

Weapons Labs: After the Cold War

Now that the steam has gone from the nuclear arms race, Livermore, Los Alamos, and Sandia are positioning themselves to be brain banks for U.S. industry

Los Alamos, New Mexico—THE GUARD tower at the top of the hill as you drive into the town of Los Alamos is padlocked and abandoned now—a vacant reminder of the days when this community turned strangers away at a gate across state road 502. Back in 1943, when Robert Oppenheimer first came here with a crew of scientists and engineers to create an atom bomb, it was truly a secret village. Since then, the government has supported its schools, its country club, fire department, garbage trucks—everything that was “behind the fence”—as property of the military and, later, the U.S. Atomic Energy Commission. The big gate came down in the 1960s and the lab’s secret life has eroded a little over the past quarter-century. But these changes are nothing compared to what is about to befall the birthplace of the bomb.

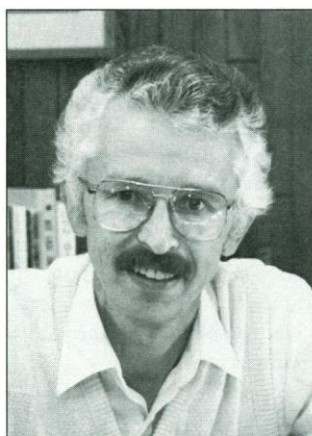
Now that the Soviet Union has all but opted out of the arms race, Los Alamos, like the other two weapons labs—Sandia in Albuquerque, New Mexico, and Livermore in California—has lost most of its *raison d’être*. For nearly 50 years, these labs have been driven by the need to design and build better nuclear explosives for the myriad new bombs and missiles the Pentagon ordered to keep ahead of the Soviets. True, they have branched out into new territory in recent years, but a substantial fraction of their business remains rooted firmly in a cold war that no longer exists. And that raises a harsh question for the labs: Does the country still need three \$1-billion-a-year, state-of-the-art bomb R&D centers, each staffed by 8000 to 10,000 people?

Congress and the Department of Energy (DOE), which owns the labs, have been tiptoeing around that question for a couple of years, but they will confront it directly soon. Before the end of the year, a top-level advisory committee established by Energy Secretary Admiral James Watkins is expected to deliver its own assessment on the future of the labs. The safe bets are that no radical proposals will be made—such as shutting

down one of the three labs—but that the labs will be induced to undergo a metamorphosis from the engines of the cold war to the spark plugs of American industrial regeneration.

Although the labs themselves (or at least their top management) see this strategy as their lifeline to the future—indeed are already touting their wares to industry, but

manding costly cleanups at DOE’s labs and production facilities. Siegfried Hecker, director of Los Alamos, mentioned that just one Tiger-related addition to his budget will cost \$3.5 million. What will it buy? An extension of just one of the lab’s 90 vent stacks so that radioactive gas will decay to a “safe” level a few seconds *before* leaving the stack, rather



LOS ALAMOS NATIONAL LABORATORY



Birthplace of the bomb.

Once a closed community, Los Alamos is now open to proposals for solving “large, complex problems in collaboration with researchers from industry and academia,” says director Siegfried Hecker.

with mixed success (see box, p. 1102)—these changes are unsettling to many of the scientists who have spent their lives in the secret world of bomb design. In a visit to all three labs in November, *Science* found the staff uneasy about the future. Many joked about early retirement, and the much-repeated gibe was: “If you learn what the future of the labs is, please let me know.” Roy Woodruff, former Livermore weapons chief now at Los Alamos, quipped: “It looks like we’ve worked ourselves out of a job.”

These doubts are hitting the labs at a moment of vulnerability. Congress and DOE have already been pummeling managers in preparation for a major overhaul of the entire weapons complex. Admiral Watkins this summer released a directive clarifying lines of authority, designed to tighten Washington’s control over activities throughout DOE’s far-flung empire. And his environment and safety enforcement squads—the “Tiger Teams”—have been busily tagging violations and de-

than *after*. Hecker, though aware of the grumbling around him over incidents like these, insists that the new environmental discipline is good because it will help to “create the research environment of the future.”

Admiral Watkins also mounted a tough inquiry into the labs’ accounting practices this year. And other DOE brass have instituted strict new limits on researchers’ travel to meetings where, for example, U.S. and Russian experts discuss weapons cutbacks. These actions have prompted a charge that DOE is smothering academic freedom at the labs (see box, p. 1101).

Meanwhile, powerful members of Congress, including Representative John Dingell (D-MI) and Senator John Glenn (D-OH), have been lashing the labs to “buy American,” to move technology more rapidly into the private sector, to keep nuclear and industrial information out of the hands of foreigners, and to crack down on business conflicts of interest. Some managers say

they feel like a punching bag. And many complain, as a DOE contract employee named John E. Tanner Jr. wrote recently in *Physics Today*, that "the entire DOE weapons complex is embroiled in an endless process of procedure writing...."

Working under a (mushroom) cloud

Ever since they were first established—Los Alamos in 1943, followed by Sandia in 1949 and Livermore in 1952—the labs have been at the center of the nuclear arms race. Sandia's assignment has been to "weaponize" the designs produced by the other two, which means that it devises the triggers, timers, electronic security devices, and the delivery shell that surrounds nuclear explosives. Livermore was created as an alternative design center to give Los Alamos competition. The two design labs are run by the University of California and are proud of the academic ethos and the self-initiated research they support. Sandia, in contrast, is oriented toward engineering, and has always been run by AT&T more like an industrial facility.

If ever there was a clear signal that the labs' role is changing, it came on 27 September, when President George Bush announced a major unilateral cut in U.S. nuclear deployments. For weapons designers, it came like the stroke of midnight at Cinderella's ball. Careers built on improving nuclear warheads will now be turned to destroying them. Most telling of all, verification experts at the labs weren't even consulted before Bush made his announcement.

The speech came as a "big surprise," said

one arms control expert at Los Alamos. Only last May, Livermore's director, John Nuckolls, told the University of California Board of Regents that one of the lab's growth areas in the future would be "developing verification technologies...which make possible new arms control measures." This latest, big step in arms control came without any technical plan for verification. It was "completely without precedent," said a Los Alamos expert. As for the future, "We don't know what's going to happen; it's frustrating."

One certainty is that there will be less work for warhead makers. Livermore is now finishing up the W89 device, designed to fit atop a SRAM II missile carried by a bomber such as the B-1; after that, it has no new designs on the production schedule. Los Alamos, however, still has several in the pipeline. Nuckolls points out that the share of Livermore's total budget devoted to nuclear weapons R&D has declined from 48% in 1988 to around 36% in 1991, and it will surely go lower. At Los Alamos, Hecker points out, in the past 6 years his lab has reduced the number of jobs related to nuclear weapons R&D by one-third.

The number of bomb tests will diminish too. Scientists at the labs have always viewed this prospect uneasily, because it would mean retreating into physics theory without experimentation, and that's not their style. As Livermore's chief laser physicist, James Davis, put it, ordering his colleagues to do no more tests would be like telling a pianist "never to play in a concert" again. Com-

puter models and laser fusion experiments can provide "piano practice" for weapon-eers, and reliance on them will increase, Davis says—but they're no substitute for the real thing. But tests will become rare events, and, as Hecker says, this means that the value of "nuclear competence" will be even greater.

There are, however, a few growth areas in nuclear weapons work, though not nearly enough to make up for the cutbacks. One of these is nuclear proliferation—the labs are being called on to help prevent other countries from following the trail they themselves blazed. United Nations teams in Iraq, for example, included a dozen specialists from Livermore and Los Alamos; they helped gather proof that Iraq was running a secret bomb factory (see *Science*, 1 November, p. 644). With North Korea apparently now joining Iraq in reneging on promises to allow inspections under the nonproliferation treaty, the international system for sharing and monitoring the use of nuclear technology may be in for a complete overhaul. The labs will be heavily involved.

The labs are also being called upon to help undo some of their own handiwork: John Immele, chief of nuclear weapons technology at Los Alamos, says nuclear weapons officials have been working overtime to devise a plan for scrapping the old weapons expected to be retired from the arsenal over the next few years, including those listed in Bush's speech. Although DOE has been dismantling "several hundred" old warheads a year, now it will have to escalate to several

Researchers Complain of Loss of Academic Freedom

The Los Alamos and Livermore labs have long prided themselves on their commitment to academic freedom—a willingness to give employees latitude not only to pursue their own research interests but to speak out on policy issues. Indeed, the University of California, which manages the two labs for DOE, has always insisted on this commitment. In recent months, however, scientists in fields that touch on the lab's weapon-building mission—physicists, engineers, and earth scientists—have been complaining that DOE has clamped down on their freedom to discuss potentially sensitive issues in public.

The pinch is so great, in fact, that Livermore's former director Herbert York, chairman of an advisory board to the university, wrote a strong letter of protest last May. York, now at the University of California, San Diego, told UC president David Gardner that "things have taken a turn for the worse" at the labs, and that "recent DOE actions are in direct conflict with fundamental values of the university."

York gave detailed examples, including a case in which arms control experts were told not to attend a meeting at the University of California, Irvine, in April at which Russian weapons experts would be present; a rule making it difficult to attend meetings

abroad; new restrictions on foreigners visiting the lab; an attempt to bottle up a congressionally requested paper on weapons safety by Livermore weapons expert Ray Kidder; a memo requiring pre-approval of contacts with the media; and a rule squelching DOE lab dissent in "intelligence analyses." He warned that if DOE insists on stifling discussion of policy issues, it will have trouble recruiting people with "originality and scientific verve." In a telephone interview last week, York said that he sees no change at DOE since he wrote the letter. In a more recent letter to *Science*, physicist Frank Von Hippel of Princeton claims that those who flout the new regime have been told their careers will suffer.

Asked about this, Livermore director John Nuckolls said that he was aware of York's letter, and that "there may be less flexibility than we've ever had before." His counterpart at Los Alamos, Siegfried Hecker, said York's letter was on target, though he added that he is optimistic that the ordeal will soon pass.

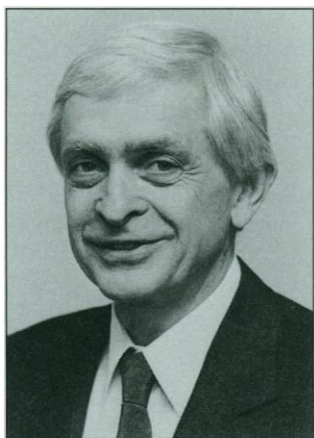
The University of California is currently in the midst of renegotiating its contract to run the labs. According to vice president for academic affairs William Frazer, the university plans to play "a more active role" as a manager, and that should ease the friction between the researchers and DOE. ■ E.M.

thousand. This will stretch DOE's capacity to the limit.

Ticket to the future

DOE's big labs will continue to enjoy a monopoly on nuclear weapons research, but like giant corporations caught with an obsolescent product, they have been trying to diversify, pumping money into a variety of related technologies over the years, building expertise in areas ranging from cell biology to astrophysics. It is these side specialties that they are now holding out as a ticket to the future.

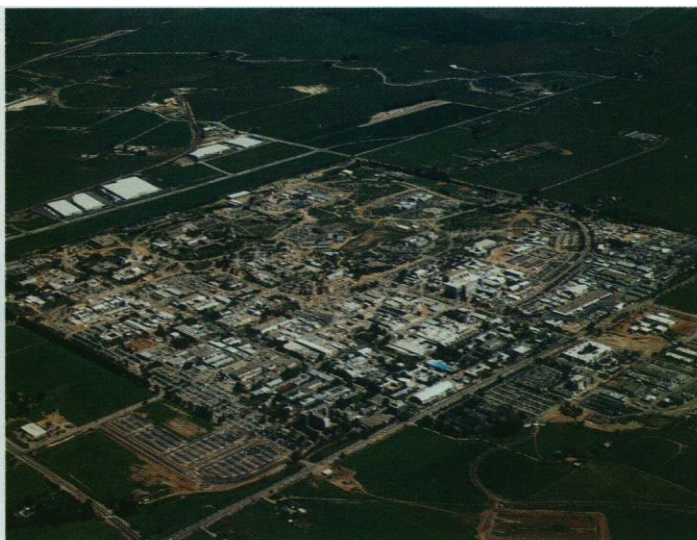
Their non-nuclear ambitions are getting a strong push from Admiral Watkins and Congress. At a Senate hearing on the future of DOE last July, Watkins said, "I believe that we must make every effort to develop partnerships between our weapons laboratories and U.S. industry to speed the flow of technology in both directions." To speed the process along, Watkins supports a bill sponsored by Senator Dennis DeConcini (D-AZ) that would make it easier for employees to move from the private sector to DOE and back without violating conflict of



LAWRENCE LIVERMORE NATIONAL LABORATORY

Suburban encroachment.

Development around Livermore is creating pressure to move some weapons work elsewhere; director John Nuckolls cites the lab's contribution to national economic security.



interest rules. In a similar vein, Representative George Brown (D-CA), chairman of the House Science Committee, said earlier this year that "we must now develop a national technology infrastructure" that responds to "the economic threats of the 1990s and the 21st century," and that the weapons labs will be at the center of this national drive. Nuckolls agrees with this new thrust, saying, "I think of this a national

security lab, broadly defined," embracing economic security as well.

At Los Alamos, Hecker cites six "core competencies" in addition to nuclear technology that will grow in importance. They include high-performance computing, dynamic experimentation, systems engineering and rapid prototyping, beam technologies, and theory and complex systems. The virtue of the labs, Hecker claims, is that they

Have Talent, Will Contract

Mort Mendelsohn left the University of Pennsylvania to become director for biomedical sciences at Lawrence Livermore 20 years ago and has "never regretted it." The lab, he says, takes on projects that are "longer-term and riskier" than anyone else would attempt. A researcher has access to expertise "way out of your discipline—right there, eager to be used." And Livermore has been generous to biology: Mendelsohn's budget has grown steadily for two solid decades.

That investment is now bearing fruit in a project to map the human genome, fast and reliable techniques for spotting chromosome mutations, methods for detecting minute chemical changes in DNA after exposure to chemicals, and others. It is projects like these, and the brainpower behind them, that Livermore and the other weapons labs see as the key to their future.

In a former cold war sanctum at Los Alamos—a windowless "Weapons Meeting Room" inside a giant Mosler safe—Kay Adams met a visitor and explained how the lab intends to join forces with U.S. industry to help it get a jump on competitors in technology development. As some see it, this challenge will be as important for the labs in the 1990s and beyond as the competition with the Soviets was in past decades.

Adams directs the Exploratory Research and Development Center, which oversees a pilot center on superconductivity research and other schemes. The goal, Adams says, is to "span the gap" between basic research and product development in key technologies. The center also backs a limited amount of basic research. Adams, who formerly worked at the phone companies'

Bellcore labs and the Defense Advanced Research Projects Agency, thinks that private R&D consortia often fail because they are too bland. To avoid conflict, they pursue "lowest common denominators." Researchers at Los Alamos, she thinks, will be bolder. By testing out ideas, they may encourage companies to be more adventurous. In nearly 3 years, the superconductivity center has signed \$14 million in agreements with companies and universities, and developed some potential products like high-performance wire.

All the labs are headed this way, though experience suggests the economic payback will be hard to measure. Consider the computer modeling codes the labs have contributed to industry. Livermore's hydrodynamics software DYNA3D is widely used in structural design, especially by automakers, as is Los Alamos' KIVA II, which models combustion processes. The irony is that it was not U.S. companies that exploited the codes when they were put in a public depository, but primarily Japanese and French entrepreneurs. They copied the DYNA3D code in particular, dressed it up, made it "user friendly," and peddled it successfully not just abroad but in the United States. A move is afoot to copyright and control future software products more tightly, but a top official at Livermore is not eager to see that happen: He feels strongly that university students should have access to codes, and that means everyone.

The labs clearly have a lot to offer industry. Finding the right terms to make the technology and brainpower available will not be easy.

■ E.M.

"provide an environment where you can solve large and complex problems...where science makes a difference."

The labs do seem unrivalled in the depth and variety of skills they have on tap. An earth scientist at Livermore boasts that if you need an expert in isotope chemistry, or fluid dynamics, or bacteria, or lasers: "You can just get them off the shelf here," while at a university—even if you could locate such people—you might have trouble getting them to cooperate.

All three labs are offering themselves as centers where researchers from government, university, and industry can collaborate on new technology. Sandia's chief, Al Narath, an AT&T executive on loan, cites the lab's pragmatic outlook as an asset that will stand it well in the coming hard times. "Sandia is well positioned because of our industrial background" to move rapidly into partnerships with commercial firms, he says. The lab, in fact, recently established a consortium with 11 industrial partners to work on specialty metals processing.

Livermore, for its part, has had a major energy research program since the 1960s, now funded at more than \$250 million, equal to the amount spent on nuclear weapons. It originated in the ill-fated "Project Plowshare," an attempt to apply nuclear explosives to the business of prospecting for oil and gas. Plowshare failed to catch on for predictable reasons. But Livermore moved into studies of recovery of oil from shale, solar power, and fusion—the last of these inspired in part by the desire to obtain data on thermonuclear events without setting off bombs. Livermore also has developed an entire \$100-million laser isotope separation plant, a scale model that could become the world's most efficient commercial uranium refinery—if only the market could support it.

While the labs have shown that they can come up with stunning new technologies, they still haven't established that they are suited to serve as industry's brain bank. They have had some partnerships with industry, but even the successful ones have not yielded a distinct commercial advantage for the United States. It will take a few years before it will be possible to judge whether this experiment is working.

Reconfiguration politics

DOE chiefs, meanwhile, are already trying to decide which weapons test facilities to cut, and when. Livermore official William Shuler spoke recently about a potential DOE reconfiguration plan that would focus all the controversial weapons work—tritium and plutonium handling, as well as high explosives facilities—at Los Alamos. Livermore's own Representative in Con-

gress, Pete Stark (D-CA), wants to go even further: He has suggested ending nuclear weapons R&D at Livermore entirely. A bill he introduced would create a commission to study consolidating its work at another lab.

Consolidation is only an option at this point, but pressure to relocate work with radioactive materials out of California is growing. University of California faculty groups continue to urge UC to cut its ties to Livermore each time the contract comes up for renewal. However, UC vice president for academic affairs William Frazer says that won't happen.

With so many question marks hanging over the labs, the special committee appointed by Admiral Watkins in November 1990 has a tough task—and a unique opportunity to put its stamp on the future of this huge R&D structure. This eight-member advisory panel, chaired by Edward Frieman, director of the Scripps Institute of

Oceanography, was supposed to report back by now. But it is running late, despite the admiral's warning at a public meeting in July that "I can't wait much longer" to restructure the labs. Watkins was worried that Congress would cut the Pentagon's budget for strategic defense, and this in turn would eliminate hundreds of scientific jobs at the labs. "I can't lose those intellectual resources," he said.

This coming transition from the hidden world of weapons building to the open competition of the marketplace will clearly be a wrenching one. At Los Alamos, some of the old-timers fondly recall the early days when they could pursue their weapons research without the need to justify what they were doing or to compete for scarce funds. For some of them, it would be a relief if only they could raise the old gate across route 502 again. But that won't happen; there's no turning back now. ■ ELIOT MARSHALL

Now Dingell Probes the Academy!

Could the world renowned U.S. National Academy of Sciences (NAS) be sucked into the wake of Stanford University's yacht? Following their highly publicized investigation of Stanford's indirect cost rate, which led to the resignation of Stanford president Donald Kennedy, the staff gumshoes of powerful House subcommittee chairman John Dingell (D-MI) have focused their magnifying glasses on the books of none other than the august NAS.

Insiders at the academy don't seem especially worried—since NAS president Frank Press had already launched an internal audit last spring. And indeed, at least one subcommittee investigator, who asked that his name not be used, has told *Science* not to expect inside-the-Beltway equivalents of the Stanford yacht, flowers, and cedar closets, all charged off as overhead costs of research, that brought down Stanford's Kennedy. "I doubt that the national academy will be another Stanford," he said.

But that doesn't mean there won't be any embarrassing revelations. NAS spokesperson Stephen Push says that at a 6 November meeting between NAS accountants and subcommittee staffers, academy officials conceded accounting errors had been made and said they had agreed to pay back some money to the government. "The nature of the accounting errors were things such as a wrong account number put on vouchers or a lack of documentation," explains Push. Asked for examples, Push added that it would be inappropriate to discuss the errors in more detail until NAS completes the internal audit Press

ordered, something the academy hopes to do before Dingell's next subcommittee hearing on indirect costs, scheduled for 12 December. But *Science* has learned that among the items questioned to date were entertainment billings, charges for the academy's study center at Woods Hole on Cape Cod, and an NAS condo at D.C.'s famed Watergate Hotel. Without addressing any of these specifically, academy insiders acknowledge that the NAS has already agreed to pay some money back to the government.

Meanwhile, Dingell staffers seem more impressed with the scope of academy federal funding and its charge-backs to the government than with specific errors they have uncovered so far. "I had no idea, nor did anyone else around here," said the Dingell staffer, that the NAS was "getting \$150 million a year from the federal government with an overhead rate of 71%." By comparison, Stanford's pre-Dingell rate was 78%—a rate that dropped to 55% in the post-Dingell era. But NAS officials contend that because universities use different accounting procedures, the academy's comparable overhead rate should be viewed as only 47%. And where does the \$150 million in federal funding come from? The National Science Foundation, NASA, the Post Office—and almost every other imaginable federal department. Indeed, government agencies now account for three-fourths of the funding NAS receives. ■ JON COHEN

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