Not Your Average Household Ceramic

Ferroelectric Thin Films Could Revolutionize Computer Memories, Optoelectronics, and Communications

Imagine a car equipped with an infrared sensor that detects things humans can't see at night, such as an animal or person crossing a dark road, and alerts the driver in time to avoid a collision.

Or a transatlantic optical communication network that permits sub-nanosecond information transfer.

Or a computer memory that stores information in 10 nanoseconds — 10 billionths of a second (that's 10,000 times faster than most non-volatile memories in use today) — and can store and retrieve data 1 quadrillion times without wearing down. NASA might use such an inherently radiation-resistant memory on space vehicle instruments to prevent solar radiation from upsetting the memory capabilities.

These are just a few of the potential applications for ferroelectric thin films — high-tech ceramic materials that are now being developed at Sandia for a variety of new applications.

A computer with ferroelectric thin film memory might store data 10,000 times faster than at present.

The materials most commonly used to make ferroelectric thin films are a family of ceramics called PZT. The letters refer to lead oxide, zirconium oxide, and titanium oxide, respectively. These materials, and sometimes lanthanum oxide (PLZT), are combined in varying proportions to get different properties.

Four divisions currently pool their talents to accomplish the design, testing, and fabrication of the ferroelectric materials. Electronic Ceramics Div. 1842 focuses on the development of the ferroelectric film itself; Solid-State Component Processing Div. 7415 handles the photolithography and fabrication of test structures; Microelectronics Technology Div. 2144 handles most of the modeling and electrical testing and incorporates the materials into integrated circuits and memory systems; and Non-volatile Memory Products Div. 2173 handles

(Continued on Page Four)

TERRI ZENDER (1842), a chemist, examines lead acetate to be mixed in solution, part of the procedure for producing ferroelectric thin films. The materials are kept inside an airtight chamber called the Inert Atmosphere Glovebox. The chamber is filled with argon gas and prevents materials from being exposed to air.

LAB NEWS

VOL. 43, NO. 10 SANDIA NATIONAL LABORATORIES MAY 17, 1991

CLOWN AROUND with the Sandia Clowns — Pixie, Sparky, and Mitzie — at the Coronado Club's annual Memorial Day splash bash, Monday, May 27. The pool will be open from 11 a.m. to 6 p.m., and the clowns will perform magic tricks for the kids from 3 to 4 p.m. The clowns' real names are (left to right) Cindy Gregory (3521), Dwight Newell (3435), and Barbara Stacey (3522). Cindy founded the magical clown group three years ago. (Photo by Randy Montoya, 3162)

Valuing Differences

AT&T Speaker Benchmarks Sandia's Diversity Program

In the 1990s, the rapidly changing international economic order will require many US companies to do business on a global level — with diverse people from diverse cultures. That's just one reason for diversifying Sandia's work force, according to Terry Howard, Diversity Manager at AT&T's Corporate Headquarters. Howard spoke to Sandia managers May 3 about AT&T's corporate diversity program.

By hiring and promoting women, minorities, and people with disabilities, Howard said, we can better understand and appreciate people who are different. This requires vision and long-term commitment from top management, he emphasized.

"We are moving toward an era of 'let's do managing diversity right,' " said Howard, "as opposed to 'we must do Affirmative Action because the government requires it.' Corporations are realizing that there are tangible benefits of a corporate-wide managing-diversity program."

Among other advantages, he says, are hiring

(Continued on Page Five)

Narath's Testimony Before Senate Subcommittee — See Page Six

This & That

Good Words from "The Big Guy" – Not often do we reprint a complete text of any presentation, but we make an exception in this issue. Beginning on page six, you'll find Al Narath's complete May 9 testimony before the US Senate Armed Services Committee, Subcommittee on Strategic Forces and Nuclear Deterrence. It's evident that Al's both "right proud" of Sandia's accomplishments and concerned about the Labs' future. I think you'll find the reading well worth your time.

* * *

Research Carols – Several issues back, we credited a patent to Carol Ashby (1126) instead of to Carol Ashley (1846), as we should have done. We ran a correction in the following issue, and in the process found that we weren't the first to confuse the two Sandia research specialists. "Whenever I find strange and unfamiliar papers on my desk – pretty often – I just assume they belong to Carol Ashby," says Carol Ashley. Or was it Ashby who said that about Ashley?

* * *

Well into Our Cups – "No one is gonna pay seven bucks for a coffee mug," I said to retired LAB NEWS editor John Shunny when he first asked us to sell the Sandia cups in January. Well, John has had to reorder several times, and, at last count, we'd sold more than 700 of 'em. We now have a good supply (along with the popular Sandia caps and T-shirts), so come see us in the LAB NEWS office (Bldg. 814) if you're interested. Livermore folks can get these items from LAB NEWS correspondent Barry Schrader (8522). All "profit" goes to charitable organizations.

* * *

Search for World's Ugliest Tie – It's been said that men will discard a necktie only if they're *certain* it'll *never* come back into style. While vacationing in Texas several weeks ago, I wandered into a Goodwill store, and the rack of used ties there pretty much confirmed that. It also started me wondering just how bad a tie I could find, so I've decided to sponsor a "World's Ugliest Tie" contest.

Here's the deal: Any Sandian or contractor – man or woman – can enter a tie for the measly sum of one dollar. All money will go to the Sandia mug/T-shirt/cap charity fund. Bring your candidate tie and dollar to the LAB NEWS office by Friday, May 31. The LAB NEWS staff will judge the entries; we'll put the winner's picture (with tie) in the LAB NEWS and I'll take you to lunch and wear the winning tie when we go!

* * *

Which Way to the Bait Stand? – May is still fairly young, but I'm betting that I don't come across a better (worse) misspelling or typographical error this month than the one I saw in a recent Department of Game and Fish news release discussing fishing prospects at Elephant Butte Lake. The lake is known for producing some huge striped bass, often called "stripers." One sentence in the news release said the lake is full of "scrappy white bass and offers fishermen the chance to hook a *monster stripper* or catfish."

* * *

Favorite New Word – Only recently did I learn a new word (actually in Webster's) that aptly describes some behavior I've observed first-hand recently: "jackassery." Please remember that I only *observed* this behavior and was not a direct participant. I can't reveal the names of the participants or where I observed this behavior; let me just say that every Friday after work is a good time to observe it. •LP

Bray Responds to GAO Audit Reports

The following information was distributed in a May 7 memo from Executive VP Lee Bray (30) to all Sandians. The memo was distributed after several newspaper articles were published earlier this month about a Government Accounting Office (GAO) report done for the Governmental Affairs Committee of the US Senate. The report criticized DOE and the national weapon labs — Lawrence Livermore, Los Alamos, and Sandia — for not fully complying with regulations and procedures for determining whether contractors are subject to foreign interests and for preventing associated risks.

You have no doubt read in the press that the General Accounting Office has criticized the Department of Energy and the national laboratories, including Sandia, concerning classified subcontracting. These news stories stem from the GAO's audit of a DOE/laboratories program to control security threats that could be caused by foreign ownership, control, or influence (FOCI) of their subcontractors.

Contrary to the impression created by the press reports, we know of no instance, and the GAO points none out, in which Sandia or the DOE has done classified work with US companies that are unduly affected by foreign ownership, influence, or control. More importantly, we know of no instance, and the GAO points none out, in which Sandia or the DOE has allowed classified information to be transmitted to persons who do not possess the required security clearances.

The GAO report focuses primarily on the period from October 1987 through March 1990. Sandia and DOE, however, did not agree on procedures to implement FOCI requirements until July 1989. Until then, Sandia had been operating under a different set of implementing regulations, approved by DOE, that fully safeguarded classified contracts.

Sandia continues to work with the DOE to assure that proper controls are in effect to safeguard classified information, and we are assessing the recommendations made by the GAO. Processes incorporating these recommendations will evolve over the next few months. •

Congratulations

To Gigi and John (8354) Laroco, a son, Jonathan Covey, April 17.

To Julie and Dave (8454) Stimmel, a daughter, Larissa Joy, April 17.

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Supervisory Appointment

MIM JOHN to Manager of Systems Analysis Dept. 8110.

Mim joined Sandia at Livermore in 1978 after a year as a postdoctoral fellow under auspices of the Organization of American States at the Instituto de Investigaciones Electricas in Cuernavaca, Mexico. Her first assignment was in the Systems Studies Department, working in solar central receiver systems analysis. In 1981 she moved to the Applied Mechanics Department, where she worked on analytical modeling and experimental characterization of packed-bed chemical reactors for weapon applications.

MIM JOHN

She was promoted to Supervisor of the Analytical Thermal/Fluid Mechanics Division in December 1982. In February 1985 she became Supervisor of the Systems Research Division, where Strategic Defense Initiative system studies were emphasized. In December 1988 she became Supervisor of the newly formed W89/SRAM II Test and Evaluation Division.

Mim has a BS in chemistry from Rice, an MS in chemical engineering from Tulane, and a PhD in chemical engineering from Princeton.

Mim's outside interests include ethnic cooking, golf, and beachcombing. She and her husband Bill Wilson (8432) reside in Livermore.

Take Note

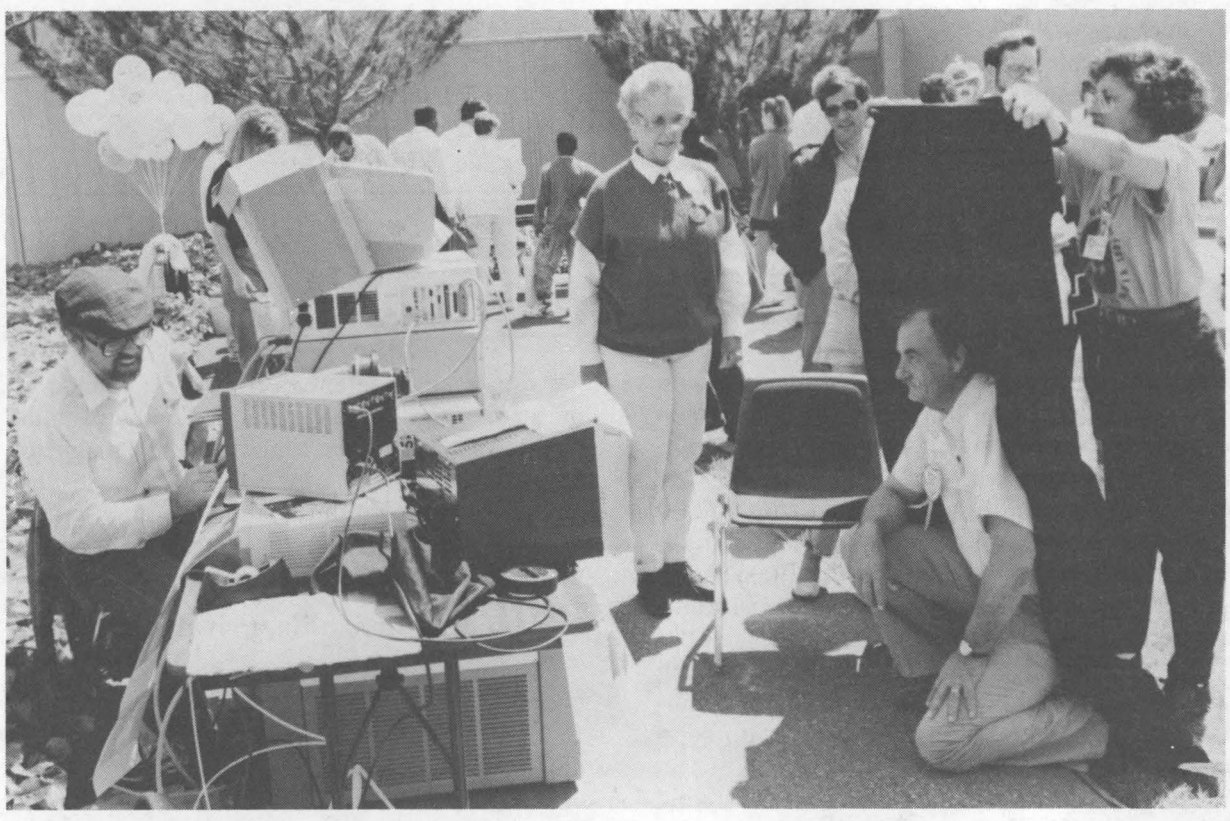
Heading the US Savings Bond drive this year at Sandia, Livermore is Al West (8431). All employees received a payroll deduction card through division canvassers within the last two weeks and should fill the card out and return it by today, even if there is no change from past years. Sandia overall had a 96-percent participation level last year, one of the highest in the nation for large work forces.

35th Anniversary Event

Thousands Enjoy Sunny Family Day at Livermore

MODEL OF ATOMIC STRUCTURE was set up in the Bldg. 916 Accelerator Lab as part of a display involving the analysis of surface structures. Art Pontau (8347, left) was one of the tour guides for that lab.

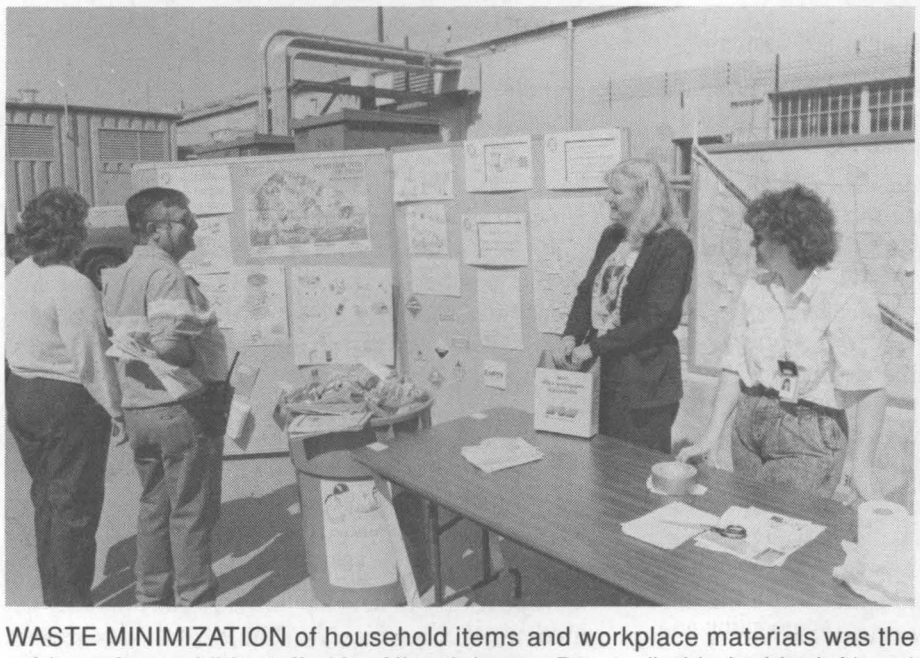
EXPLAINING B83 BOMB details in the Weapons Display tent was Gene Ives (8100, second from right). Here, Gene speaks to a VIP tour group of local officials and educators.



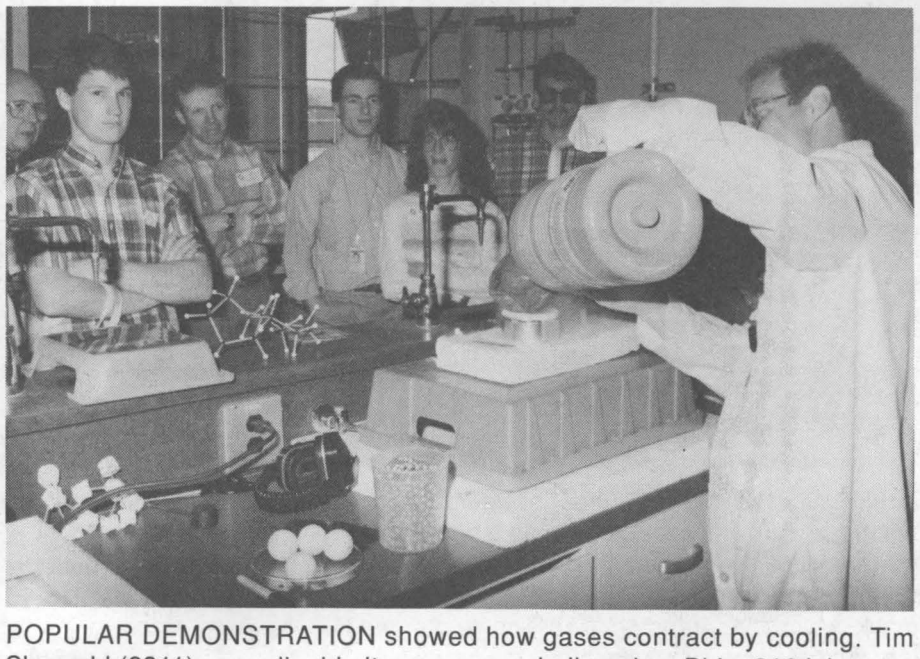
ELECTRONIC IMAGE processing was demonstrated in the Education Outreach area. Dave Chandler (8353) operates a CCD (charge-coupled device) camera and computer, producing thermal-paper printouts for folks who stopped to have their photos taken.

GREETING VISITORS to the Educational Outreach displays outside the Bldg. 904 auditorium were Smoky Bear and Sparky the Fire Dog. Another familiar figure at Family Day was Woodsy Owl.

SANDIA LIVERMORE NEWS



WASTE MINIMIZATION of household items and workplace materials was the subject of an exhibit staffed by Alice Johnson-Duarte (behind table, left) and Annie Andrade (both 8542) near Bldg. 913. Viewing the exhibit are Paul Dominguez (8531) and his wife, Bonnie.



POPULAR DEMONSTRATION showed how gases contract by cooling. Tim Shepodd (8311) pours liquid nitrogen over a balloon in a Bldg. 916 lab.

(Continued from Page One)

Thin Films

the design of high-performance memories.

"Most of these are emerging technologies that will be important in the future," says Bruce Bunker, Supervisor of Div. 1842. "They're not being used just yet, but we think they're on the cutting edge. Sandia is in on the ground level, conducting research to perfect such technologies and help maintain the status of the US as a technology leader."

Computer Memory Using Light

Ferroelectric materials have come a long way since Gene Haertling, now at Clemson University, and Cecil Land (ret.) developed the first transparent electro-optic ceramic, PLZT, and devices made with the material. PLZT was later used to design protective goggles for the military that darken instantly when exposed to a blinding flash of light. That patent went to Tom Cutchen (2560), Jim Harris (2553), George Laguna (2533), and Haertling.

The word ferroelectric refers to a crystalline structure that has a reorientable, spontaneous electric polarization. The application of an electric field causes atomic dipoles in the material to line up in one direction. Even after the field is removed, a remanent polarization remains, and the direction of this orientation corresponds to a 1 or a 0 in a computer's binary memory system, explains Bob Nasby (2144).

Such memories, called radiation-hardened non-volatile memories, are used in weapon systems, satellites, coded switches, and any other systems that need to maintain memory in the event of a power loss.

CINDY HERNANDEZ (1842), a chemist, squirts a small amount of solution onto a photoresist spinner, which turns at 3,000 rpm and distributes the film evenly across the surface of a photographically defined wafer.

Several microelectronics companies are interested in using this kind of memory in commercial and military applications. In fact, Sandia is working with Raytheon, Hughes Aircraft, Westinghouse, Radiant Technologies, National Semiconductor, and McDonnell Douglas to develop ferroelectric thin films that can be integrated into microelectronic devices.

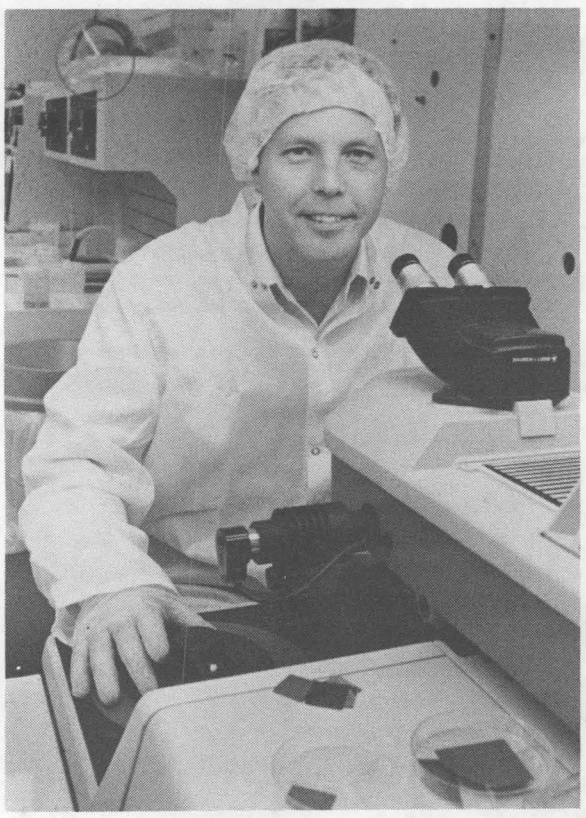
(Continued on Next Page)

Based on Sandia Technology

Albuquerque Firm Is Developing Optical Computer Memories

Just as massively parallel computers are making it possible to do more complicated calculations in a shorter time, desktop computers are also becoming capable of storing more and more information in a smaller amount of space.

Radiant Technologies, a home-grown Albuquerque firm that's working cooperatively with Sandia, reports that it expects in 18 months to have a working prototype of an optical computer storage disk that uses light instead of electricity and could conceivably store 10 trillion bits of information on a memory disk three to four inches wide.



JEFF BULLINGTON, cofounder of Radiant Technologies, uses an aligner to expose a photoresist pattern onto an integrated circuit. In the photolithography process, light is projected onto a mask, which then transfers a semiconductor pattern onto a silicon substrate, much the way a stencil transfers a pattern onto a piece of paper.

The disk is projected to handle 1 million operations without failing, compared with 10,000 operations for a typical magneto-optic disk. That means the optical disk would last much longer, says Jeff Bullington, cofounder of Radiant Technologies.

Unlike a typical magnetic hard disk, which uses a magnetic field in order to read and store information, the optical disk uses a laser diode to read and write data.

The disk itself is made of a thin-film ceramic known as PLZT. The letters stand for lead oxide, lanthanum oxide, zirconium oxide, and titanium oxide, respectively. One of its properties is that it is ferroelectric, meaning it has a spontaneous, reorientable electric polarization (see "Ferroelectric Thin Films," page one).

Optical Disks Have Several Advantages

A ferroelectric floppy disk the size of a typical back-up disk in a desktop computer could have a storage capacity of 20 to 50 megabytes, compared with less than 1 megabyte (or about 750 kilobits) in those commonly used today. A ferroelectric hard disk — the permanent memory disk inside the computer — has a capacity of 500 megabytes, or half a gigabyte, notes Bullington.

The ferroelectric disk is also more temperature-resistant. A typical magneto-optic disk generally loses memory at about 34 degrees C (100 degrees F), but a ferroelectric optical disk could withstand temperatures of 300 degrees C (570 degrees F), he adds. This critical temperature is known as the Curie point, at which the atomic structure of the material changes, causing it to lose its ferroelectric properties, and along with that, its memory.

A ferroelectric disk requires a lot less optical energy than a magneto-optic disk — about 1 watt per square centimeter of surface area to change the state of the stored data, compared with about 50 kilowatts per square centimeter for a magneto-optic disk. At that energy level, laser diodes last only about three months and then must be replaced. The higher-energy lasers also generate more heat, accelerating disk deterioration.

Teaming with Sandia, Private Industry

Radiant is now teaming with Sandia's Electronic Ceramics Div. 1842 to develop government-sponsored military or space applications for the optical disks. Radiant holds two patents for two different optical disks; Sandia holds another one for a disk designed by Cecil Land (ret.).

Radiant has already supplied Sandia with ferroelectric thin-film samples for characterization, and the firm has contracted to help Sandians produce them. While Sandia has more of a materials research background and is better able to understand the films in a classical, scientific sense, Radiant's expertise is in manufacturing and electronic engineering.

"Sandia's technical staff has been very supportive of new development," notes Bullington, "and generally, whenever we work with the Electronic Ceramics Division or people in the microelectronics groups, we find that we have device developmental capabilities that Sandians would like to have. Meanwhile, Sandia has materials characterization and analysis capabilities that a small company like ours could never hope to have."

Radiant is also teaming together with some industrial partners to develop commercial applications for the disks, says Bullington.

Radiant is an offshoot of Krysalis Inc., a company founded by Bullington and his business partner, Joe Evans, to develop ferroelectric, non-volatile memories. Krysalis left Albuquerque for the San Francisco Bay area, while Bullington and Evans stayed behind and founded Radiant. •LD

(Continued from Preceding Page)

Another property of ferroelectric films is they are electro-optic. The electric field changes the index of refraction, which determines how fast light travels through the film. (This is the principle behind the goggles that protect against the eye-damaging flash of a nuclear explosion.)

Ferroelectric films could thus be used in optical modulators to create circuits that send 1's or 0's corresponding to whether light waves passing through the film are in phase or out of phase. (When light waves are in phase, they add to one another, like small ocean waves combining to form a big one. When they are out of phase, they interfere with and neutralize each another, so that little or no light is emitted.)

One area of promise for such technology is optical computing. Sandia is currently working with Radiant Technologies, an Albuquerque firm, to develop optical storage disks that store high-density information using light to send impulses instead of electricity (see "Albuquerque Firm Is Developing," page four). Theoretically, the amount of area needed to store one bit of data would be 1 micron square, producing an astronomical storage capacity of about 10 trillion bits of information on a computer disk 3 or 4 inches wide.

Another potential application of this property is in optical communications. Ferroelectric films could be integrated into fiber-optic communication systems to manipulate optical signals and send light wherever it is needed.

Pyroelectric Infrared Detectors

One of the newest applications of ferroelectric thin films is the development of pyroelectric infrared detectors. Just as the polarization changes when the film is exposed to an electric field, it also changes as a function of temperature. If infrared radiation (heat) increases, the polarization drops, causing a charge release; if it gets colder, the charge on the electrodes of the ferroelectric thin film increases.

By placing a mechanical "chopper" between the detector and an infrared source, engineers can generate an alternating (AC) current, explains Bruce Tuttle (1842). Normally, the current remains constant, based on the amount of ambient heat present in the environment. But if another source of heat, such as a person crossing the field of vision, suddenly alters the incident radiation, the polarization decreases and the charge drops.

The automotive industry is interested in applying this technology to night driving. General Motors is working on an infrared detector to be mounted outside a car and linked to a monitor inside the vehicle, says Bruce Tuttle (1842).

Sandia is studying the potential for using pyroelectric sensors in weapon systems. They can be used in night vision scopes on rifles or night vision systems on aircraft. Though the development of pyroelectric films is still in the research stage, one of their advantages is that they operate at room temperature.They are also cheap and lightweight, making them ideal for portable instruments such as gun sights, he adds.

How Thin Films Are Made

Thin films are prepared using sol-gel techniques. To make the films, a substrate, such as a silicon wafer, is coated with a solution that dries to form a thin gel layer on the surface. This is heat-treated to make the gel crystallize into a ceramic. Today, this can be done at the relatively low temperature of 600 degrees C, just low enough to keep from destroying the underlying microelectronics.

Sandia did not invent ferroelectric thin films, but has been a leader in the development of electro-optic materials for 30 to 35 years, notes Bruce Bunker. •LD

(Continued from Page One)

Diversity

the best talents available, improving productivity and job satisfaction, and utilizing the skills of all people (not just those often referred to as "protected"). "A diverse work force enriches people's jobs," said Howard.

Diversity at AT&T

At AT&T, he said, managing diversity means creating and sustaining an environment where everyone can achieve his or her full potential, regardless of differences. AT&T's diversity program tries to manage these differences through support from upper management and diversity initiatives at the division level.

Some differences, called "core dimensions," are immutable, meaning they can't be changed: age, color, disability, gender, national origin, physical characteristics, and race. Most core dimensions are protected by law.

Other differences can be barriers to productivity. Overcoming such barriers requires flexibility on the part of the manager and the employee. One example, said Howard, is the single parent whose job requires travel. The employee must balance family and work responsibilities, and the manager must respect the employee's need for flexibility.

AT&T's managing-diversity strategy includes director-level management representation coupled with a diversity team made up of managers from AT&T's regional offices. Full-time staff members and consultants are responsible for a number of initiatives at both the corporate and division level. These include traditional recruiting programs as well as training for employees and career advisement for women and minorities.

Howard said AT&T's diversity team is continually benchmarking its progress with other leading-edge companies that have diversity programs, as well as performing cultural audits to determine how people at AT&T think in regard to women and minorities.

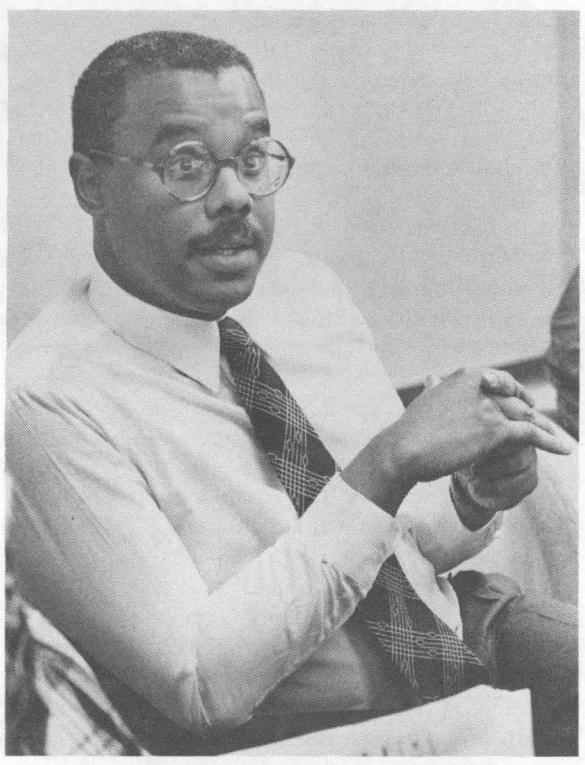
Diversity at Sandia

Julia Gabaldon, Supervisor of Equal Employment Opportunity and Affirmative Action Div. 3511, says respect for the individual, one of Sandia's corporate values, is precisely what Sandia's diversity program is all about. "We're not just counting numbers," she says. "We are preparing for a more competitive future by planning a formal strategy for diversity."

This strategy could include development of diversity panels made up of non-management employees who serve as diversity representatives for each directorate and who provide some measure of management accountability.

In 1988 the Labs formed an Affirmative Action Council. Its membership includes Dan Hartley (5, chair), Venky Narayanamurti (1000), Ralph Bonner (3500), Heinz Schmitt (5000), Joan Woodard (6600), and John Crawford (8000). Six outreach committees, including the new "La Mujer Hispaña" subcommittee of the Hispanic Leadership and Outreach Committee, are now doing "inreach" as part of the Labs diversity strategy. Inreach identifies and responds to the needs of females and minorities who work for Sandia. The goal is to help break down cultural-difference barriers. (A future LAB NEWS article will discuss the six outreach/inreach committees and how Sandians can get involved.)

"Corporations are realizing that there are tangible benefits of a corporate-wide managing-diversity program."



"WE ARE MOVING toward an era of 'let's do managing diversity right,' " — Terry Howard, Diversity Manager at AT&T's Corporate Headquarters. Howard spoke to Sandia management May 3 about AT&T's corporate diversity program.

Sandia is now offering a $1\frac{1}{2}$-day course about managing cultural differences effectively. The course, which deals with attitudes and belief systems, is offered to all Sandia managers, says Julia.

Guests from other corporations will speak to Sandia managers at several Diversity colloquia in the coming months to benchmark where the Labs' diversity program stands. UNM President Richard Peck will speak June 17 in the Technology Transfer Center about cultural diversity at UNM. Future Diversity speakers will be announced in the *Weekly Bulletin*. •JG

Paper Recycling to Expand

Recycling Update

Sandians are invited to find out more about recycling at an informational program June 3 at 10 a.m. at the Tech Transfer Center, Bldg. 825.

The program will help kick off the gradual expansion of Sandia's wastepaper recycling program. Individuals wishing to start a wastepaper recycling program in their building are encouraged to attend. Look for more information in the May 31 LAB NEWS.

Other recycling notes:

- In the first eight months of paper recycling at Sandia, 100,820 pounds of recyclable paper was collected — a savings to the environment of 857 trees, 212,000 kilowatt-hours of electricity, and 353,000 gallons of water.
- The cafeteria is now offering plastic mugs for sale that can be refilled with soft drinks for a small charge. This saves the non-recyclable drinking cups from going to the landfill.
- The LAB NEWS is recyclable and can be mixed with recyclable office paper — not with newsprint.
- Shoppers who want to complete the recycling circle can buy products with the recycled symbol. •

Take Note

May is "Better Speech and Hearing Month." The New Mexico Speech and Hearing Association is sponsoring a Speech and Hearing Fair Saturday, May 18, from 10 a.m. to 7 p.m. at Coronado Shopping Center. Purpose of the fair is to make the public aware of speech and hearing disorders and where to get help and support. Participants include private practitioners, clinics, hospitals, and support groups. Entertainment will be offered throughout the day.

Al Narath's Testimony Before Senate Subcommittee

Following is the text of Sandia President Al Narath's May 9 testimony before the Subcommittee on Strategic Forces and Nuclear Deterrence of the US Senate Armed Services Committee. This is the complete text, with the exception of five supporting figures (and references to those figures) that could not be reproduced in the LAB NEWS.

Chairman Exon, distinguished members of the Committee, thank you for this opportunity to speak with you.

When I appeared before this Committee last year, I touched on the tradition of excellence which has grown under our AT&T operating contract. The roots of this tradition lie in our Bell Laboratories' heritage, our adoption of best management practices based on the AT&T pattern, and our commitment to our historic partnership with DOE to provide real solutions to meet vital national needs.

The fundamental national need which defines our mission is the need for a strong, flexible, and enduring nuclear deterrent. Meeting the operational and surety requirements of the stockpile within the constraints imposed by changing world events and the nation's response to them constitutes our greatest challenge. It is both the primary focus of our technical expertise and the principal source of the Labs' technology base.

Significant Results This Year

The application of our technology base in the area of nuclear weapon surety has produced significant results in the past year. I would like to share with you several of these advances that are particularly relevant to issues before this Committee. We believe that these developments give evidence of real progress in our role as the coordinating laboratory for nuclear weapon safety assessments and as the laboratory responsible for the weaponization of nuclear explosives — a role that brings with it a major responsibility in nuclear weapon-system surety.

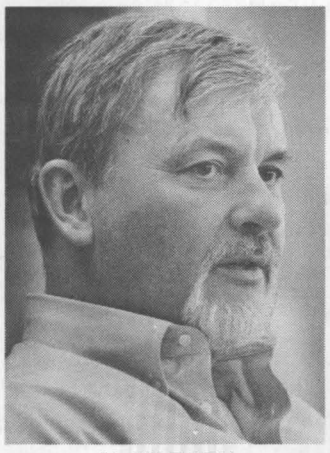
In the area of nuclear weapon safety, we are applying Sandia's state-of-the-art capability in computational engineering to examine the potential interaction of warhead high explosives and exploding rocket motor propellant. This work is being conducted under the auspices of the Navy Project Officer's Group as related to the W88. This analysis required the application of 3-D mechanical response codes developed at Sandia.

We have broken new ground in the application of probabilistic risk assessment (PRA) to safety analyses for nuclear weapon systems. Sandia began the development and application of PRA to nuclear power systems for the Nuclear Regulatory Commission in the mid-70s. The technique has been used successfully to analyze safety aspects of nuclear power reactors and to evaluate proposed design innovations. Recently, we completed a nine-month study which confirmed the feasibility of applying PRA to the safety evaluation of nuclear weapon systems. We have now embarked on a plan for applying PRA to the nuclear weapon design and weapon system evaluation processes. Our first applications of PRA are assisting us in improving the design of electrical systems that will be more tolerant of severe accident environments.

New Laser-Based Firing System

We have also completed the development of a laser explosive initiation system for controlling and initiating various weapon functions. We are ready to commit this technology to specific weapon systems. The significance of a laser-based firing system lies in the virtual impossibility of introducing the optical signal to the detonator from any accidental source. Coupled with this factor is the relative ease with which unintended optical signals can be blocked or scattered harmlessly outside of the exclusion region. In contrast, it is a significant engineering challenge in electrical detonation systems to block natural and manmade electrical signals from unintended coupling or penetration into the sensitive region of the electrical system.

In the use-control area of nuclear weapon surety — a topic which rivals safety in importance — Sandia's responsibilities are both broad and technically demanding. As you recall, Sandia pioneered the development of Permissive Action Links (PAL) which greatly enhance use control. We have continued to enhance the effectiveness of weapon use control features while also improving operational flexibility. For example, we recently began using a new generation of PALs, the Code Activated Processor or CAP. CAP increases the peacetime security of nuclear release codes by use of new encryption techniques. CAP makes the first use in coded switch applications of radiation hardened, non-volatile microcircuit memories. Additional operational flexibility accrues from this device by allowing, for example, the recode of an entire aircraft ordnance load from a single point. The first use of CAP will be in W89 warheads for SRAM-II [Short Range Attack Missile II]. CAP is the first of a new family of PAL devices that will be used on all future nuclear weapon systems requiring warhead coded control.



AL NARATH

Sandia is also DOE's lead laboratory for developing safe and secure transportation systems and secure manufacturing and storage facilities for nuclear weapons. The technology base which this program has nurtured has now been applied very widely to serve security technology needs in the DOE, the Department of Defense, the FAA, the Department of State, the NRC, and a number of other government agencies. Current examples of our work in this area include security system upgrades at the Savannah River Site and the Portsmouth Gaseous Diffusion Plant. Much of our work in this area in recent years has focused on designing security systems which rely on the integration of commercially available components to achieve extremely high levels of performance.

Turning to the composition of the stockpile, I must observe that the future is clouded by international developments and budgetary constraints. I would like to draw your attention in particular to one of our current Phase 3 weapon systems. The SRAM T [Tactical] is the only theater nuclear modernization effort in the US. The decision to terminate the other, ground-based tactical nuclear development programs was premised on continuing SRAM T development because of its added safety, flexibility, and capability. SRAM T is a central part of our stockpile improvement effort to ensure a credible deterrent. SRAM T will constitute a significant portion of the total tactical stockpile at the turn of the century, and will incorporate the most modern safety features consistent with the Drell panel recommendations. All theater nuclear CINCs [commanders in chief] have a validated requirement for SRAM T.

"SRAM T will constitute a significant portion of the total tactical stockpile at the turn of the century."

Important to Deterrent Strategy

SRAM T is important to NATO's new, evolving nuclear deterrent strategy. The Heads-of-State London Declaration (July 1990) calls for "an appropriate mix of conventional and nuclear systems, based in Europe, and kept up to date where necessary." This strategy will stress the need for flexible nuclear forces that can hold at risk both the homeland and the military forces of an aggressor nation. As ground forces are reduced, NATO dual capable aircraft (capable of delivering both conventional and nuclear weapons) must carry the weight of a credible deterrence by being able to respond to any potential threat. Both US and NATO aircraft forces are being reduced. Aircraft remaining after these reductions must have maximum flexibility and capability. SRAM T provides the needed flexibility and capability. It extends range, responsiveness, survivability, and effectiveness by tailoring flight profiles and warhead effects to limit collateral damage.

The nuclear weapons complex of the Department of Energy has also crossed the threshold of a new era of change. At Sandia, we are playing a significant role in helping to shape and implement DOE's vision of the future of the complex. I have described to you some of the exciting technical developments occurring in the areas where Sandia carries principal responsibility for DOE/Defense Programs. We will need continuing support, however, for the development of fundamental new concepts in surety and other aspects of design to address the new demands within the constraints that we are led to expect. These constraints include, in addition to our surety goals, cost of production and maintenance, waste minimization, stockpile life, and reliability. An approach which shows great promise but also will need sustained support for technical development is the concept of modularity.

Modularity is an extrapolation of the concepts of standardization and reuse toward the goal of matching a given nuclear explosive subsystem with any one of a number of non-nuclear ordnance subsystems. The idea is to maximize reuse by designing it into the stockpile by intent, and to maximize flexibility by standardizing interfaces between nuclear weapon subsystems. The ultimate in modularity would be a stockpile which consisted of a minimum number of nuclear explosive subsystems with non-nuclear ordnance modules.

Future Priority Requirement?

Let me cite an example where a degree of modularity has already been achieved. The B61 is a strategic air-delivered weapon system, developed jointly by Los Alamos and Sandia, that has been in the stockpile since 1968. In the mid-70s, Sandia carried out an advanced development project that demonstrated the feasibility of designing a new nose and a rocket-motor tail for the B61 that would have the effect of transforming it into an air-to-surface standoff weapon. More recently, the W61 project has demonstrated the feasibility of building an earth-penetrating weapon with many components and subsystems in common with the B61. When the Laboratories designed the original B61, there was no intent to create a modular weapon family. Deliberate modularity would allow field changes from one configuration to another, something we cannot achieve with the B61. Nevertheless, if the future stockpile is to shrink in size and cost, but still be capable of providing deterrence against a rapidly changing threat, modularity may become a priority requirement.

The higher into integrated subsystems we can carry the modularity principle, the greater will be the savings. The potential for greater savings from large-scale modularity is clear. In order to achieve higher levels of modularity in the future stockpile, we need priority application of R&D resources now.

Nuclear testing is a second area where current trends and future requirements demand a creative response from the weapon laboratories. Our sister labs have frequently pointed to the decline in the rate of underground testing as a major problem. To understand the trends in nuclear testing, we need to include in our frame of reference weapons effects testing. Both underground testing (UGT) and aboveground testing (AGT) are needed for this purpose.

AGT and UGT work together to establish system design reliability, to determine system response to weapon effects, and to develop new weapon system components. AGT makes the infrequent underground effects tests more efficient and cost effective. For example, Sandia conducted most of the development testing for the Mark 5 arming, fuzing, and firing (AF&F) system using AGT. We were very successful with this approach to subsystem development since no hardware failures were encountered in full system UGT exposures of the Mark 5 AF&F.

Currently, we perform all neutron effects testing using AGT, and we are rapidly moving to all AGT for gamma ray testing using Sandia's Hermes III accelerator. We need to consider an appropriate balance between UGT and AGT in order to establish the mix and levels of support in nuclear effects testing that will be needed for future stockpile programs. The bad news is that the entire program of UGT and AGT is under severe budgetary pressure, with a decline in real dollar support of over 22 percent between 1987 and 1991. Given this kind of sustained pressure, it will be impos-

sible to continue the technical advances which have permitted us to increase the use of less expensive AGT in preference to UGT. If we are to compensate for any further reductions in the rate of underground effects tests, we need to place increased emphasis on AGT, not a long term decline.

Increasing Commercial Role

A further point about the future of the weapons complex: I refer to the . . . components in the Sandia portion of the design which come from sources outside the weapons complex production agencies (i.e., commercial parts). Sandia already has in place an extensive network of relationships with commercial suppliers, with emphasis on design definition and specification. The Nuclear Weapons Complex Reconfiguration Study, which the Secretary of Energy released in January of this year, calls for increased

"The Nuclear Weapons Complex Reconfiguration Study . . . calls for increased privatization of the weapons production complex."

privatization of the weapons production complex. Privatization will proceed according to two models: Manufacturing Development Engineering (MDE), in which Sandia will work directly with industrial suppliers, and Manufacturing Development Center, in which Sandia will team with one of the weapons complex production agencies to increase utilization of commercial component sources. Sandia is working closely with the DOE/Albuquerque Operations Office to explore the MDE model.

We have also begun an internal consolidation program at Sandia as a way to achieve cost savings in the long term. As a first step in our internal consolidation program, we are moving all of our supercomputing hardware to a single location and developing high speed, secure communication to serve the needs of our personnel at sites remote from the central computing center. Simultaneously, we are expediting the transition to massively parallel computer architectures, an area where both industry and government experts have acknowledged Sandia's world-class leadership.

Tech Base Makes Progress Possible

This summary of the status of work in the area of our core mission would be incomplete without further reference to the technology base at Sandia that makes our continued progress possible. This technology base has served the nation well. It can continue to meet critical national needs so long as the Congress and the Administration recognize the capability, support and nurture the continued strength of the resource, and use it well.

I alluded earlier to the contribution which our computational engineering expertise has made to the safety analyses of the W88 warhead. This expertise rests on our leadership in the application of the massively parallel computer architecture known as multiple instruction-multiple data (MIMD). I won't try to describe the details of the MIMD architecture, but only note that our work with MIMD machines was the key to our research that, as Don Austin, Executive Director of the Army High Performance Computing Research Center, put it, "redefined the nature of parallel speed-up now accepted by most of the world in high performance computing." Speed-up, running much larger, more complex computer codes in a given time on a parallel architecture than is possible on the traditional vector supercomputer, is what made it possible for us to solve pattern recognition problems in a timely manner in support of Desert Storm. These calculations, performed only at Sandia, were so complex that they could not have been accomplished in time for military use by any other means. An even more recent example was the achievement of a speed-up by a factor of 53 in the performance of the thermal transport code used to perform calculations critical to nuclear waste depository development and for reactor safety calculations.

Proud of Work in Intelligent Machines

Our technology base in advanced manufacturing is another area where recent advances promise a high return on the nation's investment in Sandia. I am particularly proud of our work in intelligent machines. For example, our work in edge finishing and in automatically programmed machines permits robotic applications for the first time in the high quality, custom manufacturing arena where the US is still a world leader. When we talk about robotics, attention always turns to Japan. The Japanese have proposed an international Intelligent Manufacturing Systems (IMS) initiative. On the technical front, the Japanese proposal contains many elements, most of which are aimed at making design and production processes more flexible, more applicable to small-lot manufacturing, and more capable of high quality output. Sandia is already developing these capabilities for the DOE production complex, and we are moving this technology into US industry as fast as they are able to absorb it. Sandia has developed techniques by which industrial robots can be used to do light machining on precision metal parts. This technology allows parts to be finished much faster — by a factor of 100 — than current state-of-the-art practices.

Robotics applications go beyond the manufacturing arena and include such areas as waste management and weapon dismantlement. Sandia's advances in automatic planning and programming have been incorporated into a robot for use in storage vaults at Pantex that reduces worker radiation exposure by a factor of 30. Clyde Frank, Director of the DOE technology development office for Environmental Restoration and Waste Management (DOE/EM), calls Sandia "the hub of DOE's expertise in robotics."

USS Iowa Work Shows Breadth

Sandia continues to maintain and apply a breadth of engineering expertise and systems engineering experience that is at the forefront. Late last year, we were able to respond successfully to requests from this Committee that we study technical aspects of the tragic incident aboard the battleship *USS Iowa*. That work drew on resources from across the laboratory, including materials specialists, safety analysts, explosives experts, and many other disciplines. It also required state-of-the-art facilities ranging from supercomputers to explosives testing facilities. The same kind of breadth is evident in programs like our treaty verification work. The Sandia program is the largest single program for the nation to draw on for technology that may be critical in this period. The breadth of our treaty verification technology program includes nuclear and non-nuclear weapons, sensors, tagging techniques, encryption techniques, pattern recognition, and command and control for information flow. Current developments include delivery later this month of the first Designated Seismic Station familiarization unit to the On-Site Inspection Agency.

Using Sandia technology to the maximum benefit of the nation means looking beyond government programs to the private sector of our economy. It means to us that we will take advantage of every opportunity to make our work more relevant to US industry needs and to move aggressively to transfer our technology to industry.

Collaboration with Industry

Sandia has entered into a number of collaborative projects with private industry. These projects — and more are being negotiated — promise to enhance the competitive position of the participating companies as well as improve the technology available for national security applications. I would like to share with you a few details of three of these projects.

(1) Sandia is teaming with four members of the National Center for Manufacturing Sciences (NCMS) Consortium — AT&T, Texas Instruments, DEC, and Hamilton Standard — to develop a more consistent epoxy glass material with improved mechanical characteristics for printed wiring boards. This development will improve system reliability of electronic components. Industry will benefit by increasing the quality of its products as compared to foreign electronic products. The government will benefit by having access to an improved technology and in some cases, to improved commercially available products.

(2) Sandia has teamed with SEMATECH in establishing the Semiconductor Equipment Technology Center (SETEC) to improve tool designs for semiconductor manufacturing equipment. This partnership will improve reliability of operations and lead to more reliable US manufactured semiconductors. As with the NCMS agreement, this partnership will also lead to improved reliability of weapon systems.

(3) Sandia is working with 11 US companies that have formed the Specialty Metals Processing Consortium (SMPC). Though the specialty metals industry itself is small, its products are critical to American competitiveness in areas ranging from microelectronics to airplanes and are vital to national security. Only about three dozen US companies develop and manufacture specialty metals — high strength, high performance, sometimes lightweight metals. These metals are used in jet engines, satellites, chemical plants, valves and pipes in nuclear reactors, and similar vital applications, including defense hardware that must work reliably after years in stockpile. Any country that must import the basic materials for such products is at a severe disadvantage. The government will gain from this teamwork by having access to high performance aerospace alloys that are required for next generation jet engines and other demanding applications.

Increases Leverage of R&D Investment

Each of these arrangements with US industry is an example of the "dual use" concept. Dual use is a way to increase the leverage of federal, as well as industrial, R&D investments for the mutual benefit of both defense and civilian sectors of the economy. Many of the DOE and DoD critical technologies also appear on the Department of Commerce critical technologies list and are therefore of vital interest to US industry. Technologies that simultaneously serve defense and commercial needs can be more cost effective from an R&D investment standpoint than those serving a single class of user. At Sandia, we are convinced that the pursuit of dual use — or even multiple use — technologies can be a mechanism for sustaining our core competencies that serve the nuclear weapons program in the face of constrained funding.

Impacts of Budget Cuts

It is always a pleasure to share some of Sandia's technical and programmatic accomplishments, and I thank you for giving me that opportunity today. Although it is less pleasant, it is even more important

". . . serious effects on our technology base that are resulting from the recent and projected decline in funding. . ."

that I also share with you the serious effects on our technology base that are resulting from the recent and projected decline in funding for the nuclear weapons RDT&E [research, development, test, and evaluation] program.

The severity of the constraints of the FY92 budget appear to mandate a further downsizing of the Laboratory professional staff committed to the nuclear weapons RDT&E program. I estimate that the Sandia share in these reductions will be approximately 200 persons. The impact of such a sizable reduction cannot be absorbed without reducing the flow of ideas, technologies, and program achievement in areas critical to the national interest.

I referred earlier to the decline in funding we have experienced for nuclear testing, including aboveground testing. The testing program projects a loss of 20 persons in FY92. Our capability to continue our leading-edge performance in massively parallel computing will be impaired. Our investment in LDRD [Laboratory-directed research and development] is already substantially below what we think is appropriate, because we are so tightly strapped for resources to meet our near-term mission responsibilities.

A wealth of creative ideas which constitute perhaps the real long-term payoff for the nation from its investment in the national laboratories cannot be pursued if we are to continue to meet core mission deliverables on a shrinking budget. Indeed, we face in FY92 and the outyears an era of transition in doctrine, stockpile requirements, surety goals, and technical upheaval with a shrinking resource to apply to these demands. This era will be a window of opportunity for fundamental change at the same time that it poses difficult challenges to the weapons labs and the nation we serve. Unless the weapons labs are in a posture to respond aggressively to those challenges, the maintenance of a robust, flexible deterrent will be difficult to guarantee. ●

A Letter to Sandians

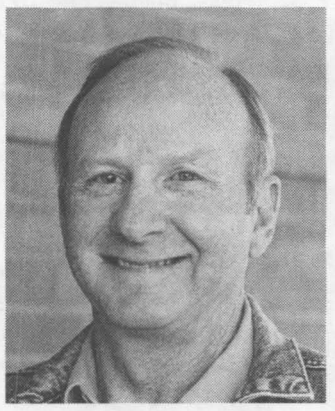
Tiger Team Leader Writes about Conduct of Operations

In this letter to the entire Sandia community, Tiger Team Leader Dave Spence explains why he believes Conduct of Operations is a vital management concept with applications independent of the discipline — technical or administrative — to which it is being applied.

He has been serving as assistant project manager for operations and maintenance at the Department of Energy's Strategic Petroleum Reserve (SPR), headquartered in New Orleans. When he turns in his Tiger stripes, Spence will begin a new assignment as assistant manager for engineering and projects at DOE's Savannah River Operations Office in Aiken, S.C.

Dear Sandians:

Conduct of Operations is sweeping across DOE faster than wildfire through a Louisiana cane field. I learned why while at one of the first weeklong training sessions (July 1990) offered on the subject by DOE. Simply put, the principles made a lot of sense to me, and I knew that they could and should be applied to operations within my area of responsibility on the Strategic Petroleum Reserve.



DAVE SPENCE

Many Conduct of Operations elements already exist at Sandia, as evidenced by your many successes of the past several decades. DOE's Conduct of Operations Order (See "What Is Conduct Of Operations?") simply collects all of those elements and presents them under one cover to increase formality and discipline with which various operations are conducted (See "Applying Conduct of Operations to Your Job").

Although the Order is new (July 9, 1990), Sandia has already prototyped its application in 20 organizations, and I'm told that you will begin Labs-wide implementation — on a graded approach based on risk — in the near future. That's both practical and cost-effective.

I wish I'd been a Conduct of Operations convert earlier in my career at the SPR. Here's one reason why. Several years ago, an operator noted a measurable drop in pressure and similar increase in flow while disposing of brine by pumping it through a pipeline into the Gulf of Mexico. The pressure drop and flow increase suggested a pipeline leak. Because we weren't very experienced then with changing operating parameters, we permitted the brine disposal system to continue operating for about 12 hours after the pressure drop was observed. Only then did we conduct a dye test with fresh water. It revealed a leak about eight miles from the pumping site, in a fresh-water inlet. No significant environmental damage occurred, but the incident resulted in an unpermitted discharge of about 675,000 barrels of brine into the fresh-water inlet.

Our decision to continue operating the brine disposal system violated a primary principle of operation: "Believe your indication (instrumentation) unless it is confirmed to be in error." If Conduct of Operations had been in place, we would have shut down immediately after the pressure and flow changes were seen and maintained that state until the condition of the pipeline was confirmed.

In March of this year, the nuclear power plant at Kansai, Japan, released radioactive steam into the environment for 52 minutes. For 50 of those minutes, engineers kept operating while they debated how they should react to instrumentation that indicated the release was occurring. Again, with proper use of Conduct of Operations, these operators would have believed their instrumentation and taken prompt, conservative actions based on available data.

Another example: the Hubble Space Telescope. As this expensive device's 2.4-meter primary mirror was being polished in 1980 and 1981, an unrecognized 1-millimeter error in the device used to check the process caused technicians to give the mirror an exquisitely smooth surface (good) but a grossly inaccurate shape (very bad). As a result, Hubble generates disappointingly fuzzy pictures.

This needless mistake, which greatly diminished the scientific value of a national space science resource, would have been avoided with an in-place Conduct of Operations program because technicians could not have ignored — as they did — worrisome and suggestive data from the one independent test they performed.

And finally, a recent article in the *Wall Street Journal* discussed a worker fatality at a Midwest meat-packing plant. The worker entered a hide-cleaning machine that had its electric power turned off, but not locked out. Not realizing that the machine was out of service, someone else turned on the power, resulting in the fatality. A proper lock-out/tag-out procedure — a Conduct of Operations key — would have saved the worker's life.

My dad once advised me, "Son, try to learn by other people's mistakes; you can't live long enough to make them all yourself." A good way to use this advice is to review all incident reports that apply to your facility or operation. This is an excellent way of learning from other's mistakes.

In closing, it's my hope that Conduct of Operations principles make sense to you and that you truly see how they can help you to do your job better, safer, and more efficiently.

Sincerely,

David R. Spence

What Is Conduct Of Operations?

Conduct of operations is a disciplined approach to facility, system, and equipment operations under which all DOE facilities have been directed to operate. Many of its key principles are equally applicable to non-hardware functions and operations.

For a refresher course, review the "attachment" section of Tiger Team Appraisals, a booklet distributed to all employees and on-site contractors earlier this year. It lists good principles of operation that were developed by George Toto, a Conduct of Operations founding father and past Tiger Team leader.

DOE's Conduct of Operations requirements are derived from "Guidelines for the Conduct of Operations at Nuclear Power Stations," developed by the Institute of Nuclear Power Operations (INPO) after the Three-Mile Island Nuclear Power Station incident in 1978. Most experts believe that this incident would not have occurred if current guidelines had been followed.

Applying Conduct Of Operations to Your Job

No matter where you work at Sandia, Dave Spence believes that Conduct of Operations principles can help you achieve consistent results that meet or exceed expectations by ensuring that you:

- Have a thorough understanding of all requirements,
- Have a set of implementing instructions or procedures that define step-by-step how to meet those requirements, and
- Guarantee mindful compliance with procedures or instructions in order to achieve expected results and process repeatability.

Congratulations

To Terry and Richard (1141) Blake, a daughter, Caitlyn Nicole, April 20.

To Lydia and Ned (6224) Adams, a daughter, Lela Erina, April 23.

TIME TO PLANT THE SQUASH — A construction worker prepares to install concrete storm drain segments, known as squash, at the Integrated Materials Research Laboratory (IMRL) construction site. The building is scheduled to be finished in the fall of 1992. (Photo by Randy Montoya, 3162)

Military, Political Minds Meet

Sandia Visitors Discuss Weapon Security and Future of NATO

The future of the North Atlantic Treaty Organization (NATO), formed after World War II as a military alliance to protect the US and Western Europe, was one of the topics on the minds of 60 military and political experts from around the world who attended a meeting several weeks ago at Sandia.

Other topics discussed by the visitors, who are all members of NATO's Senior Level Weapons Protection Group (SLWPG), were weapon safety and survivability, new developments in aircraft capability, and anti-terrorist strategy. As in previous years, the visitors saw demonstrations of what's new in weapon security and were given a tour of local facilities.

This year's gathering, dubbed Marchfest, was hosted by Rear Admiral Mack Gaston, Commander of the Defense Nuclear Agency; Brigadier General Frank Martin, Commander of the Office of Security Police at KAFB; and Jim Jacobs, Director of Nuclear Security Systems 5200.

"Sandia is a lead technical organization in doing security work for DoD and DOE," notes Bob Barker, Assistant to the Secretary of Defense for Atomic Energy and chairman of SLWPG.

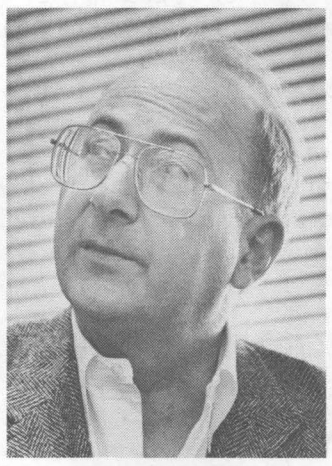
Many of the advances in NATO weapon security, such as weapon storage vaults and weapon access delay systems, were developed at Sandia, adds Barker. Always a top concern of NATO, nuclear weapon security is also a shared responsibility of DoD and DOE. DOE members attending the SLWPG meeting included Al Chernoff, Manager of the Kirtland Area Office, and Steve Guidice, Manager of the Office of Operations and Weapons for DOE/Albuquerque.

"NATO's future role is undergoing a major upheaval."

Fourth Gathering at Sandia

Sandia Executive Vice President Orval Jones (20) and John Kane, Manager of Survivability and Security Dept. 5220, guided the NATO representatives on last month's tour.

The 60 participants this year came from Canada, the United Kingdom, Italy, the Netherlands, Belgium, Germany, and the US, as well as NATO itself and Supreme Headquarters Allied Powers Europe (SHAPE). The SLWPG meeting was the fourth held at Sandia — the others took place in 1989, 1987, and 1985.



BOB BARKER, Assistant to the Secretary of Defense for Atomic Energy and chairman of SLWPG.

SLWPG meets several times a year to review initiatives being taken by NATO members to improve security and survivability of NATO weapons in Europe. "As a SLWPG technical advisor, John attends all of SLWPG's meetings," says Barker.

This year, in addition to the usual weapon security issues, NATO officials are in the midst of a Strategy Review, which will be presented to NATO heads of state in the fall, says Barker. The document will redefine the role of the defense alliance.

"As Europe adjusts to the changing environment, SLWPG is evaluating what the significance of that is for the security of nuclear weapons in Europe," he says.

But since the demise of the Warsaw Pact and the continued withdrawal of Soviet troops from Germany (expected to be completed in 1993), NATO is faced with changes in the economic as well as the political arena. For example, the US is not alone in reducing the amount of resources allocated to defense, says Barker. A similar trend is reflected in the military budgets of other NATO members.

"NATO's future role is undergoing a major upheaval. With the changes occurring in the Soviet Union and Eastern Europe, it is difficult even for 'experts' to predict what the future role of the military alliance will be," notes John.

It is important for Sandia to participate in and host groups like SLWPG, he adds. The exchange not only assists NATO in ensuring weapon security and survivability, but allows Sandians to broaden their own understanding and knowledge of NATO and US military positions on nuclear weapons.

"Changes in NATO's role may materially impact Sandia's work in many areas of the nuclear weapon program, including weapon requirements, weapon design, command and control, security, arms control treaties, stockpile management, and independent safety assessments," says John.

Future Role of NATO

However, even though NATO's future role will undoubtedly change with the end of the Cold War, Barker does not expect the alliance to dissolve.

"I think NATO is a defense alliance that works," he says. "Until something is demonstrated that can replace it, NATO will continue to fulfill its mission. It's very important to most NATO nations that the US be tied in somehow, because they're still concerned about the Soviet Union, as they value the US role in the alliance.

"About the only sure way they can count on keeping us involved is to keep NATO alive," he adds.

The Strategy Review will also address the need to be prepared for conflict in other parts of the world, such as the recent war in the Persian Gulf. It will consider the extent to which NATO needs to be prepared to operate as an alliance outside of Europe. Barker does not think it likely that NATO's membership will expand to include other nations outside of Europe, but the defense alliance probably will formulate some kind of approach toward non-NATO nations in maintaining world peace, as in the alliance with Saudi Arabia against the aggression of Iraq. •LD

BRYAN PLETTA (center, 5267) gives NATO visitors a demonstration of a robotic security system called Thomas, for TMSS, the acronym for Telemanaged Mobile Security Station. The Sandia-developed robot patrols an area, detects intruders, and assesses alarms. Small enough to be hauled in a pickup truck, the robot has intrusion sensors and can send data back to a control console more than a mile away. It is equipped with an infrared motion sensor, a video camera, a near-infrared spotlight, and a ground surveillance radar.

Take Note

New Mexico Volunteers for the Outdoors (NMVO) is seeking volunteers for the La Junta Project at the Wild Rivers Recreation Area. Meet at the La Junta Point campground at 8:30 a.m. on Saturday, May 18, Sunday, May 19, Sunday, May 26, and Monday, May 27. Activities include preparatory work for an access trail to La Junta Point for the handicapped and reopening of the Point Trail from the Point to the river. Meals will be provided. NMVO also needs volunteers for a Bureau of Land Management project at the Orilla Verde Recreation Area (previously part of the Rio Grande Gorge State Park) on Saturday, May 25. Work includes trail maintenance and placing a new bench at La Vista Verde. Meet at the visitor's center in the Orilla Verde campground at 9 a.m. Work will end in mid-afternoon. Bring your own lunch and snacks. A free Rio Grande raft ride for volunteers will be provided by the BLM staff on Monday afternoon, May 27, following completion of the La Junta project.

Work of all levels of difficulty will be available at both projects. Please call the NMVO on 884-1991 or Dennis Croessmann on 262-0444 if you plan to help on either of these projects.

* * *

Several Sandians are involved in an arms control and treaty verification symposium sponsored by the American Society of Mechanical Engineers and scheduled for May 21-22 in UNM's Woodward Hall. The New Mexico section of the ASME will present the symposium jointly with Sandia and the UNM College of Engineering. Tom Wright (9241) is general symposium chairman. Paul Robinson (9400), former ambassador for nuclear testing talks, is one of the keynote speakers. Other Sandians who will be speaking are Paul Stokes (9240) and John Taylor (9241). For more information, contact Milt West on 845-4452.

News Briefs

Superfast Recognition System May Have Commercial Applications

Sandia researchers in Computer Architectures Div. 1415 and Photometrics and Optical Development Div. 7556 have demonstrated that a beam of light can identify images many times faster than conventional supercomputers.

The advance was made with a system called the acousto-optic image correlator, which has the potential to compare, in the span of a second, as many as 1,000 stored images with a video scene and determine whether a designated pattern or target is in view.

"You could use this in any situation where you wanted to recognize a pattern," says Terry Stalker (1415). Developed for use in advanced missile guidance, the image recognition system also has potential applications in product and package inspection, robotic vision, security, and mail sorting. For example, it could be used to inspect packaging for proper labeling or postage.

Information Needed for Environmental Restoration at Sandia

Waste Management Systems Div. 6416 needs information about hazardous contaminants at the Chemical Waste Landfill in Area 3, which received wastes from 1962 to 1985. Accurate information about sources of contamination will help determine how to remediate the site. Regular users of the landfill may contact Phillip Pohl (6416) on 4-2992.

Environmental Impact and Restoration Div. 3223 is continuing to collect information about past releases of hazardous or radioactive substances at Sandia facilities. A substantial pool of information already exists, documented by the Comprehensive Environmental Assessment and Response Program (CEARP) of 1985-86. Anyone who may have unrecorded information can consult a copy of the CEARP report at Community Relations Div. 3163, Bldg. 800, Rm 105. Information about releases not in the report, no matter how small or how long ago, should be sent to Al Stotts (3163). The information is needed to focus site characterization efforts of the Environmental Restoration Program.

Sandia Software Wins SEMATECH Award

David Haaland (1821) and David Melgaard (contractor) have been awarded an SRC/SEMATECH Inventor Recognition Award for their new personal-computer-based chemometrics software. SRC is the Semiconductor Research Corporation, which manages the SEMATECH Centers of Excellence.

Sandia's chemometrics software for quantitative spectral analysis was originally available only on VAX computers. For efficient transfer of this technology to US industry, the software needed to be usable in a PC-based environment. David Melgaard programmed the software on the basis of David Haaland's specifications.

The software can be used in process monitoring and at-line analyses of thin-film dielectrics used in the manufacture of integrated circuits. It is also being investigated for use in monitoring plasmas during plasma etching.

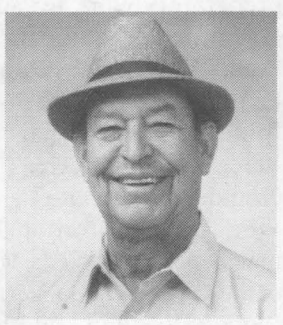
IC Quality and Reliability Papers Win Awards

Two technical papers reporting Sandia contributions to quality and reliability in the manufacture of integrated circuits (ICs) have received awards.

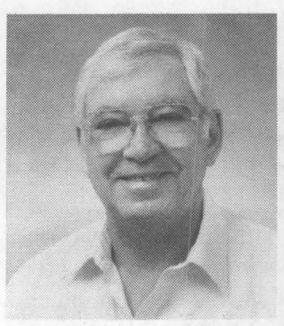
One award was for "Increased CMOS IC Stuck-At Fault Coverage with Reduced I_{DDQ} Test Sets," coauthored by Ron Fritzemeier (9112), Jerry Soden, Keith Treece (both 2118), and Chuck Hawkins (UNM), and presented last September at the International Test Conference. This paper describes how Sandia used its expertise with quiescent power supply current (I_{DDQ}) testing to provide industry with a method to greatly increase stuck-at fault coverage, which is the standard industry metric for judging IC test quality.

The other award was for "The Use of Light Emission in Failure Analysis of CMOS ICs," coauthored by Chuck Hawkins, Jerry Soden, Ed Cole (2124), and Eric Snyder (2146) and presented last October at the International Symposium for Testing and Failure Analysis. This is the first paper to show how to correctly interpret transistor photoemissions caused by defects that do not themselves emit light.

Recent Retirees



Joe Apodaca
3428 41



Joseph Valdez
7411 36

Russ Maxwell
5248 38

Sympathy

To Mike Lanigan (3155) on the death of his father in Riverton, Wyo., April 27.

To Doug (9132) and Sabina Erteza (5219) Jordan on the death of his mother and her mother-in-law in Alabama, April 27.

Earnings Factors February 1991

Long-Term Savings Plan for Management Employees (LTSPME)	Earnings Factors
AT&T Shares	1.0231
Government Obligations	1.0070
Equity Portfolio	1.0696
Guaranteed Interest Fund	1.0066
South Africa Restricted Fund	1.0789
Long-Term Savings and Security Plan (LTSSP)	
AT&T Shares	1.0233
Guaranteed Interest Fund	1.0067
South Africa Restricted Fund	1.0789
Equity Portfolio	1.0695
Employer Stock Fund*	1.0252

*Called AT&T Shares Fund Prior to 7/1/90.

Retiree Deaths

Vera Miller (79) ..... April 4
Edwin Kerl (87) ..... April 4
Mildred Johnson (67) ..... April 17
Rudolph Vinovich (81) ..... April 19
William Parker (74) ..... April 23
Roscoe Bryant (83) ..... April 28
Thomas Dadian (81) ..... April 29

feedback

Q: I have just been turned away at the TTC door once again because of insufficient seating. My management encourages me to keep abreast of ES&H, Tiger Team visits, Quality Awareness, and Management Change, and I keep trying to do so. But I don't have time to waste walking to the TTC just to find it is full or to leave 30-40 minutes early just to get a seat. Last time, I was there almost 15 minutes early. I am sure others, like me, will ignore future presentations if this continues.

To maintain interest, I recommend some means of crowd control. If there are limited sessions, allocate (by ticket perhaps) attendance to various organizations and let them decide who attends and be responsible for feedback to the rest. If there are sufficient sessions for all, urge organizations to schedule their attendance at a particular session to prevent people being turned away at the door.

A: I could not agree more that unregulated attendance at TTC events causes wasted time and is frustrating. People conducting those events are encouraged to develop some sort of plan for scheduling attendance. But unless it is an "all-hands" compulsory event, it is difficult to anticipate attendance patterns. Recent ES&H meetings have been limited to three or four sessions based on TTC availability and the schedule of the presenters. So it wound up being all the people that could be accommodated. We taped the sessions for those who were unable to see the presentation live.

I'm sorry I can't promise an end to your frustration, but I can promise that we will do all we can to encourage meeting planners to consider how they schedule attendance.

Herb Pitts (3100)

Q: Three Butler-type buildings were recently constructed southwest of Bldg. 887 and plaster and rock were laid around them. As it turned out, the buildings were not completed on the inside before the landscaping went in, and later the rocks and gravel were all torn up. If this isn't waste, well ...

Also, people exiting Bldg. 887 from Purchasing and Engineering follow the red line to the parking lot, over the wall, and across the stones, jaywalking all the way. Perhaps some more trees or bushes would deter them, or maybe a cop on occasion ...

A: We all hate to see wasted effort. In this case, the contractor didn't schedule his work adequately and got ahead of himself. Sandia tries to work with contractors and comment on schedules and sequencing, but in this case, the landscaping was put into place before the utilities work was finished. It was the contractor's mistake and corrections were made at the contractor's expense.

In answer to your second question, Sandia employees and on-site contractors who walk through the gravel and step over the wall to save a few steps probably would not be deterred by a few more trees or shrubs. However, crossing the street in the middle of the block is certainly a safety issue. The supervisors in Bldg. 887 have been asked to remind all building occupants to cross H Street at the crosswalks.

Ward Hunnicutt (7800)

Q: Suggestion for improvement: I think Sandia needs garbage cans distributed in Area I. I pick up trash when walking to meetings but find no garbage can. Good luck!

A: We have several garbage cans in Area I, but I agree with you that we could use a few more. Funds are tight right now, but we will get some on order. I thank you for picking up trash. It would be nice if we could get everyone to share your concern.

Ward Hunnicutt (7800)

UNCLASSIFIED ADVERTISEMENTS • UNCLASSIFIED ADVERTISEMENTS • UNCLASSIFIED ADVERTISEMENTS • UNCLASSIFIED ADVERTISEMENTS

Deadline: Friday noon before week of publication unless changed by holiday. Mail to Div. 3162.

Ad Rules

1. Limit 20 words, including last name and home phone.
2. Include organization and full name with each ad submission.
3. Submit each ad in writing. No phone-ins.
4. Use 8½ by 11-inch paper.
5. Use separate sheet for each ad category.
6. Type or print ads legibly; use only accepted abbreviations.
7. One ad per category per issue.
8. No more than two insertions of same "for sale" or "wanted" item.
9. No "For Rent" ads except for employees on temporary assignment.
10. No commercial ads.
11. For active and retired Sandians and DOE employees.
12. Housing listed for sale is available for occupancy without regard to race, creed, color, or national origin.
13. "Work Wanted" ads limited to student-aged children of employees.

MISCELLANEOUS

BACKPACK FRAMES, 2 large heavy-duty packs w/wraparound frames, $30/ea. Kissel, 281-2729.

DRAFTING ARM, 18-in., RH, used scales included, $150 OBO. Heath, 294-4736.

OLYMPUS 35mm CAMERA, OM-10 model, 50mm, 135mm, & 70-210mm lenses, flash, bag, $175. Davis, 883-4867.

CHARCOAL BARBEQUE, Ozark Chief, w/rotisserie, $25; aluminum screen door, 30" x 80", $5. Denish, 256-1559.

GOLF CLUBS: 3-PW irons, 1, 3, & 5 woods, Dunlop TD-Plus, $115/set; MXD-200 woods, 3 and 5, $100/ea. or $175/pair. Davis, 293-7457.

POLYPHONIC SYNTHESIZER, Roland Juno-60 w/sequencer, TR-707 drum synthesizer w/sync and MIDI hookups, $600 OBO. Hamrick, 281-4769.

EXERCISE BICYCLE, Schwinn Air-dyne, $300. Smith, 292-7540.

CAMPER SHELL, LWB, $175 OBO. Eisenberger, 877-7041.

COLT, Gold Cup National Match Series 80, stainless steel, in box, $625. Dellamura, 892-0054 after 5 p.m.

ALDER WOOD: 50+ board feet, random lengths and widths, $100. Stanton, 881-4769.

REARVIEW MIRRORS, set, for Dodge pickup or van; '84 Dodge pickup service manual; Bagboy golf cart. Nelson, 265-2248.

COLOR TV, 19-in. Hitachi, w/matching pedestal stand, $135. Dippold, 821-5750.

PGA-PAR EC IRONS, 4-PW, $50; Stag SW, $16; putter, $12.50; 1st Flight woods, 1-3-4 reg., $36; bag, $6; all for $110. Stang, 256-7793.

LIVING ROOM SOFA, chocolate brown, $65; king-size mattress and box spring, $50. Melvin, 298-6402.

ELECTRONIC ORGANIZER, Sharp Wizard Model OZ7000, including PC link, calendar, calculator, 3 phone directories, case, manual, $225 OBO. Zaorski, 281-9194.

RADIAL-ARM SAW, Sears, 10-in., w/attachments; Sears spray gun; sandblaster; other shop tools. Yaniv, 293-9584.

ATARI 1040 ST, GTS100 external drive, modem, Citizen 120D, C compiler, 2 joysticks, software, $950. Pastorek, 292-6323.

TOOLBOX, 1-piece lid, for full-size trucks, $175; Sharp MZ-100 laptop computer; two 720K 3.5-in. floppy drives; 640K RAM, w/MS-DOS 3.3, $350. Rivers, 836-6304.

CAR SEAT, Century 2000 STE, infant to 40 lbs., terrycloth cover, new, in box, $40. Fellers, 255-7176.

14-FT. AWNING, Carefree, fits either motorhome or travel trailer, $150. Tafoya, 298-6208.

ENDTABLES, slate-top, $50/ea.; octagon coffee table, $75; stereo/quad turntable, $35; vacuum cleaner, $15; auto exposure camera, $10. Vogel, 275-0774.

PENTAX 645 SYSTEM, 3 lenses, AT400 flash, Super Program, Program Plus, Novoflex Follow focus, 400mm, 600mm heads. Swanson, 281-2735.

RCA STEREO CONSOLE, record player, reel-to-reel tape deck, AM/FM radio, $150. Miller, 268-5992.

HP LASERJET; IBM XT; EGA monitor; sofa sleeper; Nintendo w/13 cartridges; Coleco video game w/Atari adapter. Robinson, 293-7231.

OWNER'S MANUALS, '76 AMC Pacer, Gremlin, $2.50; Chilton's and tune-up guide for Ford Fairmont and Zephyr, $6. Padilla, 877-2116.

CAB-OVER CAMPER, 8-ft., stove/oven, sink, icebox, storage, AM/FM cassette, dinette, sleeps 4 adults, w/jacks, ready to go, $650. Kiekel, 294-6547.

FULL-SIZE MATTRESS and box spring, $85; sofa sleeper, $175. Etheridge, 888-2633.

GARAGE SALE: Boy Scouts 337, Sat., May 25, 8 a.m.-2 p.m., 7533 Deerfield NW, Taylor Ranch. Jones, 899-0642.

SOFA SLEEPER, solid brown, spring mattress, $200. Kellogg, 299-3737.

SOFA HIDE-A-BED, blue-green tweed, $50; rust colored recliner chair, $20; 2 med.-size soft suitcases, blue, $10/ea. Saxton, 883-8835.

VCR, RCA, jog/shuttle editing, flying erase head, video/audio dubbing, new, $300. Torres, 265-6516.

IBM PC, 640K, dual floppy drives, keyboard, no monitor, $375. Lovato, 299-3293.

COMMODORE 1902A C64/C128 COLOR MONITOR, LCA, RGB, and RCA aud./vid. inputs, $135; 1541 floppy disk drive, $45. Hale, 298-1545.

ANSCOMATIC PROJECTOR, w/trays, $25; blue- and orange-tone shag rugs, $15 and $50. Jeffers, 299-7020.

DOGGIE DOOR INSERT for sliding patio door, vinyl flap, tempered glass, aluminum frame, for medium-size dog. Reynolds, 256-3670.

GOLF CART, Kangaroo Kitty, w/battery, $125. Walker, 821-5938.

MITCHELL CAB-OVER CAMPER, 8-1/2-ft., self-contained, jacks, propane refrigerator, heater, 3-burner stove, oven, queen-size bed, ready to go. McCampbell, 294-8238.

AT&T COLOR MONITOR, 12-in., high-resolution, for AT&T 6300 computer, w/color graphics card for IBM-compatible, $225. Goldenberg, 821-6209.

GARAGE SALE: handmade sweaters, adult Fairisle and infant sets, housewares, Saturday, May 18, 4208 Douglas MacArthur NE. Jones, 881-1918.

CARPET, light brown, approx. 140 sq. yds., w/padding. Archuleta, 899-8912.

LAWN MOWER, 3.5-hp engine, 21-in. cut, w/rigid rear bag, $100 OBO. Cross, 291-0964.

BABY CRIB, w/mattress, $110; playpen, $35; car seat, $40; baby carrier, $17; stroller, $45; clothes; more. Fernandez, 298-9715.

IBM PC, w/512K RAM, color and monochrome, 2 floppy drives, software, $300; Epson FX-80 printer, $75. Bainbridge, 294-4134.

GARAGE SALE: May 18, 8 a.m.-1 p.m., 5800 Cambria NW (Taylor Ranch), table saw, drafting table, serger, motorcycle, tools, toys, books. Girven, 899-1503.

FLUORESCENT LIGHTS, 3 ea., 2' x 4', $35/ea. or $100/all. Gutierrez, 865-9542.

HYBRID DAYLILLIES, many colors and heights, large and minis, call for list. Hosking, 836-2128.

IBM-COMPATIBLE SOFTWARE, Norton Backup from Semantec Corporation, in unopened shrinkwrap, $49. Mogford, 898-1416.

GARAGE SALE: May 19, 1-5 p.m., English professor moving, several hundred paperback novels, 1/2 price, 2904 Prenda de Oro. Seay, 831-4449.

QUEEN-SIZE MATTRESS AND BOX SPRING, medium firm, in plastic cover, $100. Schubeck, 821-3133.

COMPUTER, Apple IIc clone, monitor, printer, manuals, $50 or free to good home. Bingham, 298-7489.

ROLLAWAY BED, twin-size, w/cover. Boruff, 294-8324.

DESK, w/leather top, 30" x 60", 7 drawers, $160; rowing and cross-country ski machine, $75. Warner, 294-2639.

GARAGE SALE: baby/infant clothes, kitchen accessories, toys, handmade crafts, Saturday and Sunday, May 18 and 19, 700 Laguayra NE. Goodson, 265-2080.

Early Deadline

Because of the Memorial Day holiday, the deadline for ads and other submissions to the LAB NEWS is noon on Thursday, May 23.

MAPLE ROCKING CHAIR, w/cushions, $65; bookshelf, w/bottom storage cabinet, $80; brass floor lamp, $20; brass desk lamp, $15. Levan, 293-0079.

CLOTHING, man's, woman's, girl's, and baby's; Fisher Price portable swing; walker; rocking carrier/car seat; rugs; toaster oven; exercycle; misc. Barnes, 821-8902.

GARAGE SALE: Saturday, May 18, 9 a.m.-3 p.m., 1318 Hermosa Dr. SE (near KAFB Carlisle Gate), collection from 4 families. Hancock, 266-6845.

COMPUTER, AT clone, 20-MHz 286, 1MB RAM, 44MB hard disk, VGA color monitor, 3-in. and 5-in. floppies, 101 keyboard, $995. Boldt, 823-2125.

TRANSPORTATION

'84 MONTE CARLO, 2-dr., white, gray interior, power everything, tinted windows, $3,500. Padilla, 296-5048 after 5:30 p.m.

KAWASAKI KD-80 DIRT BIKE, beginner's motorcycle, $225. Davis, 883-4867.

'89 TOYOTA CELICA GT, liftback, PS, PB, AC, stereo, tinted glass, power sunroof, 22K miles, book value, $11,000 OBO. Fleming, 888-0744.

'75 MOBILE TRAVELER, GMC, 350 engine, cruise, 4 new tires, dual gas tanks, awning, AM/FM, CB, $4,800. DeMoss, 281-8781.

'81 HONDA CB-650, 15K miles, $900 OBO. Vandewart, 298-4741.

'59 METROPOLITAN. Castillo, 344-5144.

'62 CORVAIR MONZA 900 SEDAN, 40K miles on 6-cyl. factory engine, rebuilt AT, $1,800 OBO. Roose, 296-4129.

'83 TOYOTA CELICA, 5-spd., AC, 61K miles. Gallagher, 293-1611.

'70 CHEV. EL CAMINO, restored, black, vinyl roof, '84 four-bolt main, turbo trans., custom interior, AC, PS, $7,000. Olbin, 275-2681.

'68 CHEV., 327, 4-spd., needs some mechanical work, $1,650 firm. Pompeo, 898-7076 after 6 p.m.

'85 CHEV. CELEBRITY, 4-dr., V-6, cruise, tilt, 69K miles, $2,000. Reed, 821-2195.

'87 FORD AEROSTAR, V-6, AT, 45K miles, 7-passenger, cruise, tilt, power, dual AC, AM/FM tape, $8,900 OBO. Turner, 292-6819.

REPOS: '82 Chev. K-10 Silverado, 4-WD, 8-cyl., PL, PW, AC, PS, cruise, 62K miles; '79 Olds 98 Regency, 4-dr. sedan, 8-cyl., AT, AC, radio, cruise, 97K miles; bids accepted through May 24; we reserve the right to refuse all bids; subject to prior sale. Sandia Lab FCU, 293-0500.

MAN'S 12-SPD. BICYCLE, Ross Signature, Campagnolo gear, 21-in., $230; Raleigh 10-spd., 22-in., English-made, $95. Swanson, 281-2735.

'64 LINCOLN CONTINENTAL, needs electrical work, $750. Cunningham, 344-9841.

'73 CHEV. CHEYENNE SUPER 10 PICKUP, 350 V-8, AT, PS, PB, AC, AM/FM cassette, cruise, tilt, $3,500 recently invested, $2,700. Kiekel, 294-6547.

'89 CAMARO RSC, gray, T-top, loaded, 22K miles, take over payments ($9,000 plus $1,000 down OBO). Gallegos, 345-5202 or 344-3290.

'85 MAZDA GLC-LX, 4-dr. sedan, 5-spd., AC, sunroof, tilt, extras, 82K miles, $2,850. Potter, 292-3989.

'67 CAMARO, original, 327, AT, PS, $3,500 OBO. Thomas, 883-9340.

'87 NISSAN 4x4 PICKUP, V-6, AM/FM stereo. Hassig, 293-5423.

21-FT. CLIPPER MARINE, w/3 sails & 9-hp Evinrude, dual-axle trailer, extras, $3,750 OBO. Benecke, 344-7316.

'65 BONNEVILLE BROUGHAM, 4-dr., new paint, top, interior, tranny, w/cover, $3,500 or trade for Jeep CJ7 or Scrambler. Cowen, 296-5980.

12-SPD. TOURING BIKE, Schwinn Traveler, 25-in. chrome-moly frame, 27" x 1-1/4" alloy wheels, Shimano/Sakae components, $225. Kern, 822-0535.

'88 GMC JIMMY, 4x4, aspen blue, 2.8L V-6, 5-spd., off-road package, AC, PS, PB, 38K miles, $10,500 OBO. Sterk, 299-7669.

'84 PLYMOUTH RELIANT STATION WAGON, AC, PS, PB, 4-cyl., 4-spd., FWD, new battery and clutch, $1,800 OBO. Gustwiller, 268-4893.

'73 DODGE 1/2-TON PICKUP, PS, PB, AC, sliding window, AM/FM cassette, 400 motor, $1,500. Townsend, 275-8913.

'89 YAMAHA BLASTER, 250cc, 2-stroke, $3,000 OBO. Thompson, 864-3670.

'86 ASTRO VAN, luxury conversion, 50K miles, $8,650. Williams, 821-7422.

'77 VW CAMPER VAN, rebuilt engine. Ezell, 821-1768.

'78 EL CAMINO, small-block 305, no body work needed, new tires, $2,400 OBO. Archuleta, 899-8912.

'82 DATSUN 280ZX TURBO, 2+2 AT, PS, PB, PW, 103K miles, maintenance records, $2,995 firm. Miller, 281-3936.

'78 CHEVETTE ENGINE, recently rebuilt, $235 cash; complete car (can be started but not driven) $300 cash. Dixson, 298-5617.

'79 VW CAMPER, 4-spd., 96K miles, sleeps 4, gas heater, $2,900 OBO. Maloney, 828-9610.

'72 VW, new interior, brakes, and clutch, original owners, $2,000 OBO. Boruff, 294-8324.

'88 TOYOTA SUPRA TURBO, AT, 22K miles, removable roof. Hughes, 293-7320.

'78 CHEV. MALIBU WAGON, new battery, tires, & water pump, adjustable shocks, full-size spare tire & class II hitch, $1,500. McKay, 294-2935.

'82 HONDA CIVIC WAGON, 5-spd., 102K miles, $2,700 OBO. Zirzow, 281-9896.

REAL ESTATE

DEEDED TIMESHARE at Jockey Club in Las Vegas, 1-bdr., 5-star, week 35, $8,500. Steinfort, 281-9893.

10 ACRES, Sandia Park, water, electricity, phone, covenants, security gate, 20 mins. to Albuquerque, $88,000. Smith, 298-9588.

2-BDR. MOBILE HOME, '81 Wayside, 14' x 64', 2 baths, garden tub, all appliances, extras, $11,500. Russell, 823-2441.

3-BDR. HOME, NE Heights, approx. 2,000 sq. ft., 1-3/4 remodeled baths, study, family room w/fireplace, new roof, $81,000. Paek, 294-5679 or 298-9630.

3-BDR. HOME, 2 baths, den, utility room, 2-car garage, 1,400 sq. ft., 604 Figueroa NE, $72,900. Buller, 881-7797.

3-BDR., 2-STORY HOME, on fenced 1-acre lot, 2 baths, double garage, 2,450 sq. ft., $160,000. Wagner, 898-3903.

1-BDR. CABIN, Jemez Mountains, on 1 acre, 1 hour from Albuquerque, furnished, $35,000 firm. Vandetti, 299-2318.

3-BDR. BRICK HOME, NE, 2 baths, large kitchen, garage, brick patio w/barbeque, storm windows, lawns, approx. 1,400 sq. ft., $81,900. Axness, 296-4691.

3-BDR. HOME, Academy Acres, 1,700 plus sq. ft., 300-sq.-ft. sunroom, master bedroom w/sitting room, wood accents, fireplace, woodstove. Yourick, 822-8148.

3-BDR. HOME, 1,700 sq. ft., large master bedroom, walk-in closets, double garage, time sprinklers, deck, views, assumable 9.5% FHA, $91,900. Outka, 298-5707.

3-BDR. HOME, 2 baths, Lomas and Tramway, 1,792 sq. ft., city and mountain views, $109,900, 8.5% assumable loan w/qualifying. Sprauer, 275-0092.

WANTED

CHILD'S BOWLING BALL, 6-7 lbs. Redmond, 899-9744.

SIMPLE, RELIABLE COMPUTER for word processing. Barnaby, 865-1348.

GARAGE DOOR OPENER TRANSMITTER, Sears digital control model, 9-switch code setting. Nickerson, 888-4159.

HOUSEMATE, to share 2-bdr., 2-bath apartment at Mission Hill Apts. in NE Heights, $235 per month, no utilities. Mesibov, 292-1249.

SPANISH LANGUAGE CHILDREN'S BOOKS, picnic table, 4-thread serger. Meisenheimer, 899-8101.

SAILING TEAM MEMBERS for local and regional competition (J24), experience preferred. Murata, 881-8459.

SLIDE-IN CAMPER for 1/2-ton truck, 9-ft. or 8-1/2-ft., self-contained, full-size door, must be in good condition. Zaorski, 281-9194.

TANDEM BICYCLE, multi-speed, good condition. Brigham, 293-6914 after 6 p.m.

SMALL, CLEAN PICKUP, import or domestic, good mechanical condition a must. Gorman, 292-7119.

TREADMILL, electric or nonelectric. Walston, 298-1500.

BICYCLE TRAILER for towing children. Nation, 298-5605.

WATER JET SKIS, in good condition. Moreno, 294-4268.

HOUSEMATE, to share 2-bdr. home, furnished, Wyoming/Copper area, must enjoy children, $240/mo., utilities included. Hodge, 266-6501.

OLD WATER HEATERS, 40-gal.-size or larger, will haul away for free. Zirzow, 281-9896.

SANDIANS with prior Bell System service for get-together. Schubeck, 821-3133.

WORK WANTED

MATURE TEENAGE BOY desires summer work as activity director/companion for school-age kid(s) this summer, has own transportation. Clark, 296-3924.

HOUSESITTING, reliable UNM senior, good w/pets, references available. Maloney, 828-9610.

LOST AND FOUND

LOST: blue hooded sweatshirt, w/"LOBOS" in white letters on front, left on Hardin Field Tues., April 23, during Directorate Relay Challenge. Farris, 6-0464.

FOUND: woman's paisley dress scarf, Area IV parking lot before holiday break. Cowen, 296-5980.

FOUND: black cotton knit jacket, left outside Bldg. 814 April 22, claim in Bldg. 814. LAB NEWS, 4-7841.

Coronado Club Activities

Club Casino Opens Tonight, Vegas Style

PLACE YOUR BETS — Tonight is Casino Night at the C-Club beginning at 6 p.m., complete with bright lights, slot machines, roulette wheels, keno, blackjack, craps, and "$1,500 worth of poker chips" to gamble away. Admission is $10, and players receive a chance to win two round-trip tickets to any Continental Airlines destination with their admission ticket (given away in a random hat drawing). Lounge and low-cost buffet are open to everyone. Real gamblers will still have to go to Las Vegas, because tonight's event is all in fun. (Casino Night is cosponsored by the C-Club and DOE. For adults only — must be at least 18 years old to play.)

Y'ALL COME DANCIN' — Friday, May 24, is country & western night at the C-Club from 7 to 11 p.m. The Isleta Poor Boys will play their best boot-scootin' music while the kitchen staff serves up some country-style cookin': prime rib or poached halibut (two-for-one priced at $15.95), salmon steak, filet mignon, and deep-fried shrimp (all $8.95 each). Reservations recommended (265-6791).

MAKE WAVES THIS WEEKEND — The pool opens for the first weekend this season on Saturday and Sunday, May 18 and 19, and reopens for the summer on Saturday, May 25. Then on Memorial Day, Monday, May 27, the Club throws its annual pool party from 11 a.m. to 6 p.m. with games, music, magic show, and buffet line. Admission is free for members and $3 for non-member guests.

LUNCHTIME BROWN BAGGERS — Club Manager Sal Salas, aware of ES&H restrictions about eating in laboratories and work areas, extends a hearty invitation to Sandians to enjoy their homemade lunches in the Club's shady patio, grassed area, or air-conditioned dining room.

Events Calendar

Events Calendar items are gathered from various sources. Readers should confirm times and dates of interest whenever possible.

May 17-18 — "The Homecoming" by Harold Pinter, Theatre-in-the-Making presentation; 8 p.m. Fri.-Sat., CenterStage, 260-0331.

May 17-June 16 — "School for Drugs," comedy by Grubb Graebner about Santa Fe politics, power, and strange bedfellows; 8 p.m. Fri.-Sat., 6 p.m. Sun.; Vortex Theatre, 247-8600.

May 18 — "Culture Clash," hilarious look into the Chicano/Latino reality in America, sponsored by the South Broadway Cultural Center; 8 p.m., UNM Continuing Education Auditorium, 848-1320.

May 18 — Casino Night, blackjack, roulette, wheel of fortune, sponsored by the Museum Volunteer Association to raise funds for a Triassic exhibit; 7 p.m., New Mexico Museum of Natural History, 841-8837.

May 18 — Giant Block Party, benefit for Living Through Cancer, featuring Harvey and the Prowlers, the Night Shift Blues Band, volleyball, food, clowns, face-painting, the Chili Brothers, prizes, on 6th St. between Gold & Silver SW, 844-1596.

May 18 — Henry Threadgill and Very Very Circus, New Mexico Jazz Workshop Guest Artist Series; 8 p.m., KiMo Theatre, 255-9798.

May 18 — Pops Concert: "An American Salute," New Mexico Symphony Orchestra and Chorus, directed by Roger Melone; 8:15 p.m., Rio Grande Zoo, 842-8565.

May 18 — "A Gamut of Gardens," Council of Albuquerque Garden Clubs tour of seven Albuquerque gardens, featuring a xeriscape garden, an English cottage garden, a rose garden, a native plant garden, a Japanese garden, and the grounds of the Albuquerque Garden Center; 296-6020.

May 19 — Exhibit opening reception, "Nuclear Enchantment of New Mexico," photographs by Patrick Nagatani and text by Joel Weishaus, exhibit is open through Aug. 11; 2-4 p.m., Albuquerque Museum, 242-4600.

May 19 — Concert No. 4: the Albuquerque Philharmonic Orchestra with soloist Robert Nagel (New York Brass Quintet), program includes "Les Preludes" by Franz Liszt, "Symphony No. 8" and "Concerto for Trumpet" by Beethoven; 2 p.m., free, UNM Continuing Education Auditorium (1634 University NE).

May 19 — Seventh Annual Automobile Show, presented by the Albuquerque Museum and the New Mexico Council of Car Clubs; trophy presentation at 4 p.m., exhibition opens at 5:30 p.m.; free, Albuquerque Museum, 242-4600.

May 19 — Amigas y su Grupo Ritmo, performance in conjunction with exhibit, "Chicano Art: Resistance and Affirmation"; 12-4 p.m., Albuquerque Museum, 242-4600.

May 19 — Musica Antigua de Albuquerque, performing "O Merrie Month of May," 4 p.m., Central United Methodist Church (1615 Copper NE), 842-9613.

May 25 — Second Saturday Storytelling: Gerald Fierst, nationally known Jewish storyteller who has performed at the National Storytelling Festival and works with New Jersey Teen Arts and the New Jersey Foundation for the Arts; 1 p.m., West Gallery, New Mexico Museum of Natural History, 841-8838.

May 26 — Chuy Martinez, singer/songwriter/musician, Mexican and Latin American folklore music, in conjunction with exhibit, "Chicano Art: Resistance and Affirmation"; 2 p.m., free, Albuquerque Museum, 242-4600.

May 26 — "Shades of Jazz," Sonny and Co. Jazz Trio, Latin, country, jazz, and instrumentals; 3 p.m., UNM Continuing Education Center (1634 University), 277-4624 or 277-6945.

May 31 — Exhibit opening, "Treasures of the Tar Pits," ice-age fossils from the Rancho La Brea Tar Pits in Los Angeles, produced by the Natural History Museum of Los Angeles County, features complete skeletons of dire wolves, a coyote, a giant ground sloth, and a cast from the skeleton of a 9,000-year-old La Brea woman; 9 a.m.-5 p.m. daily, exhibit is open through August; New Mexico Museum of Natural History, 841-8836.

May 31-June 1 — "Frida, a Dance Drama," one-woman performance by Alicia Perea portraying the life and work of the late Mexican artist Frida Kahlo; 8 p.m., KiMo Theatre, 764-1700.

Welcome

Albuquerque — Emily Benavidez (21-1), Thomas Bomber (9411), Nancy Lee (21-1), Marjory Martinez (21-1), Tamara Sanchez (21-1), Nora Tankersley (21-1), Lily Weimer (21-1).

Elsewhere: *Nevada* — Robert Sherwood (7513).

Fun & Games

Bowling — Winners of the Four-Game No-Tap Doubles Tournament held at Holiday Bowl April 13-14 were Lyle (2818) and Alice Davis with a 1,536 handicap series. Second place went to Tom Lutz (6428) and Melissa Silversmith with a 1,496 handicap series.

March Bowlers-of-the-Month: Scratch — Tom Lutz, 624; and Trinie Chavez, 582; Handicap — Gary Laughlin (2543), 522 and 678; and Dora Gunckel (6400), 554 and 686.

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Volleyball — A Sandia Volleyball Association meeting will be held Thursday, June 13, at the Coronado Club Conquistador Room at 5 p.m. Topics will include election of officers, association rules and bylaws, and fall 1991 season play. All team captains and interested persons are invited. For information, contact Bob Patton (2515) on 898-3524.

Take Note

"The History of Extinction," a traveling exhibit from the Museum of Northern Arizona is showing at Red Rock State Park Museum (Church Rock, N.M.) through June 30. The exhibit examines the following questions: Is earth in its final episode of life? Will the damage being inflicted on the planet by mankind cause the eventual extinction of animal life? And, what is happening on the Colorado Plateau to support or deny these contentions? Consisting of photographs, text panels, and fossil remains of extinct animals, the exhibit will be of interest to school groups and families. Red Rock is open to the public from 8 a.m. to 4:30 p.m. Monday through Friday until Memorial Day, when it begins its summer schedule: 8 a.m. to 9 p.m. every day.

TWO SANDIANS received "Women on the Move" awards this year from the YWCA — Dianna Blair (left, 6612) and Theresa Carson (3726). Nominees are honored for their leadership, community involvement, and professional accomplishments. Dianna is a chemical engineer who is actively involved in the Science Advisors Program at McCollum Elementary School, is currently designing science kits for all education levels at the school, and was the leader of the first ES&H Evaluation Team for Analytical Facilities at the Labs. Theresa is a contracting representative and a past member of Sandia's Black Outreach Committee. Her volunteer activities have included encouraging troubled youngsters to continue their education through the Albuquerque Job Corps and acting as a role model and advisor to students in Sandia's Summer Student Mentor Program.