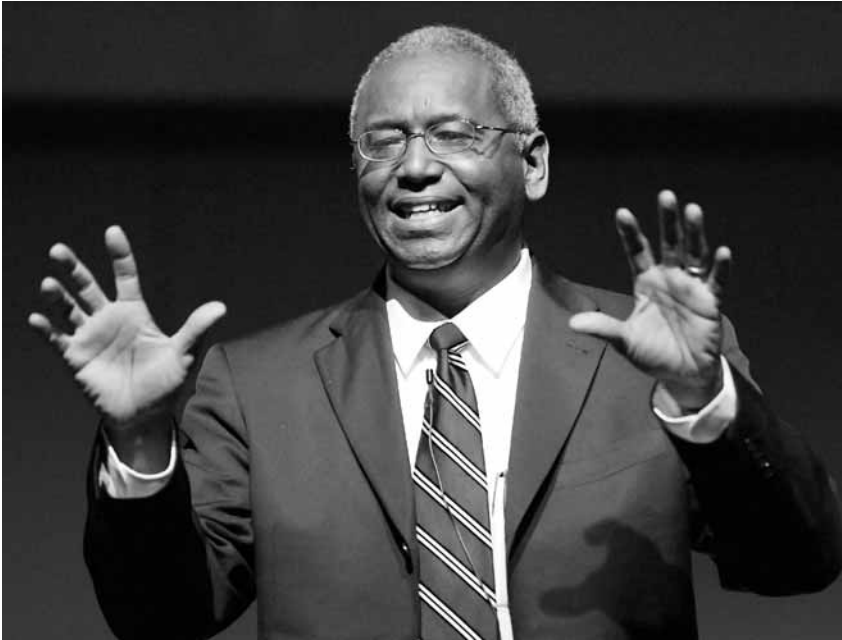
“Black History Month also tells me that black folk need to take a look inward and recognize that there’s a lot of self-destructive behavior in the black community that hurts blacks everywhere.

“The most important thing I’ve learned from Black History Month,” Wright said, “is that the only person stopping me from being anything in life is me.”

And finally, Wright said, Black History Month is an opportunity to educate all Americans about the black experience.

“The more you learn about black folk, the more you’ll learn about this nation of ours. You’ll learn how the black experience is really part of the larger American experience.”

And, addressing the young people in the audience directly, Wright said that to learn more about the black experience, “I’d encourage you to watch movies, listen to music, but above all, to read, and read, and read.”



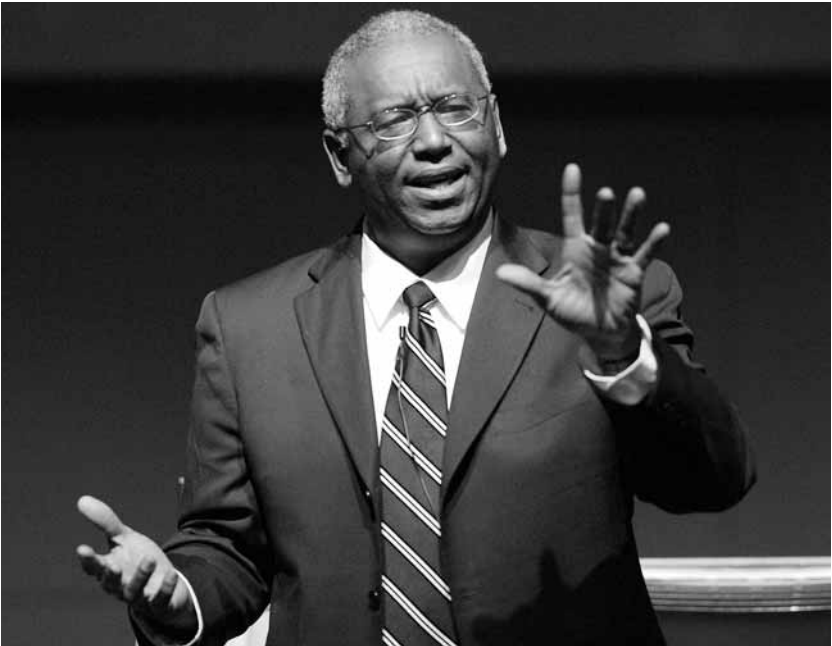
black history, Wright said, “I learned that black people had fought in the Revolutionary War, the War of 1812; and the Civil War,” where they died in far greater numbers, as a percentage of all soldiers under arms, than did white fighters.

“I learned that they fought in the Spanish-American war, World War I, World War II, the Korean War, Vietnam, the Persian Gulf, Afghanistan, and Iraq. Blacks would contribute to every conflict in this nation’s history.

“And I would also learn about the great black educators, black leaders, and so forth. It gave me a sense of pride in being a black American.”

By the 1970s, Wright said, “Some were saying ‘Black is beautiful,’ and I had no problem with that. But some were saying ‘Black is beautiful and white is not.’ Some said that black people would be better off if white America didn’t participate in Black History Month at all. And that made me think.”

Wright said that as he studied race relations in the US, he found that blacks and whites working together had made great strides; white intellectuals, white ministers and others were



Stolen dog

(Continued from page 12)

Tim shows pictures of four adults on a wall screen. These are the only people who were in the building at the time of the 'nap. One was the elementary school principal, Ms. Hamilton.

"That's her!" the kids say excitedly. "She's guilty!" It didn't help Hamilton's credibility to be the only suspect portrayed with a skeleton standing behind her.



RIVETED BY THE EMERGING TRUTH, but not blinded by the light or chemicals, because safety goggles were provided by the Sandia team, two young girls enjoy watching another clue analyzed in tracking Beaux's nefarious kidnapper.

"So, you think you can tell from a picture who's guilty?" says Tim.

Energetic but indecisive

Now he shows a description of the habits of the four suspects. Some like dogs, some don't. Some like ice cream, some lemonade. Some wear lab coats, some do not. The kids vote for guilt by a show of hands. They are energetic but, as a group, now indecisive.

Tim, sitting in the back of the room, raises his hand for each suspect, and Bernadette calls him on it.

"To me, everyone's guilty," he says, "until we prove otherwise." Dressed in jeans and running shoes, a Spy-vs.-Spy T-shirt visible under his black

corduroy jacket, with dark shades and thick dark hair combed forward over his forehead, he could be a walk-on scientist on the mathematically oriented "Numb3rs" TV crime show.

"So, from habits and appearances, you can't tell?" says Tim. "Okay, let's do some science."

The kids, aided by Bernadette and other volunteers, inspect the "crime scene" — a collection of objects that seem to have nothing visually to do with each other, side by side: purple-colored water, the ransom note — "I have your dog! If you want to see him again, then you have to take Beaux out of the chemistry magic show" — a white spilled liquid, other oddities. "What do you see that's strange, that's a little unusual?" Tim asks.

"Purple water, right? What is that and why is it there? Is there anything that could lead us to the dognapper?" He points out other tiny bits of material that look as though they weren't part of the original décor of the office.

Now the kids are broken up into groups. Each goes to a table where they watch or perform a particular kind of analysis. A pH test determines that one liquid found in a cup was acid-based, suggesting a drink enjoyed by two of the suspects. A chromatological ink analysis finds the ransom note was written by a gel pen. "Who uses a gel pen?" A nanotechnology lab (which takes some explaining) finds that nanoparticles of gold, treated with certain solvents, becomes purple in the water. "Who among the suspects do we know was working with gold nanoparticles?"

At the end of the analysis, the kids file back into the conference room, sit back on the floor, and line up suspects and attributes with analysis of the clues.

"We match the evidence to the suspects," says Tim.

The guilty party, as portrayed unassailably or at least most probably by science was big, ostensibly friendly and even fatherly-appearing manager Bill Hammetter (1815).

"Give it up, Bill," says one kid's voice.

"Why'd you do it, Bill?" the others shout.

"I wanted Beaux to be my dog and I wanted my cat to be used in the show," Bill confesses as he returns Beaux to the room.

The kids go off to celebrate the successful solution of the case by creating liquid-nitrogen-cooled ice cream.

Having fun, learning about science

The show has hidden costs. Someone needs to pay for a school bus to transport the kids and substitute teachers to stay with the kids who, for one reason or another, can't come. There are supplies.

Tim and Co. figure they can handle the fourth and fifth graders from two schools in a week during winter break, and the same in spring. That means the team can excite kids in four schools a year. Tim tells the kids they can use science in jobs like engineering and chemistry and even firefighting. He keeps statistics on many positive results arising from the three-hour event — more students turned on to science; teachers, administrators, parents all happy with the project and more aware of Sandia; the possibility of a larger student base for Sandia among local students over the years.

But Tim needs a grant to continue this effective program.

Can he get it? He doesn't have the buzzwords; he doesn't mention "strengthening the syllabus" or "fortifying the science experience."

The kids are just having fun learning about science. And, oh, yes, finding Beaux, the Magic Chemistry Dog.



MILK OR GLUE? Forbidden to touch or smell a white liquid found at the crime scene, two students use plastic pipettes to add soap to their samples. Soap separates milk fat to form a mobile rainbow; glue does not react. The criminal apparently likes ice cream.

Sandia singers enliven the Pit



MAKING A JOYFUL NOISE could be considered the mission for this informal gathering of Sandians who love to sing. You may have heard them, strolling the halls of your building or livening up your potluck during the holiday season. Director Bob Miltenberger (10328) has even helped the group to expand their engagements to include a recent performance of the "Star-Spangled Banner" in the Pit at a Lady Lobos game. And who knows, you might even get to hear them open an Isotopes game.

(Photo by David Benyak)

Who helped find Tim's dog?

All individuals are in Dept. 1815 unless otherwise noted.

- **NanoRoom:** Bernadette Hernandez-Sanchez (postdoc), Marlene Chavez
- **Spill Analysis — pH of Spill:** Diane Dickey (UNM postdoc), Malynda Aragon (6316)
- **Spill Analysis-Indicators:** Troy Russell*, Eric Branson
- **Ink Analysis:** Leigh Anna Ottley*, Rebecca Raymond*
- **Fiber Analysis:** Christina Baros*, Geoffery Brenneca (1816, postdoc)
- **Secret Messages:** Timothy Lambert, Sean Winters (1820)
- **Ceramics Engineering-Robocasting:** John Stuecker
- **Liquid Nitrogen Ice Cream:** Scarlet Widgeon*, Harry Pratt*
- **NM Firefighters Training Academy-Fire Safety/Science:** David Romero
- **Station Chaperon:** Anna Gorman

* Student intern

Mileposts

New Mexico photos by Michelle Fleming
California photos by Randy Wong



James Dawson
30 10824



Lorri Castillo
25 10263



Joanne Paulos
25 10828



William Silva
25 24312



Gary Cordes
20 27221



Edward Parma
20 6771



Louis Nogales
45 6451



Rusty Gillen
25 1725



Lila Zurzolo
25 4324



Brian Philipbar
20 2900



Catherine Benavidez
30 10241



Judith Jojola
25 10223



Virginia Clark
20 5050



Carol Skinner
20 2956

Recent Retirees



Eloy Gutierrez
37 5020



Danny Baca
33 10864



Jeffrey Keck
30 2951



Sandra Culler
15 1200



Michael Thomas
20 1716



Thomas Blanchat
15 1532

Feedback

Tobacco-free policy

Is obesity next, reader asks; does policy apply to visiting customers

Note: Sandia has approved a tobacco-free workplace policy scheduled to take effect March 1. The policy bans all tobacco use on Sandia-controlled property.

Q: I am a manager here at Sandia and I am a non-smoker. However I just saw the new non-smoking policy and cannot believe what I am seeing. Now smokers are going to be required to quit or get in their car and drive off Sandia property to smoke. My question is what is next? Obesity is also a big concern; are we going to place scales at the gate and remove the snack machines and fire those who don't meet the appropriate weight requirements? How about those who drive carelessly or too fast, are we going to create a driving school for this as well? This policy is foolish. I would also hope that as part of our hiring practices we are now eliminating anyone who is a smoker as a candidate. This is going to drive productivity way down for anyone on the staff who smokes. I cannot understand where Sandia leadership comes off thinking that it is their responsibility to protect someone from themselves.

A: Sandia has had a smoke free policy prohibiting smoking inside buildings and company vehicles for some time now. The new policy prohibiting smoking on all Sandia property is a natural extension of our current practices and is similar to that of Lockheed Martin.

In regards to your concerns about extending this workplace policy to other medical conditions such as obesity, the intent of the tobacco-free workplace policy is to encourage a safe and healthful working environment, one that is free of exposure to known car-

cinogens. The Occupational Safety and Health Administration (OSHA) and the National Institute of Occupational Safety and Health (NIOSH) recommend that second-hand smoke be considered a potential occupational carcinogen. As there are no known safe levels of second-hand smoke exposure, these federal agencies recommend exposures be reduced to the lowest possible levels. Tobacco in any form is a recognized carcinogen. Medical conditions and the diseases associated with obesity do not have similar impacts on the workplace safety and health of others. Your comment regarding driving may be rhetorical but it is a good example of how the formation of policies, regulations, laws, and consequences can lead to safer environments for populations and in safer choices adopted by individuals. And in fact we are investigating the possibility of adding healthier choices in vending machines.

Sandia does not presently nor does it intend to hire for best health behaviors. We do continue to do medical surveillance, because naturally, some jobs require lifting, good eyesight, good hearing, etc. This policy does not impose hiring practices on the corporation nor is it intended for such.

Sandia has a long history of providing awareness and opportunities for employees to achieve and maintain physical and mental health through a supportive work and community environment. Participation in the HBE Preventive Health programs has always been voluntary. Thus, the 120 employees who have successfully quit tobacco came forth on their own with their own strong desire and commitment to better personal health. This takes a lot of courage on behalf of the user, because although one may recognize the human toll of tobacco use, the addictive nature of the substance can often be foreboding. It is our hope that Sandia's tradition of providing a supportive work environment will encourage workgroups to extend the same to users and those with the desire to quit.

The human toll of tobacco use is not easily measured in health care dollars and productivity scales.

The physical and emotional distress of the user due to tobacco-related diseases and death cannot be entirely numerically calculated. We can, however, associate tobacco use with lost productivity, increased health care cost, disability, and absenteeism.

— Linda Duffy (3330)

Q: About the new Sandia smoke-free policy: we have government project sponsors (smokers) who visit routinely and who fund us millions of dollars per year to do work for their organizations. What accommodations will be made for them to smoke? Surely we do not expect them to go all day without doing so, given their addiction. Surely we do not think we can dictate to them whether they are smokers or not. Surely we want to continue receiving funding from them for our projects. How does the new policy apply to them since they are neither employees nor contractors, yet they certainly will be visiting Sandia space where smoking is now a policy violation?

A: To address your concern regarding your government project sponsors, it is doubtful that your organization's working relationship and funding is dependent on allowing visitors to smoke on the job. It would be more likely that funding and the selection of your organization would be based on the terms of the contract and the quality of the work your organization performs. However, your desire to be hospitable to your guests is understandable. But all Sandia visitors are subject to Sandia site policies regulating environmental safety and health and security. Sensitizing your sponsors of the new policy in advance of their next visit or in advance of March 1 will enable them to know what to expect on their next visit. Meeting sponsors are asked to inform attendees of the policy prior to their entry onto Sandia property. For more information about Sandia's Tobacco Free Workplace, you may go to www-irn.sandia.gov/tobaccoFree

If you have further questions, please ask at <http://hbe.sandia.gov>.

— Linda Duffy (3330)



AH, THE MAGIC OF SCIENCE — Liquid nitrogen freezes milk products into ice cream, its vapors providing excitement otherwise experienced only through Hollywood films and “haunted” houses on Halloween. The students here, from Bellehaven Elementary School, are participating in a “CSI”-type science lesson. (Photos by Randy Montoya)

Workshop on stolen dog interests students in science

‘CSI’ — or its techniques — comes to Sandia, thanks to a team of dedicated volunteers

By Neal Singer

Adults wonder how to get kids interested in science. One way, Tim Boyle (1815) and his volunteers have found, is to collect them in a room and accuse them of stealing your dog. You have their immediate, undivided attention. Then teach the students to use science to find who really did the deed.

While the approach is not systematic teaching but merely the arousal of interest in scientific techniques, it is still somewhat stunning to experience the effect achieved by Boyle’s group, one classroom at a time. There’s nothing grandiose about it. They won’t save the world and certainly won’t get rich. But Thursday morning two weeks ago, 25 fifth graders from Bellehaven Elementary School came into an impromptu classroom — the meeting room in the Advanced Materials



“I’M SOOO GLAD TO BE BACK” — Beaux, the Magic Chemistry Dog, ready for action after being released by his dognapper.

Laboratory on University Blvd. — sat down on the wall-to-wall rug, and learned that Tim’s dog Beaux — yes, Beaux the Magic Chemistry Dog — had been dognapped. And that Tim thinks one of the kids sitting in front of him took his pet. And Tim isn’t going to do the purported chemistry magic show until his dog is found.

Who’d do such a thing?

Of course it’s all in fun. The kids laugh and protest. They have their teacher Ms. Jewell and a few parents in the room for backup; they’re not scared.

Tim says he can’t believe any of the adults who work in the building would do such a thing. But wait, he says: He has a fingerprint he believes was left by the perpetrator. He challenges the kids to take a fingerprint test. Interested, they agree. Led by Tim’s assistant and event manager, post-doc Bernadette Hernandez-Sanchez (1815), the volunteer staff provide each kid a pencil to blacken a square on a piece of paper. The kids press their finger on the blackness, place a piece of Scotch tape over their fingertips, and press that tape onto another piece of paper. Presto, each child has created a fingerprint.

The game is afoot.

Tim and his assistants — drawn from a pool of more than 60 willing volunteers internal and external to Sandia — project images on a screen to show how to match one set to another — the whorls, the dips, and other patterns. Do any of the students’ prints resemble that of the perpetrator? No? Then who stole the dog?

And now the kids are off, involved in a game in which there is no competition to be best of show, as in science fairs, or the best at solving problems in a particular field for a competition. What they are going to experience — fully — and only — is using science to find the answer to a problem that interests them.

Why? “Fourth grade, fifth grade is where kids make their career choices,” Tim tells the *Lab News*. “They say, ‘Oh, I can’t do math or chemistry,’ and they’re gone forever. Here, at a crucial moment in their lives, they get a chance to see that science is useful and fun. And that they’re

good at it.”

For Galileo, it was inclined planes. For James Clerk Maxwell, it was wires, electricity, and magnetism. For Tim, it was fireworks and how they produced the varied colors of their displays. For these kids, still very young, Tim and his staff create an artificial interest, a la the TV program “CSI,” which uses intensive scientific investigation to solve crimes. Tim credits Bernadette, along with Sandia student intern Christina Baros (1815) and Saskia King (2701), for first creating a “CSI”-type program used by Sandia’s outreach MANOS program for middle school students, and then helping modify the program for elementary grades.

(Continued on page 9)



SHERLOCK HOLMES, STEP ASIDE — This young sleuth examines nylon fiber evidence left at the crime scene.