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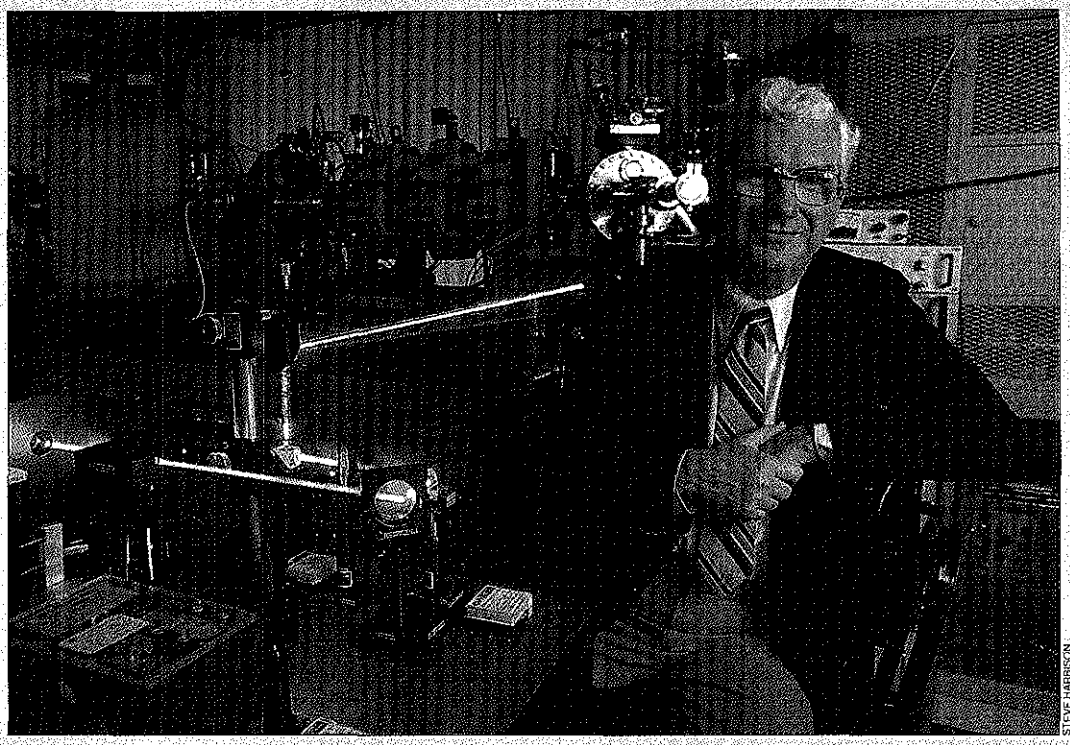


STEVE HARBISON

AT YOUR SERVICE

by Herb Brody

Forty years ago, World War II came to an end with the use of a terrifying piece of technology from new, top-secret government laboratories. Those facilities, at Oak Ridge, Tenn., Los Alamos, N.M., and a few other sites, have since grown into multipurpose "national labs" that perform wide-ranging R&D. While nuclear weapons still constitute much of their work, these labs are increasingly being enlisted to fight civilian battles. During the '70s the enemies were pollution and the energy shortage. The latest crusade: moving lab technology into the private sector to help restore the country's industrial competitiveness.

Closer collaboration with the private sector is helping to spawn new firms and shore up tired industries

The battle is being waged on several fronts. Patent policies, commonly cited as a major hindrance to commercialization of government technology, are loosening up. The labs now welcome private sponsorship for proprietary product development. A new exchange program lets companies send their technical people to work shoulder to shoulder with their colleagues at national labs, while the government picks up much of the tab. The labs are also being enlisted to apply their resources to aid struggling basic industries, like steel.

Until recently, the government took the position that the fruits of publicly funded R&D should be available equally to everyone. Thus any patent awarded for work at the labs became government property; the government then offered licenses to all interested U.S. companies for a small fee.

But these nonexclusive licenses discourage commercialization. Because the technology produced by the labs is unrefined—typically 90% of product development remains to be done when

Hal Schmidt (above) formed Atom Sciences with patents and consulting from Oak Ridge. "There aren't a lot of barriers now," he says.

The sensor consists of an optical fiber whose tip is coated with a material that glows in the presence of certain other compounds. The light, which varies in brightness with the concentration of the substance being sensed, travels down the fiber to a detector. Kelsius plans to use the technique in a blood-gas monitor; a fiber will be inserted into the bloodstream, and the fluorescence will indicate the levels of oxygen, carbon dioxide, and pH, says president Jay Schwalde.

Radtech (Albuquerque), a Los Alamos spinoff, is developing systems that use radio-frequency electrical current to heat and thus reshape the cornea, correcting visual defects. The company aims for a one-hour outpatient procedure that is simpler, cheaper, and less risky than the present surgical alternatives.

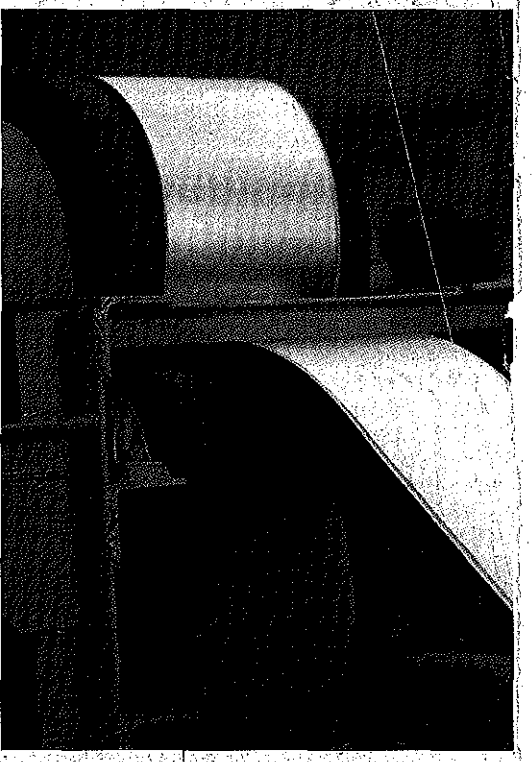
Consulting by lab staff is another important way to get know-how into industry. In the past, the national labs had discouraged—or prohibited—scientists from marketing the expertise they gained from government work. This restriction made it difficult, if not impossible, for would-be entrepreneurs to use laboratory scientists' skills. But more liberal policies have permitted the start-up of firms like Atom Sciences (Oak Ridge). The company aims to commercialize an ultrasensitive measurement system that uses precisely tuned lasers to ionize and then count the atoms in gaseous or solid samples. As little as 0.1 part per billion is detectable, and the system works on any element for which proper laser wavelengths are available, says cofounder Hal Schmidt.

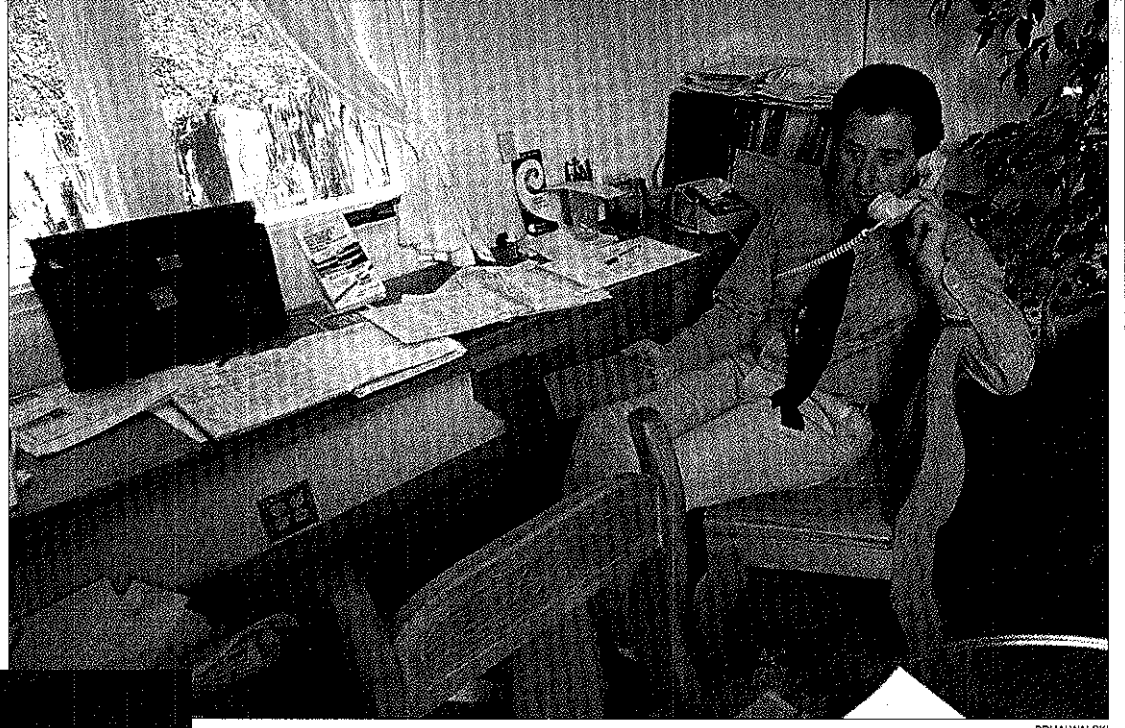
The laser technique was invented several years ago by Oak Ridge scientist Samuel Hurst. While remaining on the lab staff, Hurst has been permitted to become a cofounder and vice-president of Atom Sciences, as well as a consultant to the firm—all capacities that had been off limits for lab staff. "There aren't a lot of barriers now" to such involvement, says Schmidt, recalling the stiff opposition he met in 1960 when he and colleagues started Ortec, a maker of nuclear particle detectors. Hurst concurs: "There is no longer a perception that the entrepreneurial process is a conflict of interest."

The labs are also more willing now to grant leaves of absence. Amtech, for example, was started locally by five scientists on two-year leaves from the Los Alamos lab. The company has acquired a remote identification-tag technology that the lab had developed for the Department of Agriculture. The tags are read from a distance by microwaves; an electronic circuit in the tag alters the reflected microwave beam in an easily detected way. DOA's goal was a label for diseased cattle that would keep them out of the slaughterhouse. But the principal application Amtech sees, according to R&D vice-president Jerry Landt, is keeping tabs on the contents of railroad cars—for example, making sure that all the cars in a single-commodity "unit train" stay together.

Although each national lab is changing, none has pursued technology transfer as aggressively over the past year as Oak Ridge. The sprawling facility at the edge of the Smoky Mountains in eastern Tennessee is setting the pace for the others in the national lab archipelago. This leadership dates from April 1984, when the contract for running Oak Ridge went from Union Carbide to Martin Marietta; the aerospace company beat out competitors Rockwell and

The business community is gradually becoming aware of the national laboratories' resources





BRIAN WALSKI

DAVE VAN DEVEER

Sandia's Stromberg (left) says companies now "realize it's worth bothering" to work with national labs. The ailing steel industry looks to the future by collaborating with the labs in developing radical steel-making methods, says National Steel's Dietz (above). Venture capitalist Silver (top) struck an unusual deal: His new company hired Los Alamos to develop a marketable product.

Westinghouse with a bid that heavily emphasized industrial participation and strengthening the local economy.

"We proposed doing business in a new and different way," says Carpenter at Martin Marietta Energy Systems, the subsidiary formed to handle the lab contract. For example, Martin Marietta has asked DOE for ownership of all patents the company deems to be of commercial potential—an "advance waiver of title" that would let Martin Marietta act with autonomy. As owner of the technologies devised at Oak Ridge, the company would grant other firms exclusive licenses to bring the inventions to market. Although DOE has not yet granted this waiver, Martin Marietta has begun negotiating license agreements with other companies in anticipation. "When the word comes, we'll be ready to go," says Carpenter. "We expect to have some home runs."

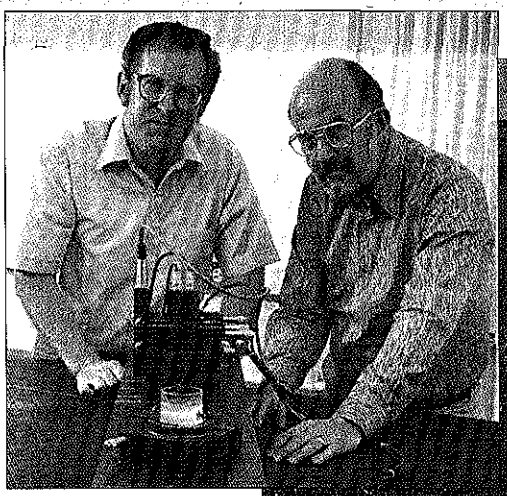
Martin Marietta also strongly encourages the Oak Ridge technical staff to serve as consultants—to "get our smarts out into the private sector," as Carpenter puts it. In contrast, Union Carbide had put a ceiling on how much a lab scientist was allowed to earn on the outside; some other national labs, particularly Sandia, continue to enforce tight restrictions on off-hours consulting.

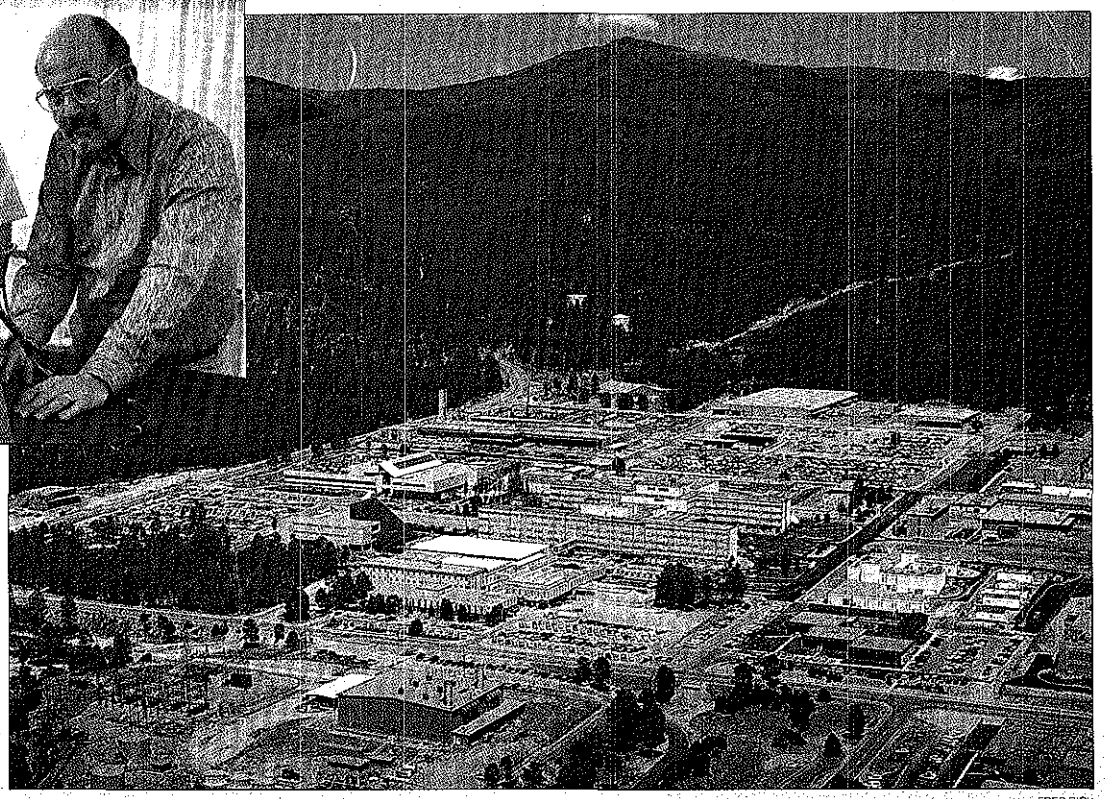
In another shift, Oak Ridge now welcomes private sponsorship of proprietary R&D. A number of companies, including Cabot (Boston), Homogeneous Metals (Clayville, N.Y.), and Universal Cyclops (Bridgeville, Pa.), are paying the lab to develop a new class of alloys with a unique property. Unlike most metals, which get weaker as they heat up, these "ordered intermetallic alloys," such as nickel aluminides, get stronger. This property is especially useful for engines, which operate most efficiently at higher temperatures. Present nickel aluminides are barred from structural use by their brittleness. Oak Ridge is working on ways to increase ductility and has obtained dramatic improvements by adding small amounts of other materials, such as boron.

Martin Marietta has also made a significant commitment to accelerating the growth of the local economy, having allocated 10% of its annual contract fee (for running the lab) to launching new companies. (The fee ranges from $5 million to $20 million, depending on Martin Marietta's performance.) In addition, the company has promised to build a 290-acre industrial park near the lab. The first tenant will be the Tennessee Innovation Center, a new subsidiary that will invest in and "incubate" high tech start-ups. The center is co-owned by Tran Tech Systems (Salt Lake City), which runs the similar Utah Innovation Center.

The Tennessee Innovation Center, a for-profit organization, identifies promising technologies at the national lab and "does everything necessary to make them commercially successful," says vice-president Melvin E. Koons. The center makes equity investments, typically of $50,000–$150,000, for start-ups that satisfy several key requirements—a product or service on the cutting edge of technology, potential for generating revenues of $7–10 million in 5–8 years, and a promise to locate in Oak Ridge.

The center tries to find commercial uses for inventions geared to specific government purposes. For example, a new lead-iron phosphate glass was de-





Los Alamos scientists Charles Gregg (left) and Gary Salzman are building a commercial prototype of their rapid-diagnosis system with private funding. Aerial view shows the lab's main technical area.

FRED RICK

for encapsulating nuclear waste. It turns out that the glass has some unusual properties that allow it to be poured as a liquid into precisely shaped molds. An exciting possibility is the direct casting of lenses, eliminating much of the expensive grinding and polishing needed for ordinary glass. The center hopes to invest in a start-up to explore further the material's commercial potential.

Despite all these efforts to make the national laboratories more relevant to industry, the labs are still largely cut off from industry scientists. DOE is seeking to remedy this isolation with a new lab/industry exchange program. Technical staff from interested companies—U.S. or foreign—will be able to spend a year working at a national lab, with the government paying part of their salaries and expenses. The program's $600,000 budget for this fiscal year should pay for 20–30 scientists, says Richard Stephens, director of university and industry programs in DOE's energy research office.

But whose agenda will the visiting scientist follow—the company's or the lab's? Stephens emphasizes that work should benefit both. "We don't want simply to augment a company's R&D," he says. "There should be a mutual interest."

The new industrial orientation of the national labs is not without its critics. The fostering of spinoff companies, for example, is seen by some as a potential distraction. Examples like Mesa Diagnostics at Los Alamos could tempt scientists to "think more of possible commercialization than of the value of their work to the government," says Everet Beckner, vice-president for energy programs at Sandia Corp., the AT&T subsidiary that runs Sandia National Labs (Albuquerque).

For instance, an entrepreneurially minded scientist may devote less attention to work on classified projects because there is less potential for commercial spinoff, says Frank Huband, head of technology policy at the National Science Foundation. And he warns that a "Russian farm" mentality could arise at the labs. In the Soviet Union, farmers are permitted to work a small private lot for profit; but a frequent result is that the farmers focus their energy and ingenuity on making the private lot more productive, while giving only minimal attention to the collective land.

In addition, some argue that spinning off new companies is an inefficient way for a lab to help the economy. "People hear that small companies are the biggest job producers, which is true, and they twist that into the false notion that *start-ups* are the biggest job producers," says Robert P. Stromberg, manager of technology transfer at Sandia. Most new companies don't survive long enough to provide many jobs, he says. Not surprisingly, then, much of Sandia's technology transfer involves established firms, such as large oil and gas companies.

One effective way to exploit national lab R&D arose informally, well before the current programs were conceived, with the Federal Laboratory Consortium (FLC). Over 100 labs, including the eight national labs, belong to what chairman Eugene Stark of Los Alamos calls an "organized old-boy network." A company in need of technical information or assistance contacts one of four regional coordinators, who check to see whether any federal lab is working on the topic. Legislation now pending would make FLC an officially recognized (and funded) organization, probably as an arm of NSF. Such a move would be a boon to technology transfer because "the FLC guys won't have to spend all their time begging for money," says one congressional staffer.

Thanks to the new programs and FLC's persistent efforts, industry is catching on that the national labs have turned a new leaf. "Companies are realizing that it's worth bothering" to do business with the labs, says Sandia's Stromberg. For many years, says Stark at Los Alamos, the labs turned down more requests for visits from the Japanese than they received from U.S. companies. That's no longer true. And "the companies involved now," he says, "are skimming the cream."

Herb Brody is a senior editor of HIGH TECHNOLOGY.

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therefore contributing insufficiently to the national good. The Packard panel recommended that the size of each lab be "allowed to increase or decrease (to zero if necessary) depending on mission requirements," adding that "preservation of the laboratory is *not* a mission."

A direct outgrowth of the report, and a striking example of how the labs can be channeled to industry's service, is the "steel initiative." The plan is to use the potent scientific and engineering talents of the national labs to perform basic research that the ailing steel companies cannot fund themselves.

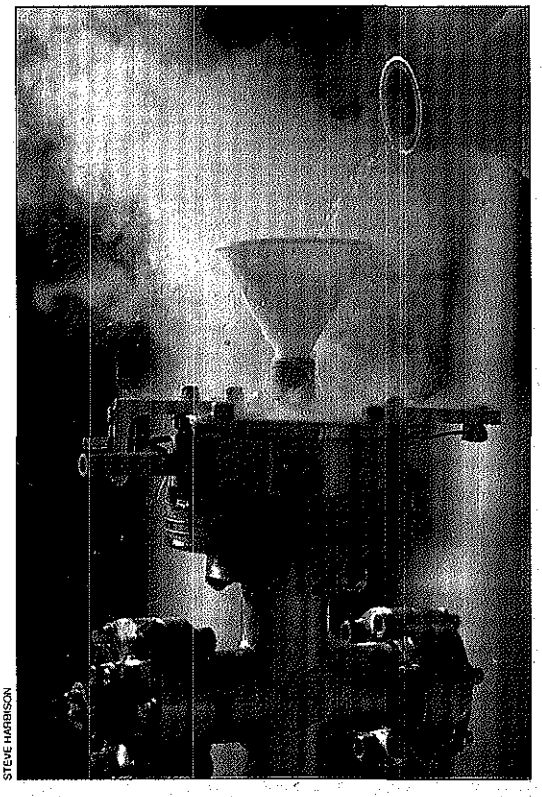
Because of financial hardships, steel company R&D is "typically geared for results in six months to a year," explains John Roberts, associate director of Argonne National Laboratory (Argonne, Ill.), which will do much of the work. The companies recognize the magnitude of their plight. The steel initiative will look 10–15 years into the future, says Roberts; it is to be a collaborative project in which steel companies like U.S. Steel, Bethlehem, National, Armco, and LTV will send their scientists to work in teams with the lab scientists to solve problems jointly agreed upon. "Incremental improvements aren't enough" to restore the industry's badly eroded competitive position, says Reginald Dietz, vice-president for research at National Steel (Weirton, W.V.). "We're going after 'leapfrog' technology that will put us a couple of steps ahead." The labs will work not on proprietary projects but on generic technologies that the entire industry should share.

One thrust of the program will be to find new ways to convert iron ore into liquid metal, bypassing the expensive coking ovens and blast furnaces now used. Another focus will be on casting the liquid metal into pieces close to the dimensions of the final product. One possibility is to use powerful, precisely shaped magnetic fields to confine the molten metal so it can be cast into thin sheets, obviating the need for strip mills to flatten thick billets. The technology loosely resembles that being developed to confine hot hydrogen gas for controlled nuclear fusion. Oak Ridge, which has a long-standing program in fusion, will contribute its magnet expertise to the problem of casting steel.

Shortly after the steel initiative was organized, George A. Keyworth II, Reagan's science advisor, asked the national labs to identify other industries that might benefit from a similar effort. The result was a proposed project for applied research on off-road machinery. In March, Argonne met with several manufacturers to determine which technical issues were appropriate for cooperative action. The resulting list includes advanced engines, electronic controls, and continuously variable transmissions. The lab hopes to begin work in fiscal 1987.

Unlike the steel initiative, the off-road equipment project will aim to develop specific products rather than basic technology. To make this work, the labs will have the liberty—unusual for the government—to keep proprietary secrets. "We won't have to tell Deere what we're doing with Caterpillar," says Argonne's director of technology transfer, Brian Frost.

Increasingly, the national labs are becoming spawning grounds for technology-based start-ups. From Oak Ridge's inception during World War II until 1980, about 20 companies started



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A glass devised to encapsulate nuclear waste may be adapted for lens making by an Oak Ridge start-up.

up with technology developed at the lab, according to technology transfer manager Donald Jared; in the following four years, he says, there were more than 30 such spinoffs.

Some of these new companies are formed under arrangements that would have been unheard of a short time ago. Perhaps the most dramatic example comes from Los Alamos. Scientists there developed a way to identify viruses and bacteria in minutes, rather than the days or weeks needed with existing methods. A laser illuminates the sample with a beam that alternates between two kinds of polarization, and a detector senses the difference in how one polarization is scattered relative to the other. This difference, it turns out, correlates with certain features of the specimen's DNA molecule.

The procedure was invented at Los Alamos in a project funded by the National Institutes of Health. NIH had no interest in commercialization, though, and ceased its support while the device was still far from market readiness. The lab began looking for companies to acquire the technology. When David Silver, a Chicago venture capitalist, came to Los Alamos in 1983 in search of technologies ripe for commercial exploitation, the rapid analyzer stood out.

Silver raised $8.5 million through an R&D limited partnership with Prudential-Bache Securities (New York) and gave half the money to the lab to develop a commercial prototype. The partnership (a tax shelter to encourage investment in technology) acquired full ownership of the technology and then granted an exclusive license to a new company, Mesa Diagnostics (Los Alamos). Mesa is wholly owned by Silver's venture capital firm, the Santa Fe Private Equity Fund.

It is a curious reversal of conventional practice, with the big government lab working for the small company instead of the other way around. The partnership pays the lab for use of its staff during regular hours and hires lab scientists as consultants after hours. "It's cheaper than hiring our own staff," says John Lonergan, Mesa's chief financial officer and vice-president for marketing.

It took two years to put the radical deal together, according to Eugene Stark, the lab's industrial liaison officer. The main hang-up was the patent. DOE had to waive its title to the University of California (which operates the lab), and then the university had to waive its title to Silver's partnership. Eventually, 11 contracts were needed to cement the agreement, according to Silver.

While the Mesa deal is unusual in its magnitude, it is one of a growing number of cases in which a small company is launched with national lab technology that would not have been available under old policies. For example, Keisius (San Carlos, Cal.) bought into the sensor business with an exclusive license to the technology of remote fiber fluorimetry developed at Lawrence Livermore National Lab.

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Martin Marietta's Carpenter, shown with a corrosion-resistant hip replacement, is leading Oak Ridge toward greater commercial relevance.

the government ceases its work—it makes little sense for a company to embark on an expensive, risky product development effort using technology freely available to its competitors. Firms are "reluctant to invest the millions of dollars required to fine-tune inventions without the guarantee that a competitor could be precluded from receiving its own government license," explains Jon Soderstrom, director of of research and technology applications at Oak Ridge National Laboratory.

As a result, "for decades, what we did here didn't matter very much" to the industrial world, says William Carpenter, vice-president for technology applications at Martin Marietta Energy Systems, which operates Oak Ridge for the Department of Energy (DOE). Technology that's available freely to everyone is "of value to no one," he contends.

A wave of patent-policy changes began with the passage of the Bayh-Dole Act of 1980. This act allows small businesses or nonprofit organizations to retain title to inventions conceived during government-sponsored R&D. An amendment to the act, signed last fall, broadens the government's waiver of patent ownership. The new law states that nonprofit institutions (such as universities) that operate government labs under contract can retain title to inventions coming out of these labs. In addition, former Energy Secretary Donald Hodel ordered last February that the patent waiver be extended to cover large, for-profit companies like Martin Marietta, but as of this writing the rule had not taken effect.

The attention recently given to patent policy symbolizes the new concern in Congress and the administration over getting our money's worth out of the national labs. Such concern first became prominent in the Stevenson-Wydler Technology Innovation Act of 1980. The law declares technology transfer to be an official mission of the labs and requires that each lab spend 0.5% of its budget on moving the results of its R&D into industry.

Perhaps more galvanizing than the Stevenson-Wydler Act, however, was the sharply critical 1983 report on the labs by a presidential commission. The panel, chaired by Hewlett-Packard cofounder David Packard, urged greatly increased interaction between government labs and industry in order to make the labs "more responsive to national needs." It accused the labs of working without clear purpose, and