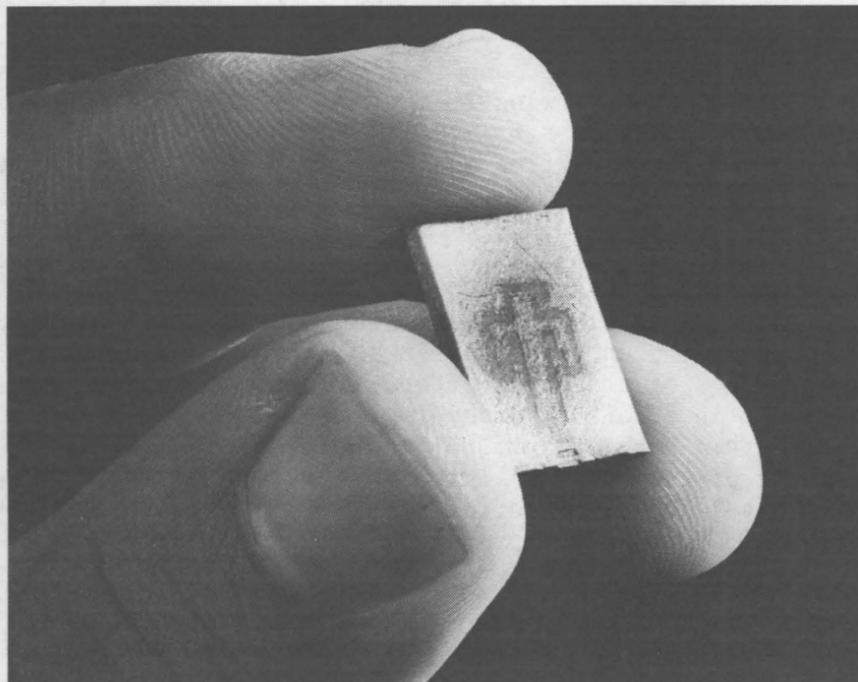


## Building High-Speed Circuits on a Non-Stick Surface Isn't Easy: The Trick Is to Make the Copper Stick

If you had a hot breakfast today, chances are it was cooked on something called (poly)tetrafluoroethylene (PTFE). It's better known as Teflon (a DuPont trade name), the material that makes non-stick frying pans non-stick. It's also used in Gore-Tex®, a popular waterproof liner in coats, gloves, and boots.

In the microelectronics industry, Teflon is used as a non-conducting substrate for printed circuit boards. Unfortunately, the non-stick properties that make it great for cooking eggs also make adhering tiny copper circuit lines to its surface difficult. Teflon is physically and chemically inert, which prevents materials from bonding readily to its surface.

**TINY T-BIRD** — Bob Rye of Surface and Interface Science Div. 1114 irradiated the shape of a tiny thunderbird on a Teflon substrate using a 0.7-mm-diameter electron beam to demonstrate a new copper-to-Teflon adhesion technique developed by Bob and three UNM researchers. The researchers found that irradiated areas of a Teflon surface become impervious to etching and that copper deposits selectively on areas that have been etched. Once fully developed, says Bob, the technique may help circuit board manufacturers build better circuits.



Last year Bob Rye of Surface and Interface Science Div. 1114 discovered that irradiation could help control the etching of patterns on Teflon and that etching could help adhere materials to its surface. Five miles away, University of New Mexico researchers Mark Hampden-Smith, Toivo Kodas, and Kai-Ming Chi reported another, seemingly unrelated development: chemical vapor deposition of copper could be accomplished on a variety of surfaces using new metal organic compounds.

### Making Teflon 'Stickier'

In May, Bob attended a local American Vacuum Society meeting where the UNM researchers presented their results. "I didn't know UNM was

involved in copper deposition research," he says. "But when I heard their findings, I knew our research might be compatible. Adhering copper to Teflon is something I've been interested in for a long time."

So the four put their heads together and within two weeks demonstrated a new way to make regions of a Teflon sample "stickier" so that copper could be deposited selectively onto its surface. Since then, a number of companies have expressed interest in commercializing the process, and several Sandia organizations may adopt it as well. Its potential applications include improved circuits for high-frequency computers, radars, and communications devices, among others. (See "Faster Circuits Benefit Industry, Military" on page four.)

### The Ideal Materials

In high-frequency applications, electrical interference, or "cross-talk," between nearby circuit elements limits the speed at which operations can take place. Because of this, the ideal combination of materials for high-frequency circuits is a Teflon substrate with highly conductive copper lines. Teflon has a very low dielectric constant — essentially a lower level of interference between circuits than other materials — which means copper lines

(Continued on Page Four)

### It Adds Up: Copper-to-Teflon Adhesion Makes 5,000

Bob Rye (1114) and UNM researchers Mark Hampden-Smith, Kai-Ming Chi, and Toivo Kodas recently submitted Sandia's five thousandth invention disclosure for their copper-to-Teflon adhesion technique, titled "Method for Forming Patterned Deposition of Copper on Polymeric Substrates."

The invention disclosure — a formal filing in Sandia's patent office of an idea that has patent potential — is an important milestone in the Labs' history, says Marvin Moss of Patent Dept. 250. Sandians now file approximately 130 disclosures a year, or about one every other work day, he notes.



# LAB NEWS

VOL. 44, NO. 1 SANDIA NATIONAL LABORATORIES JANUARY 10, 1992

## President to Brief Managers Next Week

President Al Narath will brief Sandia managers (section supervisors and above) in Albuquerque and Livermore next week. He will discuss the results of the recent "summit meeting" of DOE lab directors and Secretary of Energy James Watkins.

Al will speak at Livermore in the Bldg. 904 auditorium Tuesday, Jan. 14, at 1:15 p.m. and at Albuquerque in the Technology Transfer Center (Bldg. 825) Wednesday, Jan. 15, at 10 a.m. and 1:15 p.m. In Albuquerque, managers with last names beginning A-L should attend the 10 a.m. session. Managers with last names beginning M-Z should attend the 1:15 p.m. session.

Each session is scheduled for 90 minutes. Al's presentation will take about 40 minutes, and the rest of the session will be used for questions and answers.

Managers will be expected to share the content of the briefing with their staffs. Supporting documentation will be available at the meetings.

The sessions will be videotaped and available from the Livermore and Albuquerque technical libraries.

## Variations on the Recycling Theme

### At This Shop, the Waste Stream Has Slowed to a Trickle

As any backyard mechanic should know (though some don't), our environment is harmed when substances such as old motor oil or anti-freeze are dumped carelessly. At the Labs, such materials are disposed of as hazardous waste.

But after Equipment Maintenance Sec. II 3423-3 finishes work on one of the tractor-trailer rigs from DOE's Transportation Safeguards Division, or on one of the escort vehicles that accompany the rigs, there's only a little of the waste to be thrown away that's normally produced by vehicle maintenance. Most is reused instead — some of it in surprising ways.

Imagine a tractor brought in for routine maintenance. *First, let's change the oil: Unscrew the plug from the oil pan, let the old oil drain into a container, and empty it into a 55-gallon drum for eventual disposal through the hazardous waste system. Right?*

Wrong.

"We don't send motor oil out for disposal," says Mark Crawford, ES&H coordinator for Transportation Services Div. 3423. "We use a blender that takes it right out of the oil pan of the tractors,

filters it, and mixes it into the diesel fuel that runs the engine. We also use the motor oil drained from escort vehicles the same way. We put about 7 gallons of oil into 200 gallons of diesel fuel."

This use of engine oil is approved by the engine manufacturer, who supplied the blender. The process is certified by the Environmental Protection Agency.

Blending old oil with fuel saves the disposal of about 600 gallons of oil annually. Mark says such systems are beginning to be widely used by large commercial truck fleets.

### Putting the Squeeze on Filters

*Next step: Before we put fresh oil into the engine, we replace the filter.*

Old oil filters can't be reused, but a machine like an oversize orange juicer crushes them — and also fuel and transmission filters — to about one-third their original size. The filters are collected in a 55-gallon drum, which is eventually disposed of through the Labs' hazardous waste system. Because the crushed filters take up less space, fewer

(Continued on Page Five)

# This & That

**20/20 Club** - In our Dec. 6 issue, I wrote that Patricia Newman (5028) wanted to know if there were other second-generation 20-year Sandia veterans. Patricia celebrated 20 years at the Labs last spring; her dad, John Tolmie (deceased) earned his 20-year pin in 1970.

So far, we've learned of three other families with members in the Sandia "20/20 Club": Jack Strascina (2471) has 25 years of Sandia service, and his dad, Vincent (deceased), retired in '84 with 30 years of service. Terry Martinez (5029) has 21 years of service; her dad, Jose Martinez, retired nine years ago with 25 years of service. Brothers Art Sena (9125), with 26 years at Sandia, and Rich Sena (7841), with 21 years, not only qualify for the 20/20 Club, they are third-generation Sandians. Their mom, Jo Sena, retired with 32 years of service just before the holiday break, and Jo's dad, Joe Comiskey (deceased) worked at the Labs from '53 to '70. Joe's son, Frank Comiskey (3421) - Jo's brother and Art and Rich's uncle - also works at the Labs and has 37 years of service.

\* \* \*

**Slick Recycling Project** - Office paper recycling is probably the most visible part of Sandia's recycling program, but it's only one of several parts. Some folks may be surprised to learn that Transportation Services Div. 3423 not only recycles used motor oil by mixing it into diesel fuel, but also recycles antifreeze and even Freon refrigerant that's used in vehicle air conditioners. Read about this fine project in a page one article.

\* \* \*

**Friends: I'll Try to Work You In** - If all goes according to plan, we should know within a few weeks how the Sandia restructuring plan will affect us. The Sandia Management Council plans to settle most remaining issues at its Jan. 20 meeting and to announce the plan to employees as soon as possible thereafter. I'm really looking forward to it after getting the following message early this year in a fortune cookie: "You'll be offered a prestigious position with a high salary." I do want to reassure my many Sandia friends (OK, both of you) that I'll remain the same unassuming, down-to-earth fellow I've always been after I assume my lofty new position. However, I would very much appreciate your calling for an appointment instead of just dropping by. With that high salary, my time will be as valuable as a Russian ham.

\* \* \*

**Changing Fortunes** - Speaking of fortunes and Russia, the rate at which some fortunes have changed - and continue to change - in that part of the world is startling. Just two years ago, *Time* magazine named Mikhail Gorbachev its "Man of the Decade," referring to him as "a sort of Zen genius of survival, a nimble performer who can dance a side step." And, in truth, there's nothing funny about the price of ham and other basic foods and commodities in the former Soviet Union. The economic problems those people face (recent newspaper headline: "Prices Make Shoppers Cry") make some of ours seem pretty mild.

\* \* \*

**Wrong Desert** - Every blue moon or so, we publish a list of strange names and addresses on Sandians' mail. We don't have a sufficient collection to publish another list yet, but here's the misspelling we see the most: "Saudia National Labs." We'd appreciate your sending others that you receive (including those "creative" spellings of Albuquerque) to us at Division 3162. ●LP

## Medical Corner

# Benefits Sponsors Discussions of Health Care Issues

Next week, Carson Beadle of William Mercer, a national health care consulting firm, will speak to Sandians about national health care issues during two Town Meeting forums in the Technology Transfer Center (Bldg. 825): Monday, Jan. 13, and Tuesday, Jan. 14, from 10 a.m. to noon each day. The presentations will be telecast live to the Bldg. 904 auditorium in Livermore (9 to 11 a.m. each day).

Beadle, William Mercer's Washington, D.C., liaison, will discuss government options for addressing the current health care crisis. In addition, taped comments from Senator Jeff Bingaman and Representative Steve Schiff will give a congressional update on pending health care legislation. Benefits Dept. 3540 employees will be available to answer questions about Sandia's health care benefits.

The talks will supplement the Sandia Benefits information packet already sent to Sandians' home addresses. Tapes of the meetings will be available from the Technical Library after Jan. 15.

Employees may leave questions about Sandia Benefits on Sandia Line (5-6789) by choosing "Benefits" option 3, "General Information" option 1, and then "Suggestion Box" option 4. For questions about the forum that cannot be left on Sandia Line, call 5-9706.

Any employee who does not receive a copy of the recent benefits packet, titled "First Annual Benefits Preview: Focus - Health Care Benefits," at home can request a copy by calling 5-9812. ●

## Sympathy

To Frances Watkins (3421) on the death of her sister in Colorado Springs, Nov. 10.

To Bernard Zimmerman (3426) on the death of his mother in New York, Dec. 10.

To Joe Aranda (3426) on the death of his father in Albuquerque, Dec. 16.

To Glenn Folkins (5154) on the death of his mother in Spokane, Wash., Dec. 19.

## LAB NEWS

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## Take Note

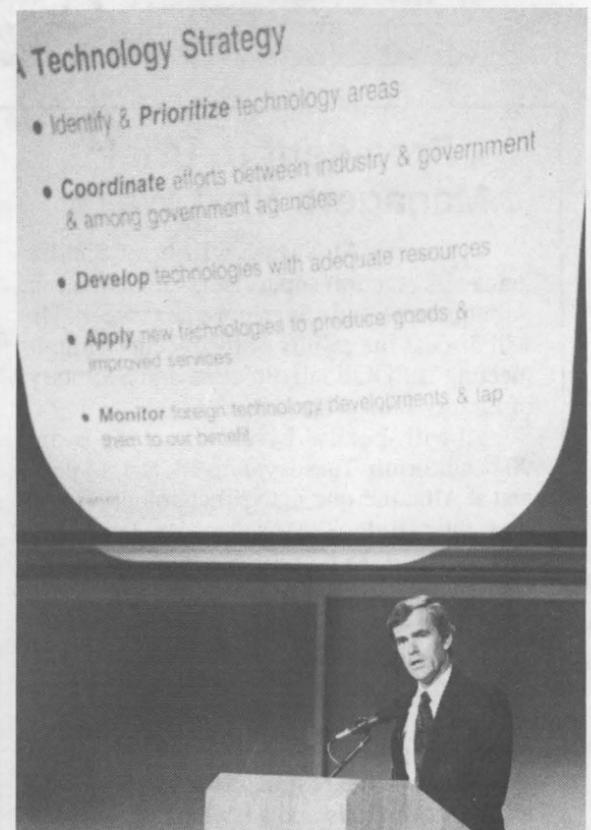
Twice a year the Albuquerque Office of Senior Affairs and UNM Continuing Education sponsor a class that emphasizes topics of interest to retirees, those about to retire, and people who assist a senior citizen. The seven-week class discusses Social Security, Medicare, health insurance policies, health maintenance organizations (HMOs), community-based services, nursing home insurance, guardianship, wills, and funerals and burials. The classes are from 10 a.m. to noon on Saturdays beginning Jan. 25. For information, contact Office of Senior Affairs Medicare/Health Insurance Counseling on 764-6471 or 764-6474. To register, call UNM Continuing Education on 277-6542. Ask for Course No. 609. The fee is \$20.

\* \* \*

The winter meeting of the Rio Grande Chapter of the Association for Computing Machinery will be held Friday, Jan. 31, at the Inn of the Mountain Gods in Ruidoso. Contact John Rowe (9232) on 4-3300 for more information.

\* \* \*

Retiring and not pictured in LAB NEWS photos: Henry Sisneros (2412) and Elizabeth Lee Frost (323).



SENATOR JEFF BINGAMAN visited Sandia, Albuquerque Dec. 20 to discuss the future of R&D in the US and its potential role in reshaping the US economy. To thrive in a competitive world economy, he said, the US must develop a far-sighted technology strategy that includes stepping up teamwork among government agencies, R&D institutions such as Sandia, and US businesses.

**Fits a Neglected Niche****Quick, Easy Plotting Program Enters Commercial Market**

Plotting more than 100,000 data points is a big job, even for a computer. But it's a lot easier if the computer is equipped with a new, user-friendly plotting package developed by Barry Hess, a senior technical associate in Hydrogen Storage Research Div. 8343.

The program, called Xplot, has proved so useful that last month it was licensed commercially to Dux Software in Los Altos, Calif., a small company that produces and licenses software for Sun workstations. Sandia already has 10 commercial licenses signed with outside companies, but this is the first one from Sandia, Livermore for a

**"I think of the program as a child that has grown and is now ready to go out in the world and stand on its own."**

software product, notes David Salazar (4213), the technology-transfer licensing specialist in Albuquerque who handled the licensing agreement.

Dux has already begun selling copies of Xplot, though further development is going on to add features for future versions.

Barry explains, "We aren't in the business of writing commercial software codes, but this program offered capabilities that outside users wanted. I think of the program as a child that has grown and is now ready to go out in the world and stand on its own."

Barry demonstrated Xplot at a Sun Users Group show held recently at the San Jose Convention Center. The package provides simple x- and y-axis plots on an easy-to-interpret data graph.

**Researchers Wanted Quick Plots**

Barry says work on the program started two years ago when Physical Science Dept. 8340 began using extremely fast Sun workstations for data acquisition systems in the department's labs. Most users wanted to plot their data on their workstation screens and get paper copies for their notebooks.



TAKING PART in a Sun Users Group trade show recently at the San Jose Convention Center were Barry Hess (8343, left), developer of the plotting program Xplot, and Robert Adams, President of Dux Software, which is marketing Xplot.

Barry and others found that most programs couldn't handle large data files easily. So, he explains, "I started to write a software package that would be as user friendly as possible and would produce high-quality prints and graphs quickly."

The package lets users simply "drag and drop" a file icon on the workstation screen into a plot window to create x-y plots of multiple or single columns. It can handle up to 40 columns of numbers with column lengths limited only by the workstation's memory. Plots can be printed in color or black and white on any PostScript™ printer.

Barry calls the package a "prototype program." It allows users to get an early, quick look at large volumes of data and eliminate unnecessary information before it's printed. Barry says, "There's nothing that compares with it for ease of use."

**Designed by Users**

After he completed the initial version, Barry started getting more and more requests for the program. Users liked the way it worked, and they liked not having to invest large amounts of time in learning how to use it. They frequently offered suggestions about how features and functions could be improved. "The program was really designed by users here," says Barry. "I listened to their comments and suggestions."

The most difficult part of development was looking objectively at the ways people would want to use the program, he says. "Any time you add another function, you make the program more versatile, but you also make it less user friendly. The most powerful software isn't worth anything if it alienates people from using it."

Barry says he likes the idea of a small company like Dux taking charge of the program. "We think the managers of a small firm will be able to give Xplot the attention it needs to become a successful commercial product," he says.

Dux's managers became interested in Xplot as  
*(Continued on Page Five)*



**SANDIA  
LIVERMORE NEWS**

**Take Note**

Marlin Pound (8530) has been elected vice chairman of the Livermore Area Recreation and Park District board of directors. He has been on the board 23 years.

\*\*\*

Barry Schrader (8522) has been elected president of the Chabot-Las Positas College District board of trustees. Barry began his second four-year term on the community college board in December.

**Congratulations**

To Terry and Danny (8535) Bernacil, a son, Daniel Dalton, Dec. 15.

**Pledges Set Record****LEAP Response Exceeds Goal**

Once again, Livermore Sandians have come to the aid of many human service agencies and local charities, surpassing the 1991 LEAP (Livermore Employees Assistance Plan) campaign goal and pledging a record \$163,518.

LEAP chairman Russ Miller (5355) says employees not only exceeded the \$163,000 goal, but the average dollar amount per participant also set a record — \$194.43. This year, 841 Livermore Sandians pledged. This 82.5-percent total is down slightly from last year.

Percentages increased for both Gold Share and Fair Share giving. Gold Share participants (those giving 1 percent or more of their salary) went from 1.5 percent in 1990 to 2.6 percent in the 1991 campaign. The Fair Share pledges (people giving 0.6 percent of their salary or more, but less than the Gold Share amount) increased from 26.7 percent to 27.1 percent.

Since Sandia, Livermore employees began their annual charity drives in 1969, they have given \$1,978,000. This year about 35 human service and charity groups will benefit.

An additional project blossomed this year, a spinoff from LEAP Committee efforts, when 1992 chairman Mark Perra (8314) organized a Holiday Gifts for the Needy campaign to provide specific gifts from a wish list provided by four area charitable agencies.

As a result, some 240 requests were filled by Sandians who purchased gifts and had them deliv-

ered through the agencies — including the Family Crisis Center and Shelter in Livermore, the Children's Emergency Council in Dublin, Valley Support Services (VASS) in Pleasanton, Buenas Vidas Youth Ranch in Livermore, and Love Thy Neighbor in Manteca.



A SPECIAL VAN for disabled passengers is now in service at Sandia, Livermore. Employees with temporary or permanent physical disabilities may request the van by calling Tim Roudebush, of Material Management Sec. 8532-1, on 294-2771. The 3/4-ton van is equipped with a special lift for wheelchair-bound passengers, as demonstrated by Lee Radosevich (seated, 5366), who is accompanied by Darlene West and Tim Roudebush (both 8532).

*(Continued from Page One)*

## Non-Stick Circuits

on Teflon can be placed closer together and operated at higher speeds.

To make Teflon circuit boards, manufacturers now follow a complicated eight-step process that involves pressing copper foil onto a Teflon substrate under high temperatures, forming a copper-clad sheet of Teflon. Then, using standard photolithographic processes, unwanted copper is chemically etched away, leaving a pattern of narrow copper wires connecting tiny electronic circuits.

The traditional process is awkward for two reasons, says Bob: First, it's difficult to produce narrow, submicrometer-sized line patterns from

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**From a microscopic standpoint, the lines would be great towers of copper.**

---

a relatively thick copper film; from a microscopic standpoint, the lines would be great towers of copper. Second, the process is largely subtractive, meaning most steps involve taking away unwanted material rather than adding it.

The new process developed by Bob and the UNM researchers is simpler, requiring only three steps instead of eight. It is also an additive process, involving the direct formation of copper lines on Teflon substrates. The trick is to make the copper stick.

### One, Two, Three

In the new process, portions of a Teflon substrate are first irradiated using either X-rays or electrons. The result is an irradiated pattern that corresponds to areas of the Teflon where no copper is wanted, essentially a "negative" of the final printed circuit board. If X-rays are used, a patterned overlay, or mask, hides portions of the surface where the copper lines are wanted. If an electron gun is used, a narrow beam of electrons is used to "draw" an irradiated pattern onto the surface where no copper is wanted.

In step two, the entire Teflon sample, now irradiated, is placed in a commercial etching solution. Areas of the surface not irradiated in step one are etched slightly, and the irradiated surface is left unaltered. (Bob believes the irradiation causes Teflon molecules at the surface to cross-link, making them impervious to the etching.)

### Why Is Faster Better?

## Faster Circuits Benefit Industry, Military

Capacitance-related interference, or "cross-talk," between nearby circuits is a limiting factor in advancing the state-of-the-art in high-frequency radar, communications, and high-speed computing. Continuing advances in materials and processes for building such circuits result in a number of advantages for private industry and the military.

In computing, reduced cross-talk means more data can be stored in less space, and higher-frequency circuits mean data can be moved around electronically much faster. A typical first-generation personal computer operated at 1 megahertz (a measure of electronic time); nowadays, PCs operate much faster, typically between 25 and 40 megahertz. Today's supercomputers are so fast their operation is measured not in megahertz, but in mega-flops (floating point operations per second). This increase is in part due to development of higher-frequency computer chips.

In military radars, high-frequency circuits are used to generate higher-frequency signals, which can provide greater detail about unknown radar targets such as enemy aircraft than lower-frequency signals. The higher-frequency radars of today, such as phased array and synthetic aperture radar, can "see" wings and bodies of aircraft rather than just whole "objects," which may help in identifying an unknown "blip." Future radars, it is hoped, will be able to discern even greater detail. In addition, powerful high-frequency radar signals can be used to penetrate and disrupt circuitry in enemy aircraft and missiles.

In communications, high-frequency circuits are used to send signals between satellites. For military communications, high-frequency signals do not penetrate the atmosphere and, therefore, cannot be easily monitored from the ground. Also, higher-frequency signals mean more data can be transmitted rapidly.

In step three, copper is deposited directly onto the sample using a chemical vapor deposition (CVD) technique, whereby a copper film is "grown" onto the Teflon surface molecule-by-molecule. Although the entire sample is subjected to the process, copper molecules deposit only on the etched areas of the substrate, leaving the irradiated areas copperless. This film, now a pattern of copper wires, can be grown as thin or as thick as desired.

"There is no inherent limitation on how thin or how thick we can grow the copper films," says Bob. "The only limit is that the film must be thick

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**"There is no inherent limit on how thin or how thick we can grow the copper films."**

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enough to be continuous, a problem we're now studying."

Bob says he and Tony Ricco of Microsensor Research Div. 1314 are also looking at another way to do step three called electroless copper deposition. This alternative method involves dipping etched Teflon in a series of chemical solutions that "plate out" metals on the Teflon surface. A thin

copper plating eventually forms on the sample, but the copper-Teflon bond is strong only in the etched regions of the surface. Unwanted copper can be peeled away relatively easily using an adhesive as simple as household tape. The process is a standard industry technique that's done at room temperature with simple equipment, he says.

### Result of Merging Research

Bob says the new copper deposition technique is the result of merging two extensive research projects. Chemists at UNM have been designing molecules with various properties for chemical vapor deposition of copper for the past few years. At the same time, Bob has been studying patterned adhesion on Teflon. "Once the two projects came together," says Bob, "it took only two weeks to realize we had something here."

Since then, the process has generated a lot of interest, both from industry and from within Sandia. (See "Teflon Patterning: Industry's Interested, and So Is Sandia.") Once fully developed, says Bob, the process may significantly reduce the costs of manufacturing many printed circuit boards, but it's still too early to tell when or by how much.

"It's still very much in the development (Continued on Next Page)

### A Unique Patterning Method

## Teflon Patterning: Industry's Interested, and So Is Sandia

In the short time since Bob Rye (1114), Toivo Kodas, and Mark Hampden-Smith (both UNM) demonstrated their new Teflon patterning and copper adhesion technique, several companies have expressed interest in developing the technique to build circuits for a variety of applications.

One of these companies, Rogers Corp., is a leading manufacturer of copper-clad Teflon sheets used to make printed circuit boards. Using the new technique, Rogers may be able to significantly reduce the cost of adhering copper to Teflon substrates.

Bob is proposing to work with a group of companies through an Advanced Manufacturing Initiative (AMI) — a new technology transfer program sponsored by DOE — to develop copper interconnects as wiring for next-generation computer chips. Interested companies include Rogers, DuPont, Motorola, and W. L. Gore.

Bob is already working with a printed wiring board consortium, sponsored by the National

Center for Manufacturing Sciences, to study the solderability of the technique and its chemical processes. Other companies that have expressed interest in the technique include IBM and the Welsh Development Agency.

"This process has immense advantages over earlier techniques," says Bob. "It involves only three steps instead of about eight, and it can make thinner circuit lines and make them closer together. It could represent a significant cost savings to industry."

### Internal Interest

While industry is looking at ways to commercialize the new technique, several Sandia organizations are looking at ways to adopt it internally. Gerald Cessac (2413) says the technique may result in better copper adhesion in high-frequency circuitry for radars, communication devices, and computers. Rick Knudson of Exploratory Radar Development Div. 2345 says

his group is considering using the technique to build high-frequency radar circuits for synthetic aperture radars.

Bob Blewer (2132) and Tom Omstead (2131) have also joined with Bob Rye and the UNM researchers to explore how irradiation helps to deposit copper on a "spin-on" form of Teflon using chemical vapor deposition (CVD) techniques. This method may result in higher-density circuits and improved-performance computer chips.

"It's something like spin art," says Tom. "You pour Teflon in solution onto a surface spinning at 1,000 rpm, then deposit copper lines between each layer. The result is several layers of patterned copper with Teflon insulation between each."

Tom says Sandia is involved in a cooperative research and development agreement (CRADA) with three microelectronics equipment manufacturers to develop a commercial process for CVD of copper with the "spin-on" Teflon.

(Continued from Page One)

## Oil Recycling

drums have to be handled. The oil that's pressed out of the filters is collected and blended into the tractors' fuel.

*It's time to service the tractor's air conditioner. We know the refrigerant is a chemical that can deplete the ozone layer shielding us from much of the sun's ultraviolet radiation. But don't we have to vent the old refrigerant into the air before we can work on the air conditioning system?*

Nope. The Freon refrigerant in air conditioners is reused. When an air conditioning system is serviced, a recovery system pumps out the refrigerant, separates the small amount of oil that's mixed with it, and stores the Freon for later re-use. Only a few ounces of oil is left as waste.

Systems for reclaiming refrigerant are no longer unusual; for instance, they're required in Bernalillo County, where it's now unlawful to release Freon to the atmosphere. Another recycling technique used at Sandia, however, is still relatively unusual: the re-use of antifreeze.

*Following a familiar routine, we drain the tractor's coolant into a pan.*

So far, so good. But the next step is unlike the old days. Antifreeze is recycled with the help of recently acquired filtering equipment. Because chemicals are added to rejuvenate the old antifreeze, it can be reused for an indefinite number of times. Only if it's too dirty to recycle — an unusual occurrence, says Dave Dellinger (3423-3) — would the antifreeze be disposed of.

### Solvent Switch

*We didn't disassemble any engine parts this time. If we had, we would have taken them to a tank containing a solvent and cleaned them before reassembly. Again, it's an old routine.*

And again, there's been a recent change.

### Rub-a-Dub-a-Dub-a-Dub-a-Dub

For about five years, Sandia has been recycling water in the Motor Pool car and truck wash. Three 1,000-gallon tanks hold a detergent solution, which is pumped out of the tanks through a filter each time a vehicle is washed. A drain then collects the solution for re-use. Large particles such as sand fall to the bottom of a sump before the solution goes back into the tanks.

Washing a car or truck takes about 30 gallons a minute, which means around 100 gallons would be lost during each wash if not recycled. About every three months, the liquid in the system is analyzed to make sure it's within legal limits for discharging into Albuquerque sewers, and then it's drained and replaced with fresh solution.

### Info about Waste Minimization

Waste minimization efforts at Sandia, Albuquerque are coordinated through the pollution prevention program based in Pollution Prevention and Environmental Monitoring Div. 7725. For information, call Dorothy Stermer (7725) on 845-3197. For information about waste minimization at Sandia, Livermore, call Alice Johnson-Duarte (8542) on 294-3266.

Instead of a hazardous petroleum-naphtha-based solvent, parts-cleaning tanks here hold a non-toxic, biodegradable, water-based detergent solution. "We're trying this out," says 3423-3 Supervisor Bill Rose, "and so far, the results look good. When someone cleans a part — by the way, it takes more scrubbing than with the old solvent — oil or grease is left in the solution. When it's time for fresh solution, three or four times a year, we expect to be able to separate the oil and have a solution that's safe to drain into a sanitary sewer."

*After all this work, our hands are pretty greasy. Let's wipe them on one of these paper towels and toss it into the trash.*

Hold it! Routinely wiping oily hands or engine parts with paper towels creates a lot of hazardous waste — the towels can't just be thrown into the normal trash. For most purposes, the people in this shop use cloth towels, which are picked up and washed by a contractor. Paper towels are reserved for the few jobs that would ruin a cloth one, such as cleaning batteries or wiping thick grease.

*Granddad used to talk about using every part*



**BLENDED THE OIL** — Fred Raether (3423) connects a blender that takes oil from the crankcase of this DOE tractor, filters it, and mixes it with the tractor's diesel fuel. This use of motor oil, approved by the engine manufacturer and certified by the EPA, saves the cost and the environmental impact of disposing of it as hazardous waste after an oil change.

*of a hog except the squeal. In this case, maybe they've gone thrift one better by reusing everything but the honk of the horn.* ●CS

(Continued from Page Three)

## Plotting Program

soon as they viewed it at their regional offices. Negotiations with Sandia for the license started the next day. Barry notes that the Dux managers seemed particularly interested because they're also bringing out a business software program that complements the scientifically oriented Xplot.

Software for Sun workstations typically costs thousands of dollars, but Xplot will be available

for a list price of \$495. "The low price is possible because Xplot fits a particular market niche," says Barry. "Most software for Sun workstations is designed to do everything that every user could want, but Xplot does just a few specific jobs. The response at the users' group show last month, though, suggests that a lot of people are interested in the specific jobs it does."

Barry believes that the program can be adapted to computers other than Sun: "It has a lot of possibilities," he says, "and that should make it an exciting product to watch." ●

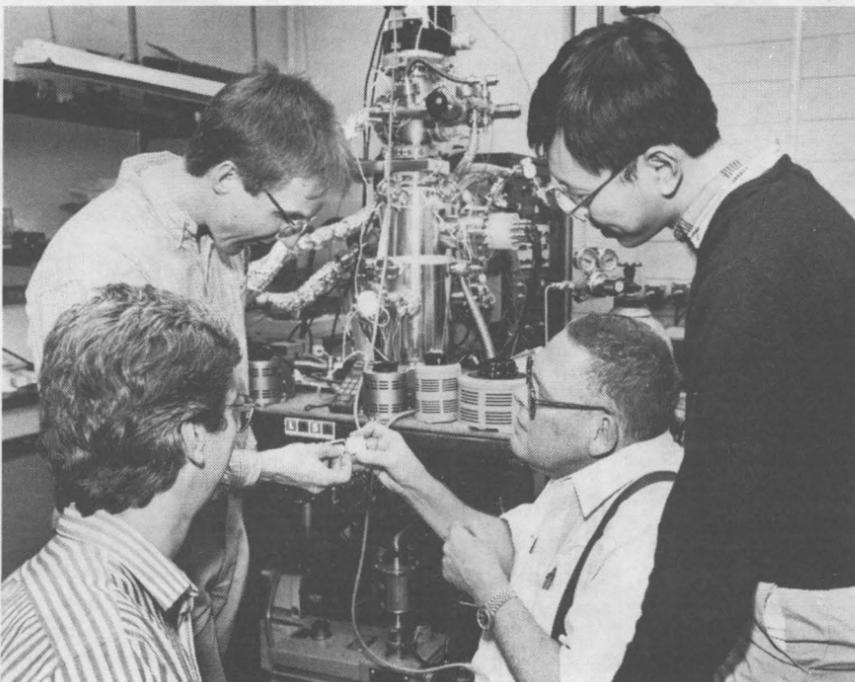
(Continued from Preceding Page)

## Non-Stick Circuits

stage," he says. "Right now, we're interested in interacting with as many different companies as possible to better understand how printed circuit boards are made."

A joint Sandia-UNM patent application for the process for patterned deposition of copper on PTFE was submitted on Sept. 30. An earlier patent was also granted to Sandia for Bob's work in Teflon patterning.

The three researchers have presented their work in technical journals and at society meetings, says Bob, and *Science News* has already published a short article on the technique. Reporters from *Chemical & Engineering News*, *Defense Electronics*, and *Voice of America* are also preparing articles on the subject. "It's creating quite a stir," he says. ●JG

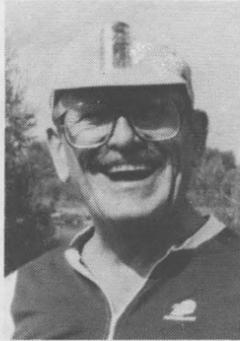


**BOB RYE** (1114, bottom right) and UNM researchers (clockwise from bottom left) Mark Hampden-Smith, Toivo Kodas, and Kai-Ming Chi examine a small Teflon sample used to demonstrate their new copper deposition technique. One difficulty faced by high-frequency circuit manufacturers is adhering tiny copper circuit lines to Teflon substrates. A patent application for the technique was filed recently with the US patent office.

**Unusual Vacation**

# Bob Peet and Friends Pedal along the Danube

Austrian vacationers typically sail down the Danube, drive the autobahn, or take the train. In September, Bob Peet (2715), his wife Jean, and Albuquerqueans Mimi Montgomery and Nancy Womelsdorf joined Bob's longtime friend Hans Aus in Germany to see things in a different way. They rode bicycles along the Danube from Passau, Germany, to Vienna, Austria, about 200 miles.



BOB PEET (2715)

The idea for the bicycle tour came from Hans, who worked with Bob at Sandia 20 years ago. Hans had asked Bob for years to come to Germany and go skiing. When Hans came up with the plan to bike along the Danube, Bob could resist no longer.

It was Bob and Jean's first visit to Europe, but not their first bike trip. They have six years of bicycle touring experience and have toured in California, Vermont, Texas, and Colorado.

Before they started the tour, Bob, Jean, Mimi, and Nancy put on a Mexican dinner prepared with New Mexico green chile for Hans and some of his friends. According to Bob, everyone ate all the hot stuff and really liked it.

**Easy Riders**

"Thousands of people bike along the Danube route each summer," says Bob. "The company that sets up the tour provides escorts, but we didn't have one. We took our time, covering 35 to 40 miles a day. Most bikers cover more miles than that."

Bob's group actually began their tour in Schärding, Austria, and rode along the Inn River to where it joins the Danube in Passau. Another river, the Ilz, also empties into the Danube at Passau. The Danube is the principal river of central and southeastern Europe and is the second largest river in Europe after the Volga.

The route they took along the Danube is on dedicated bike paths most of the way, on both sides of the river. Sometimes they were on one side, then the other, crossing the river over bridges and on ferries.



STREET MUSICIAN performing near historic Matthias Church in the Castle District of Buda, the older half of the city of Budapest, Hungary.

"We crossed the Danube three times the first day, in and out of Germany and Austria," says Bob. "The border crossings included one that was just for pedestrians and bikers and didn't have an attendant."

Their first stop for the night was in the Austrian town of Kramesau, 40 miles from where they'd started.

The second day they biked as far as Linz, the provincial capital of Upper Austria, the third largest city in Austria, and the biggest port on the Danube. That night they took in an annual festival that included fireworks.

**Roman Ruins and Disney Castles**

The third day they visited Enns, the oldest city in Upper Austria. Enns stands on the site of a Roman camp that later became the Roman city of Lauriacum. Ennsegg Castle stands to the north of the city.

"Castles along the Danube look like something from Disneyland," says Bob.

Their third night was spent in the town of Wallsee. They stayed at a hotel that reserved the

**"Castles along the Danube look like something from Disneyland."**

ground floor for horses and pigs. Accommodations were on the upper floors. That evening they joined a farewell party some Wallsee high-school students were holding for Russian students. The festivities included folk dancing.

Their fourth night was in Marbach, a sleepy little market town.

On the fifth day, they visited the famous Benedictine abbey at Melk, founded in 976. It was rebuilt in 1702-36 and is still a working abbey. Melk is also the sight of a former Roman fortress.

In Dürnstein, they saw ruins of a castle fortress where Richard the Lion Hearted was held captive in 1193 by Leopold V, the Babenberg duke ruling the country at the time. Many residences in Dürnstein date from the 1500s. Their balconies are

**"Everything is up close and personal when you bicycle. You can't get this kind of experience traveling other ways."**

filled with flowers in summertime. Dürnstein is in the Wachau region, known for its fine wines.

They spent the fifth night in a hotel in Traismauer that has been in the same family for 600 years. Traismauer boasts a Renaissance castle once the property of the Archbishop of Salzburg.

**Palaces, Cathedrals, and Ice Cream**

They rode into Vienna on the sixth day, where they took in the sights including Schönbrunn Palace, a 1,441-room Habsburg palace built between 1696 and 1712, and Belvedere Palace (with a view of the Vienna Woods from its terrace), built between 1717 and 1723. They also visited St. Stephen's Cathedral, founded in the 12th century and considered one of the greatest Gothic structures in Europe. "We also visited a



ST. STEPHEN'S CATHEDRAL stands at the very heart of Vienna. Bob (2715) and Jean Peet stand near the cathedral located at Stephansplatz 1, where according to legend if you wait long enough you'll see anybody you're looking for in the city.

lot of ice cream stands," says Bob.

In Perchtoldsdorf, an old market town just outside Vienna, they visited a winery that opens its restaurant once a year for only a month in accordance with an edict issued by Austrian Emperor Franz Joseph (emperor from 1848 to 1916).

As a side trip, they took the train from Vienna to Budapest for a day. "We saw more American tourists there than we did in Vienna," says Bob.

"Everything is up close and personal when you travel by bicycle," he notes. "You can't get this kind of experience traveling other ways."

The Peets have plans for more bike trips, this time closer to home. They plan to go to Texas in April for the wildflowers, and Hans is joining them for a Colorado trip next summer. ●JC



ON THE PATH TO KRAMESAU, a small Austrian market town that was the first stop for (from left) Bob Peet (2715), his wife Jean, Hans Aus, and Nancy Womelsdorf on their bike tour along the Danube River.

# Supervisory Appointments

MARGARET CHU to Supervisor of Environmental and Waste Management Technical Support Div. 6622.

Margaret joined Sandia in 1980 as a member of the Fuel Cycle Risk Analysis Division. She worked on performance assessment of high-level nuclear waste repositories for the Nuclear Regulatory Commission (NRC), helped the Environmental Protection Agency develop high-level disposal standards, and worked on risk assessment and ranking methodologies for mixed wastes.

She transferred to the Space Reactor Division in 1986 and did criticality and shielding analysis. In 1988, she joined the Performance Assessment Division to work on the compliance assessment for the Waste Isolation Pilot Plant (WIPP). From 1989 until her promotion, she worked in the Waste Management Systems Division on performance assessments of low-level wastes for the NRC and management of special wastes for DOE.

Margaret has a BS in chemistry from Purdue University and a PhD in physical chemistry from the University of Minnesota. Before joining Sandia, she was a National Institutes of Health postdoctoral fellow doing research on immunochemistry at Jefferson Medical College in Philadelphia. She is a member of the American Chemical Society and the Association of Chinese-American Engineers and Scientists of New Mexico. In 1987, she was named a distin-



MARGARET CHU

guished member of technical staff.

Margaret enjoys reading, music, and cooking. She and her husband Tze-Yao (6422) have three children and live in SE Albuquerque.

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MICHAEL LUCAS to Supervisor of Reproduction and Mail Services Div. 3154.

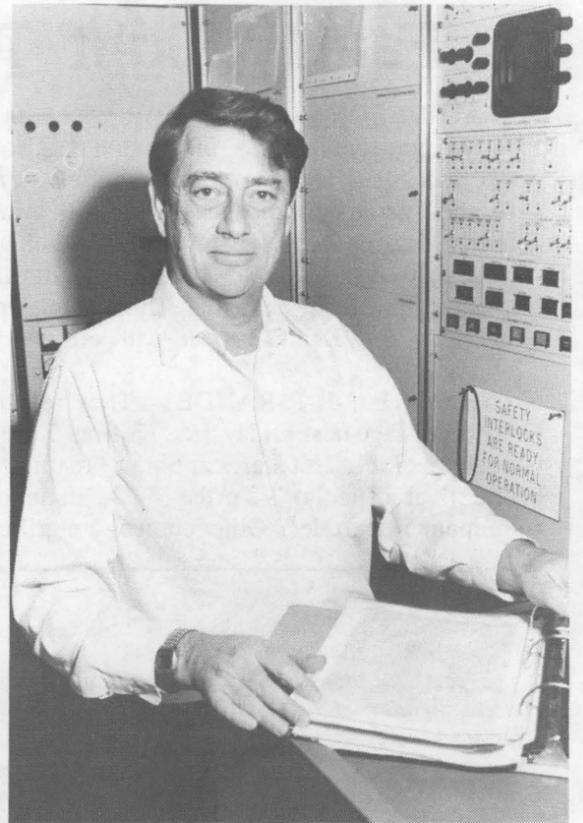
Mike joined Sandia in 1971 as a member of the Development Laboratories Division. He was an apprentice in the Specialty Materials Program. In 1975, he joined the Organic Materials Division as a craftsman. He transferred to the Ceramic Components Division in 1982 and was a lab technician working on varistor materials for the Lightning Arrestor Connector Program. In 1984, he was promoted to Supervisor of the Plastics Lab Section in the Organic Materials Division. He supervised the Photofabrication Section in the Printed Circuit Division from 1988 until his promotion.



MICHAEL LUCAS

Mike has a BS in mathematics from the University of Albuquerque. He is currently working on an MBA at UNM. He is a member of the Society for the Advancement of Material and Process Engineering, the Photo Chemical Machining Institute, the American Chemical Society, and the Sunport Optimist Club. He is secretary/treasurer of the Optimist International New Mexico/West Texas District. He has received several honors from the Optimist organization.

He enjoys church activities, reading, and camping. He tutors high school math, is a commit-



NEW FELLOW — Sam Myers, Supervisor of Microstructure and Defects Physics Div. 1112, was recently elected to fellowship in the American Physical Society for his fundamental studies, using ion-beam techniques, of defect and solute interactions in materials. His work has included pioneering studies of hydrogen-defect interactions and implantation metallurgy. Sam is among a select group: No more than 1 in 200 of APS members may be advanced to fellowship in any year.

tee chairman for the Boy Scouts of America, and does volunteer work at UNM.

Mike and his wife Frances have three children and live in the NE Heights.

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 8 1/2 by 11-inch paper.
5. Use separate sheet for each ad category.
6. Type or print ads legibly; use only accepted abbreviations.
7. One ad per category per issue.
8. No more than two insertions of same "for sale" or "wanted" item.
9. No "For Rent" ads except for employees on temporary assignment.
10. No commercial ads.
11. For active and retired Sandians and DOE employees.
12. Housing listed for sale is available for occupancy without regard to race, creed, color, or national origin.
13. "Work Wanted" ads limited to student-aged children of employees.

**MISCELLANEOUS**

- PORTABLE DISHWASHER, \$80; reel lawn mower, \$20. Kelly, 266-5977.
- NEW MEXICO CAMP RESORT MEMBERSHIP, affiliated with coast-to-coast, \$500. Eaton, 869-2847.
- GIRL'S LEATHER JACKET, burgundy colored, size 8, excellent condition, never worn. Campanozzi, 823-1610.
- OVERSTUFFED EASY CHAIR, leather, tan, cost \$1,279, sell for \$300 OBO. Cantrell, 282-1339.
- IBM-XT CLONE, 640K RAM, 20MB hard drive, 360K floppy, Hercules graphics card, amber monitor, DOS 3.3, manuals, \$300. Pasquale, 292-0133.

- COMPUTER DESK, w/attached printer stand, woodgrain finish, movable shelves, drawer & enclosed storage, \$45; typewriter stand, w/hinged extension, \$10. Reed, 268-7484.
- LAB/CHOW, 1-yr.-old female, all shots, spayed, free to good mountain home. Robar, 298-2896.
- PATIO FURNITURE: steel table, 4 steel chairs, \$150; 2 Danish modern family room chairs, \$100. Harrison, 884-4994.
- DBL. REG. ARABIAN/APPALOOSA, 3-yr.-old gelding, bay roan w/white blanket & black spots, well started under saddle by Ron Morris, \$2,000. Coleman, 299-8321.
- KING-SIZE HEADBOARD, solid walnut, \$80; pine dresser, \$20; lamps, \$15/ea.; clothes hamper, \$10. Peterson, 294-2727.
- HEAVY-DUTY AUTOMOBILE JACK, \$20; McIntosh MX-112 tuner-preamp, Marantz model 813 power amp & model 3600 preamp, \$75/ea. Babb, 865-6843.
- WORKSHOP MANUALS: 1962-1974 MGB and 1960 Dodge workshop manual plus parts book, \$10/ea. Kelly, 881-5032.
- BLACK STANDARD POODLE PUPS, AKC-registered, 9 wks. old, 1 male, 5 females, parents on premises, \$400/ea. Brooks, 891-3347.
- MEDITERRANEAN-STYLE TABLES: 2 end tables, 1 coffee table, 48-in. octagon shape, real black marble tops, \$300/set. Pantuso, 865-1597.
- ELECTRIC BASEBOARD HEATERS, new, sealed water-tube type, for permanent installation, room additions, 2 units, 1,000 watts, 240V, \$75. Walther, 823-1946.
- GAS CLOTHES DRYER, brand new, \$175. Pompeo, 266-7930.
- PRECOR ROWER, like new, \$75; grill attachment for Jenn-Aire built-in, never used, \$50. Ishimoto, 821-6518.
- TIMESHARE, Tahoe Seasons Resort, prime season, 1 week, in-room hot tubs, next to Heavenly Ski Resort, \$10,000. Ingwerson, 510-455-5024.

- PROJECTION SCREEN by Da-Lite, 50" x 50", in original box. Wagner, 823-9323.
- FILM, Kodak 35mm ASA 400, two three-packs (24, 24, 36), retails at \$12/pack, sell both packs for \$18. Shunney, 265-1620.
- EVENFLO INFANT CAR SEAT/CARRIER, w/canopy, \$30; Graco playpen, 36-in., \$30; Gerry frontpack infant carrier, \$10; all excellent condition. Meeks, 828-9825.
- MALE KITTEN, has all shots, \$5. Robinson, 293-7231.
- TRUCK TIRES, used, 2 Dunlop heavy-duty Triple Traction, 7.00-15, \$10/both. Van Deusen, 291-8196 after 5 p.m.
- SKI BOOTS: woman's size 6-1/2, \$22; man's Salomon SX91E, 9-1/2, \$65; both excellent condition. Horton, 883-7504 after Jan. 13.
- JENNY LIND SIX-YEAR BABYCRIB, \$150; hanging-style cradle, \$50; airline dog kennel, large, \$50; end table, \$35 OBO. Rautman, 345-6936.
- SOUTHWEST AIRLINES TRAVEL VOUCHER, completely transferable, roundtrip anywhere Southwest flies, must be used by Feb. 11, \$100. Pierce, 294-0871.
- BARCO CAMPER SHELL, SWB, flip top, queen sleeping, 7-ft. headroom, double doors, folds down to cab level, \$875. McAllister, 281-5188.
- DINING ROOM TABLES: 31" x 60" wood & tile, 35" x 57" wood, 4 wood chairs. Carlson, 897-1850.
- OVERHEAD CAMPER, w/jacks, \$400 OBO. Martinez, 884-5047.
- BEAGLE, female, tan & white, AKC-registered, 15 mos. old, needs good home, \$150, price negotiable. West, 292-5083.
- SEARS WASHER & GAS DRYER, white, \$60/ea.; round dining table, \$30; super-single waterbed, w/underdresser, \$100. Forster, 265-0774.
- COUCH & LOVE SEAT, earthtones, good condition, \$100; 10-channel scanner w/4 crystals, \$50. Parson, 291-8394.

- UPRIGHT PIANO, beautiful, old, cherrywood finish, excellent condition, need college money, will sacrifice, \$900 OBO. Denton, 884-9315, leave message.
- DINETTE TABLE, 4 chairs, good condition, \$100. Bisbee, 293-0356.

**TRANSPORTATION**

- '77 CADILLAC ELDORADO, 95K original miles, 425 cu. in., maroon, padded top, white exterior, completely loaded, \$3,100 OBO. Hole, 877-1903.
- '72 FORD PICKUP, 3/4-ton, w/camper, \$3,000; Glaspar fishing boat, deep hull, 35-hp motor, 6-hp trolling motor, w/trailer, \$2,000. Kindschi, 256-0531.
- GIRL'S COLUMBIA BICYCLE, blue, banana seat, \$30; man's 3-sp. Huff, gold, \$30. Simon, 299-8468.
- '68 CHEV. BELAIR, 4-dr., 307 V-8, AT, only 41K miles, excellent condition throughout, \$2,500. Tarbell, 292-0141.
- '83 MUSTANG CONVERTIBLE, 5.0L GLX, 5-sp., AC, 79K miles, \$3,200. Evans, 831-4736.
- '82 FORD F-250 SUPERCAB XLT LARIAT, 71K miles, tilt, cruise, AM/FM, dual tanks, 5.8L V-8, AT, tint, excellent condition, \$4,800 firm. Lucero, 867-2229.
- '88 PLYMOUTH VOYAGER MINIVAN, V-6, AT, AC, 7-passenger, HD suspension & towing package, luggage rack, AM/FM, shop manual, excellent condition, \$9,600 OBO. Cook, 299-5061.
- '71 POSTAL VAN, new tires, brakes, engine, transmission, front end, paint, & more, runs great, 83K miles, \$3,500 OBO. McAllister, 281-5188.
- MAN'S 12-SPD. RACING BIKE, \$35; woman's 10-sp. touring bike, \$35. Carlson, 897-1850.
- '87 CHEV. NOVA, 4-dr., 5-sp., AC, PS, radio, 56K miles, tan, very clean. Beasley, 298-3398.

- '83 NISSAN SENTRA, 4-dr., good condition, AC, stereo-cassette, good tires, well-cared-for engine, \$750. Homer, 836-5043.

**REAL ESTATE**

- 4-BDR. HOUSE, Four Hills, 2,042 sq. ft., 1-3/4 baths, \$127,000. Hsing, 293-5670.
- 4-BDR. HOME, study, den, wrought iron, 3 baths, appraised 90, now low 80s, near UNM & Kirtland. Hendren, 883-5070.
- 4-BDR. HOME, all brick, spacious, w/pool & view, quiet cul-de-sac near Arroyo Del Oso golf course, many upgrades, \$147,500. Henderson, 884-8309.
- 1.5 SECLUDED ACRES, Los Lunas, trees, covenants, all utilities, CU financing available. Bottomly, 344-2137.
- 3-BDR. HOME, 2-1/2 baths, app. 1,900 sq. ft., Towne Park (Eubank & Chico), \$108,000. Gonzales, 275-3436.

**WANTED**

- ROOMMATE to share 2-bdr. house w/garage, nonsmoker, Montgomery & Pennsylvania area, \$260/mo. plus utilities. Decker, 889-2736.
- ROCK TUMBLER for polishing small stones. Rogers, 256-0066.
- DOG CARRIER, extra large. Sanchez, 873-2058.
- ROOMMATE, female, to share 2-bdr. townhouse, 2 baths, washer/dryer, fireplace, cable, 2-car garage, clubhouse, pool, etc., \$400/mo. inc. utilities. West, 275-3223.

**WORK WANTED**

- BABYSITTING JOBS WANTED for seventh-grader who has completed American Red Cross course. Geer, 265-2094.

**Coronado Club Activities****'Family Night' Tonight: Buffet, Kids' Bingo, and Puppets**

**FAMILY-FUN-TASTIC** — Start 1992 with a Family Night special: kids' buffet (hot dog, soft drink, french fries for 92¢) or adults' buffet (pizza slice, salad, garlic bread, spaghetti for \$2.92), available from 5 to 7 p.m. tonight, Jan. 10. Kids' bingo starts at 5:30 and features a \$100 toy store gift certificate for some lucky lass or lad. During bingo intermission, Loren Kahn's Puppets will perform.

**THEY'RE G-R-R-RANDE** — They're Trio Grande, on stage next Friday, Jan. 17, from 7 to 11 p.m. A special buffet starts at 6 p.m., featuring prime rib at a special '92 price of 92¢ an ounce (minimum 6-oz. order). Other choices are grilled

halibut, golden fried shrimp, and chicken breast smothered in green chile. Mmmm! Make your reservations now!

**CUT AND DEAL** — The T-Birds card players shuffle into action every other Thursday at 10 a.m. and keep the fun going until about 3 p.m. Cardmaster Jim McCutcheon says the next few dates are Jan. 23, Feb. 6, and Feb. 20.

**TEA DANCE TREAT** — After the Champagne Brunch on Sunday, Jan. 19 (10 a.m. to 1 p.m.), Bob Weiler and Los Gatos will play for your pleasure at a Tea Dance from 1 to 4 p.m. The

brunch is all you can eat for \$6.95 (members), and Thunderbirds (retirees) showing membership cards will receive \$1 off their meal price. Reservations required.

**EARLY BIRDS AND NIGHT OWLS** alike can enjoy bingo every Thursday evening. Early Bird Specials start at 6:45 p.m., and regular bingo about 7:15. Folks who show their membership cards get \$1 off a bingo package, 10 percent off the buffet, and free treats on their birthday. For the night owls, Nite Cap Bingo starts about 9:30 p.m. in the Cantina and features some wild'n'crazy games.

**Events Calendar**

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

**Jan. 10** — "A Night in Vienna," the Chamber Orchestra of Albuquerque performs the music of Beethoven, Strauss, and Haydn; 8:15 p.m., St. John's Methodist Church (2626 Arizona NE), 881-0844.

**Jan. 10-19** — Miniature Exhibition and Sale, benefit for the Albuquerque Museum, exhibit includes more than 300 works by 130 artists whose styles range from traditional to abstract with equally diverse techniques and media; 9 a.m.-5 p.m. Tues.-Sun., Albuquerque Museum, 243-7255.

**Jan. 10-19** — "The Mystery of Irma Vep," Charles Ludlum's parody of Victorian melodrama and Hollywood horror films, presented by the New Mexico Repertory Theatre; 8 p.m. Tues.-Sat., 2 p.m. Sat. & Sun.; KiMo Theatre, 243-4500.

**Jan. 10-Feb. 3** — Exhibit, "Gustaf Nordenskiöld: Pioneer Archaeologist of Mesa Verde," details work of Swedish scientist who 100 years ago visited the Anasazi cliff dwellings at Mesa Verde and undertook the first major excavation and documentation of the ruins there; 9 a.m.-4 p.m. Mon.-Fri., 10 a.m.-4 p.m. Sat., noon-4 p.m. Sun.; Maxwell Museum of Anthropology, 277-4404.

**Jan. 10-Feb. 9** — Exhibit, "USS New Mexico Battleship," in commemoration of the 50th anniversary of World War II to honor veterans from all branches of the service, sponsored by the Navy League of the United States and the Albuquerque Museum; 9 a.m.-5 p.m. Tues.-Sun., Albuquerque Museum, 243-7255.

**Jan. 10-Feb. 9** — Exhibit, "Horse Tales: An Evolutionary Odyssey," produced by the Natural History Museum in a collaborative program with the Hubbard Museum of the Horse in Ruidoso Downs, tells about the horse from its first appearance in North America to its reintroduction by the Spanish to its modern-day place in the natural world; 9 a.m.-5 p.m., New Mexico Museum of Natural History and Science, 841-8837.

**Jan. 10-March 15** — Exhibit, "E.I. Couse: An Image Maker for America," work of Eanger Irving Couse, one of the founders of the Taos Society of Artists and a well-known painter of Native Americans for the first three decades of the 20th century; lithographic reproductions of his paintings were used extensively by the Santa Fe Railroad for advertising; 9 a.m.-5 p.m. Tues.-Sun., admission fee, Albuquerque Museum, 243-7255.

**Jan. 10-April 15** — Exhibit, "Played and Printed,"

**Employee Deaths**

Benito Marquez of Stockpile Evaluation Program Div. I 361 died Dec. 11 after a long illness. He was 62 years old.

Benito had been at the Labs since 1962. He was a senior member of the technical staff.

He is survived by his wife and two daughters.

Clifford Lucas of Waste Management Instrumentation Div. 9325 died Dec. 23 after a short illness. He was 41 years old.

Clifford had been at the Labs since 1973. He was a technical associate.

He is survived by his wife, son, and daughter.

exhibition of lithographs and monoprints made at Tamarind Institute by art students from Albuquerque, Cibola, Rio Grande, and Valley High Schools, represents students' personal expressions after exploring social issues in selected art forms; 9 a.m.-5 p.m. Tues.-Sun., Albuquerque Museum, 243-7255.

**Jan. 12** — Symphony in the Sunshine Series: New Mexico Symphony Orchestra conducted by Jorge Perez-Gomez, music includes works by Rossini, Hummel, and Mendelssohn; 3 p.m., Sunshine Music Hall, 842-8565.

**Jan. 12** — Exhibit opening, "Santiago: Saint of Two Worlds," a photo historical exhibition devoted to the history and contemporary presence of St. James, whose exploits (real or in folklore) have been celebrated in Spain, the US, and the Caribbean for centuries, exhibit runs through March 29; 9 a.m.-5 p.m. Tues.-Sun., Albuquerque Museum, 243-7255.

**Jan. 18-19** — "Rapunzel," by Leslie Hill and Jeff Resta, Albuquerque Children's Theater production; 1:30 & 3:30 p.m., Popejoy Hall, tickets available at Popejoy, Sandy's Sundial (10131 Coors Rd. NW), and Trespassers William Book Shop (700 Amherst Dr. NE).

**Jan. 18** — Lecture, "The Southern Connection," by Ike Eastvold, President of the Friends of the Albuquerque Petroglyphs, compares Albuquerque to southern Rio Grande rock art sites; 2 p.m., Albuquerque Museum auditorium, free, 243-7255.

**Jan. 18** — Family Workshop, focus on Black cultural heritage, activities to commemorate the birthday of Martin Luther King; 9:30-11:30 a.m., free, Albuquerque Museum, 243-7255.

**Jan. 18** — Buen Viaje Dancers, children's concert sponsored by Very Special Arts New Mexico; 1:30 p.m., free, West Mesa High School Performing Arts Center, 768-5188.

**Jan. 19** — Speaker, Bruce Williams, host of NBC Radio's "Talknet"; 4 p.m., First United Methodist Church (4th & Lead), 243-5646.

**Jan. 24-25** — Classical Concert: New Mexico Symphony Orchestra conducted by Lawrence Leighton Smith (director of the Louisville Orchestra and artistic director of the Music Academy of the West in Santa Barbara, Calif.), music includes works by Bolcom, Beethoven, and Nielsen, with guest pianist Yefim Bronfman; 8:15 p.m., Popejoy Hall, 842-8565.

**Jan. 24-25** — "Festival of Percussive Dance," Bill Evans Dance Company presentation of tap dance in its many forms; 9:30 a.m. & 8 p.m. Fri., 8 p.m. Sat.; KiMo Theatre, 764-1700.

**Congratulations**

To Sandra and Anthony (7812) Chavez, a son, Dustin Anthony, Oct. 10.

To Marcie (3144) and Tim (7818) Salvador, a daughter, Natalie, Dec. 25.

**feed iiback**

*Q: In reference to recent COMET and Weekly Bulletin messages about the Digital computer demonstration center in Bldg. 880, I think it is a disgrace that contractors are given hard-to-come-by facilities while Sandia organizations are forced to stay in substandard space and condemned buildings. One such organization was scheduled to move into specially designed quarters on the first floor of the north wing of Bldg. 802, but that space has now been allocated to DOE. The same organization remains spread out among four locations, two of them in condemned buildings, while customer service suffers as a result of having to go to four locations. This same organization was promised space in Bldg. 880 five years from now, where Digital has its marketing center! Once again, this organization gets pushed down the priority list and forced to wait. It seems Sandia's space allocation is based on political preference rather than good business practices or corporate values such as integrity (fairness and objectivity). Perhaps if we all went to work for a contractor such as Digital we would be allocated decent space in which to do our jobs!*

*Another objection: why is only Digital assigned prime real estate in Tech Area I? Does Sandia give equal facilities and space to other computer companies? If so, to whom and where? If not, why is Digital being given privileged status and a competitive edge? What happened to Sandia's "integrity" here?*

**A:** It is important there are no misconceptions about what we are doing with the space in question. Sandia has decided to establish a special relationship with four computer vendors through our Systems Ordering Agreements (SOAs). We have provided demonstration facilities for these contracts for many years. Sandia currently spends about \$22 million through our computer SOA contracts. The purpose of the demonstration rooms is to provide facilities to try the products prior to purchasing them. The intent is to eliminate the buying of products that do not function as desired.

Several things have changed in the past year. The biggest change is that the computer vendors are providing demonstration products free of charge to Sandia. Secondly, we have had to expand the amount of room for demonstrations to accommodate the explosion in computer technology. Our demonstration facilities currently occupy about 500 square feet. The vendors will flow about \$500,000 worth of equipment through this facility, eliminating the need for Sandians to purchase similar equipment until they are sure it will meet their needs. This facility should also prove valuable to our Chief Information Systems Architect. We believe the space allocation is worth the potential cost savings to the Labs.

Don Daigle (3127)

