Labs Learning Language of Commerce — Sales & Dollars

Tech Transfer: Success Stories Aren't Written Overnight

Bill Lenling, a metallurgical engineer with Fisher Barton, Inc. (Watertown, Wis.), who is working here as a research fellow, is becoming familiar with such obscure Sandia locales as the Atmospheric Thermal Spray Lab in Bldg. 845 and Area III's Plasma Materials Test Facility.

When Bill, whose perambulations are a part of his assignment to Process Metallurgy Div. 1833, returns to Wisconsin in August, he won't be carrying away any ready-to-market products that he and his Sandia colleagues developed in those facilities. But he won't be disappointed, either.

That's because, as the result of heightened awareness of technology transfer at the Labs, he *will* possess a gold mine of information that'll help make his company and US industry more competitive. Bill will use this technology — primarily in the form of technical expertise in materials science, processing savvy, and the like — to help his 100-employee company sharpen the quality of an expanding product line of agricultural blades and knives through application of hard, nearly permanent plasma-spray-applied coatings.

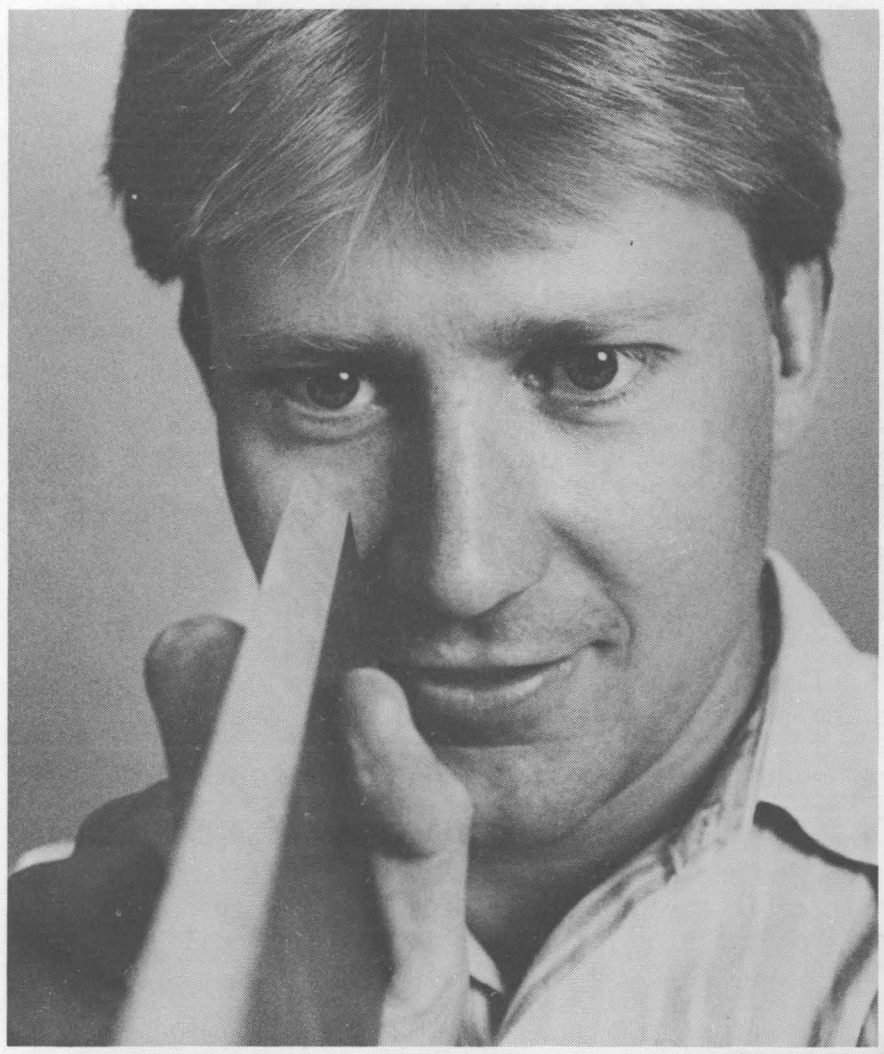
This technology will be used, for example, in a new circular corn-harvesting cutter that Fisher Barton hopes to introduce late this year. Designed to be more wear- and fracture-resistant than current cutters — many of which are now made in Europe — the new tool is being evaluated by Ford-New Holland, a farm tool and implement company.

Mark Smith (1833) is Sandia's plasma-spray-coating whiz; Bill is becoming Fisher Barton's. In fact, the two have applied for a couple of patents stemming from collaborations that began last June.

Dreams of New Products

Fisher Barton sales are now $7.5 million annually. But Bill dreams of the day when, propelled by

(Continued on Page Four)



BILL LENLING (Fisher Barton, Inc.) eyes the plasma-spray-coated blade of an agricultural knife that his company plans to make and sell. The blade's development grew from a DOE-sponsored technology transfer program between Sandia and the Wisconsin company. Hardened steel knives of this type are used to cut up logs destined to become potato-chip-sized wood chips, called wafer chips.

LAB NEWS

VOL. 41, NO. 10 SANDIA NATIONAL LABORATORIES MAY 19, 1989

Tech Transfer — More Than Just Talk

Lots of folks are talking about technology transfer these days. And Sandia is placing additional emphasis on this area (see accompanying articles). But steadily, and often with little fanfare, the Labs has been transferring its science and technology to the private sector for at least three decades.

Today, that technology accounts for thousands of jobs and estimated worldwide sales approaching $5 billion annually. That's a surprising total, and with this issue, LAB NEWS begins a series of periodic reports that gives an inside look at how this transfer of technology occurred, how it has affected the lives of many (if not most) inhabitants of the planet in one way or another, and how the Labs is now working even harder to facilitate flow of its knowledge — in ideas both large and small — into the marketplace.

PBFA Beam Team Beats the Clock

New Record: Five-Trillion-Watt/cm^2 Focused Ion Beam

Late last September, an external committee of experts in pulsed power and ion beams concluded an intensive three-day review of Sandia's ion-beam fusion program. It then hurled a challenge: Sandia should demonstrate major progress in beam focusing on PBFA II (Particle Beam Fusion Accelerator II) by achieving a beam intensity of 5 trillion watts per square centimeter on target.

Furthermore, the experts said, this should be done by April 1, 1989.

The 12-member visiting Davidson Review Committee, named for chairman Ron Davidson, an MIT professor, offered other recommendations on ion focusing, lithium source development, beam transport and other matters. But the beam-intensity milestone was the big one. It was phrased as a ''strong recommendation.''

(The committee — with members representing universities, industry, and other government labs — is set up specifically to advise and critique the light-ion inertial confinement fusion program for Sandia and DOE.)

Achieving the milestone would be difficult. There were only six months until the challenge deadline, and a tenfold improvement in beam intensity was needed.

''At the time,'' recalls Tom Lockner (DMTS) of Beam Experiments Div. 1264, ''we were at half a terawatt per square centimeter.'' (A terawatt [TW] is a trillion watts.)

The PBFA II scientists, engineers, and technicians went to work at once to try to achieve the goal.

By January and February, the researchers had ''pushed the power density up quite a bit,'' Tom recalls. By early March they were close. PBFA II was now generating the most powerful ion beams ever produced. But the challenge goal still eluded them.

Finally, on March 23, with only a week left before the deadline, the PBFA II beam team met,

(Continued on Page Fifteen)

To Help Catalyze the Flow of Technical Know-how

Yonas Returns to Head Tech Transfer Directorate

Technology transfer is as much a part of national security as ''smart rocks,'' believes Gerold Yonas, former chief scientist at the Strategic Defense Initiative Organization (SDIO), who helped make that term a Pentagon byword and who returns to Sandia on June 1 to head up its technology transfer program.

Gerry, who initiated Sandia's particle beam fusion program in 1973, will become Director of Technology Transfer and Special Projects (6100). The new directorate will work with industry, universities, and other national labs to enhance the nation's industrial competitiveness.

Gerry returns to Sandia from Titan Corporation, where he is senior vice president for corporate development. Before joining Titan in 1986, he was on assignment from Sandia as chief scientist and acting deputy director of the SDIO in Washington, D.C.

''It's exciting to come back to Sandia at this dynamic point in the evolution of the national labs,'' Gerry told the LAB NEWS. ''For one thing, I'm

(Continued on Page Thirteen)

This & That

It Sounds Easy, But . . . -- Technology transfer. Take inventions, patents, etc., out of the federal-lab idea mills and get them into the private sector, where they're turned into products that the world instantly accepts. Businesses make money, US workers have more and better jobs, and everyone is grateful to the folks who dreamed up the ideas in the first place. How sweet it would be!

Unfortunately, it doesn't happen that way in the real world. It takes time, hard work, and often big bucks to turn ideas generated at Sandia and other DOE labs into marketable products.

Our stories about the n-tuple pattern recognition concept and related products in this issue are prime examples. Former Sandians Iben Browning and Woody Bledsoe collaborated to produce the basic idea back in 1958. Working from this original concept, Excalibur Technologies, a local company, went into business, developed products -- and went bankrupt. It's since bounced back, but it was a long, hard road to recovery. It's a not-atypical story of the path from ideas to profits.

That story and several others about tech transfer in this issue are the first in a series of LAB NEWS stories on this subject -- what the Labs has done, what we're doing now, and what we're planning. We'll run them periodically in the coming year. Tech transfer will certainly be emphasized more in the future -- here and at most other labs that operate with federal dollars. Many Sandians will be involved in one way or another. We hope the series is both enlightening and inspiring.

* * *

One of Our Fifty Is Still Missing -- and maybe the mule went lame also. Wayne Lathrop, supervisor of Rocket Systems Div. II 7526, says it took nearly a month for an expense voucher to arrive here after it was mailed from Canada. Rex Meyer and Bruce Swanson (both 7526) were on temporary assignment there in March. Rex mailed a voucher (properly stamped and addressed) to Sandia on March 30. It arrived April 27, with an interim Juarez, Mexico, postmark of April 15.

* * *

Feedback's Back on Track -- It's been a while since we published "Feedback" items -- management replies to employee comments/questions. Starting in this issue, we'll run them regularly, as space permits.

Each employee who submits a legitimate comment/question on a Feedback form gets a personal reply from an appropriate administrator. We don't publish them all -- only those that we think have general interest. We print the name of the administrator answering the question, not the employee who submits it. So fear not -- submit away.

Forms are available at several locations throughout the Labs. If you can't locate a form or aren't familiar with the system, call Feedback coordinator Janet Walerow on 4-7841.

* * *

Acronyms Anonymous -- I'm proposing this new self-help group for people who think you have to have an acronym for every new program or concept. We've got enough acronyms, and we oughta put a moratorium on new ones.

I'm also forming a new group whose sole purpose will be to discourage dumb-sounding acronyms -- yes, we've invented several here at the Labs. I'm calling my new group the Society to Outlaw Dumb Acronyms -- SODA for short. •LP

feedback

Q. If I invent something at home, on my own time, with no Sandia support (a new kind of grass rake, for example), what's the proper procedure for obtaining a release of the rights to that invention from Sandia and/or DOE?

A. A direct way to find out whether the DOE will claim rights in an invention is to submit an invention disclosure to the Sandia Patent and Licensing Department (see SLI 1157) along with a memo outlining the facts and stating your request. In response, DOE will make what it calls a "subject invention determination" — normally, within just a few days. If DOE does not claim rights in the invention, you are free to pursue intellectual property protections on your own.

A good reason for requesting a subject invention determination, even in a seemingly straightforward case (such as a grass rake), is that you will receive a written answer from the DOE. A written answer disclaiming DOE interest will clear up a possible cloud on the title to your invention, which could be of concern to investors.

If DOE does assert rights to an invention, it is possible to request DOE to waive its rights in favor of Sandia or the inventor. Sandia has made a number of waiver requests for the purpose of licensing private entities in support of technology transfer. Several Sandia inventors also have requested waivers. Robert Perry and Errol EerNisse, for example, are former Sandians who became entrepreneurs with patents to inventions they made at Sandia.

Kurt Olsen — 4050

Q. KAFB went to considerable expense putting in new traffic lights on Base. Why weren't left-turn arrows installed at the intersection of Wyoming and F Streets? This is a dangerous intersection during morning rush hour for people southbound on Wyoming who must turn east on F. Are there plans to put in such arrows, or must we have a serious accident first?

A. Because of fiscal constraints, KAFB was unable to install left-turn arrows at the intersection of Wyoming and F Streets during the addition of traffic lights throughout the Base. However, KAFB plans to modify that intersection, and part of the work will include new traffic signals with turn arrows. This information is from R.E. DeRose, 1606 ABW/SE at KAFB.

Ward Hunnicutt — 7800

Fifty Cents a Carload, Too?

Drive-in movies move indoors at the American Classics Drive-In, part of a 1950s Manhattan entertainment center called Dezerland. Moviegoers watch period films from the front or back seats of '50s and '60s convertibles.

Lynn Asinof, *Wall Street Journal*

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MEMBERS AND STAFF of the House Armed Services Committee, along with Tom Thomsen (President of the Technology Systems Group, AT&T Technologies, and a member of Sandia's Board of Directors), visited the Labs recently for briefings on weapons, verification, safeguards and security, and nuclear and chemical waste programs. They also toured several Labs facilities. Here, at the Solar Thermal Test Facility, Virgil Dugan (6200) explains Sandia's solar detoxification research to (from left) Congressman George Darden (Georgia), Congressman Richard Ray (Georgia), Committee staff member Carl Bayer, and Thomsen.

SANDIA LIVERMORE NEWS
VOL. 41, NO. 10 MAY 19, 1989

Collaborative Efforts Pay Off

Simulation Techniques Improve Component Production Methods

Metal stress and subsequent failure can be a disastrous combination. That's why one of the most important challenges facing metallurgists is understanding and predicting the behavior of metals that will undergo stress or that have been deformed during the forging process.

Sandia metallurgists specifically focus on ensuring the safety and reliability — even under stress — of weapon components made of metal.

"Our goal," says Terry Lowe (8314), "is to help Sandia engineers and people at the NWC [Nuclear Weapon Complex] production plants avoid failures of any type through a better understanding of metal behavior."

Terry uses computer models to simulate the behavior of metals over their "weapon lifetime" — from the time they're shaped into components until the time they complete their time in stockpile. Recently, he has focused on improving methods used to form metals into unique shapes with special intrinsic properties.

Trial and Error Not Practical

Ordinarily, manufacturing a metal part requires repeated production trials over a period of months or longer. That lengthy trial-and-error approach may not be practical, however, if the part must be produced quickly.

That's when Terry enters the picture. If there's a problem with producing a particular component,

"This allows us to predict the properties of metals as they deform and the mechanisms by which they fail."

he uses computer simulations to zero in on why failures occur and how the problems might be solved. "With each problem we solve," says Terry, "a side benefit is learning how we can improve our computer models to solve an even broader range of problems."

According to Terry, computer modeling allows researchers to discern how forming processes interact and how those relationships affect the finished part. "We get about the same kind of information that we would if we were using a powerful microscope," he says.

"For instance, you can use an electron microscope to observe what happens when a metal rod is stretched until it breaks," Terry notes, "or you can use computer simulation. Under the microscope, we can watch the processes that occur as the rod first stretches elastically — like a spring — and then plastically — like taffy. We can see what happens to the microstructure of the metal in the rod as it deforms and breaks.

"With computers, on the other hand, we construct models representing the metal's microstructure and can simulate how the microstructure changes during deformation. This allows us to predict the properties of metals as they deform and the mechanisms by which they may fail."

Terry is studying how metals fracture in a joint project with Mike Baskes, Murray Daw, and Steve Foiles (all 8341). "The focus here is on gas storage technology," Terry says. "Gases in metal may cause the metal to degrade and subsequently fracture."

Mike, Murray, and Steve have simulated brittle fracture in metal using the Embedded Atom Method (EAM). However, the EAM can represent only a small group of atoms — not enough to describe the semi-ductile fracture processes that are of interest. "We're hoping, by combining our methods, to build a hybrid approach to studying fracture behavior on a larger scale," says Terry.

Intergranular Fracture Studies

Terry is also working on another fracture-simulation project with Bob Asaro, Director of the Center for Advanced Materials Research at Brown University. "We're looking at fractures that occur in interfaces — the boundaries between the many tiny crystals of which metal is composed," explains Terry. "Fractures in interfaces — called intergranular fractures — may occur in metals that contain gas bubbles.

"Using computer simulation, we're able to analyze factors that influence the fracture resistance of metals. That helps us determine how to avoid fractures in metals that contain gases."

Computer graphics — color images and movies, for example — have made it much easier to interpret simulation results, according to Terry. He's received computer graphics support for his simulation research from Martha Franks (contractor), Linda Armijo (8234), Gabe Gabrielson (8234), and Gayle Allen (8310).

Elane Flower of LLNL and Terry have established an interagency group of engineers and scientists from DOE production plants and labs to further the use of computer simulation to analyze the production of metal forms. "Using computer simulation, one production plant has saved more than $4 million," says Terry.

"Results like that make this kind of work very exciting." •BLS

DISCUSSING MICROSCOPIC DETAILS of fractures in metals simulated by computer are (from left) Martha Franks (contractor), Gayle Allen (8310), and Terry Lowe (8314).

Sympathy

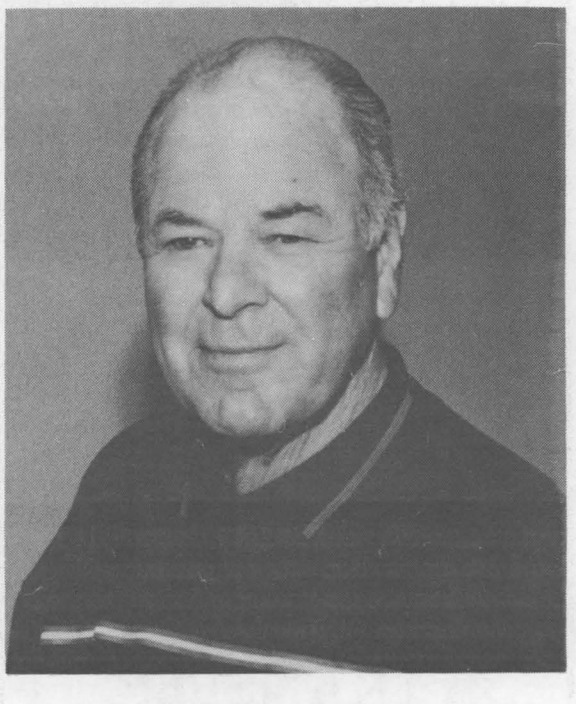
To Sandra Simmons (8535) on the death of her brother in Seattle, Wash., Feb. 28.

To Pat Gildea (8283) on the death of his mother in Cheney, Wash., April 11.

To Judy Hafner (8522) on the death of her mother in Livermore, April 26.

To Bob Freeze (8284) on the death of his mother in Ava, Mo., April 30.

RECEIVING CONGRATULATIONS from VP John Crawford (8000, left) are the three Sandia Livermore recipients of outstanding volunteer awards for 1989. Sylvester Grisby (8281, right) was honored for longtime involvement in Oakland city and civic groups, including service on several boards and committees. Carol Verity (8535) was recognized for her work with Ministry to the Aged Through Community Help (MATCH). Marvin Kelley (8446) was honored for his volunteer counseling, lecturing, and youth-motivation efforts in the Oakland School District. The Sandians were recognized with other area volunteers at a luncheon of the Corporate Community Volunteerism Council in Pleasanton.



RETIREE Mac Spivey (8284)

(Continued from Page One)

Tech Transfer

ideas from his days at Sandia, sales will skyrocket. Those ideas that Bill and his Sandia "partners in technology development" believe offer the best potential for eventual transformation into new products, in addition to agricultural blades:

- Asbestos-free thermal bulbs to control freon flow in vehicle air conditioners;
- New paper-making equipment aimed at saving that industry about $800 million a year in energy costs.

Bill's presence at Sandia wouldn't have happened as recently as four years ago. He is here because of the Industry-Laboratory Technology Exchange Program sponsored by DOE's Office of Energy Research. Other participants in the program at Sandia include:

- LENNOX (pulse combustors at Sandia's Combustion Research Facility in Livermore);
- CIMCORP (robotics).

"This exchange program," says Dan Arvizu, manager of Technology Transfer and Management Dept. 6010, "is just one manifestation of a new awareness that I see developing at Sandia (and at DOE) for technology transfer."

The new awareness, says Dan, has several parts; more opportunities for technology information exchange programs, or partnering, is just one.

"It also includes a realization that we need to carefully analyze how we have performed technology transfer in the past so that we can make improvements. Additionally, it encourages us to clearly state where we believe technology transfer fits into our overall mission and in what manner transfer of Sandia technology can contribute to US competitiveness."

"... from what I've seen, people in industry find Sandians more than willing to help them ..."

Program Plan and Definition

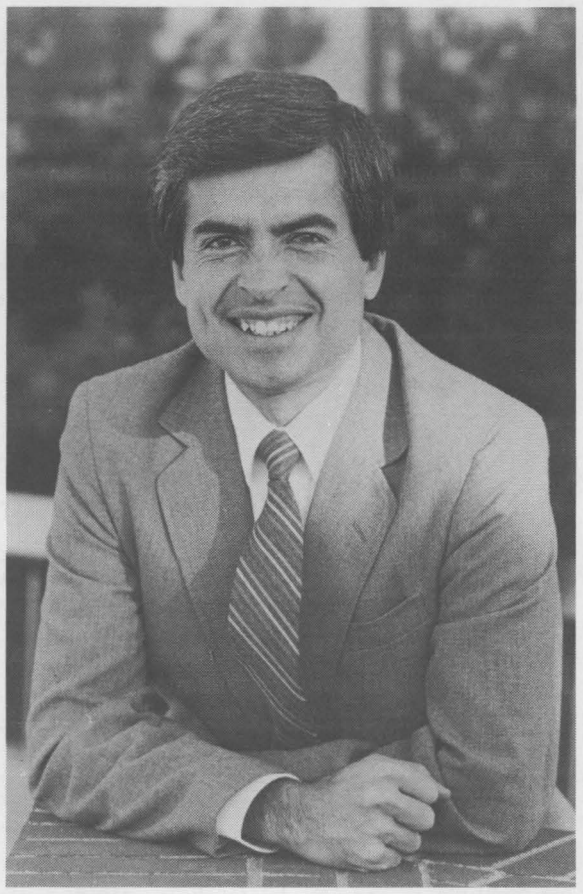
These topics, in fact, were discussed in depth during a recent Small Staff retreat devoted entirely to technology transfer and designed to help Dan develop a clear Sandia technology transfer program plan.

Dan, who's been in his position since January, sees technology transfer as a program designed to get a second major return on the US taxpayer's investment in the form of increased domestic industrial productivity. And he sees it as a focused program: controlled transfer of Sandia's scientific and engineering capabilities that seem to offer the best potential for significant commercial market success.

Productive Tech Transfer Without Fanfare

In addition to the more visible and dramatic examples of tech transfer, the Labs has examples that generally are not seen or recognized by the public or by Sandians themselves.

A good example: the productive and community-minded way the Labs interacts with local fabrication shops (see "Shop Overflow: Helping Suppliers Help Sandia" on page 12).



DAN ARVIZU (6010): "Technology transfer is a program designed to get a second major return on the US taxpayer's investment — in the form of increased domestic industrial productivity."

Dan emphasizes that it is well to remember that such technologies only rarely translate into the direct transfer of products that are ready for sales.

John Zeigler (1812), with recent patents on electrically conducting polymers and self-developing polysilane photoresists, echoes Dan's comments:

"When people from industry come here expecting Sandia to hand over a product, they often are disappointed," John explains. "On the other hand, when they come in search of a special expertise or technology that they can develop into a proprietary product in their own labs, they usually are pretty happy when they leave. In fact, from what I've seen, people in industry find Sandians more than willing to help them obtain the necessary knowledge to develop products in this manner. Often, the issue in dealing with industry is unrealistic expectations."

Post-Transfer Development Required

Even the laminar air flow clean room — the patented Sandia technology that has grown into a $4 billion-a-year worldwide industry — needed additional development following its transfer out of the Labs. "The first rooms were extremely noisy," recalls Bill Soltis, a Houston resident who built some of the first commercial clean rooms and benches when he operated Comfort Air Service during the early '60s in Albuquerque. "They also required an unacceptable amount of energy to operate," adds Bill, now president of Lepco, a Houston-based cleanroom manufacturing and supply business.

Sometimes, an idea ... born far ahead of its time will lie dormant for years, then take root in the hard soil of commerce.

"Technology transfer isn't for the impatient," says Virgil Dugan, Director of Advanced Energy Technology 6200. "New technologies and understanding frequently emerge when there is no widespread demand for them in the marketplace. That's the situation right now with some of our fossil-fuel-related technologies."

Extra Labor and Capital

"Also," adds Virgil, "people are just kidding themselves if they fail to factor in the additional labor and often substantial capital that are required to make intellectual property, or even prototype products ready for the marketplace."

The same message comes from Gary Smith, president of SCB Technologies, Inc., an Albuquerque start-up company that has obtained the rights to build semiconductor bridges, microchip-sized explosive igniters invented by Bob Bickes (DMTS, 2515) and Al Schwarz (ret.). While the new devices seem a natural for triggering auto air bags and detonating explosives in military, space, and mining applications, Gary is conservative in his claims.

"It will be at least two years," Gary says, "and probably four or five, before SCB Technologies can develop a market based on the semiconductor bridge."

There are several reasons for this: (1) It takes time to develop a specific product for a specific application from transferred technology; (2) rigorous acceptance tests are typically required by manufacturers, suppliers, and often governmental bodies before new products can be incorporated into existing systems; and (3) industry is cautious when it comes to replacing an accepted and basically reliable technology with something new, unfamiliar, and unproven, even if the new part is better.

"That means we at SCB Technologies have no real expectations for meaningful profits, dividends, or asset growth for at least that [four- or five-year] period," Gary says. "So, right now, people just have to give their all with no immediate return." (So far, SCB Technologies has contracts with Sandia and several commercial firms to provide test units.)

It's hard to pick technology transfer winners for many reasons ...

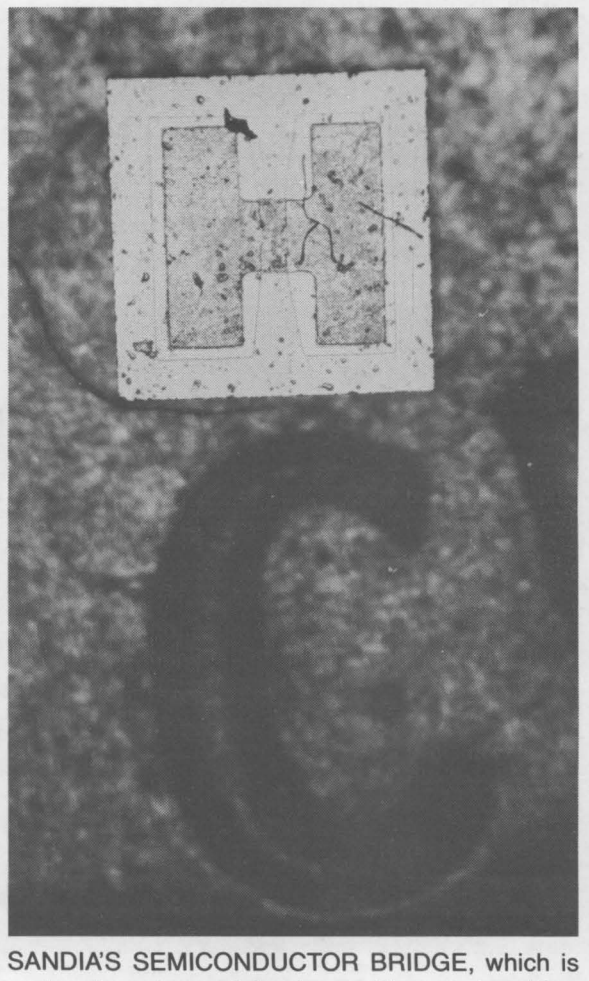
It's hard to pick technology transfer winners for many reasons, explains Gary, who also serves as director of the Technology Commercialization Office at the University of New Mexico.

Low Odds, High Risk

"Out of 100 good new ideas," he says, "ten probably are worthy of serious research, four of those are probably worthy of development efforts, and only one or two typically stand any chance of achieving major sales success.

"Additionally," Gary explains, "four of five start-up companies are gone within five years. So the chances that one good idea — very often a patented idea — will become a viable, long-term sales hit are extremely low.

(Continued on Next Page)



SANDIA'S SEMICONDUCTOR BRIDGE, which is undergoing advanced development by a start-up Albuquerque company, is lying above the capital C on the tails side of a penny. The middle of the crossbar on the H-shaped pattern, heavily doped with diffuse phosphorus, turns into a plasma and ignites an explosive powder within several tens of microseconds — about 1000 times faster than a conventional hot wire.

SANDIA TECHNOLOGY TRANSFER

Tech Transfer — It Goes Both Ways

Technology transfer can clearly help make the country more competitive. But is there a more direct benefit to Sandia's principal customer, DOE's Office of Military Application?

Listen to Mark Smith's (1833) comments about his work with Fisher Barton's Bill Lenling:

"When Bill returns to Fisher Barton, he'll surely be missed here. We've had a synergistic relationship, accomplishing much more together as a team than we would have separately.

"In fact, technology is already being transferred back to Sandia. When Bill and I started working on a thermal-barrier coating for auto air conditioners, Sandia had no application for the coating. I was essentially sharing my plasma-coating experience so that Bill could follow through on his Fisher Barton initiative.

"But, just a couple of weeks ago, we got a call from Kathleen McCaughey (2543). Her division needed a thermal-barrier coating for strong-link housings in a fire set. We had an immediate answer, but only because of our relationship with Bill Lenling and Fisher Barton."

Sandia President Al Narath, commenting recently on the matter of what Sandia's "paying customers" get out of tech transfer, said: "Our primary responsibility is to satisfy the customer who provides the funding to Sandia. Technology transfer magnifies and amplifies the impact of what we're doing, rather than being the purpose of what we're doing."

(Continued from Preceding Page)

"The chances are low because so many things are beyond your control," Gary says. "So many important business decisions must be made on imprecise data. But with proper techniques, you can increase those long odds. Look at what Apple Computer has done.

"At SCB Technologies, we have many more things going against us now than Coca-Cola had when it tried to bring out the 'new' Coke. With all of that company's resources and marketing analysis capability, successful introduction should have been easy.

"Out of 100 good new ideas . . . only one or two typically stand any chance of achieving major sales success."

Instead, it failed miserably. Coke was lucky, however; it had the financial resources to survive a big mistake. Often, the small entrepreneur can't afford even one mistake."

Dormant Ideas May Bloom Later

That's the bad news. The good: sometimes an idea, unheralded, abstruse, and born far ahead of its time, will lie dormant for years, then take root in the hard soil of commerce. A classic example — and perhaps Sandia's first big tech transfer idea — is the seminal pattern recognition concepts developed in the late '50s by then-Sandians Iben Browning and Woody Bledsoe. This three-decade-old work is only now producing products, sales, jobs — a number of them at a little-known, but growing Albuquerque company, Excalibur Technologies (see n-tuple stories).

Another late bloomer: rolamite, described in the March 1968 issue of *Popular Science* as a revolutionary device that would be used "in everything from switches, thermostats, and valves to pumps and clutches, and as an almost frictionless bearing." It failed to germinate in '68, but sales for 1989 are expected to be about $40 million, up from $15.5 million in 1988. (A future LAB NEWS story will elaborate.)

The uncommonly long dormancy of n-tuple and rolamite does not seem, incidentally, to have much to do with the way they were introduced to the world outside Sandia's gates. N-tuple was introduced completely without fanfare at a technical meeting and in technical journals — and there was no technology transfer office to push it along. Rolamite was in the spotlight from the beginning and received much help from the Labs' Office of Industrial Cooperation. The results for both were pretty much the same; other factors were at work.

Weak on Revisiting Transfers

While n-tuple and rolamite are perhaps today a confirmation of Victor Hugo's observation that "there is nothing on earth so powerful as an idea whose time has come," they also share one other distinction — they highlight a shortcoming in Sandia's past technology transfer effort.

Says Bob Stromberg (6010): "We have systematically failed to revisit our transferred technology to update our knowledge of its influence on US industry.

"It's often difficult to measure a transfer's ultimate impact on business and society without checking up on it every few years. Some technologies initially seem to have a fairly narrow industrial impact, but that changes surprisingly often."

"Technology transfer isn't for the impatient."

A prime example is the hot air solder leveler invented in the early '70s by T. A. Allen and Bob Sylvester (both ret.). It's used to level solder on printed circuit boards with a blast of super-heated air instead of with a hot liquid as previously done. Introduced in 1974, these machines today account for millions of dollars of sales annually.

Printed Circuit Fabrication magazine says that the hot air solder leveler "is becoming the primary way to apply solder to a printed circuit board (PCB) throughout the world." Several New Mexico firms use boards leveled by this offshoot of Sandia technology.

Hundreds — perhaps thousands — of products use circuit boards leveled with this process. "But that's only the primary impact," Bob says. "A closer look — the kind we haven't usually been taking — shows that hot air solder leveling also directly impacted the international chemicals industry. It resulted in two new product lines — special formulations of flux [used to clean the PCB surface] and a special tin/lead solder." In addition, there are custom hot air solder leveling services — a domestic growth industry that does about $150 million of business a year.

Still in the process of evolving the Labs' new-awareness tech transfer program, Dan Arvizu believes it's important to catalog these past successes and correct misconceptions about the extent of Sandia efforts over the past 25 years. But this glance in the rear-view mirror is only a means "of helping us get farther down the road in the future," he says.

"The idea that we haven't done a good job clearly is wrong," he says. "However, it is our responsibility to ask, 'How well could we have done?' or 'Have we focused our attentions in ways to get the most efficient use of our technologies by industry?'

"Based on dicussions with people in industry, I think we can do better in the future," he says.

Orval Jones (EVP 20) sums up his impressions of the Labs' technology transfer record: "All in all, we've made solid progress. Overall, I'm happy with what we've done. There is a substantial list of accomplishments that can actually be seen in terms of real industry, sales of products, and jobs.

"But technology transfer takes a lot of hard work, there are many challenges, and there's a constant learning process going on.

"For instance, the Labs must identify and develop the best techniques for protecting its intellectual property and the proprietary information of its industrial partners," he says. "Although many of our most widely recognized transfers have been related to energy R&D, we're now being challenged [primarily because of the new DOE Defense Programs Technology Utilization Initiative] to transfer technologies developed in the entirety of our DOE-supported work and programs."

Fortunately, the new-awareness sensitivity about technology transfer that Dan Arvizu sees throughout the Labs offers many new ways to maximize the Labs' future effectiveness.

One of the approaches is the effort that Dan and Kurt Olsen (4050) are coordinating to quickly and systematically identify developments and inventions here that seem to offer the most potential for US industry. A key is visits that Kurt and Marvin Moss (4051) have been making to each director.

"Basically," says Kurt, "we're soliciting technology transfer ideas, without regard initially for patentability. We're also discussing things like protection of intellectual property, cooperative research agreements with industry, and consulting possibilities for employees. Our approach is to encourage a technical staff member to pick up the phone and let us know as quickly as possible about any real technical ad-

"Often, the small entrepreneur can't afford even one mistake."

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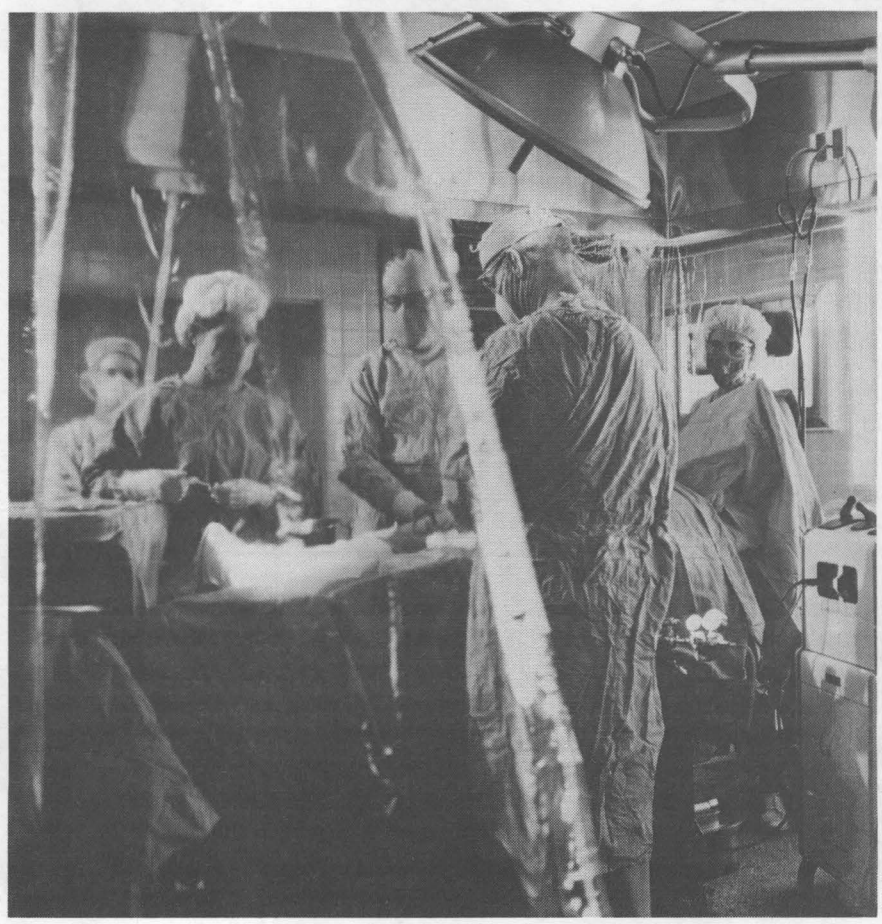


THIS MID-'60S PHOTO shows one of the first laminar air flow surgical suites built at Bataan Memorial Methodist Hospital (now Lovelace Medical Center). The clear curtain (partially opened for photo) surrounding the operating area allowed air entering the room through overhead filters to move smoothly down over the area, carrying airborne particles and bacteria down under the curtain. The descendant of the company that built this surgical suite is Albuquerque's EACI/Envirco.

It's Called 'N-Tuple'

Concept From '50s Has Round-the-World Impact — Finally

The "Bledsoe-Browning n-tuple pattern recognition method" was born in the summer of 1958, when a Sandia employee named Iben Browning had seven weeks of thinking time in bed after a heart attack.

N-tuple is arguably the earliest Sandia concept transferred to commercial use. It has in recent years taken several marketable forms — as text, vision, and signal recognition systems — but it's been a long and circuitous trip to market.

And though it has sparked interest and technological innovations as far away as England and Japan,

N-tuple is arguably the earliest Sandia concept transferred to commercial use.

another decade may pass before the technology is widely accepted, predicts the chief scientist of Excalibur Technologies, an Albuquerque firm whose products are based on the n-tuple method.

But first, back to 1958 and Iben Browning's convalescence. "I had to lie there like a vegetable," Iben remembers, "but my mind was still working. So that was more time to think than I had ever had in my adult life before. I learned Russian, polished up my Spanish, and invented n-tuple pattern recognition."

Iben attributes the heart attack to stress — he was responsible for several projects and was preparing for a special presentation (requiring special clearances for the audience) of some 20 new US defense concepts. Several of the concepts were Iben's. His heart attack came three days before the presentation was scheduled.

Iben left Sandia in 1960 but was frequently on contract as a consultant to Sandia for more than a decade after that. He has a bachelor's degree in physics and math and a master's and doctorate in biology — with assorted minors — and refers to himself as "a scientist without a specialty." The n-tuple technique, along with related work he has done in self-organizing systems, draws heavily on his biologist's outlook.

Intended for Smart Bomb

The point of working on pattern recognition at Sandia was its possible use in a "smart bomb." As Iben puts it, "If you had bombs that knew where they were, you'd need a lot less bang for a given result. So all this was on the general grounds of giving a bomb an eye."

Instead, says Iben, "the first Sandia application was to project where fallout would occur in a weapon test. That, of course, was back in the days when we were doing atmospheric tests. We taught the system multiple altitudes, wind directions and velocities, and fallout patterns for half the tests we'd made, then checked it on the other half. It predicted much better than chance — hugely better than chance — where the fallout would be."

The original n-tuple paper, titled "Pattern Recognition and Reading by Machine" and listing as authors W. W. Bledsoe and I. Browning, was given at the 1959 Eastern Joint Computer Conference. It has become a classic, frequently reprinted, summarized, and cited. (Woody Bledsoe credits Iben Browning's writing style with helping make the concept understandable.) The paper describes a text recognition system using a grid of 150 photocells, arranged 10 wide and 15 high.

When the grid received the images of letters and numerals — typewritten, block-printed by hand, or handwritten in script — the n-tuple system "learned" various ways they might look. But the learning did not consist of storing anything recognizable as the actual shapes. Instead, the system stored in a single matrix the states of *combinations* of the photocells — n-tuples, or ordered sequences — with ones and zeros

The original n-tuple paper . . . has become a classic, frequently reprinted, summarized, and cited.

representing the combinations of photocells illuminated or left dark.

In effect, the information was compressed. It was possible to compare the stored information with the pattern formed by a to-be-identified character and, with high reliability, determine what letter the photocell grid was seeing.

(Continued on Next Page)

(Continued from Page Five)

Tech Transfer

vance that has occurred here."

Dept. 4050 also recently agreed to contract with the Technology Commercialization Office (TCO) at UNM to perform preliminary market analyses on emerging Sandia technologies. The TCO is funded by the New Mexico Research and Development Institute to identify New Mexico technologies and prototype products that seem to have the best chance of success in the marketplace.

In putting together a technology transfer plan that's tailored for a specific invention or idea, San-

"Our approach is to encourage a technical staff member to pick up the phone and let us know as quickly as possible about any real technical advance . . ."

dia must decide whether information about a development will be broadly disseminated or closely held. That's a tough call. Because the Labs' intent is to support US industrial competitiveness, Sandia must also research ownership of companies interested in Labs developments. "Federal technology transfer legislation," Dan says, "requires that companies at the receiving end of government-owned technologies must manufacture substantially all their products in the US. Tom Thomsen [President, Technology Systems Group, AT&T Technologies, Inc., and a member of Sandia's Board of Directors] goes a step farther and suggests that we ask, 'Where do these companies reinvest their profits?' "

Glen Cheney (VP 2000) subscribes to Dan's new-awareness view that if Sandia is to optimize future technology transfer efforts and results, it must do more to become familiar with US industry — in essence, to think more like industry does.

Learning to Think Like Industry

"We can't just speak only our native tongue — the scientific/technical language most familiar to us," Glen says. "We must learn to speak a second language — the language of commerce, which is 'sales and dollars.'

"We must demonstrate to industry partners and contacts how advanced development of a Sandia invention could lead to new products that stand a better-than-average chance of generating new sales.

"And we must become more fluent in a third language — the language of jobs. That means doing our homework with members of Congress — whether they be from our delegation or elsewhere — so we can help them see Sandia's technology transfer contributions to their districts in terms of jobs that have existed over the years and future jobs that could be created."

An almost forgotten local example is EACI/Envirco, which pioneered medical applications of Sandia's laminar air flow clean room. Since its inception in 1966, EACI/Envirco has been a solid

"Some technologies initially seem to have a fairly narrow industrial impact, but that changes surprisingly often."

player in the gigantic worldwide clean-room industry. During 1988, for instance, Envirco had $10 million in sales, approximately 100 employees, and a payroll of $1.5 million. Today's company is a descendant of Comfort Air Service, mentioned earlier.

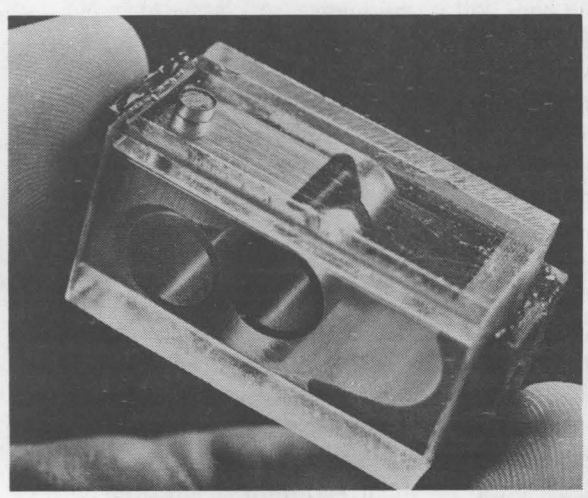
Bill Soltis, who managed (and owned a part of) Comfort Air Service in the pioneering days of laminar air flow, adds some perspective that he believes has been lost over the years. "I can say without reservation that Envirco wouldn't exist today if Willis Whitfield [ret.] hadn't invented laminar air flow clean rooms at Sandia," he says. "For that matter, the modern electronics industry [represented in New Mexico by such major semiconductor companies as Intel] absolutely would not be as advanced as it is today without laminar air clean rooms."

From all of this recitation of the transfer of science and technology from the Labs through the years, several fundamentals become apparent:

First, the Labs has demonstrated that it's a source of knowledge that can alter the pace of human progress, creating employment here and elsewhere; second, it's knowledge, not finished products, that typically emerges from the Labs; third, it's surprisingly difficult to select the technology that will be most useful in the marketplace, and years may elapse before this knowledge is transformed into products; and fourth, Sandia has shared its technology widely in the past but, in today's increasingly competitive global economy, needs to do more.

Future issues of LAB NEWS will continue to examine past and present examples of Sandia technology, drawing on them for insights that may help improve this dynamic process that so benefits both the country and the Laboratories.

(In an upcoming issue: "Rolamite, an Idea Whose Time Has Finally Come.") ●RGeer(3163)



THIS PICTURE of a rolamite, invented by former Sandian Don Wilkes, ran in the 1967 edition of the *World Book Encyclopedia*. What's happened to rolamite since that time? LAB NEWS will let you know in an upcoming issue.

(Continued from Preceding Page)

Iben originally envisioned the n-tuple system as an arrangement of hardware. Woody describes his own contribution as formalizing Iben's general idea and putting it into a ''learning matrix'' form for simulation on a computer. Woody then ran extensive computer trials to discover the results of taking various numbers of photocells at a time (that is, various values of n in the n-tuple).

A $20-Million Infant

The basic concept of scanning a pattern and encoding it in n-tuples can be extended to many kinds of pattern recognition — especially now that computers are much more powerful, and instead of hundreds of elements, a viewing grid can contain thousands or hundreds of thousands.

Possible uses range from factory inspection — are a circuit board's components all in the right place? — to vibration monitoring — does a machine's vibration pattern indicate that it's about to fail? — to computer-monitored security — does the face of a person looking into a camera match the stored record of the face (no matter whether the face wears a smile or a frown)?

But outside the laboratory, pattern recognition is still in its infancy.

According to neural-network researcher Bill Dress of Oak Ridge National Lab, there are today only three established, successful companies working in pattern recognition — and two of them have products based on n-tuple. One of the two is Excalibur Technologies, whose use of the n-tuple concept is combined with a neural network (a computer system modeled on the brain).

Bill last year served on a panel evaluating neural-network technology for the Department of Defense. He numbers the established companies as three because only that many have existed for several years and have had products in the field for more than a year.

There are many other, younger companies, but a *Fortune* article earlier this year commented that

Possible uses range from factory inspection . . . to vibration monitoring . . . to computer-monitored security.

''so far the lot of them resemble a fantasy more than an industry.'' (Excalibur was mentioned as an exception.)

Excalibur had sales of about $1 million last year — the *Fortune* article estimates the 1988 revenue of the whole neural-net industry at $20 million — and made a profit.

The WISARD From Britain

The other company using n-tuple technology, says Bill, is Computer Recognition Systems, Ltd. A British firm, it sells a hardware neural-network simulator — with origins in n-tuple — called WISARD.

WISARD is based on a design by a team of British researchers. One member of that team, Prof. Igor Aleksander of the University of London, published his first paper dealing with n-tuple in 1965. Recalling his introduction to the n-tuple method, he says, ''Bledsoe and Browning saw their method as an algorithm, whereas we saw it as a prescription for designing hardware.'' Working on the principles of both n-tuple and neural nets, his team bridged a gap generally believed in the '60s to exist between the two.

He also notes that, through several generations of machines, his team's designs moved ''more towards the neural aspects and further away from Bledsoe and Browning.'' Still, he considers the Bledsoe-Browning work a ''very early spur'' to start thinking of ''neurons as n-tuple recognizers.''

Computer Recognition Systems has a US subsidiary in Ayer, Mass. Its president, Pat Murphy, says

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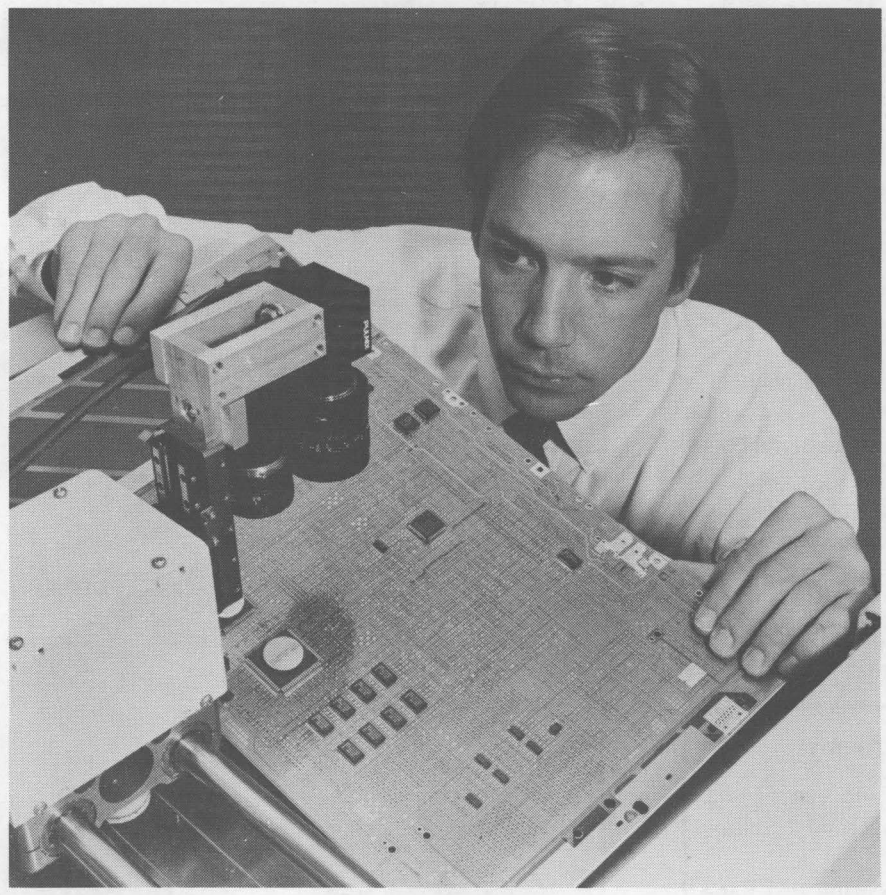

EXCALIBUR TECHNOLOGIES' Jim Strattman demonstrates how pattern recognition technology based on Sandia's n-tuple method might be used to inspect printed circuit boards.

'Colonies' of Algorithms

Excalibur Technologies: Growing N-Tuples for Market

One way Albuquerque's Excalibur Technologies extended the Sandia-originated n-tuple concept was by making a static system into a dynamic one. Jim Dowe, Excalibur's chief scientist and chairman of the board, explains:

''We realized that a lot of the parameters that had been held fixed [in the Browning-Bledsoe method] should be variables. In our use of n-tuple, a system replicates itself, but in a way slightly varied from the original. They compete against each other in the succeeding generations — that is, in succeeding problems — and, depending upon which wins, you let one of them survive and one of them die.

''Furthermore, they're able to cooperate with each other as well as compete against each other. So now, instead of having just one algorithm trying to solve a problem, you have groups.

''In some very complex problems, it's not uncommon to see the original algorithm grow into a 'colony' of as many as 2000 algorithms, all derived from the original. So you might think of what we've done as being a way of 'growing' n-tuple systems.

''It's the addition of a feedback mechanism to the n-tuple, thus creating a changing structure, that turns the n-tuple concept into a neural net.''

'A Date Which Will Live in Infamy'

The resulting performance can be disconcerting to an observer accustomed to the literal-minded computer software used in the average office. For instance, Excalibur's Savvy/TRS (Text Recognition System), when loaded with such massive texts as an encyclopedia or the Bible, locates words and phrases — even badly misspelled ones — in seconds.

Queried for Roosevelt's description of the Pearl Harbor attack as ''the day that will live in infamy,'' the system almost instantly displays the encyclopedia paragraph that contains it — even though the request is incorrect. What Roosevelt actually said was ''a [not 'the'] date [not 'day'] which [not 'that'] will live in infamy.''

The vision recognition system (Savvy/VRS) is, through a standard industrial-style TV camera, taught to recognize objects. Shown a test object, it then responds appropriately — or as appropriately as it can. In a demonstration, it is first shown a typical circuit-board component and told (through the keyboard) that it's looking at a chip.

Then, shown the socket that the chip fits into, the system ''guesses'' that it's also a chip — and in fact it looks more like a chip than anything else the system has been taught to recognize. But when told that the object is a socket, it thereafter distinguishes correctly between the two. Similarly, it identifies a hand-drawn imitation of a chip as a chip; but told that it is seeing a ''fake chip,'' the system thereafter distinguishes between real and fake chips.

Following the same general procedure would lead to a system that could inspect circuit boards for completeness and correct placement of components — but by ''teaching'' the computer, not programming it. This ''learning'' ability grows out of the n-tuple method, and in general out of the biologically oriented approach of Iben Browning.

How Do They Do It?

The exact methods used to turn n-tuple into neural-net software are proprietary. One property of the software, however, is compression of data. (In less highly developed form, that was also a characteristic of the original 1958-59 n-tuple work.) For instance, Excalibur's Pat Patterson says, ''We have searched eight megabytes of *Digital Review* [an industry magazine] with 1.2 megabytes of neural net.'' Pat says that the size of the data as represented in the network is typically 15% of the original.

Excalibur's products are described as ''a set of callable functions written in C.'' There are 15 functions for vision recognition, 14 for text, and 16 for signal recognition. They run on a wide range of standard computers.

After several years of difficulty, Excalibur appears to be gaining the confidence of the commercial world. For instance, it was featured in a recent issue of *Advanced Imaging* (see excerpts from that article) and was distinguished from a crowd of less-established neural-net companies by *Fortune*.

Excalibur's stock, selling at about 50¢ a share a year and a half ago, has recently sold for about $8 a share. The company now has 23 employees, 16 in Albuquerque and 7 in California.

For more on the outlook for n-tuple applications, see ''N-Tuple: Just Hitting Its Stride?'' ●

(Continued from Page Seven)

N-Tuple

that WISARD is currently sold in Europe (though not in the US), primarily to researchers. He says that his company considers neural-network technology generally still in the developmental stage and not yet suitable for factory automation — which is the primary focus of the company. Most of its sales are of other types of machine-vision products that do not use neural networks.

It Can't Work — But It Does

Excalibur Technologies exists as a result of a chance encounter in the mid-'70s. Jim Dowe, now Excalibur's chief scientist and chairman of the board, was then associate director of UNM's computing center. The director was former Sandian Stoughton Bell, who invited Jim to a breakfast where Iben was also present.

"At the time," recalls Jim, "I considered Iben to have some interesting ideas and also some weird, off-the-wall ideas. But through him, I was introduced to other people, particularly some on the west coast. I was asked to go out and evaluate a company and look at one of its patents.

"It turned out that one of the authors of the patent was Iben Browning. And I knew that the patent would just not work. The idea was to take the data in, randomize it, and then try to figure out what the pattern is. Everything I'd been trained to do indicated that the approach was ludicrous.

"Well, it did work. It worked quite well — I saw the hardware running. And that shook my very foundations. So I started spending more time with Iben and trying to understand his approach and his philosophy. After a while, I began to understand what he was saying."

The Mystical and the Technological

Jim and his early associates wanted to use the n-tuple concept in broad, commercial applications. Thanks to Jim's conversations with Iben, they saw, as Jim puts it, that the n-tuple method "had the potential to solve a class of difficult problems. We approached it as a challenge that, if successfully met, would be worth some money."

Work done by Jim and others in a small group of technical people — some of them former Sandians — led to the founding of Excalibur Technologies in 1980. The name was chosen to suggest the disparate elements of the company's origins:

"In my mind," says Jim, " 'Excalibur' represents the transition between the mystical and the scientific, between what's not reproducible — the sword Excalibur worked only in the hands of King Arthur — and something that's a useful tool.

"What we were doing was, at the time, belittled by many folks as a bag of smoke, as something that was just not tangible. They couldn't understand how a self-organizing system could do pattern recognition so well. It seemed that Excalibur was an appropriate type of symbolism to represent the tran-

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The Bread-Loaf Theory

How much of a contribution can Sandia claim to have made in the commercial development of the n-tuple method?

One might wonder, considering that Sandia didn't deliberately transfer the n-tuple concept for commercial application, that none of the principal figures were Sandia employees when n-tuple was finding its way into commercial systems, and that Excalibur Technologies had to extend the concept considerably to make it commercially useful.

When the question is put to Jim Dowe (Excalibur's chief scientist and chairman of the board), he answers with an analogy:

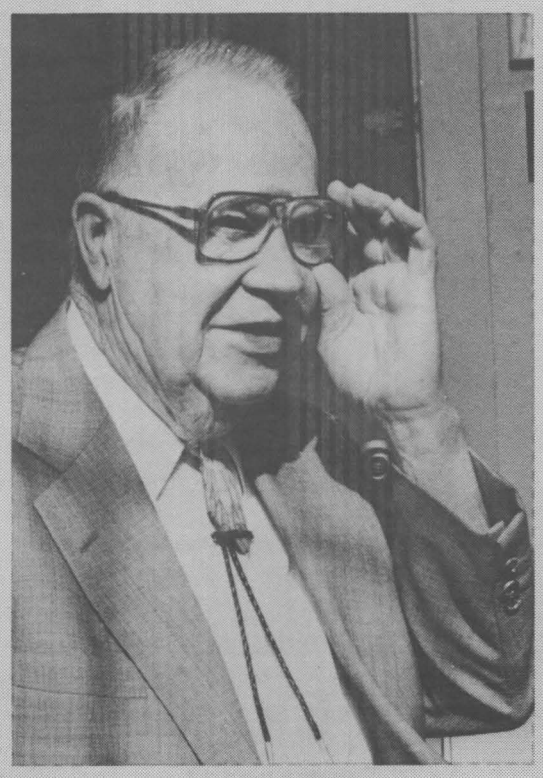
"I don't quite know how to measure Sandia's contribution, but all the ingredients of our system are like a loaf of bread. You have everything from salt, to flour, to leavening, to water or milk, to the container that holds it, to the fire that cooks it.

"If you leave out any one ingredient, you don't have a loaf of bread. You have *something*, but you don't have bread.

"I think of Sandia's contribution in that light. I don't know how to measure its value, but I know if Sandia hadn't been there, this technology would never have come to fruition."

Browning and Bledsoe: No Longer Collaborators, But Still Active in Research

Iben Browning came to Sandia in 1957, having already been a farmer, a military pilot, a biologist, a physicist, and an engineer. He has made it a practice, he says, to change professions every three years — otherwise he can come to the end of a day and realize he hasn't learned a major new fact that day.



IBEN BROWNING

By the time he left in 1960, Sandia had made a permanent impression on Iben. He calls it the only institution he knows that is consciously and entirely devoted to systems engineering — taking individual elements, even seemingly unrelated ones, and turning them into a working whole.

He grew up in south Texas but came to Sandia from Buffalo, N.Y., where he had spent a total of five years at American Optical (as a physicist) and Bell Aircraft (as a development engineer). The climate was one thing that drew him — he and Mrs. Browning now live in Tijeras.

Iben left Sandia along with Woody Bledsoe and Lloyd Lockingen (dec.) to form a California company called Panoramic Research, Inc. Four years later, Iben set up the non-profit ("deliberately non-profit," he says) Thomas Bede Foundation. Both those organizations did a substantial amount of contract work for Sandia during the 1960s.

He returned to Albuquerque about 1970 to start a company to produce an image scanner. That company, undercapitalized, did not succeed.

At age 71, Iben continues to work in a number of areas. He says that he now has 66 patents granted (US and foreign) and two in process. He expects to get about 30 more in the next three to four years.

He also spends much of his time traveling — not just to see the sights, but to give lectures on subjects such as climate, AIDS, and science in general.

(For more on Iben and his Sandia work, see the main story.)

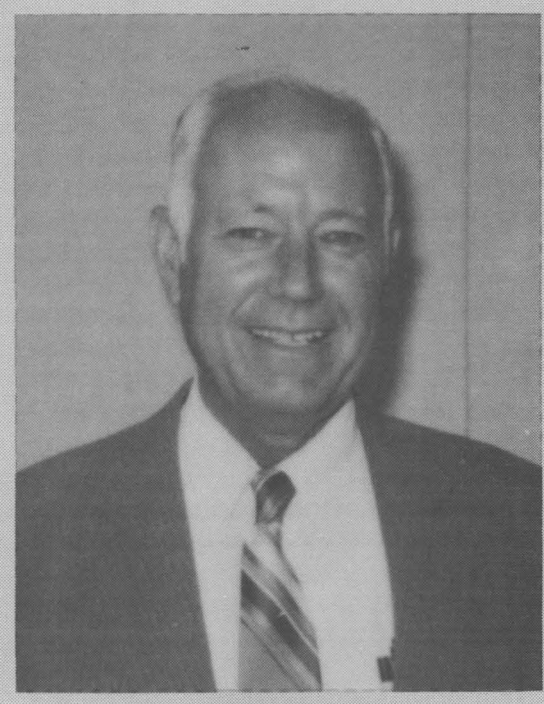
'Bledsoe of Bledsoe-Browning'

Woodrow W. "Woody" Bledsoe added his expertise in mathematics and computers to Iben Browning's concept of a learning-and-recognition scheme. The result was the Bledsoe-Browning n-tuple method.

Woody came to Sandia in 1953 as a member of the Systems Analysis Dept., which he headed from early 1955 until his departure from Sandia in 1960. He left, he says, so that he could do more individual research.

Woody describes Panoramic Research as "a small California company where the elite of the pre-artificial-intelligence community — from Stanford, MIT, Cal, all over — came by to jaw about what was going on."

Woody left that company in late 1965, joining the math department at the University of Texas in 1966. He headed that department from 1967 to 1969 and again from 1973 to 1975. In the '80s, he has served as a vice-president in the Microelectronics and Computer Technology Corp., a consortium in Austin set up for development of fast-computer technology.



WOODY BLEDSOE

Although he stopped working on n-tuple years ago, says Woody, "occasionally someone runs into me and asks, 'Are you the Bledsoe of Bledsoe-Browning?' And I say, 'Well, yeah — the same.' "

He has remained active in artificial intelligence. He has been president of the American Association for Artificial Intelligence and head of an international AI organization. He also continues to serve on various AI-related committees — for instance, this year on the conference committee for the International Joint Conference on AI.

Woody now holds a chair in computer science at the University of Texas, where he is also a professor of mathematics.

SANDIA TECHNOLOGY TRANSFER

(Continued from Preceding Page)

sition that we were making with the technology.''

By taking the n-tuple concept and extending it — in ways that were not feasible on computers three decades ago (see ''Excalibur Technologies: Growing N-Tuples for Market'') — Excalibur has developed powerful pattern recognition systems.

How much does Excalibur owe to Sandia? When Jim met Iben, neither was a Sandia employee. Nor are Excalibur's products simple, direct transfers of work done at Sandia.

Yet Jim points out that n-tuple, and thus Excalibur, wouldn't have existed without Sandia: ''Iben didn't just go out and create n-tuple on his own. He did it for Sandia Labs.'' (For further comments, see box, ''The Bread-Loaf Theory.'')

Narrowly Escaping Extinction

The irony is that, for several years, the performance of Excalibur's products largely outstripped acceptance. Although observers were regularly astounded when they saw the system at work, performance did not immediately translate into commercial success.

Seeking acceptance by customers, Excalibur has gone through three phases. The company first sold a circuit board to be plugged into Apple computers to allow communication with the computer in English — even ungrammatical English. Next it made and sold a data-base system in hardware form. But neither approach brought success. In fact, after several years of financial losses, Excalibur underwent a Chapter 11 reorganization in 1985 and was on the verge of extinction.

Here, the journey of n-tuple from Sandia to the marketplace took another turn. After rejection in the US, Excalibur stayed alive through a contract with a Japanese company. The task: Apply n-tuple pattern recognition to the difficult *kanji* script used in written Japanese.

Salvation by the Japanese wasn't the first choice, says Jim Dowe: ''I personally agonized very long and hard before we accepted the Japanese offer. I personally went to virtually every major US corporation that has anything to do with technology or computing, and I sat down — if they would give me an audience — and demonstrated the technology.

''We were not able to get any major US corporation to back the technology. Only after that, and being about to starve to death as a company, did we decide that we had to sell it where we could.''

If it's such a powerful technology, why couldn't Excalibur sell it in the US in the mid-'80s? Again, Jim has some answers. ''Anybody who knows anything about the world of technology knows that large changes usually evolve over time — they just don't happen in a short period. Experienced people have seen many scams come by, many false claims. An experienced person knows that most 'free' lunches aren't free. So they often reject any major change.

''I expect it'll be another ten years before this is really accepted. We were just lucky that in Japan they don't have the same approach to science that we have here, in the sense that if it works they'll tend to use it — whereas here you must also dem-

(Continued on Page Ten)

N-Tuple: Just Hitting Its Stride?

Predictions can be risky, as the whole n-tuple history shows. But when the LAB NEWS asked what the world should expect, Excalibur Technologies' Jim Dowe quickly responded with a list of applications that he considers virtually certain to be adopted in industry. All of them, he says, are based on what can already be done with pattern recognition technology, and all of them will probably become commonplace.

Here's a selection from Jim's list:

- Evaluate the quality of a semiconductor wafer before it's diced to make chips;
- By sensing the signals (such as vibrations) emitted while just-manufactured motors are running, determine whether they are performing correctly before they leave the factory;
- Evaluate welds by x-ray inspection;
- Predict the production capability of an oil well (within a known field, not in an exploratory area);
- Identify materials (such as plywood) by their texture;
- Inspect printed circuit boards during the manufacturing process.

In all these cases, says Jim, the underlying technology does not change. It all uses the n-tuple concept developed at Sandia. What does change is the human interface — the way the technology is applied.

A human being always has to interpret what the pattern-recognition system flags as ''bad.'' Inspecting a printed circuit board, for example, the system can identify an area that doesn't match what it has been taught is a ''good'' board. But it cannot determine *why* something is wrong.

Given the warning of a problem, however, someone can look at the board and see that the trouble is, for instance, a bent pin on an integrated circuit. It's this kind of ''pass-fail'' application that Jim sees as a future major use of n-tuple-based pattern recognition in industry.

But Timing Wasn't Right

Self-Organizing Systems Piqued Interest

Imagine a desktop that would, when you threw your papers on it, neatly sort and stack them by category — without having been instructed ahead of time what the categories should be. That may be the ultimate self-organizing system (nobody has yet promised one), but Sandia has developed others over the years.

Several show the influence of Iben Browning. The chief scientist of Excalibur Technologies, Jim Dowe, cites not only n-tuple (see main story) but two other projects as exemplars of Iben's approach: ACCEL and ''Mickey Mouse.'' ACCEL was transferred out of Sandia — with mixed results — and ''Mickey Mouse'' has recently figured in neural-net research.

ACCEL (Automated Circuit Card Etching Layout) was a computer software system for automatically arranging electronic components. The goal, says Cliff Fisk (ret.) was to reduce the lag time from the beginning of a circuit board's layout until the board could go into production. Cliff was one of several Sandians who took temporary assignments at Iben's company in California to work on ACCEL.

ACCEL was self-organizing because there was no preordained arrangement of the components. Certain rules were set — components to be connected ''attracted'' each other, all components were ''repelled'' by the edge of the circuit board, and so on — and then the components were allowed to jostle their way into a stable configuration.

Another Sandian who worked on ACCEL, Dave Caskey (5248), points out that a problem such as laying out perhaps a hundred components on a circuit board involves many variables — too many to allow solving the resulting equations, even by computer. Thus the need for a self-organizing system.

Unfortunately, says Cliff, by the time ACCEL was perfected, the age of discrete components was passing and the age of integrated circuits was beginning. A system that worked for components that had up to four leads would not work for components — chips — that might have dozens of leads.

Still, recalls Les West (ret.), who also worked on ACCEL, ''it was a red-hot item in industry. People wanted copies of it. Once these got out of Sandia, we don't know how they were used. Industry may have taken ACCEL and used a lot of the ideas in it, but we just don't know.''

Related techniques are now used in industry for laying out integrated circuits and the components of printed circuit boards. There appears, however, to be no direct connection with ACCEL.

Could Learn and Forget

Another self-organizing system, ''Mickey Mouse,'' seems more speculative, more like pure research. Work on a series of systems given that name was done by Iben under a contract with Sandia.

''Mickey Mouse'' was a neural network, a brain-like structure — but on a much smaller scale than a human brain, or even a small animal's. Iben says he named it in memory of the time he spent during WWII assisting in the making of training films at Walt Disney's studios. (He test-flew B-24 bombers on weekends.)

The abstract of Iben's report for research up to March 1964 says, ''The system as a whole has demonstrated limited 'ability' to organize itself, to learn and forget, to repair itself, and in general to exhibit 'behavior.' It responds to 'pain-like' inputs.''

An Oak Ridge National Lab researcher, Bill Dress, has built on the ''Mickey Mouse'' work to create a computer-simulated ''insect'' capable of rudimentary learning — such as avoiding areas where it experiences ''pain.'' He credits Iben's ''work and influence'' as forming the background of his own ideas and results.

A third computer-based system, though not precisely self-organizing, bears Iben's stamp. It was a text storage-and-retrieval system called SPIRAL (Sandia Program for Information Retrieval and Listing). Its developer, Les West, says he started working on it while on temporary duty in California for ACCEL work.

''The ideas were not specifically originated by Iben, but a lot were inspired by him,'' recalls Les. ''I started with his guidance and suggestions on SPIRAL after the work on ACCEL was done. And then I worked on it another year or so after the temporary assignment.

''I was kind of disappointed that it wasn't used at Sandia. But one reason was that this was back in the days [early to middle '70s] when all the text had to be punched on cards. That was very tedious — and expensive.''

SPIRAL was used by Piccatinny Arsenal, in New Jersey, says Les. He also installed it at Navy headquarters in Washington, D.C. But he doesn't know how much use it got. He suspects that it would have been adopted more widely if present-day computer hardware had been available.

Les's experience with both ACCEL and SPIRAL gives him the last word: ''I think ACCEL was a little late for its time, and SPIRAL was a little early.'' As in everything else, timing in tech transfer is everything.

(Continued from Page Nine)

N-Tuple

onstrate its theoretical underpinnings.''

Beyond that, Excalibur's experience is a lesson in how to — and how not to — get new technology accepted. Jim now consults with other companies who are trying to market their new technology. He describes himself ten years ago as naive, ''a first-class ignoramus, a babe in the woods.'' He recognizes now that a new technology has to be more than superior. It also has to fit within an existing structure. And it has to meet a need.

''You have to find someone who's desperate,'' says Jim. ''Believe it or not, that's one of my criteria [as a consultant]. That is, you must find somebody who has a real, operational problem.''

Solution Must Fit Problem

Although a new technology may be superior both technically and economically, it has a good chance of acceptance only if it is paired with a need so strong that a customer is willing to give it a try. The idea is to find a niche, a way that the new technology can be integrated into the existing system.

That's the approach Excalibur has adopted — and the approach Jim takes with his clients. They look for a foothold and try to expand from there.

As an example, Jim cites an Excalibur client who had a problem sorting wood products. The task was to watch several different kinds of material moving by at eight feet per second and throw the right switches to send the right material to the right place in the mill — a job so boring that human beings can do it for only a few days before their performance decays to little better than chance.

Because proper sorting is worth several thousand dollars a day, the client agreed to try Excalibur's vision recognition system. A predecessor system had cost several hundred thousand dollars and worked only marginally, but still better than a human being.

So here was the opportunity. The company was desperate enough to try Excalibur's system, but Excalibur would have to fit it into the existing process. ''They certainly can't take their capital investment of tens of millions of dollars and scrap it for our new technology,'' says Jim. ''Now, once the process is proved, their next mill will integrate this new technology.''

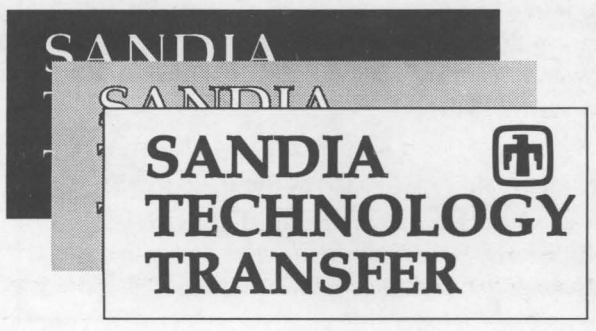
That example, says Jim, illustrates the problem of getting a new, improved, even cheaper technology accepted. It's not enough to have a single concept or a single device. The concept has to fit within the existing technological and economic system.

Impossible to Predict

Making the technology fit takes thought and planning. Yet, as the history of n-tuple suggests, there's also a strong element of the unpredictable.

It took a series of random events — such as Jim Dowe's invitation to a breakfast where Iben Browning was present — to get the n-tuple concept to the marketplace. And even then, embodied in Excalibur Technologies' products, n-tuple had tough going. It now appears to be on the way to success — thanks partly to company-saving support from Japan, again hardly a predictable event.

In retrospect, it may be easy to say that someone at Sandia should have spotted n-tuple as a candidate for commercial application. Looking forward from 1959, however — or even 1969 or 1979 — it's unlikely that any of what actually happened could have been foreseen. •CS



Tech Transfer Can Follow Strange Routes

Early '60s Math Project Leads to Ability to Forecast Diabetes in Pima Indians

Scientists recognize that the journey from research to eventual application (if ever) follows some strange and circuitous routes. Research often ends up at an entirely different destination from that originally expected — sometimes decades after the original work.

An example of just such a case recently became known to Gus Simmons, Sandia's polymathic mathematician (and now Senior Fellow, National Security Studies 200).

A mathematics project Gus carried out at Sandia in the early '60s to determine how pilots fly ground-hugging flight profiles provided the theoretical understanding for an adaptive learning program — a program that, a quarter of a century later, is

"That work was 25 years ago. I was surprised to learn that it hadn't fallen through the cracks."

helping doctors forecast the onset of diabetes mellitus in a high-risk population of Pima Indians in Arizona.

No one is more surprised than Gus.

''That work was done 25 years ago,'' he says. ''I was surprised to learn that it hadn't fallen through the cracks.''

An Algorithm Called ADAP

No one's more pleased than the originator of the adaptive algorithm, Jack W. Smith. Smith, senior technical advisor for Sigma Plus, Inc., in Fairfax, Va., is the lead author, with physicians from Johns Hopkins and the National Institutes of Health (NIH), of a November 1988 technical paper that reports how the algorithm, called ADAP, is proving highly accurate in forecasting diabetes among the Pimas.

ADAP is a generalized, adaptive, forecasting algorithm developed by Smith and a colleague in 1961. As data are input, it modifies its criteria for making decisions and improves its ability to discriminate, forecast, and diagnose. ADAP is similar to Bledsoe and Browning's n-tuple concept (among others) in the sense that it is a self-organizing system that adapts to a problem rather than doing a specific task.

''He found out why it [ADAP] worked,'' Smith says of Gus's contribution back in the early '60s. ''It seemed magic until then.'' In fact, Smith recalls that until Gus explained the algorithm's func-

. . . one of [Jack] Smith's colleagues had termed it "mathemagic."

tioning, one of Smith's colleagues had termed it ''mathemagic.''

Smith explains that he did the original work back in 1960-61. This was early research in neural networks and in connectionist models for parallel processing. Much of this kind of research was ahead of its time — particularly ahead of the computational capabilities of the era. Only in the past five years or so has it become a practical tool.

Algorithms such as ADAP deal with kinds of problems in which standard statistical techniques are usually unsuccessful. The general case concerns a situation where there are typically a very large number of input variables that together adequately determine the outputs, but the significance of any one of the input variables is unknown and its functional relationship to the outputs is either poorly or not at all established.

Neural Network Models Are Promising

Neural network models are a promising approach to these kinds of problems. Neural networks are a class of learning algorithms capable of using a ''training data set'' to discover patterns in data.

At about the same time, Gus was doing research on human capabilities to fly at high speeds and close to the ground. In performing this task, a pilot has somehow to respond to the ground topography and to his instrument readings to control the aircraft. His response must anticipate his flight path far enough ahead to alter the controls. ''So his path is a func-

(Continued on Next Page)

Excerpts From 'Advanced Imaging'

'A Software Eye for Industry'

The February 1989 issue of Advanced Imaging *published what it called 'the story behind Excalibur Technologies' pattern recognition breakthrough.' That article was written by Tom Eifler of Mate Communications, Salem, N.H. Following are excerpts:*

Few situations are more frustrating for a technologically sophisticated company than developing and introducing a product that is so advanced, that the market for which it is intended is unable or unwilling to grasp the significance of the product itself. Such was the case for Albuquerque-based Excalibur Technologies. . . .

. . . [Jim] Dowe left UNM in 1978 to start his own company. While still engaged in the early stages of this effort, Dowe was given a copy of *The Origin of Consciousness in the Breakdown of the Bicameral Mind*, by Julian Jaynes. He read the book and began, for the first time, to understand tie-ins with the work of Dr. Iben Browning, the pioneering biologist noted for his research into how biological organisms acquire and process information.

Says Dowe, ''I was so positive that I could somehow combine the concepts of both Jaynes and Browning that I literally put the book down, went over to my computer terminal, and started programming. All the while, I remembered Browning's advice to me, which was that if I were ever to succeed in building an intelligent system, then I must first understand the interrelationship between consciousness and intelligence.

Precisely because it is based on years of research on how biological organisms acquire and process information, the digital pattern recognition process employed by the Savvy/VRS today possesses biological-like attributes comparable to evolution, competition, adaptation, survival, and death. . . .

Excalibur favors the evolutionary theory that the eye came before the brain, which explains why the company's products are system-independent. If it is indeed true that, as a result, they began to evolve into more complex organisms, then it follows that a ''software eye'' may well exist for many, many years — during which it performs literally millions of useful functions — long before even the simplest truly ''brain-like'' system is ever developed.

(Continued from Preceding Page)

tion of the ground, but not a simple function. There is a lot of kinesthetic sense to it,'' says Gus. ''It's not something you can write mathematical equations for, yet there is this function.'' The Air Force was much concerned about this problem in the early '60s because of the need to fly high-speed, ground-hugging flight profiles to avoid ground-to-air missiles.

Large computer programs were written that ''learned'' by developing an approximation between

''What we'd done was set up a neural net with an enormous number of what are now called hidden units. But we didn't realize it at the time.''

all of the functions relating input variables and the output — the flight path flown by the best pilots. There may be a hundred potentially significant variables — the terrain below and ahead of the aircraft, and the instrument readings available to the pilot. A key problem is knowing which are the ''most important'' variables underlying the functional relationships.

'A Kind of Undirected Correlation'

''It's a kind of undirected correlation,'' says Gus. ''When you put data in, you don't identify the parameters that are most important. The procedure adapts.'' It learns as it goes.

But the research into these flight-control problems didn't work out. ''We were unsuccessful,'' says Gus. ''We had a mathematical technique that should have worked, but we didn't have the computational capability to take advantage of it at the time. We laid it aside.''

In the meantime, Smith, a mathematician working as an electrical engineer, had become interested in pattern recognition. He and Gus knew each other.

Smith had come up with ADAP. ''It was a special purpose neural net,'' says Smith. He says they had partitioned the inputs so that each corresponded to different input variables. ''What we'd done was set up a neural net with an enormous number of what are now called hidden units. But we didn't realize it

''Jack, I now know why the thing is learning.''

at the time.'' Smith and his colleagues also didn't understand how the thing really worked — how it learned.

''One day Gus came to see me,'' Smith recalls. ''I gave him an internal Navy paper about the research. He came back later and said, 'Jack, I now know why the thing is learning.' ''

Gus went on to develop the comprehensive theory to explain the functioning of the algorithm.

Bears Fruit 25 Years Later

But it wasn't until after Smith's retirement some 25 years later that the research bore fruit in the medical world. Smith's physician at Johns Hopkins, who'd always been interested in computers, was giving him his annual medical exam. They got to talking, and soon he'd put Smith in touch with W. C. Knowler, M.D., who was carrying out pioneering long-term studies for the NIH on diabetes among the Pima Indians.

A joint research project was set up. It was decided to test the ability of ADAP to forecast the onset of non-insulin-dependent diabetes within a five-year period.

ADAP generates ''partitioned'' digital analogs of ''perceptron-like'' devices. (The perceptron was an early concept for a cognitive machine embodying aspects of the brain and visual system. ADAP is an outgrowth of the perceptron idea.) These analogs learn by making internal adjustments when their forecasts turn out to be incorrect.

The algorithm was ''trained'' — Jack Smith's word — using data from 576 cases drawn from Knowler's two decades of diabetes studies among the Pima. ADAP was then used to forecast whether another 192 test individuals would develop diabetes within five years.

It turned out to be right 76 percent of the time, according to the group's report to the Twelfth Annual Symposium on Computer Applications in Medical Care in Washington, D.C., last November. But Smith says refinements since then have yielded even better results. In a conversation with the LAB NEWS, Smith said, ''Since then we've raised the accuracy rate. In the diabetes problem, we are now running over 80 percent accuracy.'' He has reiterated these points in a recent letter to Gus. Smith himself points out that both the paper and a presentation he gave at a national meeting in 1986 explicitly credit Gus with the theoretical underpinnings of the algorithm.

Gus Gets Credit

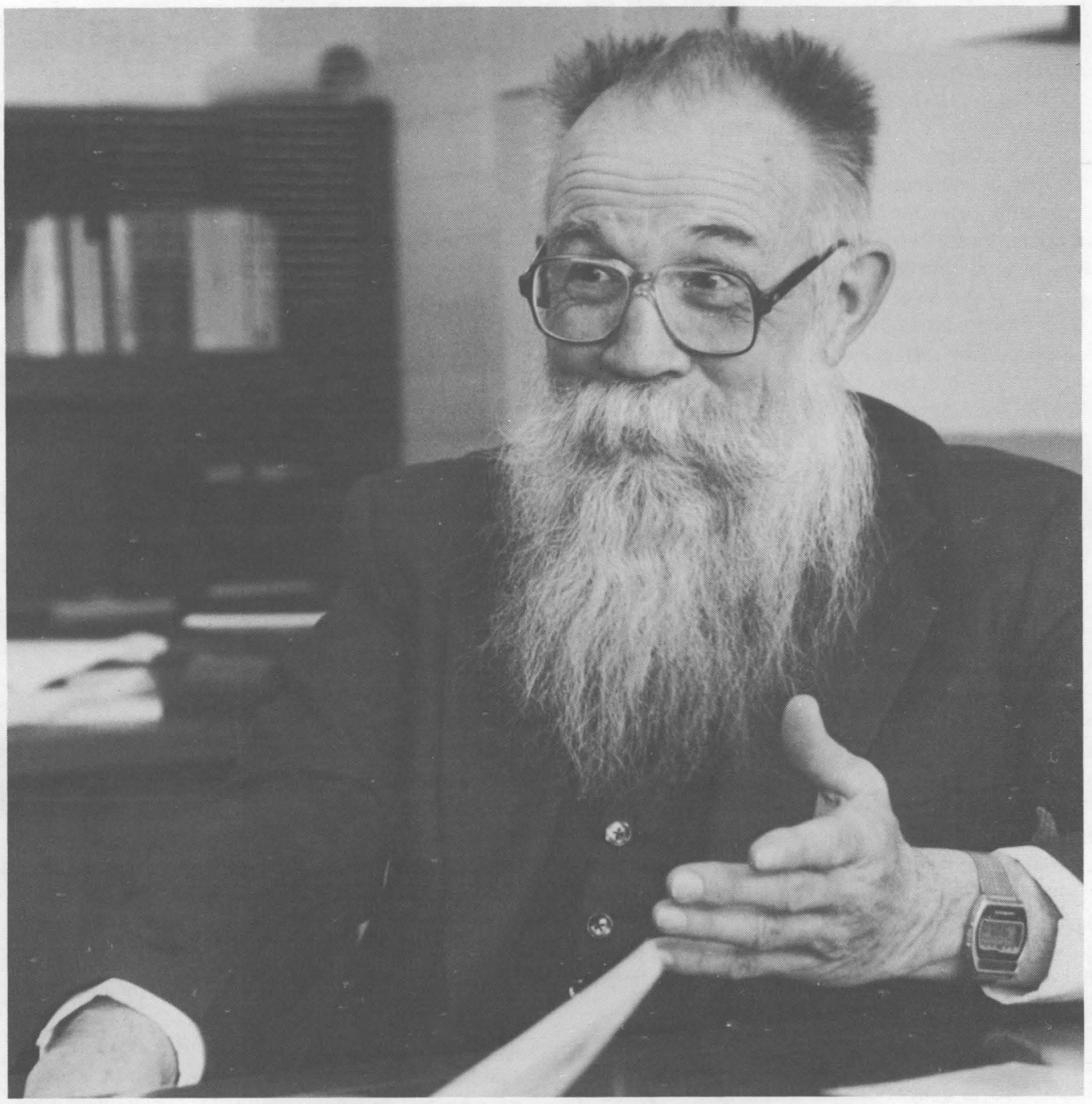
As he put it in that presentation, ''I am not attempting here to explain why or how ADAP was able to achieve these results. I will say that G. J. Simmons of Sandia Laboratory has addressed these questions in work which provides the theoretical,

Some of these algorithms are of special value in pattern recognition problems.

mathematical bases for understanding how algorithms like ADAP can do what they do.'' He refers to Gus's 1967 paper, ''Iterative Storage of Multidimensional Functions in Discrete Distributed Memories,'' as the most crucial of four papers Gus wrote on the subject from 1963 to 1967. He then adds, ''Simmons shows that . . . such iterative techniques may often be successful when standard statistical techniques fail. . . .'' In Smith's 1988 paper, Gus's 1963 paper is cited as Reference 1.

The use of theoretical work initially carried out for one purpose and eventually applied in a totally different field — health care — pleases both Gus and Jack Smith. ''I hadn't touched this stuff in 22 years,'' says Gus. ''It is gratifying to know that after that long a time, people can still find good applications for it.''

Smith continues his participation in the joint research of Johns Hopkins University School of Medicine and the Logistics Management Institute. The goal is to develop an enhanced version of the ADAP algorithm. They hope it will prove valuable as a medical diagnostic aid for a variety of medical conditions and stimulate discovery of previously unrecognized medical relationships. ●KFrazier/3161



LITTLE DID Sandia mathematician Gus Simmons know back in the early '60s that his project to help pilots fly ground-hugging flights would lead to an algorithm that's today helping doctors forecast the onset of diabetes mellitus in Pima Indians. Gus is now Senior Fellow, National Security Studies 200. (Photo by R. Smith, 3154-3)

feedback

Q. Why doesn't the Sandia phone book include a list of Sandia fax phone numbers and verification numbers listed by organization? I would find it very handy.

A. Your idea is a good one. A random survey of FAX users showed that a majority of them would find such a list useful. A notice was placed in the *Weekly Bulletin* to give everyone interested the opportunity to be included. The fax-number directory page should be distributed before the end of June. Thanks for the idea.

Herb Pitts — 3100

Sympathy

To Esther Martinez (2631) on the death of her husband in Albuquerque, Dec. 30.

To Mary Resnick (5128) on the death of her brother in Arizona, May 3.

To Frank Baca (7818) on the death of his sister in Belen, May 6.

A Hidden Face of Tech Transfer

Shop Overflow: Helping Suppliers Help Sandia

It's a plus to have a local pool of shops able to produce hardware for Sandia's research and development activities.

The Labs benefits by being able to go to these shops with ''overflow'' business. On occasion, procuring hardware outside is more economical, or the work is not within Sandia's internal capabilities.

Being able to get the work done locally simplifies communication and transportation when someone needs, for instance, a tetrahedral shape for a satellite or a mock-up transport trailer to support US-USSR treaty-verification work.

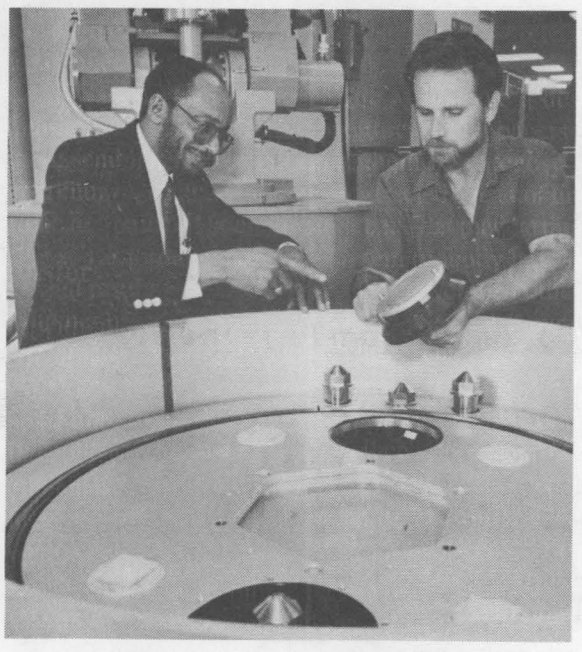
The community also benefits, because most of Sandia's projected $15 million worth of shop-overflow orders in FY89 will probably be placed locally (within about 60 miles of Albuquerque). Besides infusing money into the local economy, Sandia's orders help foster a strong, experienced group of businesses.

The 3000 or so ''fabricate-to-print'' orders that Sandia places each year are coordinated by Shop Overflow Sec. 7485-2. In this group, quality is a major issue. As supervisor Paul McKey puts it, ''We expect the same quality of parts from the outside as we produce inside.''

One way of ensuring quality is helping suppliers upgrade their technical knowledge — a form of technology transfer. For instance, Shop Overflow interacts with local suppliers to make them aware of developments in fabrication technology. The organization also offers a formal course for machinists and mechanical-measurement technicians (detailed below).

Again, the community benefits. When local suppliers are capable of doing difficult, exacting jobs, Sandia orders that would otherwise have to go out of state can be filled locally. More-capable suppliers are also more likely to attract additional, non-Sandia business.

GIVING STUDENTS in Geometrical Dimensioning and Tolerancing classes a look at Sandia's main machine shop are Jane Poppenger (right) and Andy Jojola (second from right). Both are in 7485-2.



PAUL McKEY AND BRUCE PAGE (both 7485-2) discuss suggestions Bruce made to local machine shops during the fabrication of this hardware, which is part of the Remote Operation of Cask Penetrations System (ROCAPS). ROCAPS is being developed by Intelligent Machine Systems Div. 1414 for robotic handling of nuclear-waste casks. Bruce is a technical fabrication coordinator in Shop Overflow.

Shop Overflow was formed in 1985, when technical responsibility for fabricate-to-print work was transferred to Mechanical Processing Dept. 7480. The idea was to help everyone — Sandia design groups, Purchasing, and contractors — by forming a group of technical fabrication coordinators: machinists, electronics technicians, and mechanical-measurement technicians.

''To smooth the technical liaison with the suppliers,'' says Paul, ''Shop Overflow is involved from the design phase of a job through inspection of completed parts.

''The coordinators help solve problems,'' he continues, ''beginning with design. They provide designers with cost estimates and with advice on making sure designs can be manufactured.

''Then the coordinators review completed drawings. The reviewed drawings, plus a list of suggested sources, are part of a technical package that goes to Lewis Sisneros's division [3724] in Purchasing.''

Bidders Ask Questions

During the bidding process, prospective suppliers may have technical questions. Later, after a contractor is selected, further questions may arise. In either case, Shop Overflow staff come up with the answers. That requires, in many instances, interaction with other Sandia groups, such as the requesting line organization and Mechanical Process Engineering Div. 7484.

''The shop should have the tools for the job,'' says Paul, ''but it may not have the experience to produce a certain part. Our coordinators are familiar with fabrication processes, so we can make suggestions — which are only suggestions, since the contract specifies the finished part, not a process the contractor must follow.

''In one case, for example, an owner of a small shop called one of our fabrication coordinators and said he was having trouble machining a hidden radius in a small satellite component. The coordinator suggested using a sinker EDM [electrical discharge machining] method to form the radius. The supplier then completed the work successfully.

''If it's a difficult job, we often try in-house fabrication first to prove the concept. Then we send the work out, knowing that it's feasible but also knowing that our advice may be needed.''

Course for Suppliers Is Tech Transfer

Because not every supplier is familiar with all the symbols and terminology used on Sandia drawings, Shop Overflow offers a course called ''Geometric Dimensioning and Tolerancing.'' The instructor is Jane Poppenger (7485-2). Because the course conveys technical information to private companies, it's considered a form of technology transfer.

''So far, 124 supplier personnel have completed the course,'' says Jane. ''That's during six offerings since it began in September 1987. We keep classes small so students can do in-class exercises and get

(Continued on Next Page)

Bonus Tolerancing

A 'Bonus' for Suppliers and Sandia

Jane Poppenger (7485-2), instructor of Sandia's ''Geometric Dimensioning and Tolerancing'' course for suppliers, was surprised recently to find that many students in one class had never heard of ''bonus tolerancing.'' Yet, if the designer specifies it and fabricators understand it, bonus tolerancing can help reduce work time and prevent unnecessary scrapping.

That helps keep costs down for suppliers and for Sandia.

An example: A part has a hole pattern into which another part must fit. If the designer specifies bonus tolerancing, the fabricator has the option of making the holes slightly oversize — but still within the size tolerance — and relaxing by a corresponding amount the tolerance for the holes' positions.

In other words, the bigger the holes, the less critical their positions. (Of course, the differences are matters of thousandths of an inch, not gross discrepancies.)

So, by taking advantage of bonus tolerancing, a shop can choose whether to work harder at controlling the size or the location of the holes.

SANDIA TECHNOLOGY TRANSFER

(Continued from Page One)

Yonas Returns

very pleased to see [President] Al Narath back at Sandia. And [DOE] Secretary Watkins has given strong endorsement to a number of very positive, forward-looking concepts that we can work on at the Labs.''

'A Wonderful Challenge'

''Among these is a strong commitment to technology transfer, including, by the way, the adaptation and development of technologies to environmental protection in the weapons complex. It's a wonderful challenge, and I'm delighted to have the opportunity to be one of the players who'll be helping to meet it.''

Gerry first came to Sandia in 1972. As Director of Pulsed Power Sciences (1200), he was responsible for development and applications of intense electron and ion beams, high-power microwaves, lasers, high-density plasmas, radiation sources, and energy-conversion devices.

In 1983, Gerry served as chairman of the Directed Energy Weapons Panel for the Defensive Technology Study Team (the ''Fletcher Panel''), which prepared the plan now being pursued by the SDIO. He joined the SDIO in 1984 while still a Sandia employee.

''We're in an era of economic warfare, and we must take on greater technological challenges to compete favorably . . .''

Gerry says his five years away from Sandia gave him insight into the challenges of building satisfactory relationships between private and governmental organizations, and hands-on experience in running a technically oriented, private-sector business.

''I look forward to working with Dan Arvizu [6010] and his Technology Transfer Department in developing effective ways in which we at Sandia can help make the US more competitive,'' says Gerry. ''We have to remember that technology is a great natural resource, at least as important as minerals to our national security. The world is more complicated than ever before. We're in an era of economic warfare, and we must take on greater technological challenges to compete favorably and advance our way of life.''

National Labs Need to Be User-Friendly

''My main job will be to help catalyze the flow of technical know-how into the private sector, and this includes AT&T,'' he says. ''Technology transfer doesn't mean transferring widgets. I attended a meeting recently in which [Senator] Pete Domenici said the national labs have to be user-friendly. That is an important statement. We have to learn new and better, user-friendly ways in which all of us can work with industry, as well as with other labs and universities.

''Sandia has no shelves of dusty inventions, just waiting to be wiped off and put into a box, ready for the market. What Sandia *does* have is people with a great variety of ideas and thoughts about new circuits, new materials, new processes, new systems, new ways of doing this and that.

''But the national labs aren't cornucopias for get-rich-quick schemes. For the most part, our ideas — even the most exciting — are very basic. It takes a huge amount of additional technological private-sector creativity, of market strategy, patience, and money — with a capital M — to take most of these ideas to the point where you can put a price tag on them and say 'OK world, here you are, come and get it.'

''Speaking as a recent entrepreneur, let me add a word of caution. Sandia has many customers, many clients. Its most important one is the American public as represented by Congress and the Executive Department. Our focus — our sponsor and the provider of the bulk of our funding — is the Department of Energy's Office of Military Application [OMA].''

GEROLD YONAS (6100): "We have to remember that technology is a great natural resource, at least as important as minerals to our national security. My main job will be to help catalyze the flow of technical know-how into the private sector, and this includes AT&T."

Main Job Remains the Same

''Sandia's main job, and it's a big one, is to serve the needs of that sponsor as steward of the nation's nuclear weapon ordnance program, including the responsibility for stockpile surveillance,'' says Gerry. ''Technology transfer opportunities will emerge from that work, from our activity in energy programs, and from the growing variety of DOE-sanctioned projects that we take on for other government agencies.

''We may even find some new private-sector takers for ideas that have come from OMA-sponsored pulsed-power technology. That field has occupied much of my professional career, and part of me has stayed with Pace [VanDevender, 1200] and Don Cook [1260] and all of that great crew through all the five years I was at the SDIO and Titan. I think Pace's group is a remarkable spawning-ground where high-power physicists and pragmatic engineers come together and solve problems that might be impossible anywhere else. That also happens to be the kind of interaction we need if we're to make technology transfer work.

''The thing about being Director of 1200 was that it offered many ways to win — through pulsed power, fusion research, beam weapons. If our approach reached a barrier, one could move to a new path. The reason was the richness of the technology.

''Technology transfer doesn't mean transferring widgets.''

''Sandia has such a rich technology base — it has many ways to win in a lot of different fields, and many ways to spin off onto other winning paths. That's the strength of a national lab, and particularly the strength of Sandia.''

Need to Change Industry Thinking

''The question is, how do we get industry into this way of thinking and away from the single path and the emphasis on short-term benefits, quarterly reports? The answer is bound up with ideas, culture, point of view, know-how . . . and the ability to get together in the same lab.''

While at SDIO, Gerry was presented the Secretary of Defense Medal for Outstanding Public Service. Other honors include receiving the Fusion Power Associates Leadership Award and being named a Fellow of the American Physical Society. He has served as a consultant to the White House, national laboratories, and several government agencies, and has published extensively in the field of intense particle beams, inertial confinement fusion, and strategic defense technologies.

Gerry received a bachelor's degree in engineering physics from Cornell University in 1962 and a PhD in engineering science from the California Institute of Technology in 1966. While at Caltech, he worked at the Jet Propulsion Laboratory; later he joined Physics International Company.

Gerry serves on the Editorial Board of the *Journal of Defense Research*, the National Academy of Sciences' Committee to Provide Interim Oversight of the DOE Nuclear Weapon Complex, the SDI Panel of the White House Science Council, the SDI Advisory Committee, and the Space Systems Technology Advisory Committee of the NASA Advisory Council. •NHey/3161

(Continued from Page Twelve)

Shop Overflow

individual attention. We give them a lot of actual Sandia drawings as examples to be interpreted.

''We currently have 85 people from 24 companies signed up for the next series of classes. Right now, over half the local shops have employees who've taken our course.''

It's a 12-hour course, usually taught in six sessions. Students also tour Sandia's main machine shop and mechanical-measurements area, where many see equipment that is discussed in class but not owned by their shop.

When Zero Isn't Zero

The students learn information that's valuable to their companies — information that helps them bid on and secure Sandia contracts. Says Jane, ''In the past, we've had no-bids on jobs because invited bidders didn't understand the drawings. For instance, one saw 'zero positional tolerance' and thought it meant 'no tolerance — you have to build a perfect part.' That's not what it means at all. That supplier now has people signed up for the course!''

Sandians who need parts for research or testing are the ones who ultimately benefit, says Paul. ''We're the fabrication people. We do the liaison. That's what we're paid for. By doing our job, we allow our requesters to do what *they're* being paid for.'' •CS

Supervisory Appointments

DALE SCHAEFER to manager of Organic and Electronic Materials Dept. 1810, effective Feb. 16.

Dale joined Sandia in November 1972 as a member of the Organic and Electronic Materials Division. His research has been in polymer physics, physics of disordered materials, ceramic and polymer materials science, structure of fluids, colloid physics, dielectric properties of fluids, porous materials, combustion aerosols, and inelastic neutron scattering. He was named supervisor of the Corrosion Division in February 1980. In 1982, he transferred to the Chemical Physics Division.

He has a BS in chemistry from Wheaton College (Ill.) and a PhD in physical chemistry from MIT. Before joining the Labs, Dale was an IBM research associate in Yorktown Heights, N.Y.

He's a Fellow of the American Physical Society and the American Institute of Chemists, and a member of the Materials Research Society, American Chemical Society, American Ceramic Society, and the American Association for Aerosol Research. In 1986, he received the DOE-Basic Energy Sciences Outstanding Sustained Research Award.

Dale enjoys farming and hunting. He and his wife Arlene (1500A) have two children. They live near Golden.

* * *

THELMA HARRELL to supervisor of Systems Research Operations Div. 9119, effective March 16.

Thelma joined Sandia in December 1965 as a division secretary. She was promoted to department secretary in 1966 in the Systems Research Department. She became an administrative coordinator in 1975, and was promoted to supervisor of the Administrative Support Section in 1983.

She studied accounting and law at Ben Franklin University and attended Strayer Business College (both in Washington, D.C.). Before joining the Labs,

THELMA HARRELL (9119)

Thelma worked for the FBI in Washington, El Paso, and Albuquerque.

In her spare time, she enjoys bowling, reading, oil painting, windsurfing, camping, landscaping, and attending Lobo basketball games. She and her husband Tom (ret.) have four children and five grandchildren. They live near Edgewood.

MICHAEL DeWITTE to manager of Facilities Construction Dept. 7850, effective Feb. 16.

Mike joined the Labs' Facilities Organization in January 1976 as a structural engineer. In 1978, he transferred to the Waste Management Geotechnical Projects Division, where he worked for two years on the WIPP project. He then worked as project leader for the Uranium Mill Tailings Remedial Action program.

He was named supervisor of the Buildings and Facilities Design Division in January 1982. Mike was Sandia engineering manager for the design and construction of the Microelectronics Development Lab (Bldg. 858), Technology Transfer Center (Bldg. 825), Education and Training Bldg. 856, Computer-Aided Engineering and Rocket Systems Development Lab (Bldg. 859), and several other buildings.

He has a BS in engineering from the US Air Force Academy, an MS in civil/structural engineering from the University of Illinois, and an MBA from UNM. Mike is a New Mexico registered professional engineer.

Off the job, he coaches soccer, plays softball, and enjoys music. He and his wife Barbara have three sons and live in the NE Heights.

TERRY STALKER to supervisor of Computer Architectures Div. 1415, effective Jan. 1.

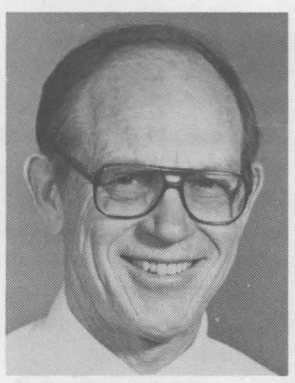
Terry joined Sandia's Optics Division in February 1974. His work has been in holographic data storage, optical signal processing, and coded aperture imaging. In 1977, he transferred to Systems Research Division IV; two years later, he joined the Radiation Physics and Diagnostics Division, where he worked on the Coded Aperture Imaging System — a real-time gamma-ray imaging system for in-core nuclear reactor safety experiments.

In 1985, he joined Exploratory Systems Division III, where he began a project that developed real-time optical processors for pattern recognition and SAR (synthetic aperture radar) image formation. He moved to the Embedded Computer Division in 1986 and continued to work on real-time optical image processing.

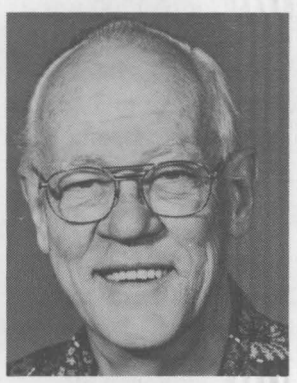
He has a BS, MS, and PhD, all in electrical engineering from Carnegie-Mellon University. He's a member of the Optical Society of America, IEEE, the Computer Society, and Society of Photo-Optical Instrumentation Engineers.

Terry's spare-time activities include bicycling, basketball, swimming, and abstract art. He and his wife Suzanne have one child.

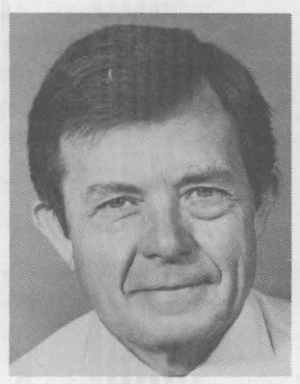
Retiring



Norris Rose (9120) 32



Ralph Dalby (7412) 32



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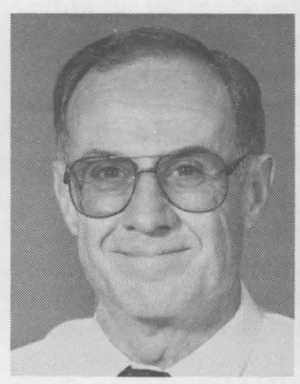
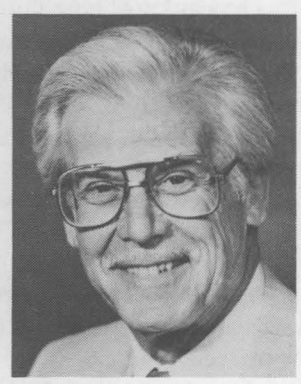
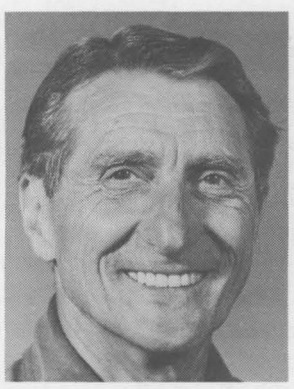


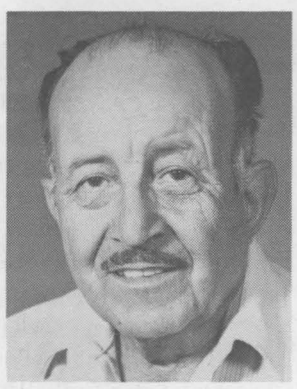
Fred Johnson (3321) 30



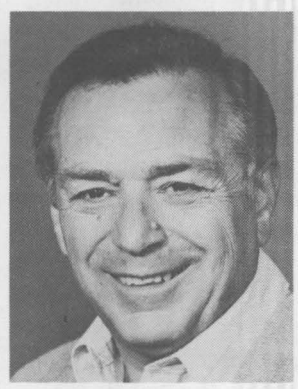
Don Rost (3216) 37



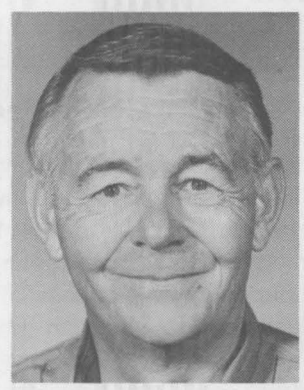
Carl Cianciabella (1275) 38



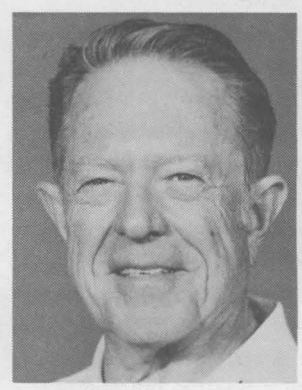
Adolfo Martinez (7523) 40



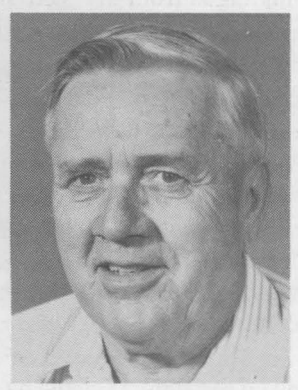
Bill Gamberale (7821) 37



Harold Linker (5214) 30



Jim Beaudet (5234) 36



Vernon Brewster (7137) 41

(Continued from Page One)

Record Ion Beam

and exceeded, the 5-TW-per-square-centimeter figure.

The Sandia team will announce these results at the IEEE Conference on Plasma Sciences, which starts Monday (May 22) in Buffalo, N.Y.

They'll report they have produced an ion beam of unprecedented intensity, exceeding an important milestone toward eventually achieving inertial confinement fusion in the laboratory.

"Seventeen years of research and technology development are finally paying off," says Pace VanDevender, Director of Pulsed Power Sciences 1200. "The achievement affirms our understanding of the relevant physics. We are very encouraged because that same understanding implies that the focusing will be adequate for attempting ignition when the rest of the PBFA subsystems are integrated."

"The high total energy and power density achieved on PBFA II is a significant step in making pulsed power a credible driver for ICF," says Venky Narayanamurti (VP 1000). "We are now within about an order of magnitude of what is believed to be necessary for ignition in the laboratory. My congratulations go out to all members of the PBFA II team for their extraordinary efforts in meeting the major milestone of 5 TW/square centimeter set by the Davidson Review Committee."

PBFA II experiments are carried out by a large team in Directorate 1200, including Tom Lockner, Dave J. Johnson (DMTS), Regan Stinnett, Bill Stygar, Tom Mehlhorn, John Maenchen, Mike Desjarlais, Ron Kensek, Ray Leeper, Rebecca Coats, Jeff Quintenz, and others in experimental, theoretical, and operations groups. The team was led by Tom Lockner, in charge of PBFA beam experiments, and Dave Johnson, in charge of proton focusing experiments.

"Seventeen years of research and technology development are finally paying off."

"Our success reflects the best marriage of experiment, operations, diagnostics, analysis, and theory that I have ever seen in a large program," says Regan Stinnett, 1264 supervisor.

He says there is much praise to be spread around. The achievement was made possible by considerable effort that helped produce a variety of improved capabilities.

Among them: the ability to get one shot a day on PBFA II at three-fourths machine energy (up from one-half earlier); the excellent overall performance of the accelerator; good agreement between experiment and theory; computational improvements; getting the right shape and height for the anode to improve the focus of the beam; and, finally, improvements in diagnostics that allow the group to accurately measure what they are getting and to test their ideas and theories.

Ion Beam Fusion Program — Three Objectives

Sandia's ion beam fusion research program has three objectives: The first is to develop improved ways of studying the physics of nuclear weapons in the lab. The second is to simulate the effects of nuclear radiation on microelectronics to better test their vulnerability. The third, a long-term goal, is to work toward developing inertial confinement fusion as a possible energy source for the 21st century.

The two short-term objectives, and perhaps the third as well, require very intense, short (about 20 billionths of a second) pulses of energy.

Sandia is DOE's lead lab for light ion fusion. Funding is from the Inertial Fusion Division in DOE's Office of Weapons Research, Development, and Testing.

LEADERS OF THE PROUD "BEAM TEAM" — Regan Stinnett (left), Dave Johnson (DMTS, center), and Tom Lockner (DMTS) — all 1264 — display the beam transport and diagnostic module that goes inside the central power feed and diode hardware (large unit below) in PBFA II. The team — including many others in Pulsed Power Sciences 1200 — recently produced an ion beam of unprecedented intensity, achieving an important milestone in the inertial confinement fusion program.

Accurately measuring the intensity of a beam that for a brief instant directs — onto a pea-sized target — more electrical power than is being generated throughout all the United States is a considerable technological challenge in itself.

Renews Optimism for Fusion Ignition

The result renews optimism at Sandia that further scaleup to intensities necessary to achieve eventual fusion ignition will be possible.

This is the most intense ion beam ever created, Ray Leeper (1234) emphasizes. The beam intensity is three-and-a-half times that produced on any other accelerator, with 35 times more energy delivered in ions.

Specifically, the intensity reached 5.4 TW per square centimeter equivalent power density and 73 thousand joules per square centimeter equivalent energy density on a 6-millimeter-diameter sphere.

"Our success reflects the best marriage of experiment, operations, diagnostics, analysis, and theory that I have ever seen in a large program."

The 6 millimeters — about the width of a large pea — is the size of a baseline target for future fusion ignition experiments.

"This result shows that there are no new gross instabilities in the virtual cathode or in the beam arising at the higher powers and longer pulse lengths we use on PBFA," says Dave Johnson.

The record beam intensity was achieved using protons as the charged particle. Additional increases in beam intensity, machine power, and beam quality are necessary, points out Don Cook, manager of Fusion Research Dept. 1260. But he says the milestone gives confidence for scaling experiments up to the higher intensities needed.

"If we can do as well on beam quality with a beam of lithium ions [instead of protons] and can go from 6 megavolts to 30 megavolts, then the eventual goal of achieving a beam intensity of 100 terawatts per square centimeter is within reach," says Don.

Lithium Boosts Beam Intensity

Although some theories indicate that power densities of 10 TW/square centimeter might ignite a fusion fuel pellet, the most common view is that 100 TW/square centimeter will be necessary. Don considers there to be "a reasonable chance of igniting a fusion fuel pellet" if the 100-TW level can be achieved with a 30-million-electron-volt lithium ion beam.

Lithium was selected for the ion to be used in fusion experiments for a variety of reasons, including its greater mass (seven times that of a proton), which minimizes its bending in magnetic fields and makes the beam easier to focus. This, in turn, should boost beam intensity.

The use of lithium ions also allows target experiments to be conducted at higher voltages, resulting in greater beam brightness. Focusability should increase rapidly with increased voltage.

Sandia scientists have found that developing a good source of lithium ions in PBFA II's ion diode — where the machine's pulse of electrical energy is converted into an ion beam — poses many challenging problems.

Don says three different types of lithium ion sources intended to solve this problem are nearly ready for testing.

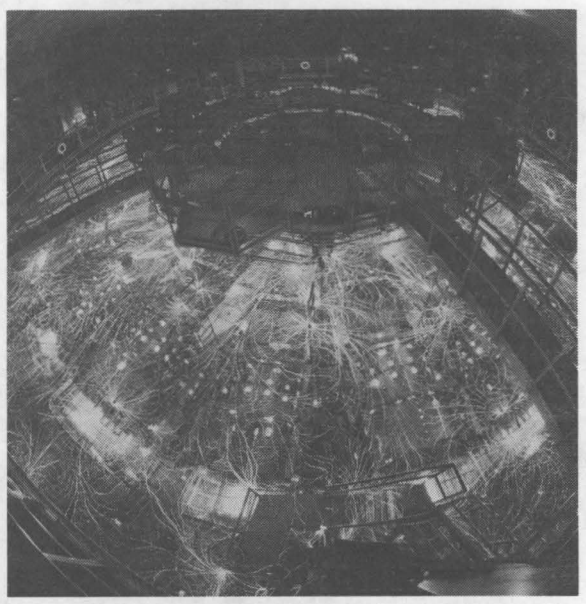
Sandians also plan to study the physics of how ions deposit energy in a target to produce x rays, an important intermediate step in producing an implosion and fusion reaction in a fuel-filled capsule.

"We now have a tool capable of beginning simple target experiments," says Don.

Two years from now, Sandia hopes to be achieving miniature implosions using the x rays produced by ion beam deposition in a target. Sometime after that, says Don, will come the first attempt at achieving ignition of a deuterium-tritium fuel pellet in an implosion.

Ignition is defined as the point when fusion reactions cause the fuel temperature to double the value obtained by the hydrodynamic compression alone. Ignition would be a major advance in demonstrating the feasibility of inertial confinement fusion.

●LP/KFrazier(3161)



ELECTRICAL DISCHARGES illuminate pulse-forming section of PBFA II during its second shot in early '86. The 100-trillion-watt machine, most powerful particle beam fusion accelerator in the world, is believed to be the first machine with the potential for igniting a controlled laboratory fusion reaction.

Medical Corner

Health$mart — Frequently Asked Questions

Health$mart, a package of new and changed benefits added to Sandia's Medical Care Plan (MCP), became effective April 1 (LAB NEWS, Feb. 24, 1989).

The Health$mart package includes CareCALL — a medical information service — and ReviewPLUS — a comprehensive review of medical treatment. Both are provided by Health Risk Management (HRM), an independent health-care review firm that administers the medical treatment review part of Health$mart.

There is no change in MCP claim administrators (Provident) or in the way claims are filed. But there is a change in what you're asked to do before entering the hospital, before having surgery, and before receiving psychiatric or chemical-dependency treatment.

Patients needing these services are asked to call HRM *before* non-emergency treatment and *after* emergency treatment.

Here are some of the most frequently asked questions concerning this very important telephone call:

What is HRM's telephone number?

The toll-free number is 1-800-221-1471. Call from 6 a.m. to 6 p.m., Monday through Friday (Mountain Time), to reach either ReviewPLUS or CareCALL. Under certain circumstances, you *must* call ReviewPLUS to receive full MCP benefits.

When should I call ReviewPLUS?

- Ten days before any scheduled non-emergency hospital admission, and before outpatient surgery (except surgery done in a doctor's office);
- As soon as a pregnancy is confirmed by a doctor;
- Before the fourth treatment session of an outpatient psychiatric or chemical-dependency treatment program;
- Within 48 hours, or two business days, following childbirth or emergency hospital admission.

Each time you, or a covered dependent, do not contact ReviewPLUS in these circumstances, a $300 penalty will be applied to any benefit payable from the MCP.

The $300 penalty will not apply to —

- Persons with primary medical coverage other than the Sandia MCP — retirees age 65 and over and their dependents covered by Medicare, for example, or working spouses with coverage from their own employers;
- Benefits from Sandia-provided health maintenance organizations (Kaiser and Foundation at Sandia Livermore);
- Participants receiving medical care outside the US.

Are there times when I don't have to contact ReviewPLUS?

Do *not* call ReviewPLUS for —

- Doctor's office visits, including surgery in a doctor's office, or for chiropractor or physical therapy office visits;
- Emergency room or urgent-care treatment that does not result in a hospital admission or surgery.

Who should make the inital call to ReviewPLUS?

The patient or a member of the patient's family should make the first call because HRM needs certain personal information — and provides information about the ReviewPLUS process. The initial call to HRM is handled by a ReviewPLUS clinical assistant who asks for specific information and then provides the information to a ReviewPLUS nurse, who contacts your doctor's office and reviews the medical details. HRM generally will not accept an initial call from a medical provider — but if you are unable to call, a family member, a friend, your doctor, or the hospital may call for you.

What are outpatient psychiatric and chemical-dependency treatment programs?

These programs consist of regularly scheduled treatment sessions, with a frequency of at least once a month. Once a condition is diagnosed and a treatment plan is developed, ReviewPLUS must be notified before the fourth outpatient session (fourth after April 1, 1989). If you are in a program with weekly, twice monthly, or even monthly visits, ReviewPLUS must be notified.

What are the new MCP provisions for psychiatric and chemical-dependency treatment?

For either psychiatric or chemical-dependency treatment, the MCP reimburses 90 percent of usual-and-customary charges for inpatient treatment and now reimburses 80 percent of usual-and-customary charges for outpatient treatment. There is an annual limit of $30,000 per person per year and $120,000 per lifetime for any combination of psychiatric or chemical-dependency treatment — both inpatient and outpatient. Inpatient confinements of more than 30 consecutive days must be separated by at least 180 days to qualify a patient for MCP benefits.

MCP will pay for chemical-dependency rehabilitation only when treatments are medically appropriate and are delivered in approved facilities.

What is CareCALL?

CareCALL is a medical information hotline. (Use HRM's toll-free number, 1-800-221-1471.) CareCALL puts you in touch with registered nurses who can answer questions about various medical services in your area, provide non-technical explanations of medical terms and procedures, and explain how to read a medical bill. CareCALL nurses can also describe treatment alternatives, help you communicate with your doctor, explain your rights as a patient, and discuss prescription drugs and their side effects. CareCALL is not a substitute for your doctor and will not provide medical care, diagnoses, or emergency and crisis services.

What should I do with the new MCP identification card in my Health$mart packet?

Each member of your family should carry a new MCP identification card. It should be filled out with the name and social security number of the MCP participant (the employee, retiree, or surviving spouse).

Call Benefits at (505) 844-3545 if you have not received your Health$mart packet or if you need additional new MCP identification cards. If you didn't attend one of the 30 Health$mart information meetings and want to view a videotape of the presentation, you can check one out from Dept. 3540 secretaries.

You Can Reserve A Copy

Sandia History to Be Published

Sandia National Laboratories: The Post-War Decade, a scholarly history of Sandia written by corporate historian Necah Furman (3141-2), will be published later this year by the University of New Mexico Press.

The 900-page work traces Sandia's history from its genesis in 1945 as an outgrowth of what is now Los Alamos National Lab to the mid-'50s, when Sandia had grown into a full-fledged, independent laboratory of nearly 6000 people. The volume will include many photos.

The Technical Library needs to give UNM Press an accurate estimate of the number of copies needed. If you expect to purchase a copy, either for business or personal use, send a note to Nancy Pruett (3141-2) *before* May 31.

The price of the volume is not firm yet, according to Nancy, but should be about $45 retail and $25 for Sandians and retired Sandians.

A copy of the volume will be provided for organizational use to Departments and above. No response is needed for these copies.

CORPORATE HISTORIAN Necah Furman (right), author of *Sandia National Laboratories: The Post-War Decade*, and research assistant Tonimarie Stronach (both 3141-2) display the manuscript of the 900-page scholarly history to be published by UNM Press later this year. Behind them is a 1946 photo of Sandia Base taken about a year after Sandia's forerunner, a branch of Los Alamos National Lab known as "Z Division," had moved into an assortment of prewar structures on the outskirts of Albuquerque.

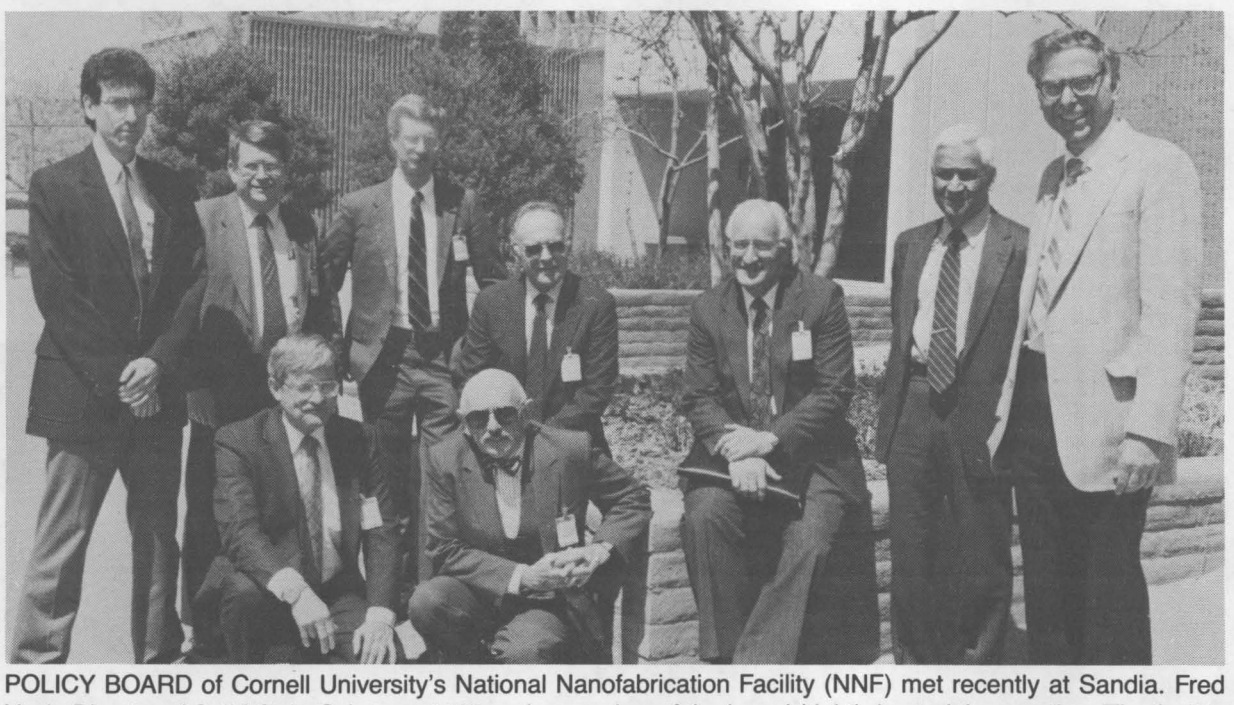
Yogi Thinks It's Berra, Berra Nice

Twenty-four years after he hung up his catcher's mask, former New York Yankees star Yogi Berra is appearing in three commercials — for Miller Lite beer, Kinney shoes, and a car dealer in Washington, D.C. Why Yogi? For one thing, Mr. Berra (who will pocket more than $250,000 for the three ads) is considered a bargain; other sports personalities command $750,000 or more for a single ad campaign.

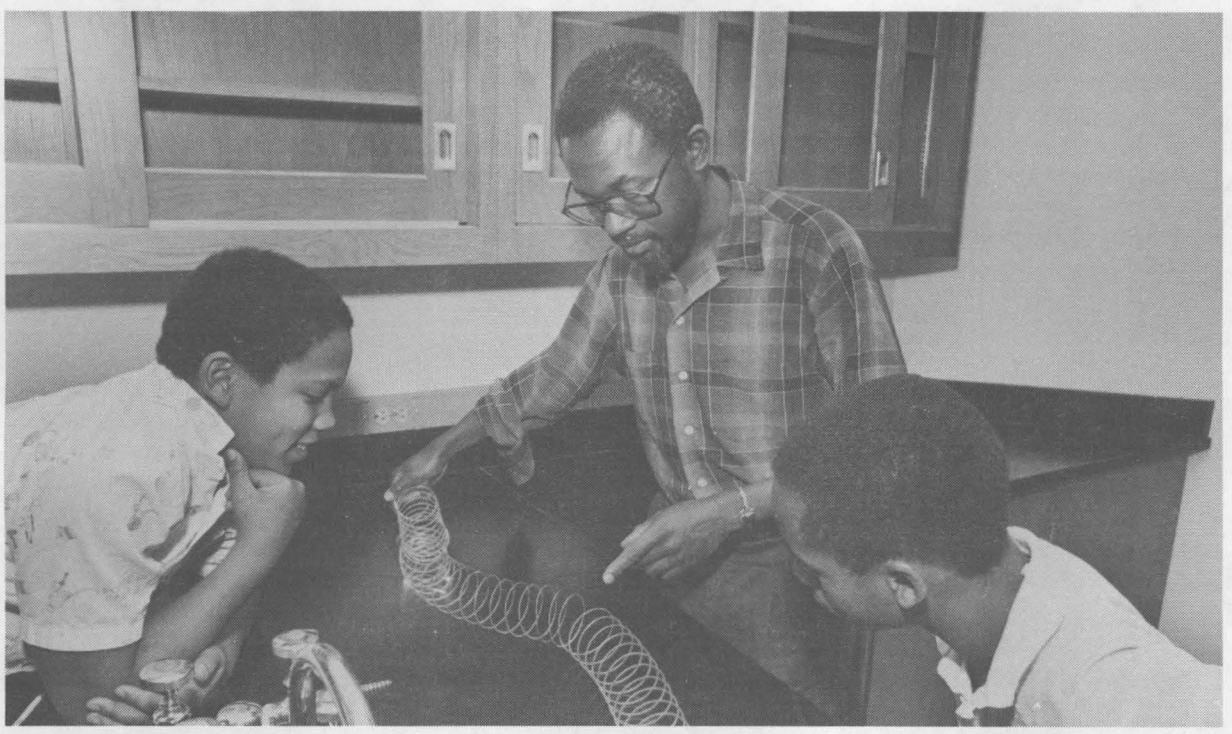
. . . Advertisers also like his, well, unique command of the English language. In the Miller Lite spot, for example, he delivers one of his trademark Yogi-isms: "It's less filling than it would have been if it was more filling than they didn't want it to be."

Ronald Alsop, *Wall Street Journal*

GREAT SHOOTIN' IN THE BADLANDS — Sandia's eight-man pistol team brought back this tableful of trophies from the Badlands Shootout pistol match last month in Oklahoma City. Captain David Stout (second from right) presents the Badlands traveling trophy to Bob Kelly (3430); that trophy — for first-place by a two-man team — was won by Gary Malin (left) and Tommy Serna (right). Other team members, all winners of at least one trophy, are Maurice Sandoval, Shane Murray, Ernest Torrez, Lawrence Armijo, Jeff Johnson, and Stout. Captain Harold Garcia is team coach. All are members of Patrol Divisions 3434 or 3435.



POLICY BOARD of Cornell University's National Nanofabrication Facility (NNF) met recently at Sandia. Fred Vook, Director of Solid State Sciences 1100 and a member of the board (right), hosted the meeting. The facility specializes in building super-small devices for electronics, biology, and physics — devices measuring about 25 nanometers (2000 times smaller than a human hair) — "about the size of many viruses," says Fred. The facility is the only one of its kind in the US available to visiting scientists. Several Sandians — Paul Peercy (1140), Jim Arzigian (7413), Alan Hurd (1152), Steve Casalnuovo (2532) — have conducted projects using the facility. The Board discussed future interactions with Sandia in optoelectronics and learned about Sandia's research on optoelectronics and compound semiconductors. Back row, from left: Harold Craighead, Cornell; William Howard, Jr., Motorola; Greg Galvin, Cornell; Gordon Moore, Intel; Edward Wolf, Cornell; Kumar Patel, AT&T Bell Labs; and Fred. Kneeling: Joseph Ballantyne, Cornell; and Norman Einspruch, Univ. of Miami.



BILL BROWN (1533) USES A SLINKY to demonstrate the physics of wave motion to middle-school students Herman Norwood (left) and Shabaka McKey (son of Paul, 7485), participants in "Hands On/Minds On Technology." The six-week educational program is sponsored by Sandia's Black Outreach Committee for black students in grades 5 through 12 and is offered each spring. Other Sandians who taught classes in computers and basic electronics and physics at the APS Career Enrichment Center at Albuquerque High School include Roberta Ingram (2851), Larry Stevenson (5147), Lacey Learson (3428), Basil Steele (5249), Ken Washington (6429), Ivory Alexander (2648), Mark Schafer (7253), and Joseph Perry (1815). Other volunteer instructors were from LANL and KAFB. The Black Outreach Committee is sponsored by Equal Employment Opportunity and Affirmative Action Dept. 3510. Patricia Salisbury is the "Hands On/Minds On Technology" program coordinator.

Take Note

Ann Riley (3714) was recently elected president of All Faiths Receiving Home Volunteers. All Faiths (a United Way agency), a temporary crisis shelter for abused and abandoned children, provides counseling and teaches parenting skills as part of its Family Services program. Volunteers are always needed. For information, call 345-8938.

Sandia Colloquia

Richard Lester (Commission on Industrial Productivity, MIT) will talk about "Made in America: Regaining the Productive Edge" at the Technology Transfer Center (Bldg. 825) May 26, 9 a.m. Call host Bill Snyder (6500) on 4-8203 for information.

John Ahearne of Resources for the Future (Washington, D.C.) will talk about "Addressing Public and Personal Concerns about Science" at the Technology Transfer Center June 2, 9 a.m. Call host Dave McCloskey (6400) on 6-0834 for information.

Anyone interested in the design, development, and use of prototype electric vehicles is invited to the monthly meeting of the New Mexico Electric Vehicle Users Group May 20, 9:30 a.m., at the Manzano High School automotive shop (12200 Lomas NE). Call Mike Lechner on 296-8523 for information.

Retirement Planning

Dean Witter Reynolds, Inc., presents "Planning for Your Retirement" June 7, 5 p.m., at the Coronado Club, Coronado Rm. Features of an IRA rollover — as it relates to the Tax Reform Act of 1986 — will be compared. Call Michael DeVincentis on 883-0123 for information.

Sandians are invited to hear Walter Maybee (DOE) speak on the Chernobyl nuclear reactor accident at the monthly meeting of the Society of Fire Protection Engineers, Rio Grande Chapter, May 25 at the Radisson Inn (1901 University SE). The meeting includes a social period at 6 p.m., dinner at 6:30 ($13), and the program at 7:30. Advance registration is necessary. RSVP to Vern Duke (7816) on 4-1958 by May 23.

* * *

Tickets are on sale for the 3rd Annual Chairman's Benefit Ball & Art Auction (sponsored by the All Indian Pueblo Council) June 23-24 at the Albuquerque Clarion Four Seasons Hotel. Artwork by Helen Hardin, Amado Pena, Michael Naranjo, John Nieto, Lincoln Fox, Armand Lara, Juane-Quick-to-See Smith, Danny Valdez, Juan Tafoya, Elizabeth Tafoya, and others will be featured. An art preview and artists' reception will be held Friday from 6 to 8 p.m. Saturday events include an art auction at 5 p.m., dinner at 8, and a dance from 9 p.m. to 1 a.m. Tickets are $50; proceeds benefit disabled pueblo people. For information and tickets, call Randal Ray on 881-1992.

* * *

Sue Stone (5131) has been named "Catholic Daughter of the Year" by the Albuquerque chapter of the Daughters. She has been an organist for more than 50 years and was honored for her volunteerism.

* * *

Retiring and not shown in LAB NEWS photos: Herman Levine (1821), Robert Seavey (5231), Robert Bass (7111), Allen Dale (2834), Virginia Hill (3152), and Pablo Maes (2174).

Matrimonial Maladroit

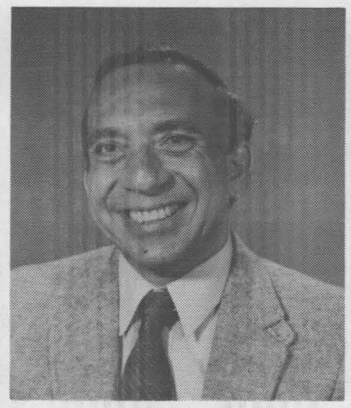
Twice married, first to a fellow student at Zurich, later to a devoted and motherly cousin, he [Einstein] was no model husband and father, even in his own eyes. When his friend Besso died, old Einstein wrote: "What I most admired in him as a human being is the fact that he managed to live for many years not only in peace but also in lasting harmony with a woman — an undertaking in which I twice failed rather disgracefully."

Scientic American

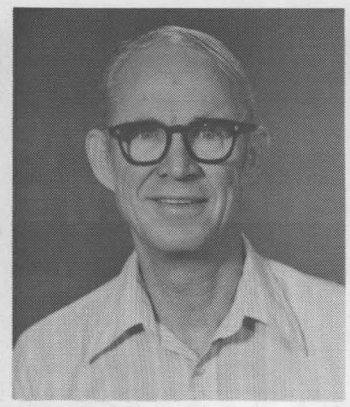
MILEPOSTS

LAB NEWS

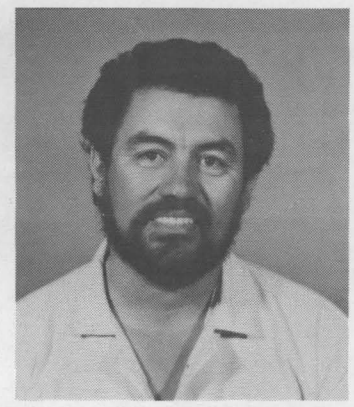
MAY 1989



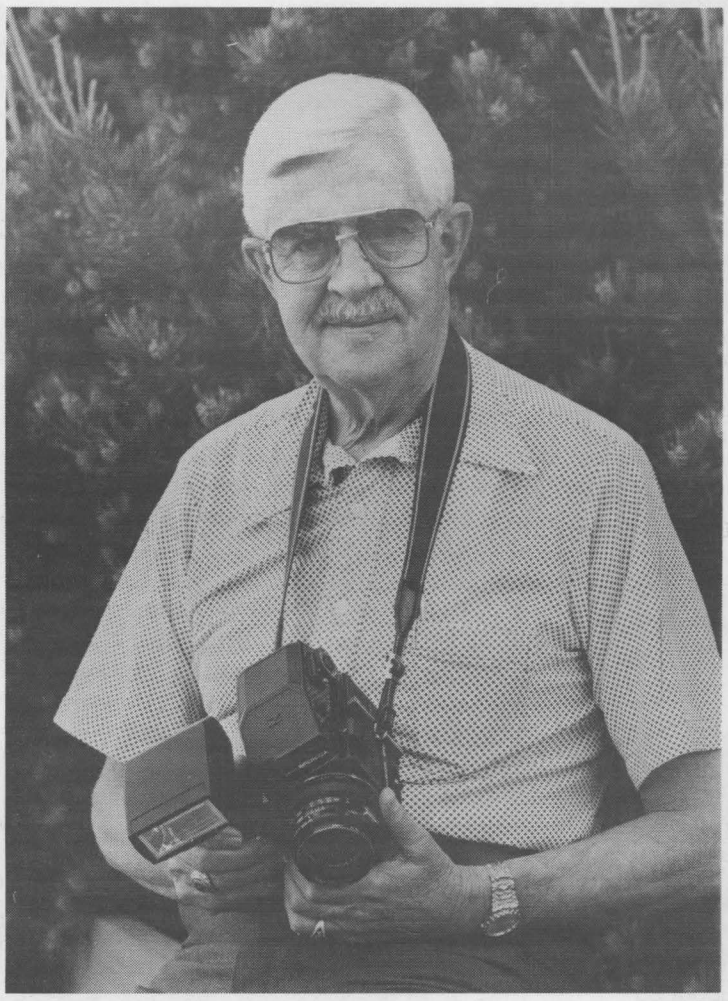
Juan Ramirez (1245) 15



James Leeman (2361) 25

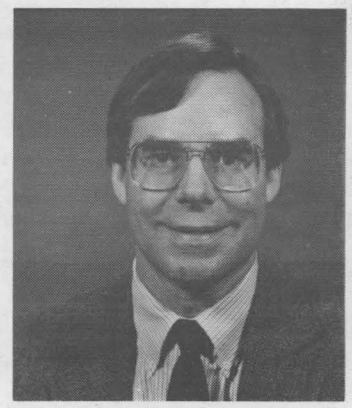


Chester Chavez (3414) 15

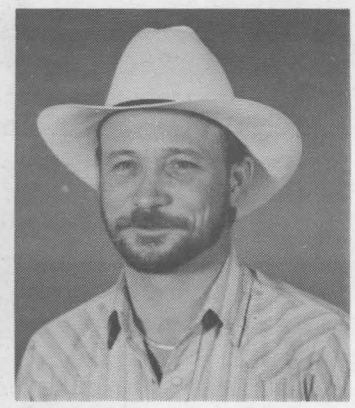


Oscar Goodwin (3154) 35

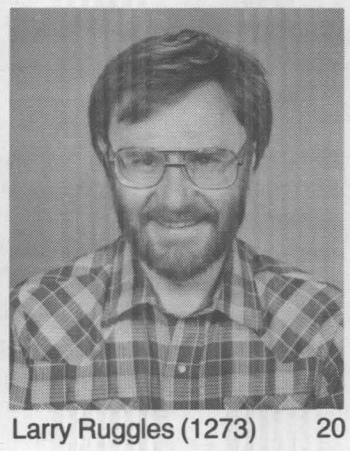
Bob Sheldahl (1553) 20



Kevin Murphy (2100) 15

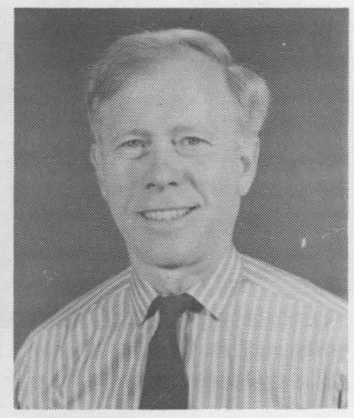


Bruce Whittet (2643) 15

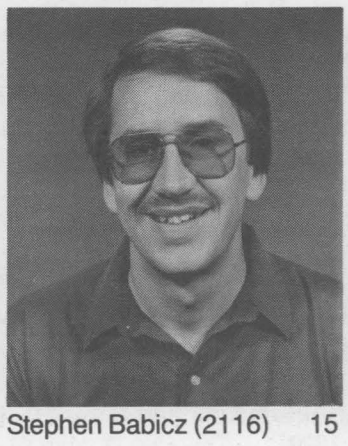


Larry Ruggles (1273) 20

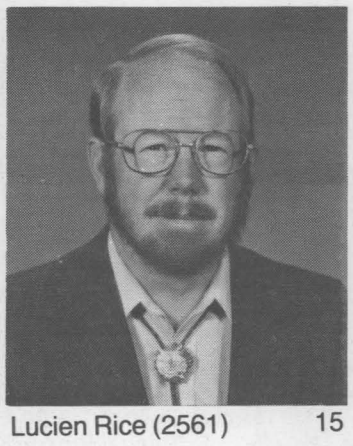
Fran Roelle (7200) 25



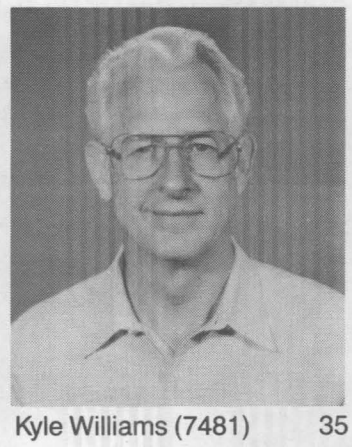
Robert Blewer
(DMTS, 2147) 20



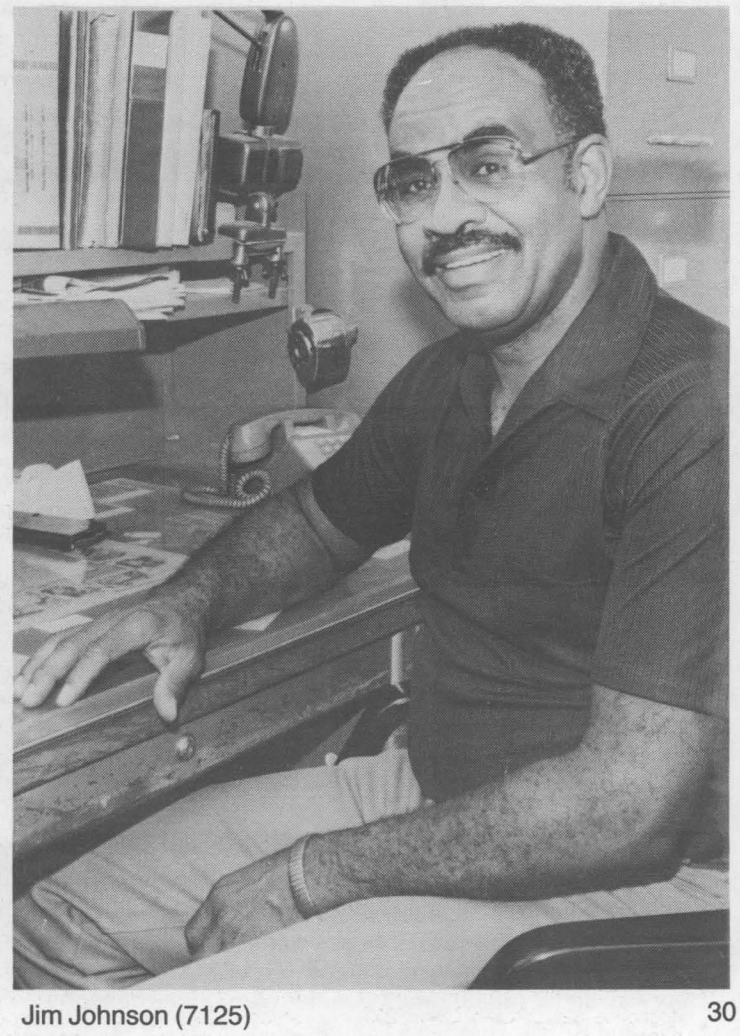
Stephen Babicz (2116) 15



Lucien Rice (2561) 15

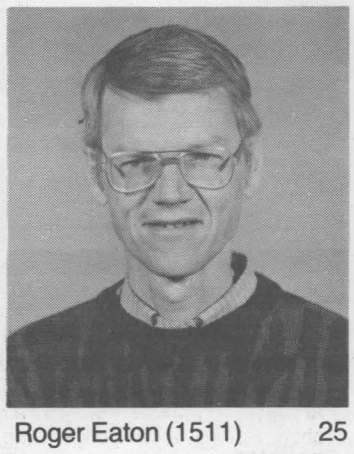


Kyle Williams (7481) 35

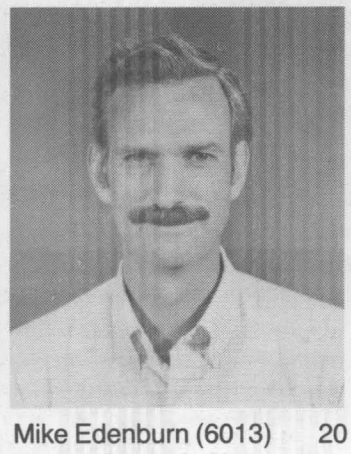


Jim Johnson (7125) 30

Roy Ellison (2361) 25



Roger Eaton (1511) 25



Mike Edenburn (6013) 20

Favorite Old Photo

A GRAVE BUSINESS — Taken in about 1870, this photo shows my great-grandfather and other relatives working at the family stonecutting business in Marietta, Ohio. At the time, they were producing grave headstones, the "cornerstone" of their business. My great-grandfather (on my mother's side), John Meisenhelder (right) was born in Germany and immigrated to the US in 1847. The others are his son (my great-uncle), Charles Meisenhelder (middle), and Fred Wommer, a relative by marriage.

—Bill Shepherd (ret.)

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

STRUCTURAL PIPE, delivered: 2", 75¢ to $1.25 per foot; 3", 85¢ to $1.25 per foot. Eavenson, 260-1805.

DISK DRIVE, half height, 360K, TEAC, 5-1/4", beige front, $50. Cancilla, 293-1620.

SELMER SIGNET CLARINET, new pads, cleaned, adjusted, w/case, $300. Leisher, 281-5258.

SHOWER-STALL DOORS, 6' wide, $35. Nowicki, 294-6572 after 5.

CAR VACUUM, Black & Decker, plugs into cigarette lighter, w/all attachments, never used, $15. Barr, 821-5870.

KLIPSCH LASCALA SUB-WOOFERS, w/18" Gauss, $400/pr.; phase linear 700 series power amp, w/new power transistors, $400. Klarer, 344-0612.

KENMORE REFRIGERATOR, new, 17.7 cu. ft., w/ice maker, white textured. Chavez, 298-1649.

AMIGO THREE-WHEEL CART for handicapped, $2500. Nichols, 296-8259.

TRAILER HITCH, w/1-7/8" ball, was on '82 Chev., $25; Sears Craftsman hedge clipper, $20. Brion, 298-1761.

AUTO AND TRUCK PARTS, call for complete list, will mail it to you; lead cakes, 122 1-lb. cakes, $42/all. Chavez, 842-6374.

CRIB AND MATTRESS, $120; Gerry carrier, $15; Nuline security gate, $10; Chinon 132PXL 8mm movie camera, $40. Jojola, 292-7962.

MULBERRY TREES, fruitless, saplings, you dig, you take, $15/ea., $60/five. Baldwin, 822-1860.

OSTER FOOD CENTER, $75; Oneida stainless flatware, $40; 8-piece aluminum cookware set, $30; 6' Danish sofa, $250; crib mattress, $20. Loehman, 265-3179.

'70 SHOP MANUAL, Ford, Mercury, Lincoln, etc., 5-volume set, plus wiring diagrams, $15. Wyant, 298-0371.

MINI TRAMPOLINE, $5; medium-size doghouse, $25 OBO/ea. Owen, 299-3487.

CARPET (sculptured plush): 51 yds. rust; 86 yds. gold, $1/yd. firm or $125/all. Freshour, 256-9168 after 6.

POP-UP TENT CAMPER, '84 Coleman, w/awning, $1500 firm. Whitehead, 292-1604 after 5.

NYLON CARPET, 80 yds., rust/red, w/foam padding, $3/yd.; adjustable wood-grain metal shelves, 16" x 72" x 48" high, $20. Anderson, 294-8451.

MATCHING SOFA, RECLINER, & ROCKER, 1 yr. old, $600. Wilson, 299-3046.

PIONEER REEL-TO-REEL TAPE DECK, RT-707, $195. Bauer, 299-0640.

FURNITURE: 2 twin-size headboard/footboard bed sets, Colonial maple, $85; dining set, contemporary, chrome, upholstered, new, $200. Sons, 294-3953.

WINDOW AIR CONDITIONER, 5000-Btu, $25; remote control car, $30; walkie-talkies, $30/pr.; macrame supplies, $10. Parson, 291-8394.

WINCHESTER SHOTGUN, model 50A 12-gage, $250 or trade for M-1 carbine. Zamora, 836-6101.

VAN ACCESSORIES: cushions; 2 storage bolsters; table and post, $150 OBO; bench seat, 56" wide, converts to bed, $175 OBO. Witek, 296-5198.

FILL DIRT, 1732 Martha NE, free, you haul. Morris, 292-5112.

SOFA, red w/antique gold, $195. Heatherly, 294-4378.

YARD SALE: children's items (toys, clothing to size 8), housewares, knickknacks, more, May 20-21, 9 a.m.-3 p.m., 2900 Vista Del Rey NE (East of Tramway/Candelaria). Finley, 275-8118.

EXERCYCLE, Huffy Windrift, electronic sequencing mph, time, & miles, $80; utility cabinet, $40; 2-tube fluorescent fixtures, $8/ea. Myers, 294-7316.

WATER LILIES, red or white flowers, $9/ea. Halbgewachs, 268-1584.

COLOR TV, 19" Quasar w/stand, mechanical tuning, $50. Van Deusen, 291-8196.

ESTATE SALE: antique and new furniture, pots and pans, dishes, knickknacks, paintings, records, more. Burstein, 821-6688 for appointment.

UTILITY TRAILER, spare tires, new paint, $390 OBO; Jason telescope, 60mm refractor, extra lenses, tripod included, $75 OBO. Tapp, 821-3843 after 5:30 or weekend.

TABLE, Formica w/iron legs, $10; Smith-Corona antique typewriter, $10. Noel, 884-4491.

POP-UP CAMPING TRAILER, '76 Apache Ramada, hard-side, sleeps 8, forced-air furnace, 3-way refrigerator, new cranking gear & chain, $2000. McCutcheon, 298-7740.

ZENITH COLOR TV, 23", wood console; Early American couch; rust lounge chair w/ottoman; insulated drapes; Anderson office desk, wood. Kellogg, 299-3737.

FOUR INFANT AND YOUTH CAR SEATS, GM and Cosco/Peterson, $20/ea. Bauer, 266-8480.

AKC-REGISTERED BORDER TERRIER PUP, 8 months old, male, $90; student desk (grade/mid-school), 4-drawer, $30. Lawson, 821-0360.

A-FRAME SWING SET, 2 swings, 2-child glider, space for more, $15. Shirley, 821-0480.

GOLF CLUBS: 3-PW Ryder Cup II irons, $150; 3-PW '86 PGA Cameron, reg. D2, $200; metal woods, Lee's Rawling's No. 1 & No. 2, $50/ea. Stang, 256-7793.

Early Deadline

Because of the Memorial Day holiday, the deadline for ads and other LAB NEWS submissions is noon May 25.

TRANSPORTATION

'81 BMW 528i, leather, sunroof, alloy wheels, 5-spd., 75K miles, below book, $7300. Babb, 296-7955.

'83 CHEV. MONTE CARLO, all power options, w/glass T-tops, V-8, 80K miles, $4500. Gentry, 298-3574.

'87 KAWASAKI ZL1000, dealer-maintained, 5K miles, $3000. Strait, 842-1695.

'72 DODGE, one owner, $550 OBO. Robb, 821-2999.

'73 CADILLAC, 4-dr., $800; '75 Mercury Monarch, 4-dr., $1000; '71 Toyota Celica, custom wheels, $400 OBO. Appel, 292-0463.

'87 KAWASAKI 750 GPX, 15K miles, accessories, $3800 OBO. Yip, 294-8124 after 5 or weekend.

'75 FORD F100 PICKUP, body needs work, $600. Costales, 268-8955.

'81 CHEV. IMPALA, 4-dr., AT, V-8, PS, PB, AC, 72K miles, $875. Sanchez, 292-1982.

VW BUG, custom upholstery, trailer hitch. Rose, 268-1431.

'84 GMC 1/2-TON SIERRA CLASSIC PICKUP, V-8, AT, silver/red, loaded, custom wheels, 53K miles, $6995 OBO. Eldredge, 298-3520.

ALL-TERRAIN BIKE, 18" Mongoose, 300 miles, upgrades, never raced, $600 invested, sell for $450 OBO. De LaPlain, 281-3318.

'84 NISSAN 300ZX TURBO, 5-spd., AM/FM tape, AC, PS, PB, T-top, cruise, bra, louver, 31K miles, $9750 firm. Kubiak, 265-6525.

BICYCLES: Fuji 10-spd. racing bicycle, 23" frame, $225; Univega 10-spd., 19" frame, 24" wheels, $60; child's Schwinn dirt bike, $75. Loehman, 265-3179.

BICYCLE, 3-spd., English-made, w/basket. Brion, 298-1761.

MAN'S BICYCLE, $50. Owen, 299-3487.

'86 MALLARD SPRINTER MMH, 22', generator, roof and dash AC, sleeps 6, $21,500. Schuler, 298-5827.

SUMMIT FREESTYLE DIRT BICYCLE, rotor, $85; Gitane bicycle, $45. Dupree, 294-1835.

'81 SUZUKI GS650G, Windjammer, crash bars, shaft drive, backrest, 10K miles, cruise, $1000 OBO. Clingan, 275-0849.

IRONMAN DIRT BICYCLE, silver, w/pads, $50. Snyder, 296-5771.

'82 ALFA ROMEO GTV6 COUPE, 41K miles, 5-spd., V-6, AC, sunroof, PW, AM/FM stereo, sheepskins, $4500. Jones, 255-4539.

'82 HONDA ACCORD, 4-dr., 5-spd., 76K miles, $3550. Hendrick, 296-2163.

'83 HONDA 650 NIGHTHAWK, Aero XP fairing, 4-cyl., shaft drive, AM/FM cassette, $1250. Bauer, 299-0640.

'57 CHEV. PICKUP, best offer. Turner, 294-9674.

'77 JAMBOREE MMH, 21', Dodge 440 engine, options, $7900. O'Neal, 298-2859.

BICYCLES: man's 27" 10-spd., $25; man's 26" 12-spd., Huffy, $50; woman's 26" touring bike, 10-spd., Huffy, ridden twice, $90. Parson, 291-8394.

'82 FIREBIRD, white, new tires, accessories, $3000 OBO. Doyeto, 291-9691.

'74 CORVETTE, T-top, 350-CID, AT, uses regular gas, no emission check required, metallic green, $6500 OBO. Britton, 294-9710.

'86 HONDA PRELUDE, loaded, $9600, would consider trade for Toyota 4x4 pickup. Nichols, 275-1241.

'72 CHEVELLE SW, AT, PB, PS, AC, needs paint, $400 w/o AM/FM cassette. Kinsey, 294-2690.

'76 TOYOTA CELICA, new tires, $1000. Martinez, 821-6096 after 5.

'84 BUICK CENTURY, 37K miles, 4-dr., PS, PB, AC, AM/FM cassette, new tires, one owner, $5180. Ernest, 293-1757.

'73 WINNEBAGO INDIAN, 24', sleeps 7, 57K miles, power station, AC, $8200. Bauer, 266-8480.

'82 HONDA GOLDWING, w/matching trailer & helmets, AM/FM cassette, CB, intercom, custom seat, armrests, extras. Baker, 888-0410.

TWO 10-SPD. BICYCLES, Sears Free Spirit, Huffy Catalina, both 27" wheels, rear racks, $40/ea. Stang, 256-7793.

'73 WINNEBAGO, 20', 1-ton, sleeps 6, dual AC, generator, radio, dual battery, stove, refrigerator, shower, regular gas, $10,500. Salazar, 262-0344 or 255-3152.

'88 KTM 250 DIRT BIKE, $1900. Smith, 299-1959.

'79 HONDA ENDURO MOTORCYCLE, street-legal, knobby tires, 185cc, $275. Marchi, 291-9681.

'77 MIDAS MMH, 23-1/2', sleeps 6, generator, dual AC, TV antenna, 70K miles, $9650 OBO. Soto, 1-864-1452.

BICYCLES: boy's 20", $25; boy's 26" Schwinn, $50; girl's 20", $55. Vigil, 296-5335.

RALEIGH 10-SPD. BIKE, dual-pull calipers, Shimano derailleur, $60. Chambers, 898-6419.

REAL ESTATE

3-BDR. HOME, NE, 1-3/4 baths, 2-car garage, den w/FP, dishwasher, double oven, refrigerator, 1460 sq. ft., no qualifying, 9.5%, $77,800, $640 PITI. Babb, 296-7955.

2-BDR. MOBILE HOME, 1-1/2 baths, washer, dryer, dishwasher, carport, privacy screen, Four Hills park. Palmer, 294-7656.

3-BDR. PALM HARBOR CUSTOM MOBILE HOME, 2 baths, 28" x 70', at Vineyard park, refrigerated air, shop, storage, 2-car garage. Illing, 344-0453.

PATIO HOME LOT, Heritage East, just north of Tanoan. Jojola, 292-7962.

5-20 ACRES, Sedillo Hills, off I-40, bank/owner REC financing, $10,000/acre. Troncoso, 897-1167.

5 ACRES MOUNTAIN PROPERTY, 21 miles from Sandia off North 14, electricity, solar exposure, view, negotiable terms. Penn, 883-4195.

TOWN-N-COUNTRY MOBILE HOME, located in east mountains, stove, refrigerator, washer, dryer, air conditioner, skirting, $7600. Gallegos, 281-5515.

3-BDR. HOME, 2 full baths, jet tub in master bath, great room, formal DR, skylights, Sandia Heights, 1-1/2 yrs. old. Christensen, 294-6866.

3-BDR. CUSTOM HOME, study & den w/FP, 2-1/2 baths, double garage w/shop area, 2784 sq. ft., Academy Estates. Randall, 821-0388.

2-BDR. MOBILE HOME, 3 add-ons, 10' x 63', 1 bath, appliances, 2 sheds, $14,500 OBO. Duran, 275-0539 or 892-3418.

3-BDR. MOSSMAN HOME, 1860 sq. ft., 1-3/4 baths, 2-car garage, 7828 Hermanson Pl. NE, $107,000. Delnick, 298-5276.

4-BDR. HOME, 3 baths, 3-car garage, 3 FPs, 2250 sq. ft., master suite, landscaped, 12924 Eastridge Dr. NE. Lusader, 298-3469.

FOOTHILLS LOT, view, next to NW corner house at Piedra Larga Pl. and La Cueva NE. Stixrud, 298-0478.

WANTED

AUTO-TOWING DOLLY. Horton, 883-7504.

GAS RANGE, 36", white, propane or natural gas, good condition. Doggett, 293-6210.

USED TVs, working or not. Montoya, 883-9115.

STAINED GLASS, tools, equipment, and grinder for making stained-glass items. Vigil-Lopez, 242-7001.

HANDYMAN, for residential plumbing, carpentry, and electrical work, retirees encouraged to call. Davis, 281-1248.

BACKPACKERS for moderate Sierra Club trip (#89109) to John Muir Wilderness of Sierra Nevada, July 21-29. Bolden, 1-209-951-3114.

SMALL PUSH-TYPE REEL MOWER; sprayer, electric vibrator type. Underhill, 294-5774.

BOAT, rowing shell, w/oars. Holmes, 292-0898.

FISHER-PRICE TRAVEL TENDER (portable playpen/crib) and Gerry backpack w/hip strap. Reno, 296-6290.

QUEEN-SIZE SOFA SLEEPER, earth tone, good condition. Liguori, 256-3613.

OLD J.C. PENNEY'S CATALOG, large, 2 or more years old. Kellogg, 299-3737.

SHARE-A-RIDE

VANPOOL RIDERS WANTED, along N14 and Frost Rd., $34/mo., ride every day. Rentzsch (281-5017) or Burns (281-3922).

It's Wheel of Fortune (C-Club Style) This Evening at Casino Night

BLACKJACK BUFFS, ROULETTE REVELERS: Tonight's your night to shine. Casino Night, starting at 6:30 p.m., promises nonstop fun with all kinds of games of chance — slot machines, blackjack, craps, roulette. For just $5/person, you receive $1500 in chips to help you become a big-time winner. Reasonably priced food and beverages are available throughout the evening. If your gambler's luck holds, you may find yourself carrying off one of the prizes to be raffled off at the end of the evening — including the grandest of them all: a trip for two to Glitz Gulch (Las Vegas).

THE RETIREE PICNIC next Thursday (May 25) means the Club is closed to the rest of us (includes lunch service), so the kitchen crew can get ready for the invasion of hundreds of former Sandians. Take heart, gang — someday we too may be invited to live it up at the annual bash.

PRIME RIB OR FRIED SHRIMP are your elegant entree selections next Friday night (May 26) at the two-for-one special dinner (two dinners, $17.95). Afterward, kick up your heels from 8 p.m. to midnight, as the Isleta Poor Boys provide their own special brand of sagebrush-shuffle tunes. Here's a great way to start the holiday weekend. Chow-line reservations requested (265-6791).

A MEMORABLE MEMORIAL DAY is in store for all celebrants on Monday, May 29, in the pool/patio area from 11:30 a.m. to 6 p.m. The pools open officially that day, so the party should go swimmingly. It's free admission for all C-Club members and $3/person for guests.

IT'S BACK TO THE TABLES for the T-Bird card sharks on Thursday, June 1, starting at 10 a.m. It's the first of three gaming sessions in June for this intrepid group (the other dates: June 15 and 29). Come on out for good conversation, free refreshments and door prizes, and all kinds of card games.

Events Calendar

May 19-21 — "The Seven-Year Itch"; 8 p.m. Wed.-Fri., 6 & 9 p.m. Sat., 2 p.m. Sun.; Albuquerque Little Theatre, 242-4750.

May 19-27 — "Four-Wheel Drive," new play by Joe Forrest Sackett about male identity and sexuality in the '80s; 8 p.m. Fri. & Sat., Centerstage (3211 Central NE), 260-0331.

May 19-July 16 — Exhibit, "Carthage: A Mosaic of Ancient Tunisia," organized and sponsored by the American Museum of Natural History (New York City), featuring mosaics, sculpture, and recently discovered artifacts; 9 a.m.-5 p.m. Tues.-Sun., special museum hours (exhibit lecture May 21, 2 p.m., by David Soren, University of Arizona); Albuquerque Museum, 242-4600.

May 20-21 — Iris Guild Show and Sale; 1-5 p.m. Sat., 12 noon-5 p.m. Sun.; Albuquerque Garden Center (10120 Lomas NE), free, 296-6020.

May 21 — Canterbury Concert Series: Surgite Sacred Dance Company; 4 p.m., St. Thomas of Canterbury Episcopal Church (425 University NE), 247-2515.

May 24 — "Mozart & Poulenc," with pianist Evelyne Brancart, presented by the New Mexico Woodwind Quintet and Friends Concert Series; 7:30 p.m., St. Andrew Presbyterian Church (5301 Ponderosa NE), 243-3696.

May 27 — Astronomy Day at the Museum: visitors can look through a 15-ft.-tall telescope (set up in the parking lot by the Albuquerque Astronomical Society); 9 a.m.-5 p.m., New Mexico Museum of Natural History, 841-8837.

May 27 — Taste of Summerfest: variety of ethnic foods and entertainment; 5-10 p.m., Civic Plaza, 768-3490.

May 27-29 — Memorial Day Observances: various activities in celebration of Memorial Day; 9 a.m.-5:30 p.m., Indian Pueblo Cultural Center, 843-7270.

May 31-June 11 — "A Walk in the Woods," New Mexico Repertory Theatre production of a drama by Lee Blessing about US/USSR relations and the arms race; 8 p.m. Tues.-Sat., 2 p.m. Sat. & Sun.; KiMo Theatre, 243-4500.

Welcome

Albuquerque
Ricardo Contreras (9114)
Richard Heckler (2853)
Roberta Jaramillo (121)
Robert McInteer (3153)
Carol Sumpter (3412)

Illinois
Sue Goudy (2635)
Roy Jorgenson (7553)

Kansas
Charles Richardson (7484)

Michigan
Patricia Mahoney (7532)

Nebraska
John Brozek (5112)

New Mexico
Barbara Ortiz (3142)

Ohio
Randy Peterson (5212)

March 1989 Earnings Factors

	Earnings Factors
Savings Plan for Salaried Employees (SPSE)	
AT&T Shares	1.0513
Government Obligations	1.0050
Equity Portfolio	1.0257
Guaranteed Interest Fund	1.0071
South Africa Restricted Fund	1.0260
Diversified Telephone Portfolio	
Unrealized Appreciation	1.0417
Realized Appreciation	.0059*
Savings and Security Plan — Non-Salaried Employees (SSP)	
AT&T Shares	1.0516
Guaranteed Interest Fund	1.0073
South Africa Restricted Fund	1.0245
Diversified Telephone Portfolio	
Unrealized Appreciation	1.0405
Realized Appreciation	.0058*

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

Congratulations

To Karen and Eric (7813) Pettiford, a son, Eric Daniel, April 22.

To Kathy (22-2) and Isaac (3142) Mitchell, a son, Jonathan, April 28.

To Bernadette Llorens and Michael Swanson (9211), married in Albuquerque, April 29.

To Mary (1556) and Larry (9222) Walker, a daughter, Katie Leigh, April 30.

To Karen and Bill (7482) Silva, a daughter, Simone Beatrice, May 7.

Retiree Picnic Reminder

If you're planning to attend the annual retiree picnic bash next Thursday (May 25), here's a last-minute rundown on time, place, parking, etc.:

- *Time* — 4-7 p.m.
- *Where* — Coronado Club patio area
- *Parking* — In parking areas at the C-Club, Base chapel, Que Pasa Recreation Center, Base hospital, and Sandia Base Elementary School. (A shuttle bus will run between the Club patio entrance and parking areas on "B" Street.) Parking for the handicapped available near the Club's main entrance.

NOTE: All reservations, including "no-shows," must be paid for. Therefore, if you have made a reservation for the picnic but are unable to attend, call Sandia's Benefits Department (844-5072 or 846-0466) by May 23 to cancel.

PART OF A GROUP belting out gospel music at International Day May 12 were (from left) Belinda Holley (3522), Cynthia Williams (153), Olivia Harris (4021), and Laurence Ann Washington (7522). Vernon Koonce (5122) conducted the group; Tom Henderson (2851) was accompanist.