Adhering to the KISS Principle

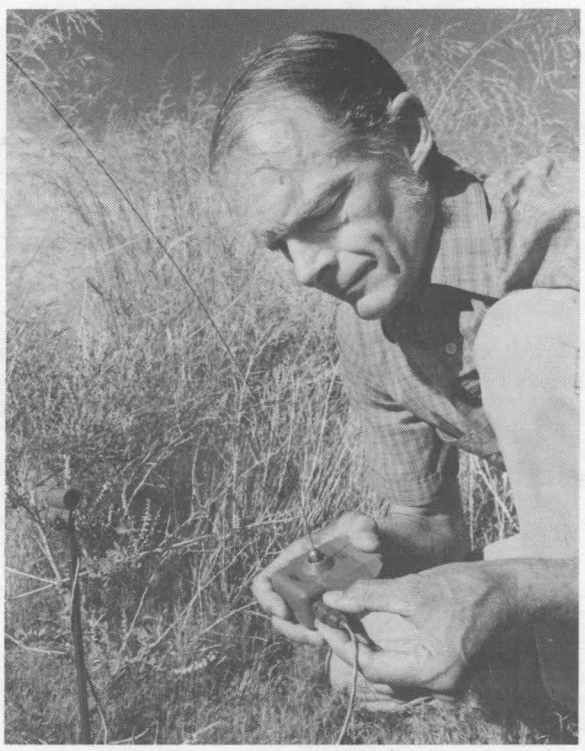
Low-Cost Intrusion Detection System: From Panama to Pecos

You wouldn't think that an irate rancher in Pecos, N.M., and the US Immigration and Naturalization Service would have much in common.

However, there's a connection, reports Dori Miller, supervisor of Sensor Systems Div. 9235. Both are searching for a low-cost, easy-to-use system that can detect interlopers — poachers, in the case of the Pecos rancher, and illegal aliens, in the case of the INS.

The Miniaturized Intrusion Detection System (MIDS), recently developed by Dori's division for use by the military services, might be just the ticket for the rancher *and* the INS. MIDS is the latest in a string of Sandia sensor-development projects that began in the 1960s during the Vietnam war (see "In the Beginning").

"In 1983," says Dori, "the Marines asked Sandia to work on a sensor intrusion-detection system to replace the family of sensors, called Phase III, used in the Vietnam war. Phase III, designed specifically for the Vietnam environment, did not meet many of the Marines' requirements in the '80s. The new system was to incorporate modern technology — including longer-life batteries, and was to be portable and smaller and lighter than existing systems.



TOM McCONNELL (DMTS, 9235) demonstrates two key components of the Miniaturized Intrusion Detection System. He's connecting the infrared unit, left, used to detect the passage of people or vehicles along a path or road, to the mini seismic detector. In actual field use, the detector is buried so that only its very thin antenna is above ground.

Uncomplicated System Needed

"In response, Sandia developed the TRSS (Tactical Remote Sensor System), an unattended ground sensor network using modern detector and microelectronics technology. Even though TRSS was smaller and lighter than any system previously available, it still wouldn't fill the bill for yet another need — expressed by the Marines, Army, and Air Force — for a very-low-cost, uncomplicated, remotely operated sensor system for use by small patrols in low-intensity-conflict areas."

While Sandia was working on TRSS, Dori says, it became apparent that several TRSS components could also be used in a low-cost system such as that sought by the military. Therefore, while development work was winding down on TRSS, the MIDS program was born.

"To hold down costs, we needed to substitute a simpler transmitter and receiver," says Tom McConnell (DMTS, 9235), principal designer of the MIDS. "We envisioned single-channel RF units using no microprocessors and that could be powered by an ordinary 9-volt alkaline battery."

Sandia acquired the basic transmitter and receiver units from Qual-Tron, a Tulsa-based company that has manufactured many sensor-system components for the Labs since the '60s, and proceeded to assemble some prototype low-cost intrusion detectors, which involved, in Tom's words, "a little tweaking of the original TRSS circuit design."

When the new units — a seismic detector and a display monitor — were tested, the Army's Southern Command recognized an immediate application for the system in its low-intensity-conflict program and began to fund tooling and further development.

The MIDS program delivered what it promised: a highly reliable, low-cost and portable, remotely operated intrusion detection system that's easy to set up and operate. MIDS components include a mini seismic detector (about the size of a cigarette package) that detects seismic signals and transmits one of 64 possible ID codes to identify its location; a portable hand-held monitor, operated from a remote location, that receives and displays the sensor IDs; and an active infrared unit with a

(Continued on Page Four)

'Can-Do Heritage'

VP Roger Hagengruber (9000) commented recently to LAB NEWS on MIDS: "Sandia's work with sensor systems such as MIDS goes back to our early field test activities for nuclear weapons. The seismic network that 7100 runs at NTS and various sensor activities in 5200, 9100, and 9200 share these common roots. While people involved change from time to time, the operational focus and 'can-do' heritage persist.

"The current MIDS program is a valuable contribution to the government in that it demonstrates that important technology can still be made available at modest cost and on a short timetable."

LAB NEWS

VOL. 41, NO. 18 SANDIA NATIONAL LABORATORIES SEPTEMBER 8, 1989

Jeff Johnson Wins DOE Security Inspector of Year Honor

"When I put all the medals on at the awards ceremony, I sounded like a junkyard," says Jeff Johnson of Patrol Div. — South 3435. But there was nothing junky about the performance he turned in during a recent competition for DOE's 1989 Security Inspector of the Year.

In five tough phases at the DOE's Central Training Academy on Kirtland AFB, Jeff came out on top of a field of security inspectors from 20 DOE installations. He received several prizes, including a trip to Washington, D.C., where he will meet with DOE Secretary James Watkins and other DOE officials.

Besides the overall gold medal, Jeff took the gold in shooting and the silver in decision-making, knowledge of DOE policy, and tactical ability.

Excellence is Vital

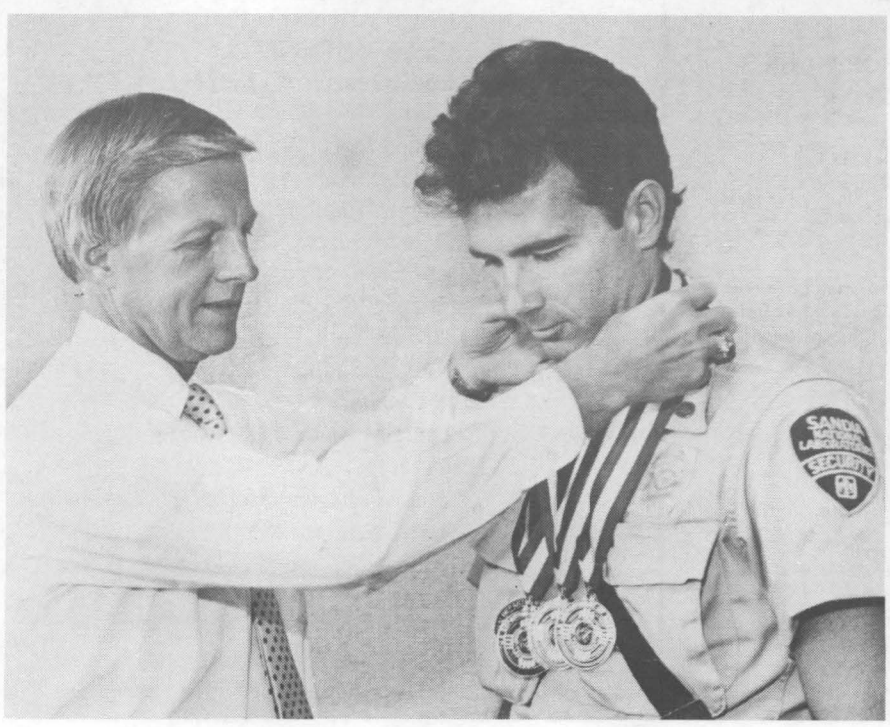
"Jeff's accomplishment is an example of dedication and commitment to excellence," says Executive VP Lee Bray (30). "Quality is dedication to doing the right things, and doing them as well as we know how. And the kind of excellence that Jeff demonstrates is vital to all of us, because he is one of the group that protects our people and our facilities every day."

"This is the first time a Sandia Security Inspector has won the competition, although we've done well in past years," says Bob Kelly, manager of Safeguards and Security Services Dept. 3430. "Jeff's efforts reflect the quality of the entire Sandia protective force."

"Anybody would have to be very good just to be in the competition," says Jim Martin, Director of Security and Facility Support Services 3400. "Winning really sets Jeff apart."

The annual competition is a full test of a security inspector's responsibilities. There are physical requirements, such as being able to shoot well and to meet the physical fitness and coordination de-

(Continued on Page Fourteen)



EXECUTIVE VP LEE BRAY (30) admires the medals that Jeff Johnson (3435) won while on the way to being named DOE's 1989 "Security Inspector of the Year." The competition, held at the Central Training Academy, was a full test of a security inspector's responsibilities. Jeff competed against security inspectors from 19 other DOE installations.

This & That

Talk About Experience! – B.G. Edwards and his 10 employees in NTS (Nevada Test Site) Staff Div. 7131 at Mercury, Nev., average 31 years of Sandia service. What's more amazing is that all but one have 30 years or more. If it weren't for the "pup" of the group – Larry Carrillo – who has "only" 10 years' service, the average would be more than 33 years. Others and their years of service: B.G., 36; Leo Brady, 31; John Brouillard, 35; Dick Dye, 32; Hank Kerr, 34; Hank Passmore, 37; John Patrick, 30; Don Shadel, 32; John Talbutt, 32; and Chuck Wimmer, 32. I'm betting no other divison can match that level of experience.

* * *

"Mr. Clean" Was a Sandian – The laminar flow clean room is probably the most successful case ever of Sandia tech transfer. Invented in the early '60s by Willis Whitfield (ret.), the clean room is used worldwide today by industry and hospitals to provide ultraclean conditions. Annual sales of equipment in the US alone are more than $1 billion. Willis was even dubbed "Mr. Clean" by Time magazine in a 1962 article. That article is reprinted within a special tech transfer section about the clean room in this issue. It's a lot of copy, but is one of the Labs' real success stories, and I hope you'll find it interesting. Ken Frazier (3161) and Rod Geer (3163) did the writing.

* * *

He's Done What? – An actual write-up on a Sandia maintenance service request: "(Name of person) has dropped his drawers. The drawers on the right side of his desk have come loose and dropped to the floor. Please repair ASAP."

* * *

Anyone for Camping? – From an article in the July issue of *Dollars & Sense*, the Sandia Lab Federal Credit Union newsletter, talking about qualifying to buy a median-priced home ($267,634) in the San Francisco Bay area: "If you put 10% down on that median-priced home, you'd be financing $240,870. With the Credit Union's 12-year adjustable rate mortgage . . . you would only need an annual income of $77,146 to qualify (assuming that you have no other debts). . . ." Only? Ouch!

* * *

Experimenting with the System – In the "I-should-have-known-better" category: We have been trying a few new things on our new desktop publishing system – various layout "tricks," different typefaces, etc. In this column last issue, I tried a new typeface that I didn't particularly like after the paper was printed. It came out too light, so I decided to try some of the other faces on my type menu. I found one called "Cairo" (see sample paragraph) that looks promising. Would go well with our "inverted pyramid" writing style.

* * *

An Endorsement for Careful Proofreading – Near every copying machine at Sandia is a notice listing materials that are illegal to copy. At the top of the list: "Certificates of Inbedtedness." Tech writer Lori Parrott (3151) brought that one to our attention. •LP

LAB NEWS

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ECP Needs You

ECP Helps the Homebound Elderly

The 1989 Employee Contribution Plan (ECP) Campaign for United Way is Oct. 9-13. This is the first of several articles to give employees examples of agencies and people helped by our contributions. Other articles will follow in future issues.

Below are some of the thank-you's received by ECP Chairman Dick Shepardson (3550) from HomeCare Resources clients who benefited from an ECP Reserve Fund donation for cleaning supplies. The Fund was set up to meet emergency, one-time needs of United Way member agencies.

"Thank you for the cleaning supplies that you gave to my elderly parents. Thanks to all the employees of Sandia Labs for their kindness in doing things for people who can't afford to buy such things."

"You will never know how much I appreciate what you have done for me. I just got in from the doctor. He removed a skin cancer. Pray for me. I have no one."

"I want to thank all the people who are involved in my receiving cleaning supplies from HomeCare Resources. I have a hard time buying all this stuff."

"I am one of the United Way clients who benefit from your generosity. I'm legally blind and have been receiving help from HomeCare Resources for about eight years. My mop had been stolen from my stoop, so my HomeCare homemaker asked for one to be included in the generous gift I received."

"The cleaning supplies came in very handy and helped my meager funds stretch."

"Thank you and HomeCare Resources for the Tide and all. I am sick, but I'm trying to get around."

HomeCare Resources employs trained, paid workers (whom they call homemakers) who go to clients' homes. These homemakers noticed that many clients often didn't have the proper cleaning supplies or equipment and asked that cleaning supplies somehow be supplied. "The money for the cleaning supplies was a godsend," says Carol Jordan, HomeCare Resources counselor. "Homemakers were making do with the things the clients had on hand. One woman had a mop with three strings and another only had a bottle of pine cleaner to clean everything, including laundry."

HomeCare homemakers provide various home-cleaning services and help prepare meals. They provide transportation to the doctor, lab, or clinic; do errands, including grocery shopping; and help with personal care. Other services provided by homemakers include community service contacts, paying and mailing bills, correspondence assistance, and supervising children.

Most important, though, is the companionship and emotional support the homemakers give people who might otherwise be lonely and isolated. The typical client referred by United Way is someone living alone, who can't drive, and is on a fixed income. Homemakers also provide a respite for people who must care for a disabled or handicapped spouse. "Even if the spouse just needs a break to take a nap or get out of the house for a while, our homemakers can help by staying with the client," says Carol.

There's also help for new mothers and people recovering from illness or surgery who have no one else to care for them. For a list of HomeCare Resources' services, call 883-1222. •JW

Congratulations

To JoNon and Kevin (5132) Eklund, a daughter, Danika Elizabeth, Aug. 15.

To Anna Marie and David (7481) Van Ornum, a daughter, Sarah Lynn, Aug. 19.

'Just Get a Foot in the Door'

Forty Years Later, Ernie's Packed With Memories

Ernie Alford (8161) remembers every one of the 40 years Sandia has been in existence; in fact, his employment with the Labs began April 11, 1949 — some six months before AT&T took over its operation. He plans to retire early next year and recently shared some of his Sandia memories with the LAB NEWS.

As a young man just out of the service, Ernie had to drop out of college and find a job after his father, an Air Force pilot, was killed in a flight accident at Kirtland Air Force Base. He was hired by Bill Jamieson (ret.) and remembers Bill's words at the time: "Take any job here you can, just to get a foot in the door; then you can move around and choose your career path later. . . ."

Ernie followed Bill's advice. Even though he had been a chemical engineering major at UNM, he began his career in the electronics shop outside the tech area, while he waited for his clearance — just as employees do today.

Recurring flash floods provided exciting times during those days outside the fence, he says. Water would pour in under one roll-up door of the shop, flow across the floor, and run out under the roll-top door on the other side. "Employees would just lift their feet and wait for the water level to go down," Ernie recalls.

After-Dark Encounters

His first "inside-the-fence" job was as a taxi driver, which drove him (so to speak) even further from his engineering major. Ernie recalls how frightening it was, when he was working in outlying areas after dark, to hear the command "Halt!" come out of the shadows.

"Military-base sentries expected you to drop your badge on the ground, step away 10 paces, and then recite information about yourself as they checked your ID," he says. "If the sentries had to shout the "halt" command twice, the next sound you'd hear was the bolts clicking into place on the guns they carried."

While serving in the motor pool as a dispatcher, Ernie says he pulled stunts that would never be tolerated today. He recalls one incident in particular — the day he decided to even the score with a friend who had doused him with water. Ernie set a bucket of water atop the entrance door of the motor pool, in anticipation of his buddy's arrival. Murphy's Law prevailed, however, and their department manager showed up first.

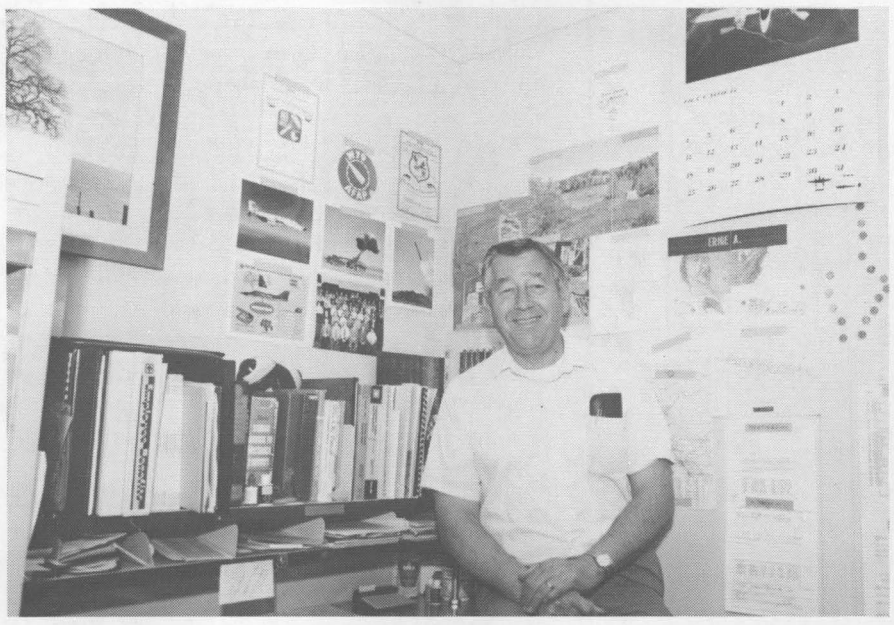
Quick to react, Ernie grabbed the pail off the door, slipping at the same time and dousing himself. "The totally unaware DM was just pushing the door open and thought he had knocked me down as I was carrying the water outside," says Ernie with a grin. "He apologized profusely; meantime, my buddies were breaking up laughing."

Even though he had some fun on the job, Ernie remained serious about his future. He was the first Sandian to apply for — and receive — financial aid under a new program in the mid-'50s for employees who wanted to further their college education. His tuition and books were paid for, and he was given a limited amount of time off to continue his engineering studies at UNM. Meanwhile, he moved to the electronics shop and then on to an engineering group, where he worked on Mk17 sled and flight-test activities.

Transfer to Livermore

In 1956, he was asked to transfer to Livermore. Though he was reluctant, Ernie made the move with his wife and family in November, just seven months after the new branch had officially opened to provide support for Lawrence Radiation Lab (now Lawrence Livermore National Lab).

Ernie worked on arming and firing and, for the next few years, did a lot of testing work with Lawrence Lab employees at the Nevada Test Site.



ERNIE ALFORD'S (8161) office is full of memorabilia from his 40-plus years at the Labs.

The infamous 1957 "Diablo" test provided a memory he'd just as soon forget: "When the unit didn't detonate, I observed from a considerable distance as three men [one was Sandian Bob Burton, who retired in 1981] gingerly climbed the 500-ft. steel tower to disarm the bomb."

Because traveling to the test site shortchanged him on the time he needed to finish his degree, Ernie transferred to telemetry development — a job that allowed him more time for course work. In fact, by the time he graduated in 1968 from San Jose State with a bachelor's degree in industrial engineering, he'd taken so many courses that he had a triple major — in chemical and electrical engineering and management administration.

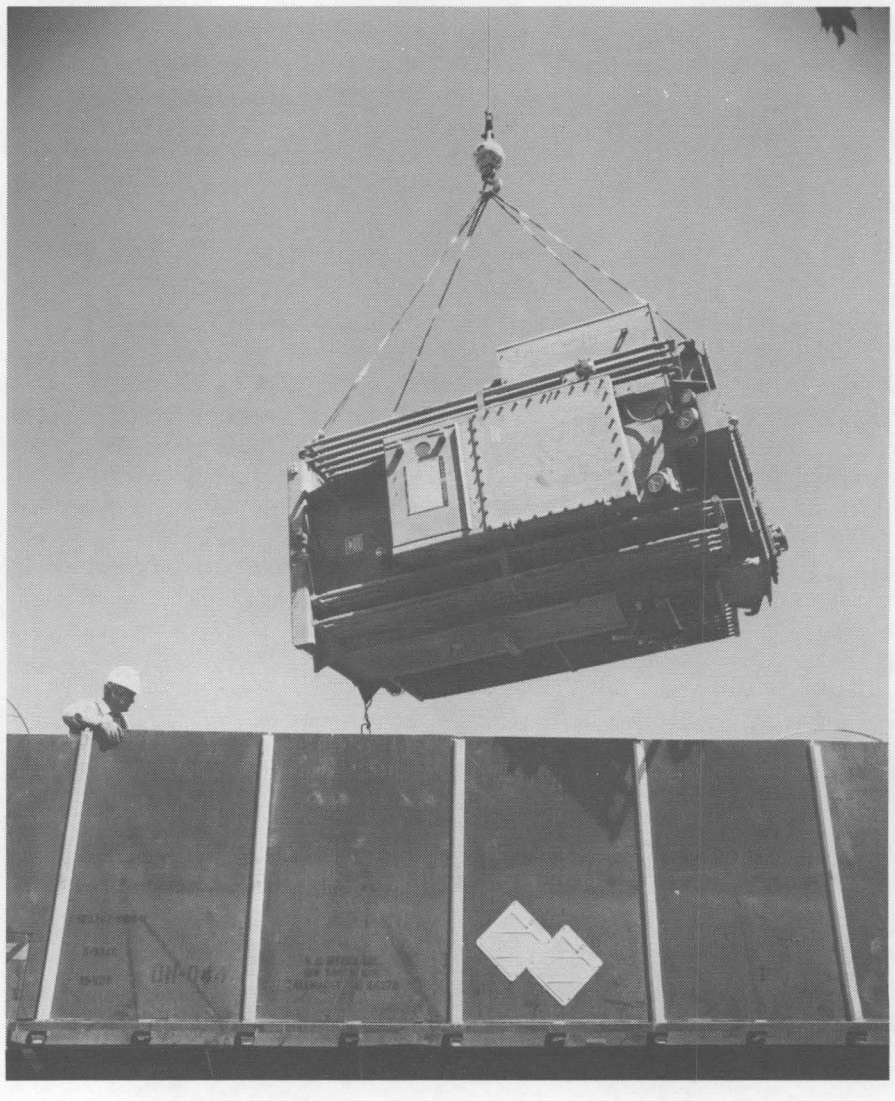
In 1959, meanwhile, he'd been named an electronics section supervisor, with responsibility for developing facilities for electronics fabrication and inspection, printed circuits, and transformer development. In 1965, he was promoted to supervisor of the Materials Management Division, a job he held for the next 12 years.

Remembering Bill Jamieson's advice, Ernie felt overdue for a move in 1977, so he left supervision behind and became an MLS in the Safety Division, where he worked on hazardous-material packaging and also taught Sandia, LLNL, and DOE classes on packaging requirements.

One more move was in the offing — in 1981, to the Program Control (now System Control) Division — where he's supported gas-transfer-system and Joint Test Assembly programs.

What's in store for Ernie after retirement? "My wife and I like Livermore and plan to remain here in our home," he says. "We'll have a lot more time for our hobbies and for our four grown kids and their kids." Ernie enjoys tennis and plays regularly with the same group. And he's looking forward to continuing his wood-sculpturing with saw and drill, as well as jewelry-making and model-airplane building. •BLS

SANDIA LIVERMORE NEWS



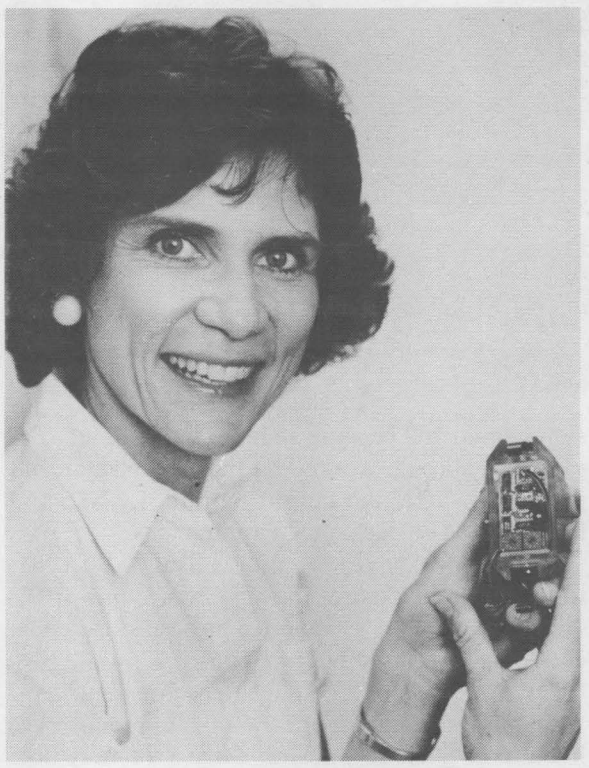
ONE FOR THE ROAD — Two giant transformers at Sandia, Livermore, weighing in at 12 and 14 tons, recently were removed from the premises. The transformers operated east of the steam plant for 30 years. When they were originally brought to Livermore by railcar, the event made front-page news as the largest delivery of utility equipment ever unloaded in town. The units have been trucked to Ohio, where a firm will dechlorinate the PCB oils and recycle them.

(Continued from Page One)

MIDS Sensor

break-beam detector that signals a break in the IR beam across — for example — a path.

A MIDS unit — including eight detectors, a monitor, a state-of-health beacon that transmits a signal every 10 minutes to assure the remote operator that the monitor is working, and associated



DORI MILLER (9235) holds a MIDS seismic detector used for demonstrations. Its transparent cover allows a view of the Sandia-developed circuitry inside.

mounting hardware and antennas — fits into a canvas bag measuring 16 x 7 x 4 inches. It weighs 5 to 7 pounds.

In the field, the seismic detectors, each programmed with a different code (to indicate different positions in the surveillance area), are buried so that their very thin antennas — looking much like blades of grass — are the only parts above ground. If it's necessary to detect the passage of people or vehicles along a path or road, the infrared unit (a beam emitter and beam-break detector) is also deployed.

"All components have a 1-watt RF [radio frequency] transmitter," notes Dori, "which gives you line-of-sight transmission capabilities of up to 6/10 of a kilometre [1/3+ mile] in the jungle or about 10 miles in open desert.

"We just finished a relay unit — a receiver and transmitter — now in production, that will provide a capability to transmit a greater distance. It will receive the ID code from the sensor, then retransmit it to a monitor farther away."

How low-cost is the MIDS, really, in comparison to other systems? *Very* low-cost, says Dori: "For example, the Army's REMBASS [REMote BAttlefield Sensor System] unit — one monitor and eight seismic sensors — costs $85,000; a MIDS unit costs less than $3000. Keep in mind, however, that REMBASS is for use in large battlefield management systems — by a tank division, for instance. The MIDS, on the other hand, was designed for use by patrol-sized units, and works very well for that application."

Several Reasons for Low Cost

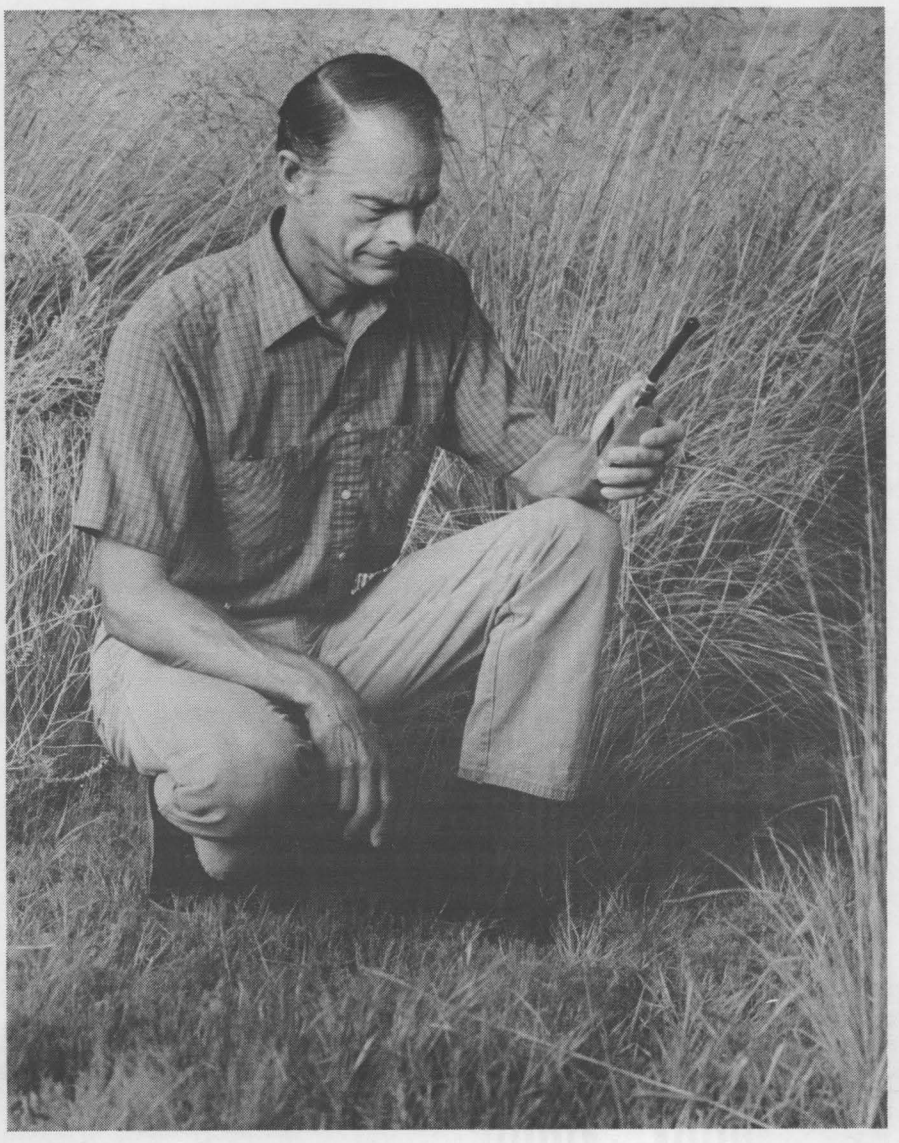
The reasons for the MIDS' low cost are several: A single-channel system is used (rather than a selectable RF channel at each sensor); no microprocessors are used; common 9-volt batteries power the unit; and MIDS is built to best commercial quality, rather than to more costly military specifications. All components are off the shelf, though Sandia designed the circuitry.

The biggest challenge in MIDS development, according to Dori, was adhering to the "KISS" (Keep It Simple, Stupid) principle. "Simplicity is a key to low cost," says Dori. "But when creative technical people are working on a program, it's very difficult to forget about ideas that pop into one's head — ideas that, in the long run, could add a lot to costs."

After the US Army tested the MIDS in 1987 and 1988 at its Tropic Test Center in Panama, some minor modifications were made — on gaskets and potting material — to make the unit more impervious to moisture in a jungle environment. Going to the other extreme, the MIDS will undergo cold-weather testing this winter in Alaska and Vermont.

Dori estimates that some 5000 MIDS units are now in use worldwide. Besides being used by land-based military units, the system is also being used by other US agencies: the Bureau of Land Management (for detecting poachers, protecting archaeological sites, and monitoring drip-gas facilities); the Drug Enforcement Agency (at landing sites where drugs may be coming into the country); and the aforementioned Immigration and Naturalization Service (for border monitoring).

And the angry Pecos rancher? "I referred him to Qual-Tron," says Dori. "He was ready to place an order." •PW



CAN YOU SPOT THE ANTENNA of seismic detector buried by Tom McConnell? Clue: If Tom's dark socks weren't there for background, you'd probably think the antenna was just another blade of grass. It's barely visible as a streak against his left pant leg. Tom's holding the compact monitor that's used at a distance to pick up ID signals from the detector.

In the Beginning: "McNamara's Line"

In the summer of 1966, the Jasons — a brainstorming team composed of top university scientists — sent a report to then-Secretary of Defense Robert McNamara suggesting the feasibility of a "fence" as an alternative to the massive, costly, and relatively ineffective aerial bombing campaign being conducted in Vietnam.

The Jasons suggested that the fence — between North and South Vietnam, and extending into the Laotian panhandle — should consist of physical barriers and sensors, the latter to be sown by aircraft that would also monitor the sensors' output. Such a fence, it was theorized, could be used to detect — and block — convoys delivering supplies to the enemy, without the enormous cost in US lives and equipment then being incurred.

That September, McNamara appointed Lt. General Alfred Starbird as head of the Defense Communications Planning Group (DCPG), which would plan and later implement what came to be known as "McNamara's Line" in Vietnam. Though the DCPG looked to various large defense electronics manufacturers for help on designing sensors for the project, Gen. Starbird also asked for — and got — assistance from Sandia.

Tom McConnell (DMTS, 9235) went to Washington as the Labs' DCPG representative. (Besides Tom, many other Sandians eventually were involved in the effort.) "Though I admit I had a few reservations," says Tom, "Gen. Starbird was very insistent on our involvement, and, subsequently, we had major responsibilities for sensor design."

Rapid Response

In less than a year, Sandia — working with David Israel, who was in charge of engineering for the DCPG — had designed and built the ADSID (Air-Delivered Seismic Intrusion Detector). The ADSID, a mainstay of the McNamara Line, was part of the "Phase III" family of sensors — both air-delivered and troop-deployed — eventually used in Vietnam.

In a story last spring, *Aerospace Engineering* magazine reports that the first effective test of the new tactical warfare concept took place during the siege of the Marine base at Khe Sanh in the northwestern corner of South Vietnam in early 1968. The 7th Air Force dropped seismic and acoustic sensors along likely avenues of enemy approach to the base.

When the siege was broken in April, base commander Col. David Lownds estimated that, without the sensors, casualties would have almost doubled. And, observes *Aerospace Engineering*, "After Khe Sanh, sensors became part of the standard operating procedure [in Vietnam]."

$1 Billion in Annual Domestic Sales

Sandia's Laminar Flow Clean Room Helped Make Microelectronics Age Possible

When Willis Whitfield (ret.) invented the laminar flow clean room — arguably the most successful case of technology transfer ever to come out of Sandia — he was sure someone else had already done it.

"I went over to Gene Newlin in Patents and asked if it was much trouble to do a patent search on clean room design," says Willis. "I thought, this thing is so simple that somebody has to have thought of it and found something wrong with it. It's too simple, it's too obvious. There was so much effort and money going into clean rooms that it would not have been overlooked. I was convinced.

"A patent search turned up nothing. Then I talked to my section supervisor, Pat Quigley. He said the idea was interesting and asked if I had it written up. I said no, I just have a few sketches.

"He really got onto me. He said, 'We'll get you an engineering notebook and you start drawing these things up. You're on to something here.' I still was not convinced, but anyway I wrote it up in the engineering notebook and then filed a patent disclosure."

Major Success Story

Willis's modest, unassuming manner has not diminished in the nearly three decades since then, despite the fact that the idea he thought had already been invented — but hadn't — soon thereafter mushroomed into a major industrial success story, with today more than $1 billion in annual domestic sales alone. The laminar flow clean room was such an extraordinary improvement over previous cleanliness capabilities that the electronics and aerospace industries, hospitals and pharmaceutical companies — any group that needed ultraclean conditions — quickly adopted it for their own needs.

It is generally considered that without his invention, the microelectronics age probably would have been impossible, or at least much more difficult.

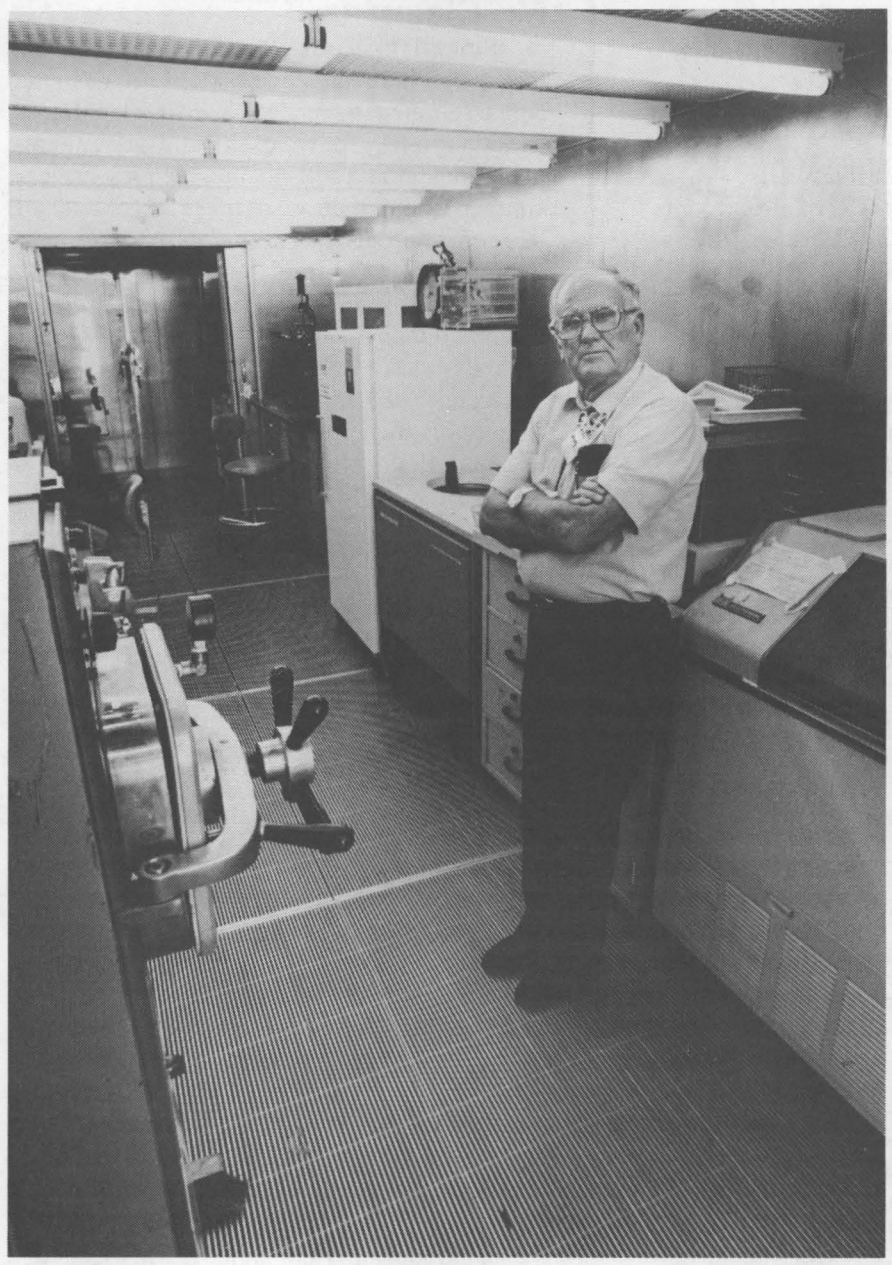
"It has probably had the single largest impact on our current semiconductor and computer industries as any development I can think of," says Gordon King, a semiconductor facilities expert. "It made it all possible." From 1965 to 1982, Gordon was with Texas Instruments, responsible for designing all the company's semiconductor clean rooms worldwide. He was involved with the Sandia development while a section supervisor at Sandia in the early 1960s and later pushed Federal Standard 209 (see "Defining Clean Air").

"It was a revolutionary development," says Doug Ballard, now retired, who was Willis's division supervisor at the time. "It was not a minor improvement. It was an improvement [in air cleanliness] by thousands of times. And there has been no basic improvement since that time."

"I thought, this thing is so simple that somebody has to have thought of it and found something wrong with it."

The nation's electronics industry was in "a real mess" until the clean room came along, says Doug. "A dust particle or a human hair or any other object of that size could short out a circuit or otherwise compromise its integrity. There was no way we could prevent the things from being damaged by a grain of anything."

In a sunny, glass-enclosed portico in his pleasant ranch-style home in Albuquerque, a few miles north of the Sandia complex where he spent his 30-year career (1954-1984), Willis displays boxes of reports, records, and memorabilia from those years.



IN 1983, SANDIA'S ORIGINAL CLEAN ROOM was still in operation and being used as a biology lab for the sludge-irradiation program. Willis Whitfield, still on roll at the time, demonstrated the room's essential features: A large uniform flow of filtered air sweeps down from the ceiling, removing particles via the floor grating.

Among them is a bronze replica of the Holley Medal (the original is in a bank vault), which he received from the American Society of Mechanical Engineers in 1969. The medal goes only to one "who by some great and unique act of genius of an engineering nature has accomplished a great and timely benefit." Other winners have included Henry Ford, and Nobel laureates William Shockley (the transistor) and Ernest O. Lawrence (the cyclotron). There's also a program for the 1981 Awards Banquet of the Institute of Environmental Sciences, noting the first Willis J. Whitfield Award (for the top contamination-control paper).

First Drawing in 1959

Willis recently rediscovered among all these materials the first drawing he made of the entire clean room concept. Neatly drawn and lettered on yellow engineering graph paper, his "Cross section of proposed clean room" shows the familiar smooth, parallel flow lines of air through an entire, filtered wall, down past a laboratory bench, and out through an all-floor grating. The necessary filters, blower, and floor grating are also delineated.

"This I drew up probably in late 1959," he says. In reports published years later, not to mention the first federal-guidelines document defining clean air (see page nine), there are clean-room drawings virtually unchanged from that version Willis first put to paper 30 years ago this year.

How this all came about has been told often (LAB NEWS, Sept. 16, 1983, for example), but the main points, recently recalled by Willis for the LAB NEWS, bear recounting.

Willis, a Texas-born physicist, was part of a Sandia group that was responsible for helping solve problems in advanced assembly and manufacturing of electromechanical weapon components. Miniaturization was becoming increasingly important, and contamination by small particles was increasingly a problem.

A Pennsylvania company making mechanical timers for weapons had an expensive clean room, supplied by Sandia, that wasn't getting the job done. Every morning, dust could be seen on all the work benches. Such rooms were, says Willis, essentially tight air-conditioned rooms with a lot of attention paid to the design and cleaning of walls, floors, and ceilings.

"It has probably had the single largest impact on our current semiconductor and computer industries as any development I can think of."

Most rooms depended mainly on mechanical means for cleanup. Well-operated rooms had a full-time janitor for each 100 square feet of surface. "A normal-sized room might have several janitors," Willis recalls. "It was a mess and expensive. A room had very little recovery capabilities of its own."

"All the rooms were pretty much carbon copies of a bad idea," Doug Ballard says.

Willis and his colleagues went on a tour of such "clean rooms" in the East, where they saw the problems firsthand. In conversations with scientific colleagues, especially at Bell Labs, they began questioning and understanding how the rooms worked — and didn't work.

"We visited about a half dozen clean rooms in a week's time, and it was the same story," says Willis. "People were struggling to get their rooms clean. The only saving factor was that the require-

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(Continued from Page Five)

Clean Room

ments at that time just weren't that stringent." But Bell Labs was getting into microelectronics and had an intense interest in controlling contamination. So did many other laboratories.

'Radically Different Approach'

"It occurred to me," recalls Willis, "that instead of trying to upgrade the type of clean room we had at the time, some radically different approach was necessary. People had already tried flushing the rooms out with more air, but this just resulted in a lot of high-velocity, highly turbulent air. It was just unworkable." Willis says he was surprised to learn that much effort had gone into trying to solve the problem, without success.

He then came up with the idea of using a whole wall or a whole ceiling as an air-entry area. "The original idea was basically sort of a combination of a wall and ceiling," he says.

"If we could mechanically and economically afford to have an entire ceiling as the air-entry point and take the air out through the floor, through a grating, then it might work."

The key was a smooth, unidirectional flow, all the air moving down (or across) through the room, with practically no variance in speed or direction throughout the entire area. This was the laminar flow concept. The incoming air would pass through high-efficiency particulate filters, then through the room, carrying the dirt from it. Once the air in the room was clean, it would stay clean.

"The Air Force had a crew — a colonel and several lieutenants — down here almost the next week."

He at first thought the amount of air required would be prohibitive. But he did a bunch of calculations. He talked to Plant Engineering about the amount of airflow people can work in and still be comfortable. He did more calculations. It began to look workable.

"I began to realize this idea might really solve the problem," he recalls. That's when he went to Patents. (The patent was issued in 1964.)

In fact, the laminar flow clean room did solve the problem. It did so well that when Willis and his colleagues put a particle counter in the first working model — a quickly contracted and built 8-by-10-ft. clean room — they got no particle counts at all. They thought something was wrong with their counter. Repeated tests showed between zero and 10 particles a half-micron or larger per cubic foot of air. (A micron is a millionth of a metre).

Willis feared nobody would believe such a low figure, so to be conservative, his group decided to state the capability as allowing a maximum of 100 particles of that size per cubic foot. "Even then, we were a factor of 1000 better than the cleanest clean rooms of the day," says Willis.

Willis presented the first formal report about the work, titled "A New Approach to Cleanroom Design," at the national meeting of the Institute of Environmental Sciences in Chicago in April 1962 (see "We Haven't Told Whitfield Yet"). A thousand or more people were at the meeting, and — among those interested in clean rooms — word about the advance spread "like a forest fire." At the same time, *Time* magazine published its news story (see reprint above). Other publications quickly followed. With that, says Willis, the news scattered "to the four winds." The response was "overwhelming."

The military, the Air Force particularly, was very quick to respond. "The Air Force had a crew — a colonel and several lieutenants — down here almost the next week," Willis says. "That became a very happy liaison. They could see the benefits, because they were building missile radars and

"This guy waved this report all the way across this big restaurant and said, 'I've got something to tell you, I've got to get with you.' "

were having a lot of problems. They were one of the real early users of the clean bench. When they could see what could be done, they jumped in with both feet."

Over the next year or so, Sandia was inundated with requests for information and visits.

The flood of industrial visitors was a security problem. "Sandia, as a result of this, had to develop procedures and methods for handling people coming in," says Willis. "Finally someone came up with the idea of escorting these people in with guards."

One of the first groups was from RCA. RCA head David Sarnoff read of the work, apparently in *Time*. He immediately told his people to get with it and build a facility based on the concept. RCA had a whole team of engineers from its Lancaster, Pa., color-picture-tube plant at Sandia the next week. "They had the whole team down here, the plant manager, the plant engineering manager, the whole works," says Willis. "Within a month, they had a roughed-out design of a 20,000-square-foot downflow clean room."

First Large Clean Room

It was the first large laminar flow clean room built. It was a gutsy move. "I thought it was very daring of those people to go to 20,000 square feet, which at that time meant several million dollars — a lot of money in those days — and to go with an untried principle, based just on our lab work," he says.

"I had never seen a scale-up like that. There was no question in my mind that it would work, and there wasn't in their minds either. Sarnoff said it would work."

RCA was the major color-tube manufacturer in the world at that time. "They then had about a 50-percent failure rate. That was big bucks, not trivial," says Willis.

RCA's 20,000-sq.-ft., Class-100 clean room began operation in 1965. A short time later, Willis was giving a paper in Miami, Fla. At lunch, the RCA delegation came in and saw him. "This guy waved this report all the way across this big restaurant and said, 'I've got something to tell you, I've got to get with you.' All these people were looking, and I was scooting down in my seat.

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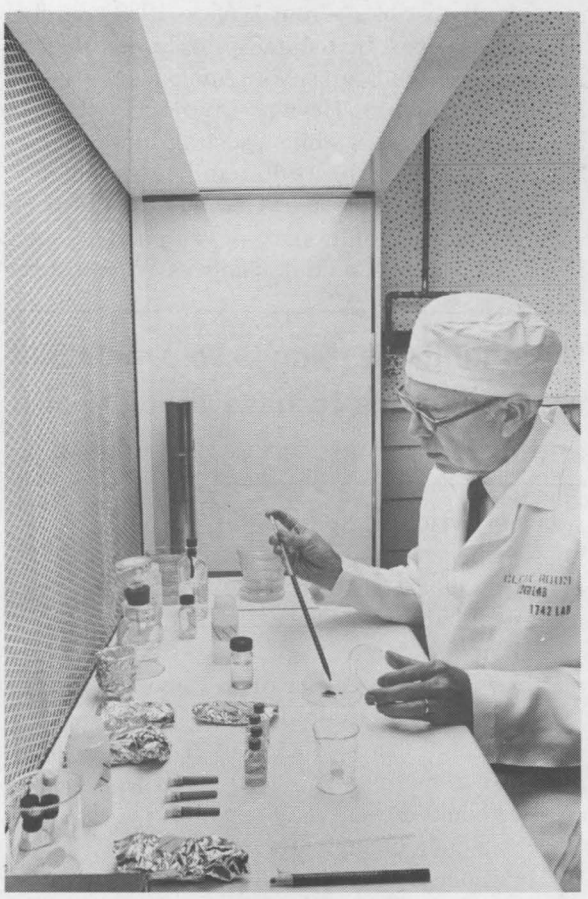

EARLY LAMINAR AIR FLOW WORK STATION: Filtered air passes from filters in the grilled wall at left and flows over the work area.

SANDIA TECHNOLOGY TRANSFER

Time Featured Clean Room

This *Time* magazine article, dated April 13, 1962, produced a flood of inquiries on the laminar flow clean room invented at Sandia by Willis Whitfield.

Mr. Clean

Scientists at the Sandia Corp. in Albuquerque, where nuclear weapons are designed and assembled, have a passion for cleanliness. They have to. As weapons components are made smaller and still smaller, the presence of a single particle of dust can make larger and still larger trouble. The strictest housekeeper in all Sandia is Texas-born Physicist Willis J. Whitfield, creator of the Whitfield Ultra-Clean Room. "I thought about dust particles," he says with a slight drawl. "Where are these rascals generated? Where do they go?" Once he answered his own questions Physicist Whitfield decided that conventional industrial clean rooms are wrong in principle.

The usual system in clean rooms, which are necessary for an ever-increasing number of industrial operations, is to keep dust particles from being released. Smoking is forbidden; so are ordinary pencils, which give off graphite particles. People who work in the clean rooms are "packaged" in special boots, hoods and coveralls and are vacuum-cleaned before they enter. The rooms themselves are vacuumed continually. But despite all these precautions, each cubic foot of their air still contains at least 1,000,000 dust particles that are .3 microns (.000012 in.) or larger in diameter. This is a vast improvement over ordinary air, but Whitfield was sure he could do better. Abandoning the idea of keeping dust particles from being generated, he decided to remove them as soon as they appear.

The Whitfield Ultra-Clean Room looks like a small metal house trailer without wheels. Its floor is metal grating. It is lined with stainless steel, and along one wall the workbench faces a 4-ft. by 10-ft. bank of "absolute filters" that remove all particles above .3 microns from a slow stream of air. Most clean rooms use their filters simply to clean up incoming air. Whitfield's trick is to make the clean air from the filters keep the room clean. It flows at 1 m.p.h. (a very faint breeze) across the workbench and past the people working at it. Workmen can dress in ordinary clothes and smoke if they desire. Dandruff, tobacco smoke, pencil dust and any other particles generated are carried away by the clean air, whisked down through the grating floor, and discharged outdoors. Every six seconds the room gets a change of ultra-clean air. No particles get a chance to circulate, and as a result, Physicist Whitfield's room is at least 1,000 times as clean as the cleanest of its competitors.

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"But what he had to tell me was very fascinating. They had just gotten approval from their accounting office to write off the cost of this facility in one year's savings. He said the clean room had more than paid for itself in the first year of operation. The rejects went down from just less than 50 percent to less than 20 percent."

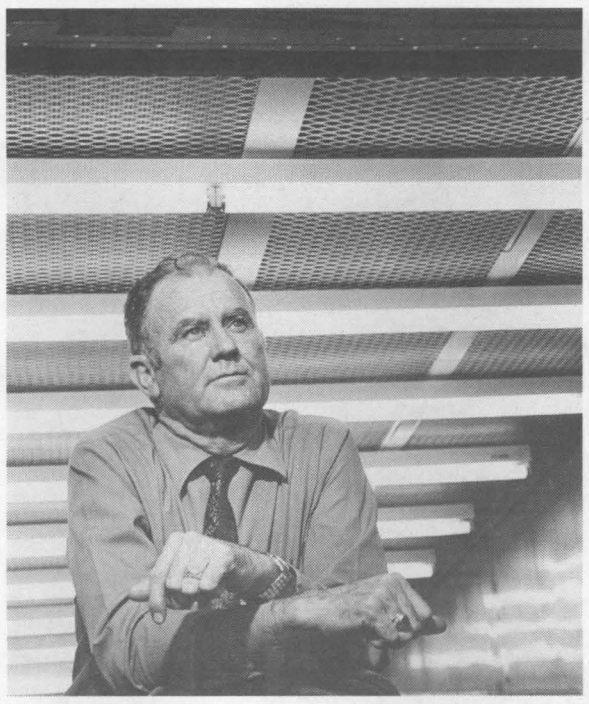
'A Lifesaver'

What had been happening, says Willis, was that dust had been clinging to the three electron guns in a picture tube, causing an arc breakdown. "When they got rid of the dust, the failures went to a very low level, less than 20 percent. They were able to trim way down after that. The contamination control was a lifesaver."

About that time, Willis got a request from Zenith to come give it a hand in setting up its color-picture-tube line, which he did. "They did it a little differently than RCA. RCA just built a big massive facility of 20,000 square feet, whereas Zenith just put it over their picture-tube line. They cleaned out the air just over the line. Of course, by that time, we had learned enough to know how to do that. This greatly reduced the cost."

Willis also gave similar assistance to Western Electric. He spent a lot of time at Western Electric's Allentown plant, which made printed circuit boards that were very sensitive to dust. At Western Electric's Indianapolis location, Willis was in on design of the company's first plant for producing touch-tone telephones. "At Allentown, we had to modify existing buildings, but in Indianapolis, the unique part was that I was in on it before they even broke ground, which made it really fun. Of course, it was all for the AT&T telephone system."

Western Electric must have been happy with the results. "One of the real interesting things — a personal gratification — involved the plant manager there at Allentown," says Willis. "He had a standing order with the receptionist: Anytime I came in that plant, he wanted to know about it. I took that as appreciation for what we had done for Western Electric."



A YOUNGER WILLIS WHITFIELD, in an early publicity shot, is shown outlined against the ceiling of the laminar flow clean room that he invented in the early '60s.

By 1966, laminar flow technology was quickly coming into widespread use in the US and was getting started in Europe. Thirty manufacturers were advertising "laminar flow" products. The Bataan Hospital (now Lovelace Medical Center) in Albuquerque put the first laminar flow surgical suite into operation that year. A number of other hospitals were planning or considering laminar flow operating rooms. NASA was beginning to complete clean rooms for support of the space program (see "The NASA Connection").

By 1972, laminar flow equipment was in widespread use in Japan, Europe, Australia, Asia, and Africa. More than 50 companies were making it. Laminar flow was being used in orthopedic surgery and in manufacturing heart pacemakers. By 1973, M.D. Anderson Hospital in Houston had 22 laminar flow leukemia treatment rooms. Lawrence Livermore National Laboratory was using a large high-bay laminar flow clean room for controlling contamination in its Sheva-Nova laser fusion research program. By the mid-'70s, laminar flow was in use in operating rooms in more than a thousand hospitals in the US.

Contributions by Hundreds

The laminar flow principle had been carried from laboratory to production hardware to mature industry in little more than 10 years. Willis points out that hundreds of persons in industry, government, the military, and private life contributed to this achievement by developing hardware, adding numerous innovations, and having the vision to apply the technology to fields far beyond industrial clean rooms.

Willis Whitfield, after his seminal invention and hectic years of helping establish laminar flow clean rooms all over the country, is now a relaxed and fulfilled man. He can lean back in his chair, surrounded by the mementos of that achievement, and realize the social good that came from it.

"It was a very gratifying experience to have done something that really helped, really made a difference," he says.

"You like to do something that gives you a sense of accomplishment.

"The old country boy finally did something that was really worthwhile." •KFrazier(3161)

Clean Rooms: A Multibillion Dollar Business

What Willis Never Would Have Predicted

Back in the early '60s, when laminar air flow clean room technology was first being transferred from Sandia to some pretty notable companies — Western Electric, Zenith, and RCA, for instance — Willis Whitfield generally was too busy to muse about what size the clean room industry might become someday.

"In fact, when things were just starting," Willis says, "I recall thinking that there weren't a lot of places then operating that needed Class 100 or even Class 1000 clean areas.

"By the mid-'60s, I was figuring that we probably had, in clean rooms, clean hoods, and related apparatus, a domestic industry that could exceed $500,000 in annual sales," Willis says. "But many businesses — some that I never would or could have predicted — started jumping on the clean-room bandwagon.

"Here's a for-instance. Factories that didn't need that kind of cleanliness for their operations became interested for another reason — possible reduction of janitorial costs, because work areas would simply be cleaner if they installed laminar flow systems.

"Also, I couldn't have predicted the birth and growth of the microelectronics industry."

It Surprises Even Willis

So, it's not hard to see why Willis Whitfield can still be somewhat taken aback when he reads that domestic sales of clean rooms and components topped $1 billion in 1988, and that experts predict sales to keep climbing.

Bob McIlvaine, president of The McIlvaine Company (Northbrook, Ill.), which prepared an exhaustive report, "Clean Room Industry 1986-1996," predicts that domestic sales for 1990 will be between $1.2 billion and $1.8 billion.

He also believes a worldwide market — including Warsaw Pact countries — could be $5 billion in 1990. In fact, McIlvaine published that prediction, attributed to a West German expert, in his *Clean Room Design Newsletter* in late 1987.

"In addition to the growth in end-user industries such as pharmaceuticals and electronics," McIlvaine says, "the trend toward cleaner work spaces is having a big impact — cleaner means costlier. The cost of HEPA filters per square foot of floor space is only $4.50 in a Class 100,000 room, but is $21 in a Class 10 room."

Echoing McIlvaine's optimistic view is Andrew Witter, publisher of the two-year-old *CleanRooms* magazine.

"The total clean room market has strong growth potential in all industry segments," he says, "although some areas present greater expansion opportunities than others. Increased microelectronic applications, newer and emerging non-semiconductor applications — pharmaceuticals, medical, and food, for instance — as well as more sophisticated process equipment demands, will help fuel market growth at an average annual rate of 17 percent through 1992."

Market research by *CleanRooms* magazine isn't quite as optimistic as the McIlvaine predictions, but totals are in the same ballpark. Says Witter, "The total domestic clean room market should top $1.3 billion in 1992." (His projection for worldwide sales by 1990, exclusive of the Soviet Bloc: an upper end of $3 billion.)

More Clean Rooms in Food Industry

The *CleanRooms* magazine research team concludes that the food industry has perhaps the greatest potential in terms of new clean room uses. "Cheese production, beer and other beverage filling lines, and newer food-processing steps that will eliminate the pasteurization process are examples of new clean room applications by this industry," Witter says.

"In addition to the industries that currently require clean rooms for manufacturing, newer industries such as printing and film-making special effects are beginning to experiment with clean rooms to help eliminate different aspects of particulate contamination."

Keeping clean rooms properly equipped, McIlvaine points out, is another growing industry of already-substantial size. "Total yearly expenditures for clean room garments, supplies, and services," he predicts, "will rise to $378 million in 1990."

And, Witter adds, "Perhaps the most dramatic product improvements will come in the category of garments. Since it has long been established that clean room personnel are the largest single contributor to contamination problems, garment manufacturers are continually researching new fabrics and manufacturing methods with the ultimate goal in mind of making the clean room cleaner."

Some Saw Clean Room's Potential, Others Needed Persuasion

Quick recognition of the laminar flow clean room's potential by top industry officials and scientists may have been the reason it was so readily embraced. Yet it didn't happen automatically.

"Looking back on it, if I were to cite a single reason for the quick spread of the clean room," says inventor Willis Whitfield, "it would be that the people who were really in the forefront of technologies recognized it. People like [David] Sarnoff [of RCA], like the General Motors research-laboratory director, like Western Electric and Bell Labs people — they saw it as something that was going to work and that would be needed."

'They Were Not Dummies'

"They jumped in, no hesitation. Those people knew where they were going, and they knew how to get there. They were not dummies from the standpoint of recognizing applicable technology. I think that was really the big reason the thing caught on."

It is ironic that while top management and scientists at companies recognized the potential, those working directly on existing clean rooms did not. "They had very little sense of what this unidirectional airflow would do for them, but the scientific people, the top administrative people, knew immediately," Willis says.

"People in the right position who needed it just grabbed it and ran with it. We didn't have to sell them. They came running to us."

But that wasn't true with everybody. And it didn't happen without hard work. Sandia organized an aggressive effort to inform industry about the extraordinary new capability.

"I don't agree that it sold itself," says Doug Ballard, supervisor of Willis's division (Advanced Manufacturing) at the time. He calls Willis's unidirectional flow concept "a beauty of a concept" and a

. . . "a beauty of a concept" and a "revolutionary" advance.

"revolutionary" advance, but he says it nevertheless didn't become immediately known — or understood — by everyone who could make use of it.

Doug was there throughout it all, and he helped run the campaign to inform industry. "Without the help of management and of Jim Mitchell [3160, who handled the media and other publicity though the Public Information Division], the concept might never have been widely accepted."

(Doug retired in Albuquerque in 1983 after a career that began in 1944 with the Manhattan Project at Oak Ridge and Los Alamos and concluded with 33 years at Sandia, beginning in 1950. He's now an accomplished artist, a Southwestern watercolorist, who exhibits at art shows and galleries.)

Management's Full Support

Doug says his group eventually wrote more than 50 reports about different aspects of the clean room concept. A 17-minute film, dramatically showing how smoke injected into a clean room quickly disappeared, was widely disseminated. "I hate to say how many thousands of reports we distributed," he says. "They were reprinted and reprinted and reprinted. They were widely distributed."

DOUG BALLARD (ret.), Willis Whitfield's division supervisor when Willis invented the laminar flow clean room, says, "Management realized that this capability would help not only the AEC, but all of industry." Doug's now embarked on another career; he's a well-known watercolorist, specializing in Southwestern subjects. This 1985 photo shows him at work in his home studio.

Management gave full support to the effort. "We were given a travel budget and authorization to speak and make presentations," recalls Doug. "Management realized that this capability would help not only the AEC [Atomic Energy Commission], but all of industry.

"It's the first real example of Sandia feeling an obligation to help all of high-tech industry solve a problem. We knew we had something good.

"We learned a lot," Doug says of the informational effort. "We learned what to do and what was most effective." And this was before there was any formal "technology transfer" operation at Sandia.

He thinks the experience has lessons still pertinent today. It's "not enough just to put out a news release" about a new Sandia technological advance, he says. "You need to have additional technical reports available. You need to encourage people to present talks. If you don't have a follow-on — a sound basis for getting the technical word out — even a very good idea can get lost and die. You need technical backup to ensure the continuity of bringing a useful innovation to fruition.

"Those people knew where they were going, and they knew how to get there."

"Just because you may have a clever idea doesn't ensure that it will be picked up."

Now, of course, Doug points out, Sandia has an organized tech transfer mechanism to help develop new technologies. Back then, however, they had to come up with the whole effort from scratch.

Willis wonders if today things would be handled differently.

"If this were to come up today, probably the technology transfer would need to be done another way. I think we probably stumbled into it right, and I say 'stumble,' because it was certainly not any expert knowledge that we had. Our public information people were some of my best friends through this. They played this game very, very well. They really did a superb job disseminating the technical information. They did it conservatively and very accurately." •

'We Haven't Told Whitfield Yet, But We Tested the Idea . . .'

Willis Whitfield presented his first paper on the laminar flow clean room concept in April 1962 at the national meeting of the Institute of Environmental Sciences in Chicago. He gave another report in 1963 to a meeting of the American Society for Contamination Control in Boston, which proved to be a very interesting occasion.

"I went into the session to give my paper, and the chairman stopped me at the door," Willis recalls. "My paper was first on the list, and he asked if we could change the order and put my paper last. He said they were expecting a big discussion about it, because it was the first time it had really been presented to the contamination-control community, and there was some controversy attached to it.

" 'Do whatever you want,' I responded."

'People . . . Standing Around the Walls'

"I gave my paper, and there were about three concurrent sessions going on, and the people came from the other two sessions into this one. There wasn't enough room to seat them, and people were standing around the walls, everyplace.

"I presented my paper not thinking a whole lot about it, and I guess I didn't understand why there was so much interest, because I didn't see this as that big a deal.

"Anyway, in the question/answer session, the head of the Baker Manufacturing Company [which made clean rooms based on existing technology] got up and said, 'Your whole thing is a hoax. I don't think this thing is any good.' "

"I said: 'Look, I'm not asking you to believe it. All I'm telling you is what we did at Sandia. Here're the results, here's the kind of instrumentation, and here's the experiment. As a manufacturer, you are free to arrive at your own opinion. In fact, you could set up your own experiment if you disagree with us. As a matter of fact, I would be very much interested if I have overlooked something, because I'm not interested in trying to peddle something that doesn't do somebody some good.'

'Factor of 10 Conservative'

"Then a guy from Bell Labs stood up and said, 'We haven't told Whitfield this yet, but right after we came down to Sandia, we built several of these clean benches and tested the idea ourselves at the Western Electric plant. The only thing we find with Whitfield's work is he's a factor of 10 conservative.'

"Then it turns out that another outfit or two had done the same thing, and all this began to come up out of the woodwork, and this poor fellow from Baker almost got booed out of the meeting.

"I think the success of this whole thing was due to the fact that there were people who quickly realized the potential, then tested it and used it."

SANDIA TECHNOLOGY TRANSFER

First Federal Standard

Defining Clean Air — Sandia Helped Clear the Way

One quick outgrowth of Sandia's invention of the laminar flow clean room was as intangible, yet as important, as air itself — the first federal standard defining clean air. And Sandia was responsible for that too. It became known as Federal Standard 209.

Because nuclear weapons have to work perfectly — once — with no second chance, components and assemblies have to be reliable. Control of airborne contaminants during the assembly processes is crucial. The same is true of new inertial guidance systems and other space-age electromechanical instruments and components.

Yet, in the early 1960s, there was no coordination of standards and specifications for defining clean air.

'Born of Necessity'

"Like most documents of value to mankind," says former Sandian Gordon King, who spurred development of the standard, "Federal Standard 209 was born of necessity." He says the birth came "at a time when the contamination-control industry was floundering with diverse opinions as to the methodology and philosophy of how to define and achieve a controlled, clear environment." There was a "plethora of specifications and standards" and a "total lack of coordination" among the military agencies.

"Everyone had a different way to skin the cat," says Claude Marsh, another former Sandian who played a key role in writing the document.

"I have gone over my files, of twenty-plus years, and have found more than 200 'standards,' and I am sure there are many others of which I was never aware," says Robert Peck in summarizing the history of contamination-control standards. Peck is president of Controlled Environment Equipment Corporation.

Because Sandia is responsible for the reliability of nuclear weapons, the Labs had a strong interest in seeking a scientific basis for bringing all the diverse specifying methods together into one unifying document.

"We decided that it would be a real contribution if we could get everyone talking about the same things in the same terms."

"We decided that it would be a real contribution if we could get everyone talking about the same things in the same terms," Gordon recalls.

The Sandia invention of the laminar flow clean room had made an overall federal clean-air standard possible. Gordon, as Willis Whitfield's section supervisor, had helped nourish the clean room into fruition. Gordon remembers that time with gusto.

"It took us a long time to believe it," he says of the clean room development, "but we had improved the cleanliness of clean rooms by five orders of magnitude."

Tremendous Group Effort

Although Willis conceived the basic concept, Gordon remembers all that followed as a tremendous group effort. He says Sandians Doug Ballard (division supervisor), Claude Marsh, Jim Mashburn, Bill Neitzel, J.A. Paulhamus, and Benny Trujillo, as well as himself and Willis, all deserve credit for sharing in the clean-room development. "The whole group worked on it. I couldn't tell you who did what."

In any event, these new capabilities for achieving air cleaner than ever before possible "transformed this confusion" over diverse standards "to a focused thrust."

Gordon King came up with the idea of writing and proposing a federal standard and then spearheaded the effort to push it through the federal bureaucracy. "I think it was my suggestion to write a Federal standard," he recalls.

Willis Whitfield remembers that time well.

"By then, Gordon King was my section supervisor. He got the idea to set up a federal standard based on our work. Gordon had talked to Claude and me about this. We told him our opinion was that standards could be written based on the laminar flow technology, because we were now in a position to define what cleanliness really meant — and because of the reproducibility and predictability of what would be in a room under certain circumstances. The whole thing was based on that.

"Everyone had a different way to skin the cat."

"Gordon was so interested in it that he finally ended up being appointed chairman of the working group."

Petitioning the GSA

In January 1963, Sandia petitioned the General Services Administration (GSA), through the Atomic Energy Commission, for permission to generate such a standard. "We had to get the AEC to sponsor us. Sandia had to be given the responsibility," Gordon recalls. "It was foreign to Sandia's charter."

Sandia simultaneously started drafting what the Sandians considered its essential provisions. Claude Marsh and Willis Whitfield were key players. Gordon King says Claude's contribution was extremely important. "We haven't given Claude enough acknowledgment," he says. "He was a tremendous spark plug in writing the federal standard."

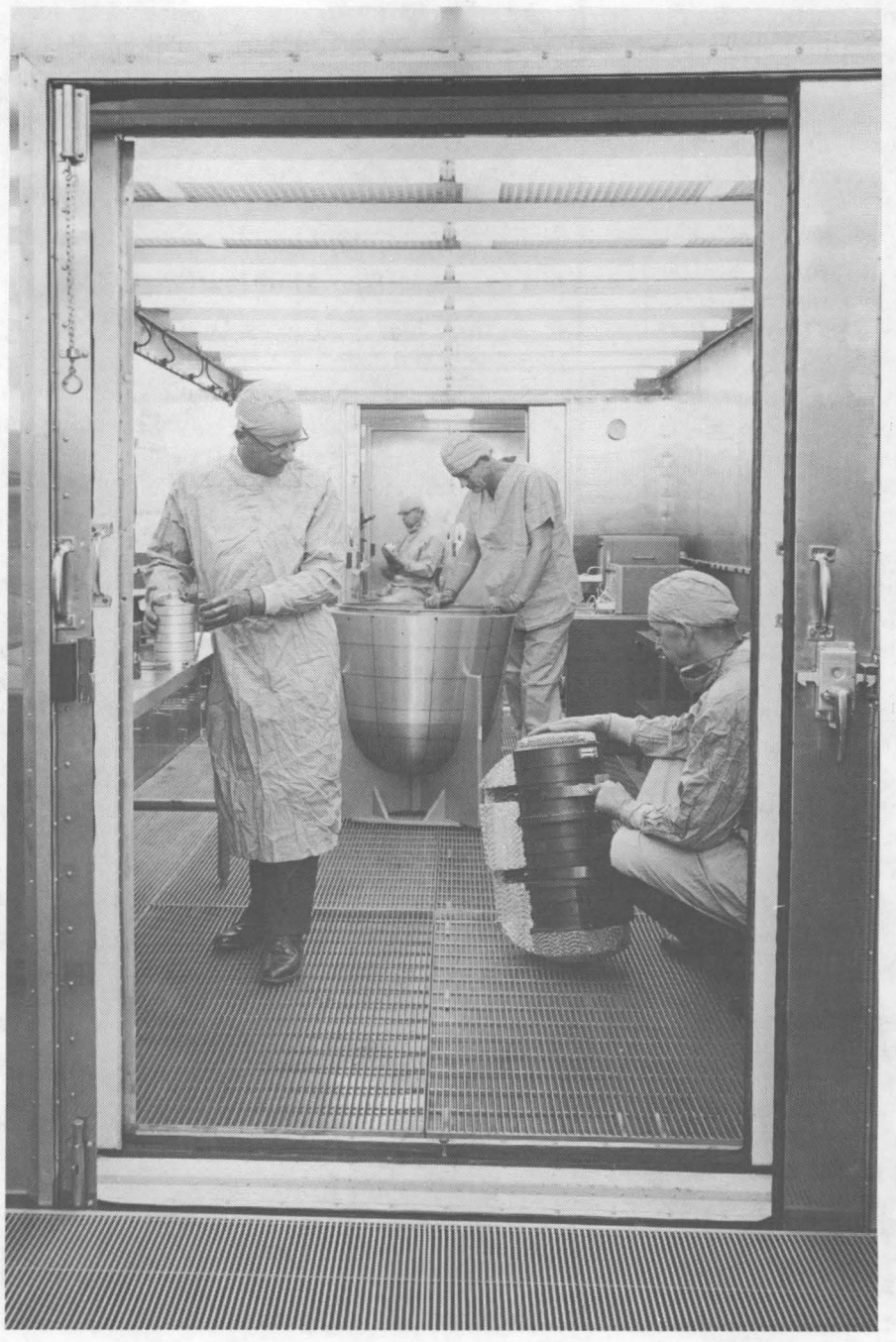
Claude had responsibility for the cleaning processes in contamination control for advanced manufacturing (of electro-mechanical accelerometers), and he was interested in writing specifications and developing procedures. This fit the need perfectly. "As I recall, Willis and I sat down and wrote the content of what we thought was important," says Claude.

"In February, we decided we'd have a national symposium at Sandia and invite engineers interested in the subject," says Gordon. Some 150 industry and government leaders in contamination control met late that month for a three-day technical symposium to initiate development of the standard. GSA approval to go ahead had arrived just one week earlier.

The proposed standard was based not on counting particles in the room — there is really no, one representative location, says Claude — but on leak-testing the filters and on mapping the air-flow uniformity. Once those matters were taken care of, one could achieve a fairly repeatable particle distribution. It also defined Class 100,000, Class 10,000, and Class 100 air cleanliness. (The latter allows a maximum of 100 particles 0.5 micron or larger per cubic feet of air.) Particle-size distribution curves allow extrapolation to other size particles.

At the February meeting, "I got up and said that we had proposed for Sandia to write a standard and to establish a working group right then and there," says Gordon. He headed the group, and the draft went through revisions in follow-up meetings in March and May.

(Continued on Page Ten)



GORDON KING (left) with Sandia co-workers in the first vertical laminar flow clean room built at the Labs. The former Sandian led efforts in 1963 to establish a federal standard for defining clean air, an outgrowth of Sandia's invention of the laminar flow clean room. Federal Standard 209 quickly became the government and industry standard and has been disseminated and applied worldwide. Gordon later went on to work for Texas Instruments (TI), developing semiconductor facilities and designing clean room facilities. He's now retired from TI, but continues to do clean room design and fabrication consulting, working out of his small ranch in Eustace, Tex.

(Continued from Page Nine)

Defining Clean Air

The completed standard outlined general and detailed requirements for air cleanliness. It also provided nonmandatory supplemental guidance information, including a glossary, recommended environmental conditions, design information, tests, monitoring, operational guides, and guidelines for achieving clean room classes.

On to Washington

By August, when Gordon went to Washington and met with officials of the Atomic Energy Commission and the GSA, he already had in hand a completed final document bearing the signatures of the representatives of all the relevant agencies. The document had been completed, coordinated, signed off, and delivered to the GSA in less than six months. It was published in December.

"It's the single most popular [contamination-control] document the Government Printing Office has ever put out."

"This quickened by about 10 years the preparation time of any standard that had ever been made," says Gordon. "We probably broke all the rules. We didn't know any better. We just went ahead and did it.

"The document was a *fait accompli* when we turned it over to the GSA. I'm real proud of that."

Federal Standard 209 indeed quickly became the governmental and industry standard. It was also disseminated and applied worldwide. It has become one of the most useful and internationally copied documents of our time, Gordon says. "It's the single most popular [contamination-control] document the Government Printing Office has ever put out," he says. "It is still the standard for the world."

Gordon King is still closely involved with clean air and with Standard 209. He left Sandia in 1965 and spent the next 16-1/2 years with Texas Instruments, based in Dallas, developing its semiconductor facilities all over the world. "So I've designed clean rooms on a number of continents," he says, including TI's first one in Japan in 1973 (and two others since). Since 1982, when he took early retirement from TI, he's been a consultant. He works out of his small ranch in Eustace, Tex., 75 miles southeast of Dallas, designing clean rooms and fabrication facilities all over — the latest, he says, in Taiwan.

Federal Standard 209 was amended in 1966 and 1976, but without any significant changes to the original document. In 1982, the Institute of Environmental Sciences — the organization now designated by GSA to oversee revisions of the standard — initiated further revisions, approved in October 1987 (as Standard 209C) and slightly corrected in June 1988 (as Standard 209D). Classification curves and the basic air cleanliness definitions of the original standard are retained, but Classes 1 and 10 have been added, as well as smaller particle sizes for measurement.

Now version 209E is in the works, and Gordon's working on that too. "We have to keep the standards up for the industry," he says. "There have been so many changes and improvements in what we can do. Now we're requiring no more than a single particle one-tenth of a micron in diameter per cubic foot.

"Still," he says, "it's the same basic concept.

"I consider myself among the luckiest people," he says. "I've been fortunate throughout my career to be in the right place at the right time. I wouldn't trade it for anything."

Claude Marsh is still very active in clean room technology as well. After leaving Sandia in 1965, he too went to Texas Instruments, and then was director of research at Envirco (see page eleven) in Albuquerque for 11 years. For the past 2-1/2 years, he's been responsible for defect reduction in Signetics Corporation's state-of-the-art semiconductor manufacturing plant on the north outskirts of Albuquerque. His office is just a few steps from the plant's new Class 10 and Class 1 clean rooms. ●KFrazier(3161)

Weapon Connection Forgotten

The NASA Connection: Myth and Reality

Do you have the impression that the clean room was developed by NASA? Do you know someone who thinks the Apollo program was the main stimulus for clean room advances? Many people do.

This is the only misconception about development of the laminar flow clean room that Willis Whitfield, its inventor, feels needs correction. "I would like to get that straightened out," he says. "The clean room was developed with weapon money, and this all occurred about two years before we [Sandia] got involved with NASA. The patent disclosure came about three years before we had any dealings with NASA — it was back before NASA was really going."

As Sandia's January 1962 news release announcing the clean room reported, "Sandia will use the new rooms to establish production standards for subcontractors who manufacture weapon components for Sandia." Gordon King, who became Willis's section supervisor, emphasized the weapon connection in a recent historical review: "All the military services were involved with atomic weapons. This [contamination control] aspect had become an important consideration because of the extreme reliability demanded of components and assemblies of atomic weapons. They had to work perfectly — once — with no second chance, and thus, the rationale behind Sandia's interest in the matter."

Time Had It Right

Time magazine, in its April 13, 1962, story called "Mr. Clean" — which helped launch the Sandia clean-room concept into international prominence — lead off by correctly stating the weapon connection: "As [nuclear] weapons components are made smaller and still smaller, the presence of a single particle of dust can make larger and still larger trouble."

But once the space program caught the public fancy and headed for the moon, the clean-room concept became intertwined in the public mind with lunar and planetary quarantine, and the original weapon connection was forgotten.

The myth that the clean room was developed for or by NASA has been persistent. Just last year, an AT&T publication, in an article about the Sandia/AT&T connection, innocently but mistakenly said the clean room was invented at Sandia "out of work on planetary quarantine." This prompted Sandia Public Relations Manager Jim Mitchell (3160), who was responsible for the first publicity on the clean room back in 1961 and 1962, to circulate a memo last October reemphasizing that the "clean room grew directly out of the nuclear weapons program."

What is true is that NASA quickly saw the value of laminar flow clean rooms and then asked Sandia's help in adapting the concept to the needs of the space program. Willis Whitfield played a strong role there too.

NASA asked Sandia to serve as a consultant to the planetary quarantine program. Sandia, after much agonizing — it was an unusual request for Sandia at the time — eventually agreed to a contract accepting NASA funding for the work. A NASA contract announced in 1966 called on Sandia to develop instrumentation and monitoring techniques for bio-clean assembly rooms. It also asked Sandia to carry out a systems analysis to investigate the amount of pre-sterilization microbial contamination expected on a spacecraft designed to land on other planets. Then NASA's manned spaceflight program wanted similar assistance.

'My Life Wasn't My Own'

"Once that was agreed on, my life wasn't my own," says Willis. "I guess I consulted on every clean room that NASA built for probably 10 years. I spent time at the Cape, at JPL, at Huntsville, at Rocketdyne, at Grumman in New York, which was building the modules, and any number of small contractors where they had a problem.

"For the biological side of the house, NASA was worried about spacecraft sterilization. The clean room controls particles. The bacterium is a particle, so if we keep all the particles out, we keep the bacteria out too. That was their approach, which I found to be very refreshing, a very wise approach really. They really didn't have a bacterial problem, but it took a long time to figure that out.

"On the other side of the house, they were worried about things like hydrocarbon contamination of liquid oxygen lines, because that was disastrous. In fact, I got a panic call from Rocketdyne. One day they had an explosion that killed several people. Chemical analysis showed there was enough hydrocarbon inside the building to contaminate the oxygen lines. When the liquid oxygen would contact the hydrocarbon, they could react and explode. Rocketdyne said, 'Do you have any ideas?' I said, 'We've got this curtain downflow unit, and you can just get one of those and operate it outside the building. That would keep the dust and other stuff from your essential components.'

"I think they had one built and had it airfreighted out there and put it up in just a matter of days. I got a letter from them later, and they said the hydrocarbon contamination was practically zilch. They said the idea was great. They could now safely assemble these liquid oxygen lines without this problem. That was just one of the many examples that happened with NASA. NASA had all kinds of problems. It was pushing the state of the art in practically every field of engineering and science.

"So it is correct that NASA has made great use of clean rooms. It's just that they were developed at Sandia for other purposes first, and then the space program began using them."

Envirco – One of the Larger Clean-Room Equipment Manufacturers

Clean Room Invention Sparks Albuquerque Company

One day recently at a plant on the northwest corner of Jefferson and Osuna in Albuquerque, new equipment just off the assembly line was being packaged in pure-white neatly imprinted cartons for shipment to Japan.

The shipment of 70 laminar flow air purifiers will hardly dent the US trade imbalance with Japan, but at least the nudge was in the right direction.

The purifiers are just one of an extensive line of laminar flow contamination control products built in Albuquerque by the Envirco Division of Environmental Air Control Inc. (EACI).

Unlike the small stand-alone air purifiers, which are as much for consumer as for industrial use, most of Envirco's products help high-tech companies, pharmaceutical packagers, biomedical and chemical laboratories, and surgical hospitals attain the cleanest possible air consistent with their needs.

And most of it is based on the laminar flow clean room concept invented by Willis Whitfield at Sandia. In fact, Envirco's roots go back to that Albuquerque achievement (see "From Houston to Albuquerque").

LAMINAR FLOW AIR FILTERS are inspected by David Schlegel (left) and Skip Erickson at the Envirco Division of Environmental Air Control Inc. (EACI). Schlegel is general manager of Envirco and executive vice-president of EACI. Erickson is Envirco Company Controller. The filters are just one of an extensive line of laminar flow contamination control equipment built in the Albuquerque plant, which employs about 78 people. Most of the company's products are based on the clean room concept invented by retired Sandian Willis Whitfield.

Broad Spectrum of Equipment

Envirco employs about 78 people in Albuquerque, General Manager David Schlegel says, and the laminar-flow equipment they manufacture and sell covers a broad spectrum of clean-room and contamination-control equipment.

"We are one of the larger clean-room equipment manufacturers," says Schlegel. "And we're probably the only one that's as diversified as we are." He is also executive vice-president of the parent company, EACI. Although he lives in Maryland, Schlegel spends at least one week a month at the Envirco facility in Albuquerque, and often more.

Clean-room facilities can be big capital construction projects, but Envirco's emphasis is on modular clean-room elements that give companies considerable flexibility in initial size, future scale-ups, physical siting within a building, costs, and clean-air rating.

"Everything we sell is based on laminar air flow design principles."

"We have tried to gravitate away from being a general contractor," says Schlegel. "Our emphasis is on our equipment lines that go within a building. Envirco's strength is our ability to design and supply equipment for a variety of special applications. We emphasize self-contained equipment."

The laminar flow equipment market Envirco serves is divided, as company controller Skip Erickson puts it, 60-30-10. This means, he explains, that 60 percent of sales are to the industrial market — companies that are producing a product.

Typical examples are plants for microelectronics fabrication and pharmaceutical packaging. Thirty percent of sales are to laboratories, including those in government agencies, universities, and hospitals.

And the final 10 percent goes for hospital surgical rooms, where clean rooms can provide the ultra-antiseptic conditions needed for highly invasive transplant surgery, hip and other joint-replacement surgery, and control of special infectious diseases. This, says Schlegel, is the "smallest but fastest growing" part of the market.

$10-Million-A-Year Operation

The company is a $10-million-a-year operation. The vice-president for sales is in Albuquerque. For its industrial products, the company has a western regional sales manager in California and an eastern regional sales manager in Hagerstown, Md., where EACI headquarters is located. Its laboratory products manager is in the Albuquerque plant.

The Albuquerque manufacturing plant — essentially one giant "high bay" with all the necessary equipment in fairly close proximity — begins with little more than basic starting materials and ends by turning out finished laminar flow products.

Everything Is Tested

Skip Erickson recently gave the LAB NEWS a brief tour.

On one side of the facility, workmen cut and shape metal sheets. Others nearby weld them together. The metal materials, suspended from overhead, then move through an automated painting room and on to the assembly area.

In another area, off to the side, all the electrical equipment is assembled. Once a complete product is assembled, it goes on to a test area, where blower air-flows, seals, and all other critical components are checked. "Nothing goes out without being tested first," says Erickson.

"The requirements for sterile and controlled environments have become greater."

Erickson has high praise for the company's employees, many of whom have been there for 10 or 15 years or more. (The plant was built in 1965.)

Envirco even makes its own HEPA (high-efficiency particulate air) filters. One corner of the plant is devoted to this purpose, which Erickson says helps ensure high quality and consistency.

Six-inch-wide rolls of thin aluminum are strung through a corrugating machine, then set within a metal frame. Fans of filter paper are inserted between the rows of corrugated metal.

In the design and manufacture of the filter units, special attention is given to tight seals, Erickson explains. Seals are of crucial importance in filters and filter modules. Envirco has invented its own patented locking mechanism for its modular ceiling grid units.

On this day, a variety of Envirco's biohazard containment cabinets, which are based on laminar flow and offer a double whammy of special leak-tight, negative-pressure protective features, are nearing completion. They'll be sold to a company that specializes in marketing such equipment to laboratories.

Cabinet-Within-a-Cabinet Design

The "cabinet-within-a-cabinet" design is a reminder of something Skip Erickson had said earlier. "Everything we sell is based on laminar air flow design principles," he said. "Laminar flow is required, but it is no longer in itself good enough."

And it also brings to mind something David Schlegel had said in looking at what appears to be a bright — if very challenging — future for suppliers of clean-room equipment.

"It's a pretty exciting business now. It's an exciting area," he said.

"Chips are getting smaller, society's needs for ultra-clean working environments are steadily increasing. The requirements for sterile and controlled environments have become greater." He doesn't see that trend changing. ●

Building the Clean Room Industry

From Houston to Albuquerque to Houston

Bill Soltis recalls the day clearly — " a Friday in August of '62" — that changed the course of his life.

"That's the day I was invited out to Sandia to talk with Willis Whitfield about some humidity-control problems. That's all I knew," says Bill, speaking from the office of his Houston company, Lepco, Inc.

Bill's tale — an early chronology of laminar air flow clean room technology transfer and how that gave birth to one of Albuquerque's most respected companies, the internationally known Envirco — actually begins in February of 1960. That's when he moved to Albuquerque to take over local operation of Comfort Air Service, owned by a Houston firm.

Comfort Air, operating out of a small North Second Street warehouse, was doing an increasing amount of work for Sandia, Los Alamos National Laboratory, and White Sands Missile Range. Its service: designing and constructing special industrial air conditioning and environmental control systems needed to meet unusual requirements.

"We quickly built up a pretty good reputation for being able to deliver solutions for these special problems," says the Texas A&M mechanical-engineering graduate.

Introduced to Laminar Flow

When Bill arrived at Sandia on that fateful Friday, Willis and Sandia colleagues Claude Marsh, Gordon King, and Doug Ballard introduced him to the first functional laminar air flow clean room. Built by Agnew-Higgins, a Southern California firm, this horizontal-air-flow prototype was essentially a wall of HEPA (high-efficiency particulate air) filters that extended over a countertop. The result: a walk-in-closet-size Class 100 clean room.

"But the group really wanted me to look at another prototype — a vertical-air-flow hood — that needed an additional feature — humidity control," Bill recalls.

As Willis and Bill talked, each sensed the other's excitement. "He [Willis] finally asked if I'd like to try to build a larger vertical-flow room. I asked, 'When do I start?'

"So during the next couple of months, I built some vertical-flow prototypes [about 10 x 12 x 8 ft.] at my place on North Second [which in those days employed just six people].

"I also have vivid recollection of the day we first tested one of those prototype clean rooms. We turned the system on. Gordon King blew some cigar smoke into the room. The smoke showed us that the room's air flow clearly wasn't laminar," Bill says.

"With that demonstration, I realized there were lots of nuances in properly handling air flow for clean work stations. All of us then also realized another vital point — it's a point that should never be forgotten by anyone involved in technology transfer — it takes time to develop viable products, even from very good ideas."

Overnight Success and Challenge

"Although it took a while to develop successful products, the basic laminar flow technology was an overnight success and it remains essentially unchanged today from that Agnew-Higgins prototype system that proved the idea," Bill continues.

THIS SURGERY FACILITY, the first in the US to use the laminar flow clean room concept, was built in 1964 at Bataan Hospital (now part of Lovelace Medical Center).

The challenge basically was to transform a remarkable idea that worked well on a laboratory scale into practical, large-scale mechanical equipment. First of all, engineers were not used to moving the volumes of air through space that laminar systems required. Bill and other designer/builders had to learn more about that. The first clean rooms were noisy — not the most comfortable place to work. That problem had to be solved. Systems gulped large amounts of electricity. Also, frame structures that could lock many HEPA filters together to form walls or ceilings had to be developed. Bill, working with Sandia, did that.

"We quickly built up a pretty good reputation for being able to deliver solutions for these special problems."

"In fact," Bill recalls, "it was that patented Ultracell and the conviction that laminar flow clean rooms had medical applications — which Willis and I both strongly believed — that really launched Comfort Air into the clean room design and construction business."

Besides Albuquerque's entrant, two other companies, Agnew-Higgins and Air Control of Philadelphia, quickly began designing and making laminar air flow clean rooms in the early '60s.

"We all entered the market within a few months of each other and became competitors," Bill says.

Rare Time for a Businessman

"That was an amazing time for me," he adds. "Since there was a great demand for clean rooms and just a few players, I was able to develop my business very rapidly. It surely was one of those rare times when a businessman finds himself in the right place at the right time."

But getting a head start on most other laminar air flow clean room manufacturers didn't mean that Bill could just sit back and watch the money flow in. It did begin to flow in, but he had to work for it.

"First of all, I had to get financing," Bill says. "I remember talking with bankers about this new technology. It would have been a lot easier if I'd come to talk with them about loans for a land or cattle business.

"Sandia was extremely helpful during those days in the early '60s when I was converting Comfort Air [by 1963, Bill had become 75-percent owner of the Albuquerque operation] into a clean room design and manufacturing business. In fact, I believe my first sales — some vertical-flow clean hoods — were to Sandia.

Another early sale was a specially designed 20-ft. x 40-ft. clean room for Gulton Industries, which then had its offices just off Route 66, near the entrance to Tijeras Canyon.

"Doug Ballard always offered encouragement as I worked to build up our business," Bill recalls. "Doug let me know of various companies that'd be interested in clean rooms, and he told companies about us, Agnew-Higgins, and Air Control."

Fostering an Albuquerque Business

The timing of laminar air flow's development was extremely fortuitous — in the midst of a growing aerospace industry and shortly before the birth of the microelectronics industry. (Actually many experts, including Bill, believe the modern microelectronics industry couldn't exist without the laminar air flow clean room.)

"And without a doubt," Bill says, "Sandia fostered and encouraged development of my Albuquerque business. I just happened to be the guy who had the know-how to make it work in real applications. I seized upon an emerging Sandia technology.

"As a result, Comfort Air developed a widespread and significant clientele very quickly. Only a few years after we went into the clean room business, we had customers throughout the US, and in West Germany, England, France, and Italy."

The toughest part of Bill's business plan was

(Continued on Next Page)

SANDIA TECHNOLOGY TRANSFER

(Continued from Preceding Page)

getting into the medical field. Although he and Willis Whitfield believed from the start that laminar flow clean rooms could be an aid to medical treatment, events didn't proceed along that line.

"It was in '64 that I really went to work on penetrating that market," Bill recalls. "Being a young naive guy, I went to Houston — my home territory — and started banging on doors at Baylor College of Medicine and M.D. Anderson Hospital. I didn't get a very warm reception."

"It surely was one of those rare times when a businessman finds himself in the right place at the right time."

Straight to Lovelace

Bill learned a valuable lesson: don't try to sell products or technologies to the medical profession unless you have some credentials.

"Nevertheless," he continues, "I was undaunted and absolutely convinced of the clean room's worth to medical treatment.

"So when I returned to Albuquerque, I called Dr. Randy Lovelace [of Bataan Hospital and Lovelace Clinic]. To my surprise, he knew my name, and he was familiar with — even enthusiastic about — my message."

Dr. Lovelace teamed Bill with Dr. John Whitcomb, then the facility's head surgeon, and set them to building a laminar flow surgical theater.

The unit was installed around Christmas of 1964, but tragedy struck. Dr. Lovelace never saw his pioneering surgical unit. He and his wife were killed in an airplane crash while on their way home from a holiday trip to Colorado.

"But during that six months, while Dr. Whitcomb and I were working on the surgical unit," Bill recalls, "Dr. Lovelace had been spreading the word about medical applications for laminar air flow. He talked a lot with Dr. James Goddard [then head of the Center for Disease Control in Atlanta, and later head of the Food and Drug Administration during the Johnson presidency]."

LEPCO, INC., president Bill Soltis (left) and one of his technicians, Kevin Box, inspect a process support module for a Perkin Elmer manufacturing electron beam exposure system (MEBES), which must be operated in a clean room structure that Lepco will custom-make. Lepco serves a diverse customer base — the pharmaceutical, microelectronics, bio-technology, and aerospace industries — with its products that address contamination-, temperature-, humidity-, and process-control requirements.

World's First by Local Firm

The technology's credibility increased, and within a year Albuquerque's Comfort Air built the world's first sterile patient-isolation system at the University of Minnesota Medical Center.

As a result of this activity, Dr. Goddard began pitching Comfort Air to the medical director of Becton-Dickinson, a Fortune 500 company. By 1966, Bill had received one of those "once-in-a-lifetime offers that I couldn't refuse." He sold Comfort Air to Becton-Dickinson; the company's name changed to Envirco.

"I stayed on, though, under a multiyear contract, to be the first manager of Envirco." During that time, Bill's credentials and those of Envirco were clearly established. Bill, in fact, designed a laminar air flow patient isolation system for M.D. Anderson Hospital in Houston.

Bill, an entrepreneur at heart, left a healthy Envirco in 1970 and headed back home to Houston. Since that time, he has started two companies, including his present one, Lepco, which builds advanced technology facilities using laminar air flow clean-room techniques.

The first page of a Lepco sales brochure states that the company's "roots stem from the original research in laminar flow and micro-contamination control, which took place at Sandia. . . ."

Bill Soltis is not one to forget his friends.

●RGeer(3163)

What One Magazine Predicts

CleanRooms magazine began publication two years ago. Today, its articles about new clean room technologies and accessories and its "how-to" coverage reach every industry that uses clean rooms.

The magazine's staff also has conducted detailed research about the size of the clean room industry in this country and industries that rely on clean rooms.

Figures on this chart emerged from that research:

Predicted Total Domestic Clean Room Market in $ Million

Industry	1990	1992
Microelectronics	$679	$754
Pharmaceuticals	129	165
Hospitals	59	82
Medical Devices	47	69
Food	29	41
Aerospace	23	27
Others*	205	233
Total	$1171	$1371

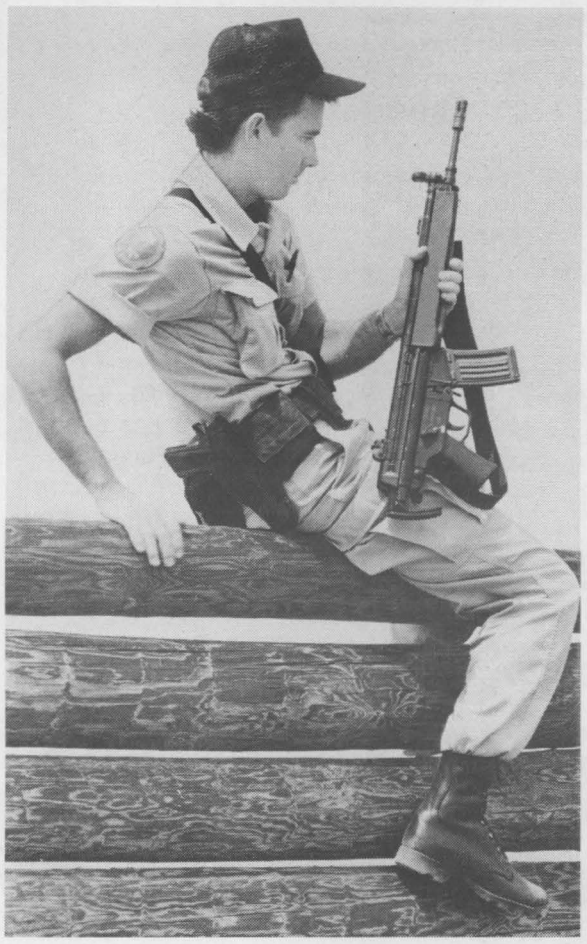
*Includes automotive, laser/optics, compact disks, plastics, printing, etc.

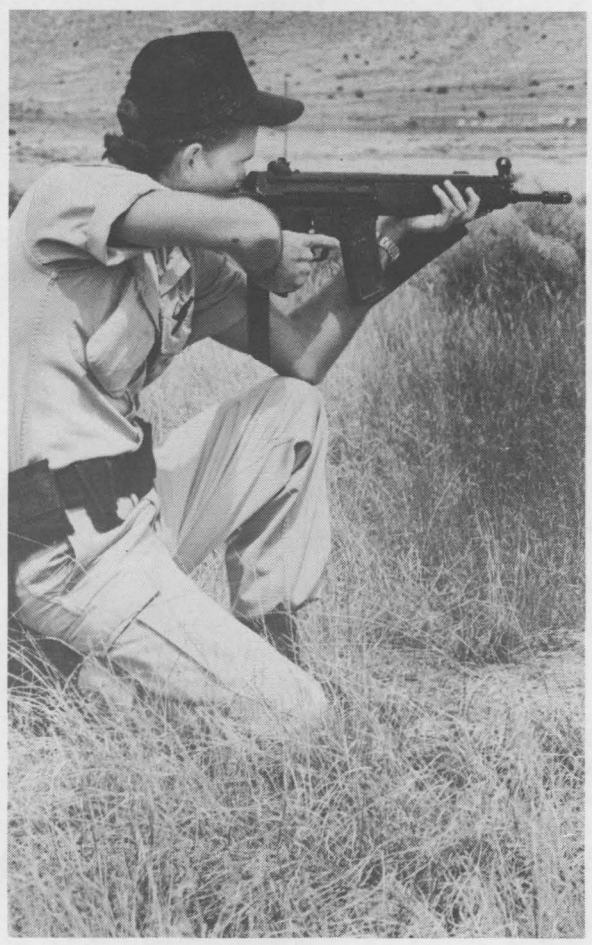
Clean Room Growth Projection By Industry Through 1995

Compiled by *CleanRooms* magazine

Microelectronics	10.7 %
Pharmaceuticals	25.7
Medical Devices	36.2
Hospitals	34.1
Food	34.2
Others	26.4

CLEAN ROOMS are used throughout Sandia today. Here, April Howard (2131), wearing a special clean-room suit, transports a set of silicon wafers down the aisle between clean-room bays in the Microelectronics Development Laboratory. The muted lighting in the photo is from safelights that protect unexposed wafers.





OVER THE TOP, DOWN THE OTHER SIDE, TAKE AIM — Jeff Johnson (3435) demonstrates some of the physical skills required for DOE Central Training Academy competition to determine the 1989 "Security Inspector of the Year." (Photos by Gerse Martinez, 3162)

(Continued from Page One)

Johnson Wins

mands of an emergency. In fact, since those two demands might occur at the same time, the competition required the competitors to complete part of the handgun phase immediately after the physical-conditioning phase.

"Near the end of the physical phase, we were crawling a 12-inch-high tunnel," says Jeff, "scurrying as fast as possible, kicking up dirt and just about hyperventilating. Then there were some barricades to go over, and finally a 12-foot rope to climb.

"When I first heard about the rope, I thought, 'No problem, I'll just jump as high as I can and then climb,' but by the time I had been through the rest of the course, that rope looked a hundred feet high. I lost a lot of skin from my hands on the rope, which made the next part — clearing a room with a handgun — pretty uncomfortable."

In the room-clearing phase, says Jeff, there were eight rooms in a building, and adversaries in just one. Going in, the competitors didn't know which room held the "bad guys."

But, since security inspectors' jobs aren't just physical, the competitors also had to prove their knowledge of DOE and federal regulations. They did that by taking a written test.

In the tactical phase, they had to demonstrate such skills as observation, unarmed defense, knowledge of contraband and security violations, searching techniques, interrogation, arrest techniques, and radio competition. Scoring was based partly on how many actions the competitor was able to complete during a specified period.

Another phase tested the inspectors' ability to make critical decisions under stress. "We were confronted with a situation involving deadly force," says Jeff, "and we had to make a split-second decision: do nothing, or neutralize the adversaries. Fifteen of the competitors 'died' in that phase."

The possibility of suddenly facing that kind of situation, emphasizes Lee Bray, is one thing that makes a security inspector's job difficult: "They have to be on their toes and ready to respond at the first sign of a problem, yet they're almost always in a world that denies a problem exists. They're expected to be pleasant and positive, but, at a moment's notice, to switch into a response to an emergency."

The Central Training Academy competition also included several shooting contests for teams from DOE facilities. Sandia's team finished fifth out of the 20 teams there. All medal winners are employees of the Labs' two patrol divisions — Bob Baca's Patrol Div.-North 3434 and Sam Ortega's Patrol Div.-South 3435. The medal winners, besides Jeff, include Tom Serna, Gary Malin, Ernie Torres, and Celso Montano (all 3435); and Jim Smith, Dave Stout, and Harold Garcia (all 3434). •CS

June 1989 Earnings Factors

	Earnings Factors
Savings Plan for Salaried Employees (SPSE)	
AT&T Shares	.9909
Government Obligations	1.0158
Equity Portfolio	.9953
Guaranteed Interest Fund	1.0071
South Africa Restricted Fund	.9848
Diversified Telephone Portfolio	
Unrealized Appreciation	.9909
Realized Appreciation	.0049*
Savings and Security Plan — Non-Salaried Employees (SSP)	
AT&T Shares	.9907
Guaranteed Interest Fund	1.0071
South Africa Restricted Fund	.9822
Diversified Telephone Portfolio	
Unrealized Appreciation	.9903
Realized Appreciation	.0050*

* The 1 has been removed from the earnings factor. Current month's DTP earnings may be calculated directly: Earnings Factor X DTP Current Worth = Current Month's Earnings.

Take Note

Craig Jones (9145) was recently promoted to Lieutenant Colonel in the Air Force Reserve. Craig has seven years of active duty in the Air Force and seven years in the Reserve. He serves 38 days a year at theWarner Robins Air Logistics Center in Georgia as an aeronautical engineer in the C-141 Structures Section. He specializes in the fields of aircraft battle-damage repair and crash-damage repair of C-141, C-130, and F-15 aircraft.

* * *

Jim Tichenor (2565) was elected governor of the New Mexico-West Texas District of Optimist International for 1989-90 at a recent district convention in Roswell. Jim has held several offices in the Albuquerque Sunport Optimist Club.

* * *

The September meeting of the Albuquerque Section of the American Society for Quality Control is Sept. 13 at the Indian Pueblo Cultural Center (2401 12th St. NW) at 6:30 p.m. UNM engineering professors Dick Williams and Chuck Hawkins will speak about "Errors in Testing." For information, contact Bob Holkup on 291-5006 or J. F. Nagel (7222) on 4-6551.

Sandia Colloquium

Ralph Alewine III (DoD's Nuclear Monitoring Research Office) will discuss "Seismic Nuclear Test Monitoring" Sept. 22 in the Technology Transfer Center, 9 a.m.. Call host Paul Stokes (9240) on 4-9943 for information.

KNME-Channel 5 is now observing Hispanic Heritage Month with special programming: "Del Valle," music, Sept. 13, 7:30 p.m.; "Great Performance: Linda Ronstadt — Canciones De Mi Padre," Sept. 17, 8 p.m.; "Birthwrite: Growing Up Hispanic," a look at Mexican-American and Puerto Rican writers, Sept. 19, 9 p.m.; "Coronado Trail: A Rediscovery," Sept. 21, 9 p.m.; "Vista: My Lady of Milk and Wafers," drama, Sept. 27, 10:30 p.m.; and "Salt of the Earth," drama filmed in New Mexico about striking mine workers, Sept. 30, 8 p.m. For information, call KNME on 277-2121.

Countdown to 40

Sandia Was Mighty Busy Place in the Sixties

Sandia Corporation will be 40 years old on Nov. 1, 1989. Until then, the LAB NEWS will publish related articles and historical tidbits.

Sandians in the 1960s were spacecraft testers, earth movers, hole diggers, sun-shadow chasers, cloud watchers, and ocean-floor probers.

Space Labs?

Labs employees were involved in the US space program from its beginning. In 1960, Sandians went to Cape Canaveral to install and check telemetering packages used to monitor non-explosive warhead components during missile flights. They also performed drop tests of the Project Mercury space capsule at Salton Sea Test Base.

In 1962, environmental tests began for a Sandia-designed reentry vehicle and telemetry package to study safety features of nuclear power sources for the aerospace program. Sandia conducted centrifuge acceleration tests in 1963 to check reliability of a solar research satellite to be launched from Cape Canaveral.

Sandia and Los Alamos scientists that year also developed detection instrument payloads in satellites launched by the Department of Defense. The satellites' purpose was to determine the feasibility of policing space for clandestine nuclear blasts by detecting and recording x rays, gamma rays, and neutrons from a burst.

Astronauts were "walking" in space in 1965. Ed White took a 20-minute stroll outside his Gemini 4 spacecraft, the first American to do so. There was concern about spacecraft bringing back contamination from space in the '60s. In 1967, Sandians developed the first sampling device designed specifically for assaying microbial contamination on large surfaces of spacecraft hardware. The vacuum probe sampler was developed for use in ultra-clean environments, such as the laminar flow clean room.

In 1969, Sandians developed a method of spacecraft sterilization involving simultaneous application of heat and radiation and wrote a NASA-sponsored handbook on contamination control.

A "crash" six-month program was completed for analysis and safety testing of a tiny radioactive heater for Project Apollo. That year, two of these heaters, designed to keep seismic instruments operational during the extreme cold of the two-week lunar nights, were left on the moon by Apollo 11 astronauts.

Moving the Earth

In 1961, Sandia was conducting seismic studies of high-explosives tests as part of Project Plowshare studies of potential peaceful uses for nuclear explosives.

Sandia completed a DoD program in 1963, conducted on the site of two 1951 nuclear detonations at Nevada Test Site, to aid in understanding of cratering effects of nuclear explosives. Also in 1963, Sandians participated in Project Shoal at Fallon, Nev., an experiment to improve ways to distinguish natural earthquakes from underground, nuclear-detonation tremors.

Project Dribble, a series of underground nuclear detonations in the Tatum Salt Dome 20 miles southwest of Hattiesburg, Miss., in 1964, was part of a DoD project to improve techniques to detect and identify underground nuclear detonations. Sandians prepared free-field particle motion studies, including instrumentation of four drill holes with surface-motion gages and subsurface instrument stations.

In 1965, the Labs completed design of an unmanned seismic observatory to be used in remote locations to detect nuclear detonations. One observatory was placed in a 90-ft. borehole near Fairbanks, Alaska, to evaluate the effect of permafrost on the instrument package.

Sandians used conventional high explosives in 1967 to blast holes in dry lake beds at Tonopah Test Range to develop laws for excavating with explosives. Two field-test divisions were asked to provide arming and firing system designs and to perform earth motion studies in 1967 for Project Gasbuggy — the nation's first experiment using an underground nuclear explosion to stimulate natural gas production.

Chasing the Sun

In 1965, Sandians traveled to the Arctic Circle to study the auroral spectrum. Rockets were fired 60 miles into space to obtain data.

Sandians studied cosmic rays in 1966. Two groups went to the South Pacific to take part in experiments in connection with the May 30 total eclipse of the sun. One group "chased" the sun's shadow in an NC-135A flying laboratory; others launched instrument-carrying rockets from Rarotonga in the Cook Islands.

The NC-135A flying laboratory, with Sandians aboard, also flew over the North Atlantic from the equator to the Hudson Bay area to gather cosmic-ray data. An NC-135A from LANL carried out similar measurements in the Southern Hemisphere. The scientists were interested in simultaneously measuring the distribution of intensities of cosmic rays over wide ranges of latitudes. Scientists and members of Sandia's rocket and diagnostic aircraft teams conducted solar eclipse studies off the coast of Brazil to measure the sun's corona and to study cosmic rays.

Upper-atmosphere studies were conducted at Barking Sands launch site in Hawaii in 1966 with 18 launchings up to 500,000-ft. altitudes. Scientists were interested in wind currents, atmospheric temperatures, and densities.

Research continued in 1967 on the auroral spectrum and cosmic rays when scientists went to Antarctica. In 1968, reentry conditions experienced by space vehicles were being simulated routinely at the new plasma arc testing facility here.

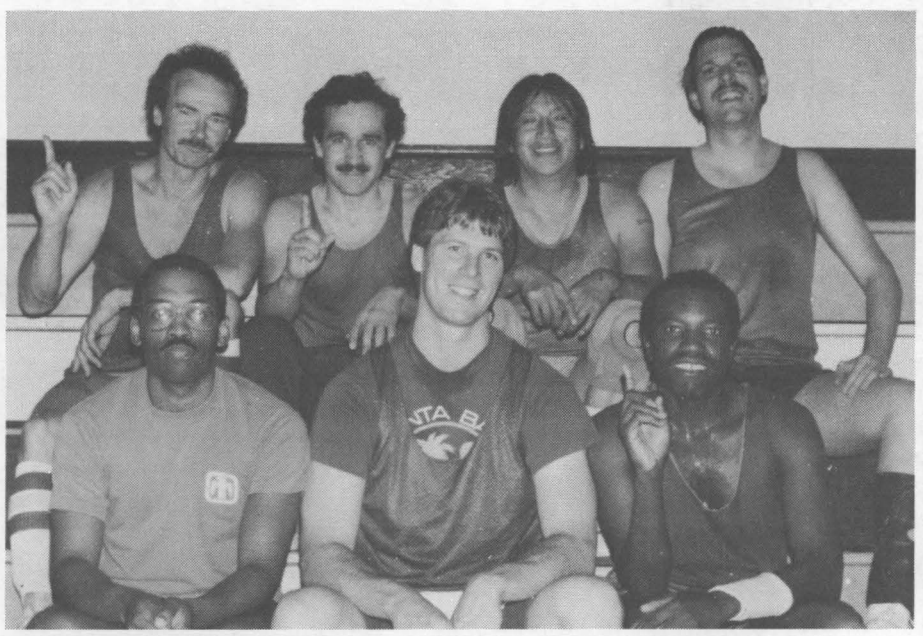
Searching the Ocean Depths

Sandia received international attention in 1966 for the part it played in helping locate a missing nuclear weapon off the coast of Spain. A nuclear safety team from Albuquerque conducted on-site investigations of the mid-air collision of two military aircraft. Trajectory computations at Sandia aided in pinpointing the recovery site.

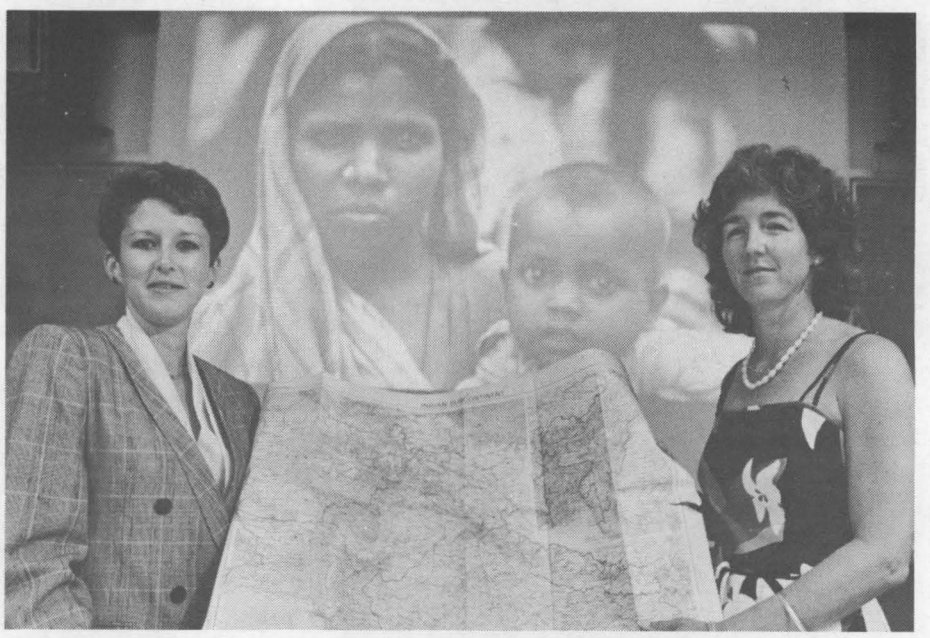
In 1968, Sandians from Livermore performed environmental monitoring and completed a bioassay program in connection with search and recovery operations at a Greenland site where a B-52 crashed with nuclear weapons aboard.

Also that year, a Sandia-led underwater search team, working off the California coast near Santa Barbara, helped locate a Nimbus B weather satellite and its radioactive power supply on the ocean floor. The missile carrying the satellite was intentionally destroyed after veering from its flight path.

In 1969, Sandia provided scientists and instrumentation for earth and underwater measurements of the shock waves created by an approximate one-megaton underground nuclear blast on Amchitka Island in the Aleutians. •JW



EIGHTH STRAIGHT — Sandia Labs Basketball Association's Phi Missa Jumpa successfully defended its A-League championship title by defeating Jim Cheykaychi's team 68-48 in the spring. This is the team's eighth consecutive championship. Phi Missa Jumpa then went on to lead Sandia to victory over Los Alamos in Lab vs. Lab competition. Front row, from left: Ron McIntosh (1534), Marc Polosky (2542), Clarence Collins (2533). Back row, from left: Thom Fischer (2171), Charlie Sandoval (2175), Mo Yellowrobe, and Jim Bryson (6452). Not pictured: Hal Morgan (1521), Scott Sanderville (3434), and Vic Chavez (3414).



"WOMEN AND WORK IN INDIA" was presented by UNM associate professor Helen Muller (right) on Aug. 21 as part of the bi-monthly program series sponsored by the Sandia's Women's Program Committee. WPC representative Merri Lewis (3428) helps Helen hold a map of India. Helen visited India for two months in 1988 with 11 other UNM faculty members and graduate students, under a Fulbright grant for studying the social and health conditions of Indian women. A videotape of the presentation is available from Debbie Eaton (3510) on 4-9482.

Unusual Vacation

Trek Through Thailand Substitutes for Tour of China

ALEX (6221) AND MARILYN MAISH enjoy a ride on one of Thailand's elephants, once used to help harvest teak logs. "The elephants are unemployed, now that harvesting has been banned to prevent further destruction of the teak forests," says Alex.

Thailand — old Siam — was not the place Alex (6221) and Marilyn Maish planned to go for their vacation last June. "We'd actually planned a two-week bicycling tour through China with a group of Marilyn's students," says Alex.

Marilyn teaches gifted high-school students at Del Norte. "I've always been interested in China," she says. "This trip was a dream finally coming true."

But in the months before departure, several students had to cancel out, leaving fewer people than required for the tour. Alex and Marilyn found replacements in time for the planned June 12 departure, and then, on June 4, came the the massacre of student demonstrators in Beijing's Tiananmen Square.

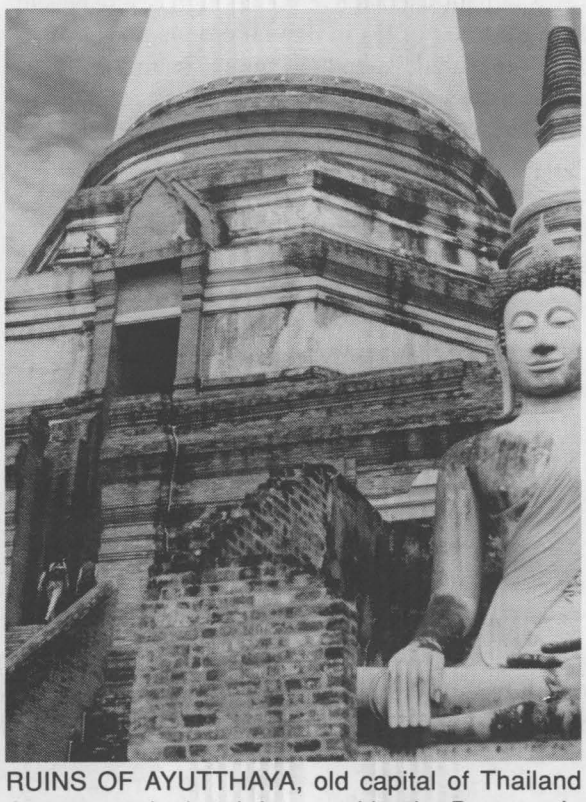
"When we first heard the news, we thought we could just confine the tour to the southern part of the country, bypassing Beijing," says Marilyn. "But as the repression became more widespread, people again started dropping out of the tour, and we knew we'd have to change plans."

Accepting the tour company's suggestion of Thailand as an alternative, Alex, Marilyn, and the five remaining group members flew to Los Angeles to board a plane for the 30-hour trip to Bangkok, including stops in Tokyo, Seoul, and Taipei.

CHILDREN OF THE HMONG TRIBE, one of the five major tribes known as hill people who inhabit mountainous regions of northern Thailand.

Clamorous, Glamorous Bangkok

"Bangkok, with a population of seven million, is Thailand's capital and largest city," says Alex. "It's an interesting mixture of old and new." Modern luxury hotels and skyscrapers sit comfortably among ancient temples and palaces; new bridges and expressways keep company with the klongs — historic canals that still plait old parts of the city.



RUINS OF AYUTTHAYA, old capital of Thailand that was sacked and destroyed by the Burmese in the 18th century.

Alex and Marilyn liked traveling on the klongs in long-tailed boats driven and steered by long-shafted outboard motors, but they did no bicycling in Bangkok. "It was too dangerous," says Marilyn. "Bangkok's traffic jams are truly world-class." Cars, trucks, vans, buses, and motorcycles jam the streets, sometimes slowing traffic to a crawl or full stop.

"It's nothing like China, where bicycles are the chief mode of transportation," notes Alex. Tourists typically get about the city by hailing a mini-taxi called a *tuk-tuk* — a small, three-wheeled vehicle.

"The Thais take even the most horrendous traffic jams with a philosophical calm," continues Alex. "There's some jockeying for place, but no horn-blowing, shouting, or fist shaking. They have a saying, *'mai pen rai,'* that translates roughly as 'never mind.'

"Once traffic gets moving, though, they drive like crazy. Sometimes they even borrow the wrong side of the street until oncoming traffic forces them back into the proper lane. That can get pretty exciting, especially when you're in a tuk-tuk — little more than a motorized rickshaw — and facing down a huge bus."

'Thai' Means 'Free'

"We really liked the Thai people," says Marilyn. "There's a strong national pride, yet a gentleness and dignity about them. Maybe it's because their country is the only one in Asia never to have been colonized by Europeans. 'Thai' actually means 'free' — they're ruled by a constitutional monarchy. We sensed their warmth as we walked around the landmarks of Bangkok."

One of their favorite places — and one of the great sights of Asia — is the Temple of the Emerald Buddha in Bangkok's Grand Palace.

"The Emerald Buddha sits high on a golden altar," explains Alex. "No one knows for sure where the figure came from, but it's considered the country's most sacred Buddha. It still plays a vital role in the lives of the Thai people — 95 percent are Buddhist, and many still prostrate themselves before the Emerald Buddha to pray or meditate."

The group also enjoyed the Temple of the Dawn and a temple popularly called Wat Po, the biggest and oldest temple in Bangkok. "Wat Po is a collection of buildings, including living quarters for monks and a magnificant 145-foot Reclining Buddha, the largest in Thailand," notes Marilyn.

Beyond Bangkok

Short trips outside Bangkok included a visit to the Damnoen Saduak floating market, an hour southwest of the city.

The market, conducted from boats floating in the canal, was in full swing when they arrived. "The klong was teeming with people in their little boats loaded with fruits, vegetables, and meats of all kinds," says Alex. "And in the balconies and stalls along the klong was everything imaginable — straw hats, carved teak, clothing, whatever."

North of Bangkok, Alex and Marilyn visited the old capital of Thailand — Ayutthaya, founded in 1350.

"In its day, Ayutthaya supposedly outshone London and Paris," says Marilyn. "They say people from the West traveled thousands of miles just to get a glimpse of it. It's built on three rivers, and the Thais thought they had made it indestructible by converting it into an island. But the city's riches

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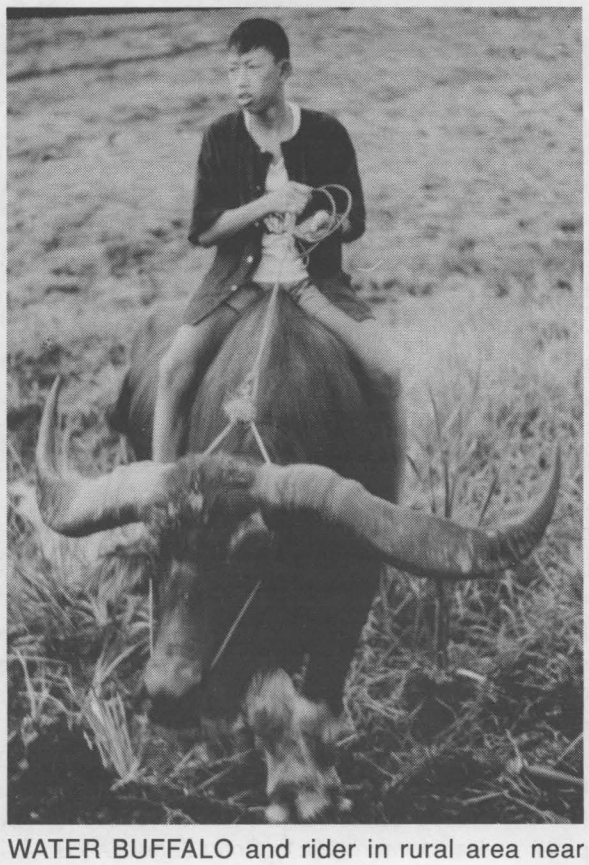


WATER BUFFALO and rider in rural area near Bangkok.

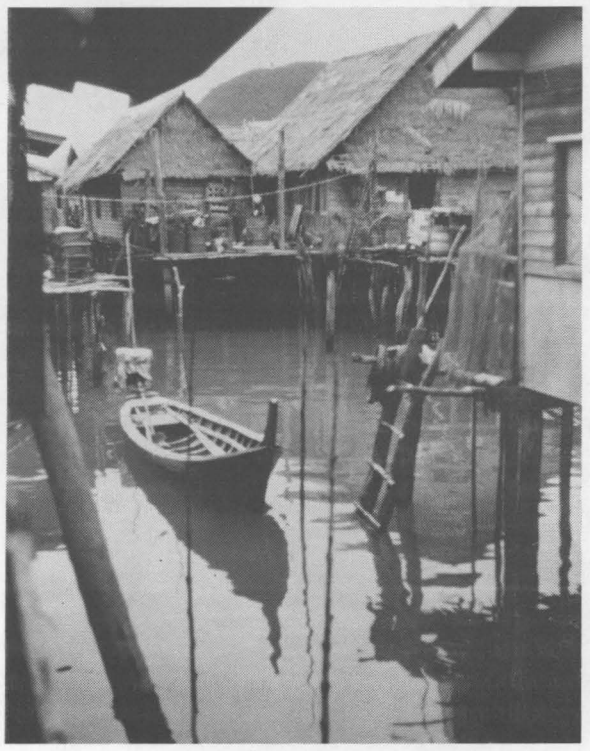
(Continued from Preceding Page)

were too much for the neighboring Burmese — they sacked and destroyed it in the 18th century.

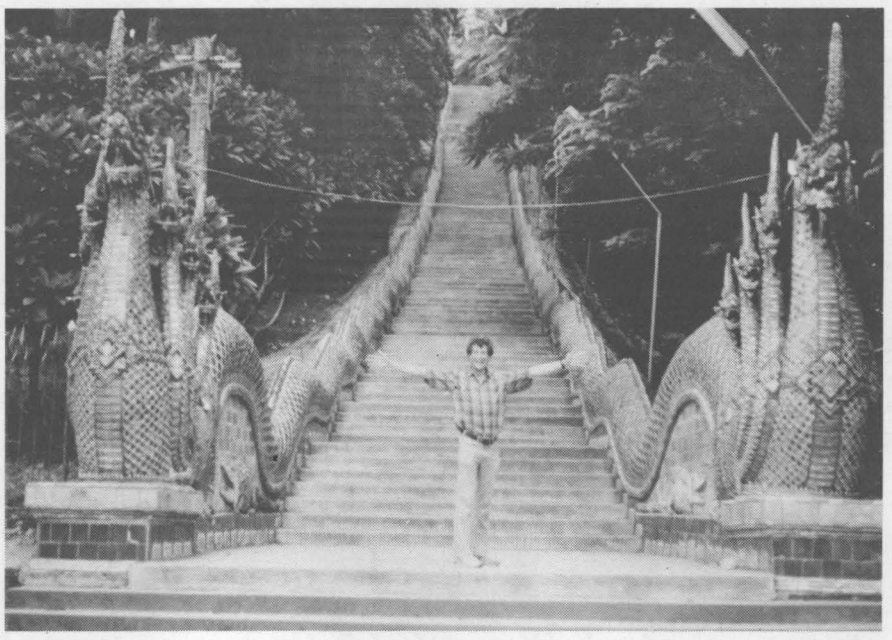
"Now it's a country town with a few hotels and restaurants beside spectacular ruins."

Another side trip from Bangkok took Alex and Marilyn to Kanchanaburi, where, from a riverbank restaurant, they viewed the bridge on the River Kwai, built during World War II and made famous by the 1957 movie.

"The bridge isn't called a 'monument to misery' for nothing," says Alex. "It's believed 16,000 Allied prisoners of the Japanese, and perhaps 100,000 Asian laborers, died building the bridge and the 250-mile 'death railway' that crossed it. The current bridge, constructed of concrete and steel isn't really remarkable — the original, we understand, was constructed of bamboo."



MUSLIM VILLAGE built entirely on stilts in Phang Nga Bay by mysterious people called Mokens — known locally as Sea Gypsies.



BALUSTRADES OF GUILDED DRAGONS guard a staircase of 300 steps at Wat Prathat outside Chiang Mai.

Setting for James Bond Thriller

From Bangkok, Alex and Marilyn also took two longer trips — one south, the other north.

For the trip south, they flew 600 miles to the tropical island of Phuket in the Andaman Sea off the Malay Peninsula.

"Phuket and the surrounding islands have the most beautiful beaches in the world," says Alex. "The intense, deep blue of the ocean and the stunning beaches reminded me of the Mediterranean, especially with all the rustic wooden boats pulled up on the beaches.

"We did some snorkeling and tried scuba diving for the first time — it was as colorful and beautiful under the water as above."

The people of Phuket, says Marilyn, are noticeably different: a mixture of Thais, Chinese, Muslims, and a mysterious people called Mokens — known locally as Sea Gypsies.

"The Sea Gypsies, who occupied this area as far back as the time of Ptolemy, are Muslim — they help make up the 2 to 3 percent of the Thai population that is Muslim. We visited their village built entirely on stilts over the water.

"We also spent some time in Phang Nga Bay, another beautiful area — it was the setting for the James Bond thriller, 'The Man with the Golden Gun.' "

Rose of the North: Chiang Mai

For the second trip, the group flew 400 miles north of Bangkok to Chiang Mai — in the mountainous region of Thailand near the infamous Golden Triangle, opium center of the Far East.

"Once, the only way to get to Chiang Mai was on the backs of elephants — a trip of several weeks," says Alex. "Or by an exhausting river journey, until sometime in the '20s when a railroad was built. Now Thai Airways flies several times a day between Bangkok and Chiang Mai."

Chiang Mai — about one-fortieth the size of Bangkok — is Thailand's second largest city and is known for the striking beauty of its people and for its local handicrafts. "The most beautiful women in Thailand are said to come from Chiang Mai," says Alex. "And the handicrafts — carved teak, silver work, lacquer ware, and silk weaving — are truly dazzling."

They also visited an elephant farm in the mountains north of Chiang Mai. "The elephants are trained to work in harvesting teak logs — but they're unemployed now," notes Alex. "Teak harvesting has been banned to prevent further destruction of Thailand's teak forests."

The high point of the Chiang Mai trip was the group's visit to a Hmong hill-tribe village. "Getting there was a kidney-jolting trip over some of the worst mountain roads I've ever seen," says Alex. "But it was worth every jolt."

"We were surprised to see the colorful, hand-embroidered costumes we'd seen in the shops back in Chiang Mai being worn daily by the hill people, even as they went about their chores," notes Marilyn.

On their last day in the area, they watched traditional dances performed by the Hmong and the four other hill tribes at the Hill Tribes Cultural Center back in Chiang Mai.

Do Alex and Marilyn regret the last-minute change of plans that took them to Thailand? "Not one bit," says Alex. "Thailand is an extraordinary country — we both enjoyed it. There'll be another day for China." •DR

Events Calendar

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

Sept. 8-15 — "Raymond Jonson Cityscapes," exhibit featuring drawings and paintings by Jonson from the 1920s to 1940s; 9 a.m.-4 p.m. Tues.-Fri. (5-9 p.m. Tues. evenings); Jonson Gallery, UNM Art Museum, 277-4967.

Sept. 8-17 — "Art Since 1945," exhibit featuring paintings, sculpture, and prints from the permanent collection, highlighting later twentieth-century art (realism, geometric abstraction, and expressionism); 9 a.m.-4 p.m. Tues.-Fri. , 5-9 p.m. Tues. evenings, 1-4 p.m. Sun.; upper gallery, UNM Art Museum, 277-4001.

Sept. 8-23 — "Fallen Angels," Noel Coward comedy, 60th Diamond Anniversary season-opener; 8 p.m. Thurs.-Fri., 6 & 9 p.m. Sat., 2 p.m. Sun.; Albuquerque Little Theatre, 242-4750.

Sept. 8-24 — New Mexico State Fair: exhibits, shows, entertainment, rodeo, midway, contests, demonstrations, horse racing; New Mexico State Fairgrounds, 265-1791.

Sept. 8-30 — Exhibit, "Moon, Man, & Mars," commemorates 20th anniversary of man on the moon with video, still photographs, and a moon rock; 9 a.m.-6 p.m., New Mexico Museum of Natural History, 841-8837.

Sept. 9-10 — "Harry," avant-garde dance; 8 p.m., KiMo Theatre, 848-1374.

Sept. 10 — Explorations! Classes for Children: "Buzzing the Hive," series of activities for children ages 6-8 on studying the behavior and environment of honeybees, reservations required; 1-3 p.m., New Mexico Museum of Natural History, 841-8837.

Sept. 11 — Monthly Lecture Series: "Stone Tools — Manufacture and Analysis," lecture by Robert Lawrence, assistant forest archaeologist, Carson National Forest; 10 a.m., Indian Pueblo Cultural Center, 247-4907.

Sept. 12-Oct. 8 — Exhibit, "Rio Grande Blankets from the 1880s," group of Hispanic weavings from a private collection in Oklahoma (Sept. 12 gallery talk, 5:30 p.m.); 9 a.m.-4 p.m. Tues.-Fri., 5-9 p.m. Tues. evenings & 1-4 p.m. Sun.; study gallery, UNM Art Museum, 277-4001.

Sept. 14 — Albuquerque Chapter, National Wildlife Turkey Federation Superfund Banquet, proceeds go to habitat improvement in New Mexico and management research, reservations required; 6 p.m., Holiday Inn Pyramid, 294-5858 by Sept. 12.

Sept. 20 — Great Artists Series: Leontyne Price with the New Mexico Symphony Orchestra, program includes operatic excerpts, German art songs, a spiritual, and works by American composers; 8:15 p.m., Popejoy Hall, 842-8565.

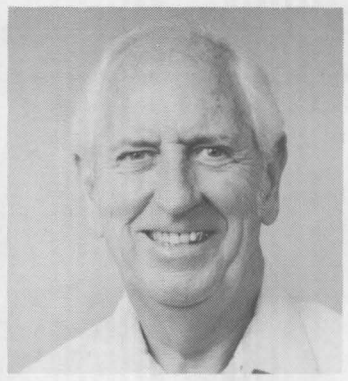
Sept. 22 — "The Edith Head Costume Collection by June Van Dyke," Opera Southwest dinner and benefit, glamorous movie star costumes modeled against backdrop of slides from each star's movies; 7 p.m., Convention Center, 266-8043.

Sept. 22-24 — Lighthearted Living Conference: science, health, arts and humanities experts explore the role of humor in our personal and business lives and the benefits of being able to laugh at ourselves; Glorieta Conference Center (18 miles east of Santa Fe), call for reservations, 1-757-6161 or 294-2289.

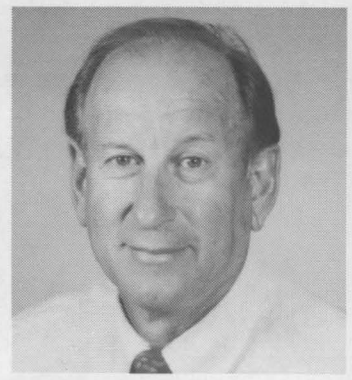
MILEPOSTS

LAB NEWS

September 1989



Morgan Kramm (5230) 35



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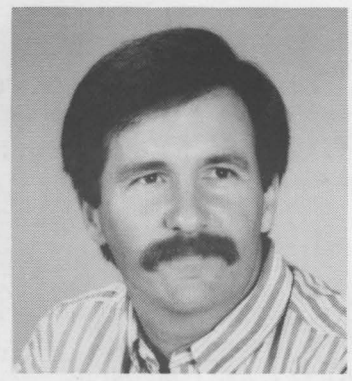

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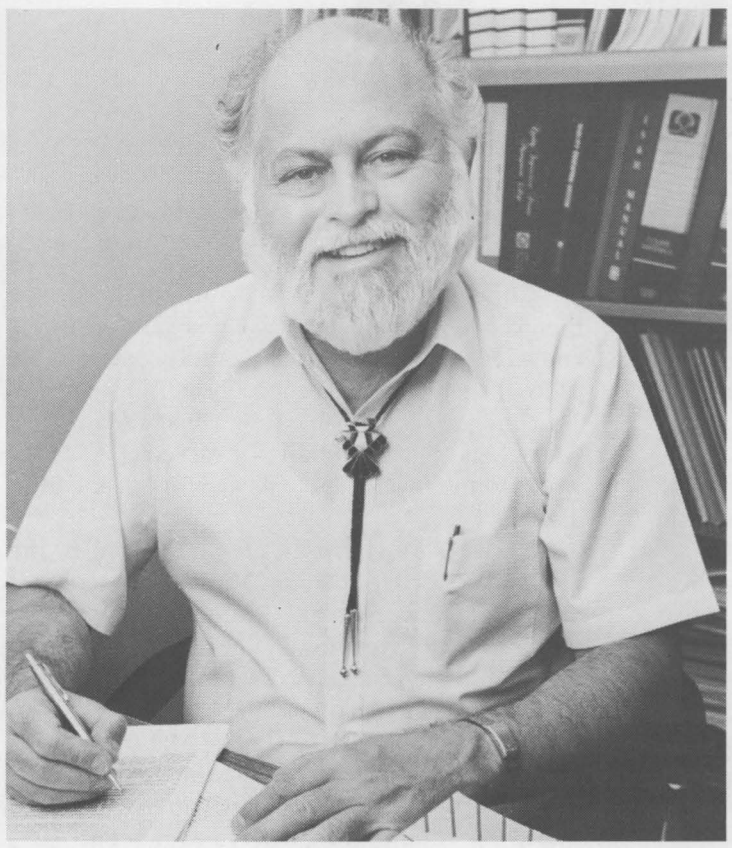
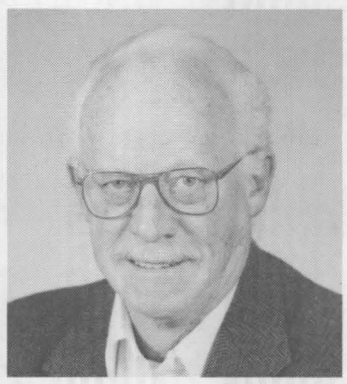
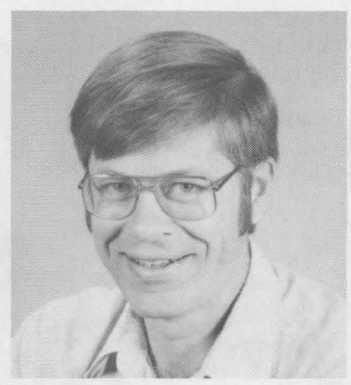


Al Iacoletti (2614) 35

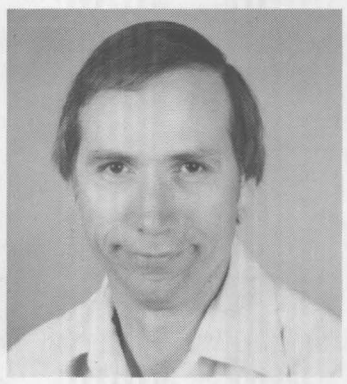


Doug MacMillan (8281) 30

Louise Taylor (8236) 15

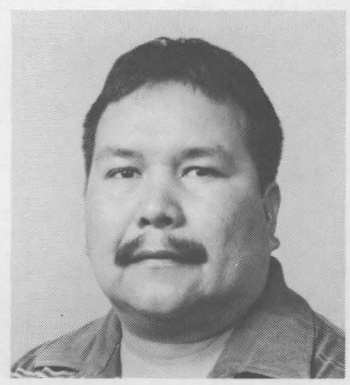


Dan Folk (8343) 25

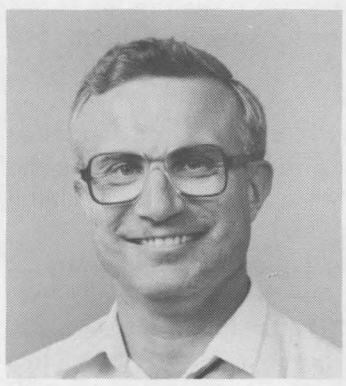


Lee Bertram (DMTS, 8243) 15

Hal Norris (8161) 30



James Coriz (7555) 15



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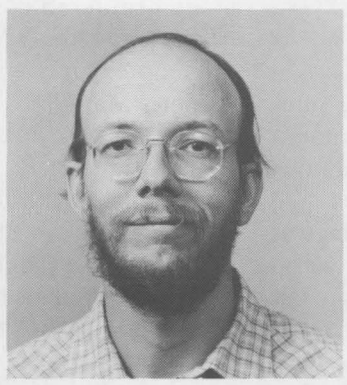

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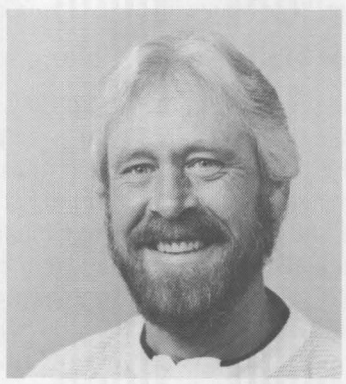

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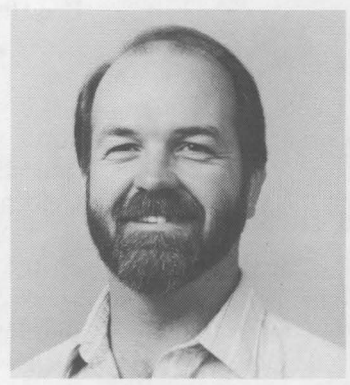

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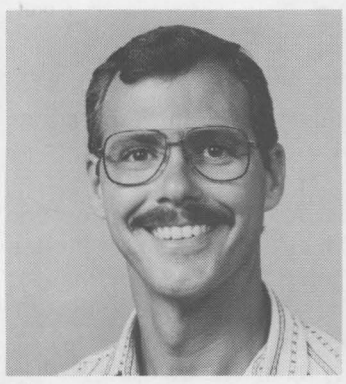
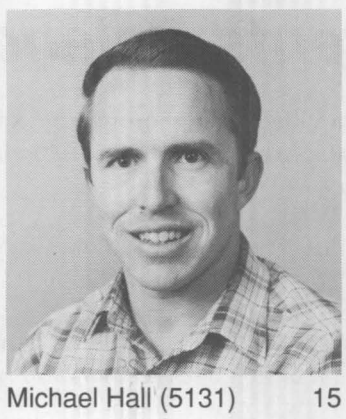
Frances Morris (3010) 25

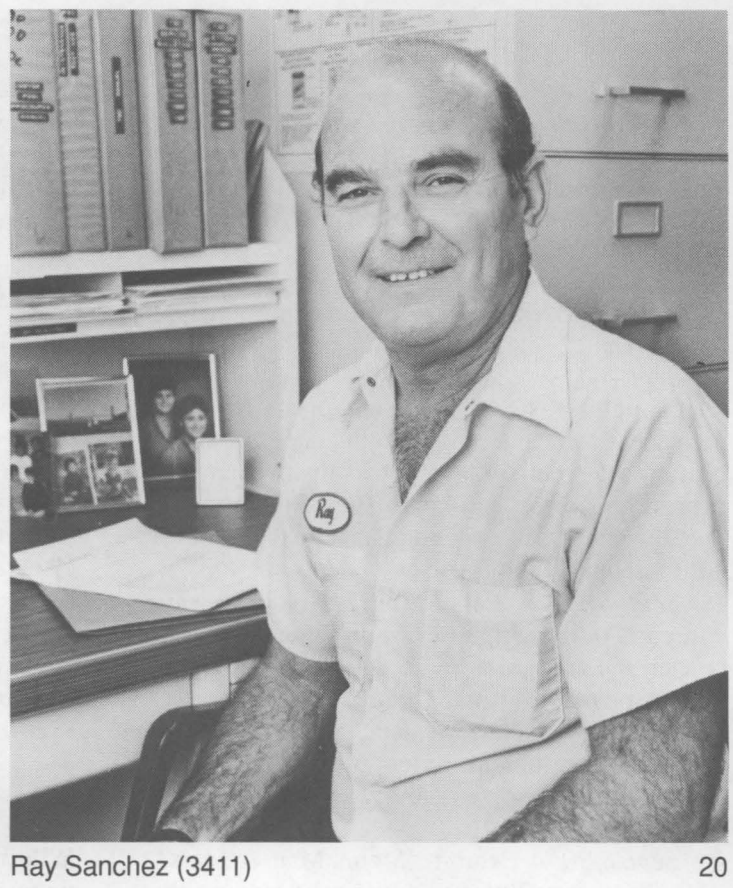


Charles Greenholt (5213) 20

Karen Greulich (3211) 15

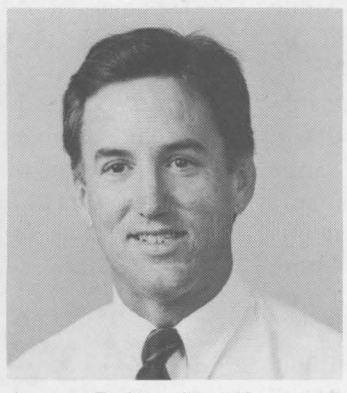


Michael Hall (5131) 15

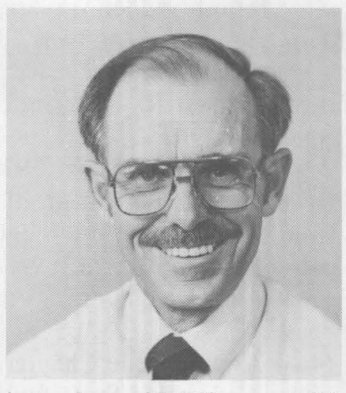


Ray Sanchez (3411) 20

Olivia Armijo (2832) 15



James Dalton (5122) 15



Larry Lane (2172) 30

Take Note

Retirement Seminar

Guy Trujillo of SunAmerica Securities, Inc., will present "What Should You Know About Retiring Before You Retire?" Sept. 13 at the Coronado Club, Eldorado Rm, 5 to 6 p.m. RSVP to Guy on 294-5566.

Parentcraft, a division of Family and Children's Services (a United Way agency), is offering a variety of Wednesday evening parenting workshops this month and next. Registration fee is $5/person, $8/couple. Free child care is available. For information, call 243-2611.

Think Christmas

The season to be jolly isn't all that far away, so it's time once again for the LAB NEWS staff to start thinking about a cover for the Dec. 22 Christmas issue.

As in the past, we're asking readers (Sandians, DOEans, retirees, and members of their families) to submit original paintings — appropriate for the season — in any medium that could be reproduced for the Christmas cover. Entry deadline is Nov. 1, so we can start the selection process at that time.

Bring your potential cover to the LAB NEWS office, Bldg. 814, before Nov. 1, but no sooner than Oct. 23, please. All art submitted for consideration will be returned to owners, though we'll need to retain the winning entry until the Christmas issue is published.

The prize for the winning entry: our eternal gratitude and our sincere wishes for a happy holiday season.

Fun & Games

Bicycling — LAB NEWS has received a limited supply of the new "Metropolitan Albuquerque Bicycle Map." The map is free and may be picked up at the LAB NEWS office in Bldg. 814.

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.

MISCELLANEOUS

MIRRORS: 1/4", 94" x 64", 94" x 50", assorted smaller sizes, $1.50 per sq. ft.; color TV, 19", $125. Dubbert, 281-9269.

GRANDFATHER CLOCK, Seth Thomas, walnut, $499; antique burled-walnut cabinet, Berkeley & Gay, $499. Brooks, 298-8448.

POWER POLE, meter box, 110V GFI, 220V outlets, $250. Hubbard, 281-1779.

FLUTE, Armstrong, w/case & music stand, $85. Davidson, 293-9486.

ENGLISH SPRINGER SPANIEL PUPPIES, AKC-registered, 28 field champions in last 4 generations, available after weaned, $150. Woodfin, 281-2702.

REEL-TO-REEL TAPE DECK, TEAC X-700R, bi-directional, 2 speeds, DBX professional noise reduction, $425. Ford, 294-6133.

CANNING JARS, 2 electric water heaters, 16' power pole, 330-gal. oil tank, food dehydrator, kitchen base cabinets, top. James, 298-0709.

RADIAL TIRE CHAINS, fit most 14" or 15" radial tires, new, still in box, $30 OBO. Plummer, 296-4327.

FOUR MICHELIN TIRES, 215-75R15, 30% tread remaining, $80; one 225-15 nylon tire, 80% tread remaining, $15. Grosbier, 881-1958.

DROP-LEAF TABLE, 5 chairs, extra leaf; lawyer's bookcase. Walston, 298-1500.

DINETTE SET: 36" x 46" oval wood-grain-finish table, 4 tan leatherette chairs on rollers. Moyer, 881-3879.

OLYMPUS OM-25 CAMERA, 28/2.8 Zuiko lens, 50/1.4 Zuiko lens, 35-200 macro zoom, 2x teleconverter, flash, case, camjacket, $400. Wayland, 299-2587.

ELECTRIC TYPEWRITER, IBM Executive, carbon ribbon, $25. Coleman, 884-5009.

PORTABLE WASHER/DRYER SET, Whirlpool, $150. Cook, 266-3042.

'67 FORD FUEL PUMP, AT kits: B-31, C4, and FMX-MX 3-spd.; 6 quarts AT-F fluid. Roberts, 255-9527.

MISCELLANEOUS FURNITURE, ski rack, boy's 15" bicycle training wheels, toy box/desk/bench. Grossman, 298-2096.

WASHER (needs repair) and dryer, $50; Kenmore refrigerator w/ice maker, $300. Janik, 839-9455.

GLASS-TOP DINETTE SET, double-oven electric range, music stands, tripod. Scheiber, 298-0904.

SKIS, 2 prs. boots and poles, gloves, down jacket, Bronco II/Ranger nose bra, solid-wood door, single-size box spring and mattress, power booster. Burke, 294-7548 leave message.

CUSTOM AQUARIUM STAND, solid wood; saltwater-aquarium decorative corals; size 6 women's clothes. Boal, 296-4660.

FLEA MARKET & BAKE SALE, sponsored by Manzano High School Band Boosters, Saturday, Sept. 16, 7 a.m.-2 p.m., north parking lot, Manzano High School. Bickes, 293-4037.

COMPUTER, Panasonic Senior Partner, IBM-PC-compatible, 640K memory, two 360K disk drives, monitor, Panasonic KX-P1091 printer, WordStar, MS DOS 2.1, BASIC, more, $500. Cochran, 842-1528.

WHITE AND BLACK MALE CAT, 13 months old, short hair, free. Ennis, 298-3631.

DRILL PRESS, Industrial Precision Powermatic, 15" floor model, continuously variable speed, cost $1400, sell for $900. James, 294-6837.

MISCELLANEOUS ELECTRONIC EQUIPMENT: stereo (tube), Ampex tape deck, amplifier, you fix, parts, free. Johnson, 296-1917.

FOUR CAPTAIN'S CHAIRS, solid maple, Ethan Allen, $170; Noritake china, service for 4, 26 pieces, $65. Krahling, 268-8126.

GENERAL ELECTRIC UPRIGHT FREEZER, $100 OBO. Sisneros, 873-3989.

APPLE IIc, additional 5.25 drive, color monitor, ImageWriter II printer, mouse, joystick, software, $990. Josephson, 299-9495 after 5.

STUDENT TRUMPET, Yamaha, w/case, $150 OBO. Carne, 822-1738.

NEW DINETTE SET: four 20"-wide oak chairs, 42" x 42" table w/two 12" leaves, American Furniture, cost $800, sell for $700. Long, 294-4591.

QUEEN-SIZE SOFA-SLEEPER, $200; Pioneer 16" chain saw, w/extra chain, $125; La-Z-Boy recliner/rocker, $200. Beck, 294-6868.

STUDENT TRUMPET, Reynolds, used one year, w/music stand, $150. Chinn, 296-5172.

WINCHESTER 1300 12-GA. SHOTGUN, Winchokes, rib, walnut stock, $235; Thompson Center Seneca .45-cal. muzzle loader, bullet mold, $175. Klett, 884-8354.

RADAR DETECTOR, Radio Shack Road Patrol XK, $60; solid-wood speakers, 16" x 24", $60. Gabaldon, 897-2817.

RUSSIAN OLIVE TREE, 10', free, you dig, you haul. Greer, 831-0019.

SOFA AND CHAIR, $150; coffee and end tables, $75; dining set, 6 chairs, buffet, expandable table; misc. items. Ruttle, 883-5547.

GARAGE SALE: household items, furniture, appliances, clothes, misc., Sept. 9, 9 a.m.-3 p.m., 12406 Brentwood Hills NE (by Chelwood). Falacy, 293-2517.

NYLON TENT, sleeps 4, $50; Coleman 2-burner stove, w/stand, $25; free-standing hammock, $25; console-type humidifier, $30. Schubeck, 821-3133.

DIRT, free if you haul, Juan Tabo/Candelaria area. Gorman, 255-4431 or 292-7119.

ANTIQUE OAK TABLE and 4 chairs, 30" x 41" w/two 12" pull-out leaves, $400. Forsman, 298-0911.

BUNDY CLARINET, w/case, $75. Laffoon, 298-7282.

GRACO SWINGOMATIC CRADLE/SWING, 45-min. ride, $35; Kolcraft Rock 'N Ride car seat/carrier, $15. Kiekel, 294-6547.

SOFA AND CHAIR, green/gold cut velvet, matching companion chair; stainless-steel double sink; wire animal yard cage. Carter, 275-8376.

CAMPER SHELL, fiberglass, white, 2 bubble windows, 2 sliding windows, fits Datsun or other small trucks, make offer. Baca, 275-2049.

DOUBLE-SIZE MATTRESS AND BOX SPRING, Beauty Rest, w/headboard and frame; TV/VCR cart; oak-base cabinet; household items. Harrison, 821-9099.

MAGNAVOX STEREO CONSOLE, AM/FM, fully automatic record player, wood cabinet, $125 OBO. Kozlowski, 298-4869.

'84 COACHMAN FIFTH-WHEEL CAMPER, $9000.Tuthill, 281-2562.

REMINGTON RIFLE, .308-cal. model 788, w/scope, $250; Kanga-Rocka-Roo baby carrier, $12. Parson, 291-8394.

LAB/CROSS PUPPIES, 6 weeks old, 3 males, 2 females, free to good home. Mangum, 823-1984.

BOOKSHELF, $20; love seat, $60; curio cabinet, $125; solid-brass fireplace set, $40; fan, $15; blender, $15; humidifier, $25. Levan, 344-9794.

LANCE 11.3' PICKUP CAMPER, self-contained, rooftop air conditioner, Kohler 2.5 generator, $10,000 OBO. Martin, 296-8154.

TRANSPORTATION

'88 YAMAHA WAVERUNNER, 15 hrs., $2995. Bland, 344-9969.

'68 MERCEDES 280SL CLASSIC, white w/red leather, hard and rag tops, $22,500 OBO. Howard, 292-0783.

'87 CONQUEST MMH, 23', 19K miles, AC, generator, storage pod, awning, microwave, weather station, rear bed, bath. Jillson, 299-1648.

SAILBOAT, Topper (J.V. Dunhill, England), 12', car-topable, racing dinghy, 65-sq.-ft. sleeved sail, cost $1200, sell for $700. Schkade, 292-5126.

WOMAN'S 10-SPD. BICYCLE, bright pink, $79; 2-man rubber raft, $99. Brooks, 298-8448.

'86 YAMAHA 350 XT, 525 miles, $1450. Rivord, 296-9151.

'86 GRAN MARQUIS, all options, AM/FM stereo, AT, 32K miles, $10,000. Gonzales, 255-9678.

'75 DUCATI, 860cc, 12K miles, needs ring job, front cowling, 2 shop manuals, $800. Bercaw, 275-1691.

'84 DODGE ARIES SW, AT, AC, sell for loan balance. Danella, 892-2892.

'78 SUZUKI GS400 MOTORCYCLE, 9.5K miles, $400 OBO. Parsons, 298-7363.

GIRL'S 20" BIKE, pink & white, $20. Stewart, 296-4341.

MAN'S 12-SPD. BICYCLE, 21", black, $300. Cook, 266-3042.

'82 DATSUN 280ZX, 5-spd., AC, silver, gray interior, AM/FM tape, 6-cyl., 68K miles, power everything, $4900; man's 10-spd. bike. Grossman, 298-2096.

'77 PLYMOUTH VOLARE, 6-cyl., AC, 4-dr., one-family-owned, rebuilt transmission, service records available, best offer. Dederman, 298-5560.

'86 HONDA CRX, 38K miles, AC, cruise, alarm, $5500 firm. Tessler, 293-5628.

CLASSIC BRITISH MOTORCYCLES: '68 Triumph TR6 (650); '73 BSA B50MX (500); original condition, standard oil leaks included. Eckstrom, 281-9508.

'87 SUZUKI GSXR 1100, custom paint, Comp Ks, 1.9K miles, Arai and Shoei helmets, Bates leathers, $5300. Gonzales, 823-4484.

'74 CHEV. NOVA, 4-dr., PS, PB, AC, $700 OBO. Torres, 299-5789.

'87 HONDA CRX Si, silver, auto sunroof, 5-spd., $7300. Barnes, 291-8952.

'83 HONDA CB1000C MOTORCYCLE, fairing, AM/FM cassette, CB/intercom, 5 performance/ 5 economy gears, 15K miles, $1935 book, sell for $1750. Bowman, 883-1657.

'81 HONDA CB750K, fairing, saddle bags, trunk, Lucas lights, AM/FM cassette, 8K miles, new tires and forks. Shoaf, 296-6166.

'79 DODGE ASPEN, V-8, PS, PB, AT, $800. Diltz, 899-0372.

'84 HONDA CIVIC, hatchback, blue, 52K miles, all maintenance records, $2000. Allen, 292-4238.

'79 FORD FAIRMONT, 4-cyl., AT, PS, AC, 4-dr., $1600. Padilla, 877-2116.

'85 BMW 318i, CD/AM/FM, radar, all electric, custom paint, sheepskins, bra, custom stereo, 50K miles, sunroof, tinted windows. Brantley, 299-1221.

'75 CAMARO, red, AT, AM/FM cassette, $1500 OBO. Arguello, 821-9635.

'86 HONDA NIGHTHAWK, 3.2K miles, helmet, extras, $2400. Cameron, 275-7516.

'64 CHEV. SW, 283 engine, one owner, tires are 1 year old, new battery. Gonzales, 265-2671.

'87 NISSAN PULSAR, 39K miles, T-top, Yamaha stereo w/6 speakers, code alarm, AC, PS, $500 and assume loan. Sanchez, 873-0219.

'57 HARLEY-DAVIDSON SPORTSTER CHOPPER, girder front end, rigid frame, magneto ignition, front disc brake, $3500. Dawson, 281-1235.

'80 CHEV. CITATION X-11, 2-dr. coupe, 2 spare tires, one owner, $1600 OBO. Stephens, 242-2311.

'81 DATSUN KING CAB, 4WD, 5-spd., AC, roll bar w/lights, custom paint, chrome wheels, AM/FM cassette, receipts, more, $3950. Johnson, 294-6932.

'81 YAMAHA 250 XT, new cables, chain, and sprockets, carb-jetted, manuals, extras, street-legal, $475. Miller, 281-3655.

'84 VOLKSWAGEN GTI, 5-spd., AC, PB, $3500 OBO. Helsel, 294-3418.

'82 MIDAS TRAVEL MASTER MOTORHOME, Class A. Stoever, 296-3717.

'83 YAMAHA HERITAGE SPECIAL, 650cc, $650; '81 Yamaha Maxum, 650cc, $750. Van Zuiden, 296-6034.

'67 COUGAR, V-8, AT, PS, AC, new engine, transmission, radiator, $2500 or offer. Phipps, 299-8490.

REAL ESTATE

3-BDR. HOME, two 1-bdr. apartments, 4 garages, landscaped, $14,000 tax credit, $7000 income, owner financing. Vigil, 256-1172 or 242-2969.

2-BDR. PATIO HOME, Taylor Ranch, 2 baths, double garage, sprinklers, skylights, 1200 sq. ft., $79,500. Sanford, 898-4823.

1-ACRE LOT in Rowe, N.M., on mesa overlooking Pecos River, water, power available, $7500. Hesch, 275-7630.

BRICK DUPLEX, 1-bdr. units, security. Haycraft, 299-3220.

3-BDR. HOUSE, all brick, 2 baths, 2-car garage, FP, 1700 sq. ft., golf-course area in Belen, $125,000. Accardi, 821-9684 leave message.

TWO LOTS near Navajo Lake, one block from water, $7000/ea. or $13,000/both. Bertholf, 296-7657.

2-3-BDR. HOME, SW, w/new den and roof, fully fenced w/chain link, on 1/3 acre. Vanselous, 877-6128.

HOME w/separate apartment, remodeled kitchen, new carpets, Jacuzzi, separate workshop. Baca, 877-0625.

WANTED

CABIN TO RENT, Northern New Mexico or Southern Colorado, for one week in September or on occasional basis. Glass, 291-8324.

SAILING DINGHY, 8-10 feet, prefer a Montgomery. Harris, 299-6606.

SOLOFLEX, in good condition, prefer almost new. Garcia, 897-0807.

AUTOHARP, reasonably priced. Dykhuizen, 281-9463.

3-4-BDR. HOUSE: by single woman, two docile cats, no kids, rent/option to buy, nice neighborhood, reasonable payment. Schubeck, 821-3133.

WORK WANTED

BABYSITTER, registered CPR, 14 yrs. old, Indian School/Chelwood area, call for references and information. Falacy, 293-2517.

LOST AND FOUND

KITCHEN ITEMS found in Bldg. 802, second floor. Camal-Elder, 4-9650.

SHARE-A-RIDE

VANPOOL SEATS AVAILABLE, along N-14 and Frost Rd., $34/mo., ride every day. Rentzsch (281-5017) or Burns (281-3922).

Coronado Club Activities

Western Night Wingding Features Steak, Shrimp

WESTERN WHOOPLA is on the front burner tonight — along with T-bone steak and fried shrimp. Both Friday-night entrees, at $7.95, include your choice of rice pilaf or baked potato, steamed vegetables, rolls, and coffee or tea. Afterward, put on your sagebrush-shuffle shoes and head for the dance floor, where those inimitable Isleta Poor Boys preside from 8 p.m. to midnight. Dinner reservations recommended (265-6791).

THERE'S STILL TIME TO VOTE for seven C-Club Board members between now and the annual meeting next Monday, Sept. 11. Cast your ballot at the Club at midday (11:30 a.m.-1 p.m.) today or Monday, this evening (6-8), or from 4:30 to 6 at the meeting, which officially gets started at 5 p.m. Enjoy free refreshments afterward, while the votes are being tallied.

SNOW IN SEPTEMBER? Doubtful, but that doesn't stop members of the Coronado Ski Club from thinking about it. These savvy schussboomers launch the 1989-90 season with Ski Fair XII Sept. 19 in the patio and ballroom areas, starting at 5 p.m. Here's your chance to sign up for some of those tremendous trips planned by CSC this winter, and to learn about the latest in Alpine attire, plus what's new at your favorite ski area. You needn't be a CSC member to get in on the fun, but you can sign up right then and there if you want to. Some of the trips are very popular and fill up fast, so if you're interested, get there early and bring along the checkbook (no cash, please). A short meeting starting at 7 p.m. features some of those fabulous door prizes for which the CSC is famous.

IT'S MEXICAN FIESTA TIME next Friday night (Sept. 15). Start out with a meal offering two good-hot-stuff selections — a grilled fajita plate ($6.95) or a beef burrito plate ($5.95). Both entrees are served with refried beans, rice, chips and salsa, and sopaipillas/honey. A group called Eva Torrez With a Cast (did Eva break her leg?) makes the mambo music from 8 p.m. to midnight. Fiesta means a sellout, so make that reservation early.

A BRUNCH OF FUN is in store if you reserve some space Sunday, Sept. 17, for the best meal-deal in town, served from 10 a.m. to 2 p.m. The bountiful buffet features Virginia baked ham, baron of beef, sausage, scrambled eggs, green chile, tossed and fruit salads, and an assortment of puddings and cakes for dessert. Top it all off with a glass of champagne, compliments of the management. This fantastic feast is just $6.95/adults, $3.50/children from 3 through 11 years old, and free for toddlers under 3.

NO UNDER-THE-TABLE DEALS: That's the guarantee of the T-Bird card sharks as they swing back into gaming action on Thursday, Sept. 21, starting at 10 a.m.— a civilized time of day, to be sure. Master card-player Jim McCutcheon, who tries his best to keep this irrepressible group in line, promises a good time for everybody — plus lots of freebies, including refreshments and door prizes.

Recent Patents to Sandians

Roger Clough and Al Sylwester (both 1811): Electrically Conductive Composite Material.

John Zeigler (on leave): Interrupted Polysilanes Useful as Photoresists; Poly(silyl silane) Homo and Copolymers; and Method for the Preparation of Novel Polyacetylene-Type Polymers (three patents).

Carol Ashby (1126), Paul Brannon (1128), and Jim Gerardo (1120): Laser-Driven Fusion Etching Process.

Bruce Bunker (1842), Diana Lamppa, and James Voight (both 1846): Superconductor Precursor Mixtures Made by Precipitation Method.

Mike George (1242), Lyndon Pierson (2647), and Mark Wilkins (former Sandian): Universal Null DTE.

George Schils (8435), Don Sweeney (8435), and Ellen Ochoa (former Sandian): Position, Rotation, and Intensity Invariant Recognizing Method.

Arlin Cooper (5145): One-Way Transformation of Information.

Welcome

Albuquerque
- Todd Adelmann (9231)
- Hue-Su Hwang (3202)
- Johnnina Ortega (2631)
- Daniel Rondeau (2833)
- Alan Zelicoff (9241)

Arizona
- Emmet Slayton III (2175)

Indiana
- Thomas Tarman (5172)

Oregon
- Edward Hanson (2346)

feedback

Q. Some benches — unshaded and unsheltered — are placed near the water-tower parking lot and between there and Gate 6, near the motorpool turnstile. It would be more practical to place them under the Dome area near the east entrance of Bldg. 891. There are now some picnic tables north of 891, but the trees are not sufficiently grown to keep the sun off. Can the benches be relocated?

A. I agree with you that the benches near the water-tower parking lot will get little use; however, they were requested through Feedback, so we decided to give them a try.

I am reluctant to put benches under the Dome area east of Bldg. 891; I think they aren't in keeping with the appearance we want to provide. However, I'm willing to put a couple of benches close to the north side of 891, which would place them in the shade of the building until the trees get big enough to provide shade for the existing picnic tables.

Ward Hunnicutt — 7800

Q. Sandia National Labs is one of the premier labs in the world. So why is it that our magazine racks in the Tech Library only serve three-to-four-foot-high people? I am 6'2" and have to stoop over until my head is three or four feet above the floor to read the magazine titles. We should either modify the existing shelves or buy new ones.

A. The periodicals display in the Technical Library is an ongoing concern. We've recently made some minor adjustments to accommodate the diverse information needs of the technical staff, considering both their ergonomic needs and our space limitations. Obviously, we have not succeeded for you, but we have succeeded for those who are handicapped and in wheelchairs. We are considering raising the shelves about 1-1/2 feet. If you have any other opinions that you would like to voice in person, please feel free to contact Jennie Negin (3140) in the Technical Library.

Herb Pitts — 3100

Sympathy

To Jerry Soden (2118) on the death of his father in St. John, Kans., Aug. 16.

To Donald Schofield (7481) on the death of his father-in-law in Iowa, Aug. 19.

To Leo Armijo (7818) on the death of his sister in Clovis, Aug. 27.

THE POTPOURRI OF ART now on display in the lobby of Bldg. 802 and in the Technical Library foyer was created by these members of Computer-Based Graphic Design and Technical Art Support Div. 3155. Shown are (standing in back row, from left) Don Wagy, Faye Ganzerla, Bonnie Skenandore, Tom Salazar, John Bell, Jerry Gorman, and Barbara Potts. Seated around George Dooley, who's front and center, are (from left) Kay Lang, Doris Jackson, Mitzie Morrato, Cynthia Figueroa-McInteer, and Kay Rivers. Not shown is Jim Walston. The artwork will be on display through Sept. 15, according to 802-lobby "curator" Joe Laval (3163).