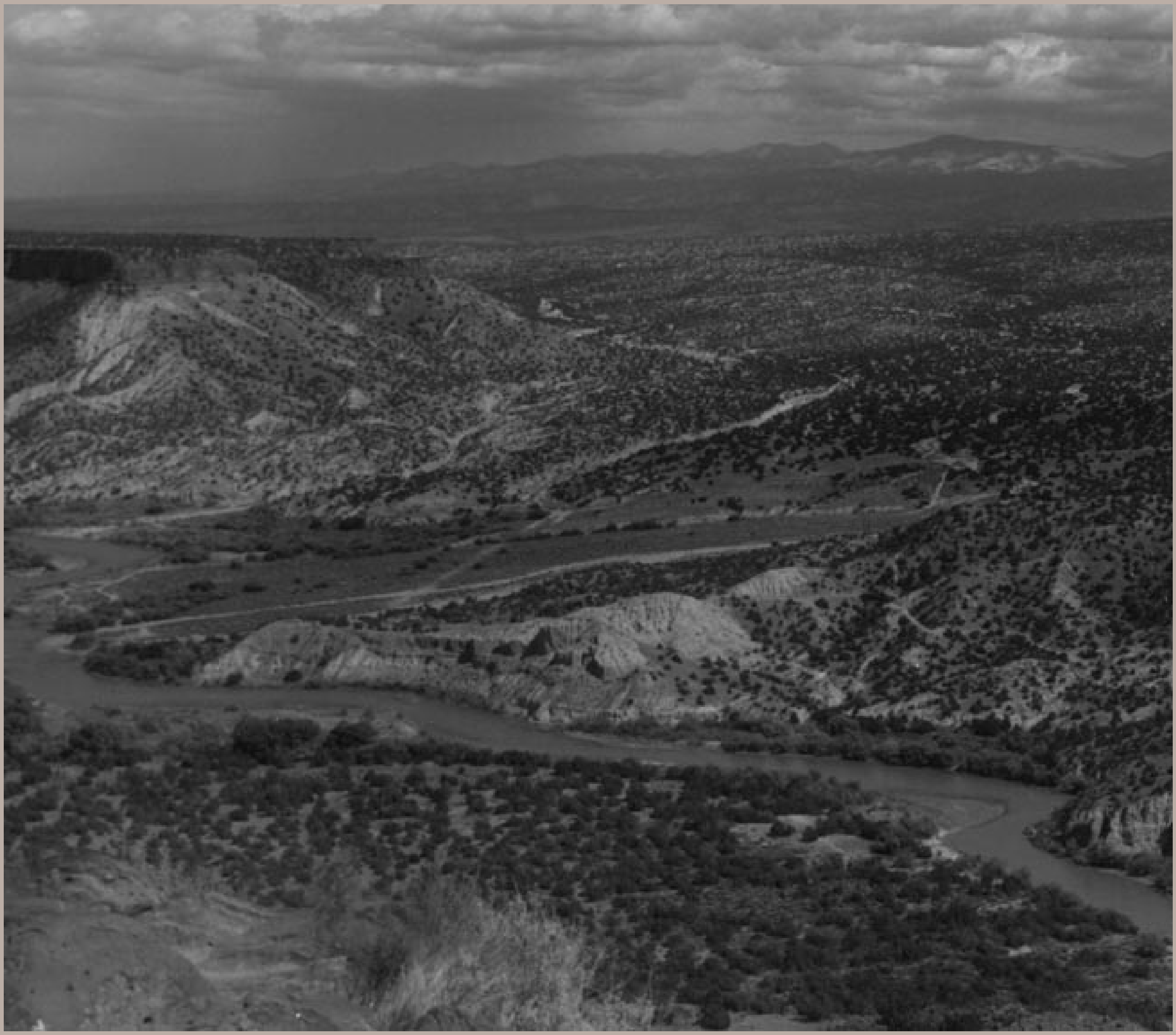
Los Alamos
NATIONAL LABORATORY

A U.S. Department of Energy Laboratory

The View from Los Alamos

Siegfried S. Hecker, Director



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This publication features a collection of excerpts from articles by Siegfried S. Hecker, Director of Los Alamos National Laboratory. They are arranged to present his views on subjects that are relevant to the Laboratory's progress. The quotations from President Clinton were taken from his recent visit to Los Alamos.

If we’re going to march confidently into the 21st century, we will have to do it on the minds and with the creativity and with the investment represented here in this laboratory and in others like it around the country. . . .

These labs are our great national mind treasure, the world’s finest scientists and engineers. . . .

You have the world’s most powerful computers and lasers and accelerators, some of the world’s best materials facilities, the most sophisticated diagnostics. You are our crown jewels in technology and science.

President Bill Clinton. Excerpts from his speech at Sullivan Field, Los Alamos, New Mexico, May 17, 1993

The end of the Cold War allows the Laboratory to address numerous other needs of the nation in addition to its continuing military responsibilities. Among the nonmilitary needs are those of our society and of our industry. Tapping the exceptional technical expertise and capabilities of the Laboratory will not only help tackle the new priorities but also keep the requisite defense expertise strong.

Siegfried S. Hecker, Director Los Alamos National Laboratory. Los Alamos Science, *Los Alamos National Laboratory document LA-UR-93-1350, 1993*

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“ I am sure that almost all of you heard [the president’s] speech. . . . It was reassuring to have him pay such a great tribute to our people and to issue us a great challenge for the future.”

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“I was so gratified to be invited to come to the high school commencement—I didn’t make it, but this is almost as good, don’t you think? I’m really glad to be here.” (President Bill Clinton)

Fiftieth Anniversary Tribute

The president's visit to commemorate the 50th anniversary of our Laboratory was a terrific tribute to the men and women who have worked here to protect freedom and democracy. . . .

From the moment [President Clinton] stepped off the Marine 1 helicopter he was all smiles. . . . In the limousine this smile became even wider when he saw kids and adults on fences and rooftops. . . . He was clearly surprised as he said to Gov. King and Energy Secretary O'Leary, "Did you see all those people?"

Throughout most of the people-lined journey of his motorcade to the Laboratory, he remained glued to the window—waving and smiling. I managed to get in a bit of history and geology—the Jemez Mountains . . . , the mesas, Oppenheimer, Gen. Groves. . . .

The challenge, he said, is to structure the government and the funding so that we would not be inhibited by barriers within the government—such as the separation between defense and civilian research efforts.

At . . . the first tour stop, I had the opportunity to set the stage by presenting our post–Cold War vision. He resonated very strongly with the theme of using our technical competencies, built up principally as a result of defense and basic research, to help the nation with its domestic and economic needs.

We featured exhibits of our collaborations with industry in enhanced oil recovery, biotechnology, magnetic separation for environmental cleanup, fuel cells and LIDAR [light detection and ranging] for detecting air pollutants. For each of these areas our researchers were joined by their industrial partners to demonstrate the benefits of these collaborations.

The centerpiece was a demonstration of the new plasma-source ion implantation chamber recently completed. . . . It will be the main feature of a four-year, $13 million partnership with General Motors and the University of Wisconsin.

After the president asked lots of questions and peered into the eerie glow of the huge plasma chamber, he delivered an impromptu lecture to the news media. Holding up one of the surface-treated parts he talked about the importance of tool life to manufacturing, of manufacturing to competitiveness and of competitiveness to good jobs in America. . . .

When we needed the military muscle to end a global war, the answer was the Manhattan Project. . . .

. . . From the Berlin crisis of 1948 to the Berlin celebration in 1989, when the Wall came down, the work of this laboratory helped to ensure America's might, America's security, and in the end a total triumph for democracy and freedom and free market economics in the Cold War. . . .

President Bill Clinton. Excerpts from his speech at Sullivan Field, Los Alamos, New Mexico, May 17, 1993

In the Central Computing Facility, which we opened on this special occasion for the first time to TV cameras, he was briefed on our nonproliferation activities. He was quite intrigued by the potential of accelerator-based systems for nuclear waste transmutation and plutonium burning.

He appeared to relish the computer modeling demonstrations on global climate change, internal combustion engine design and enhanced oil recovery. He saw the CRAY YMPs and the Connection Machine [supercomputers]. . . . He met the team . . . that won the recent New Mexico High School Supercomputing Challenge, and he shook hands with many Laboratory employees who were helping with the demonstrations. . . .

. . . I took a look at some of the projects under way at a facility that handles—listen to this—plasma ion implantation. Now, that sounds like something a plastic surgeon would do, but it has nothing to do with the human body. Instead it involves a steel vacuum chamber containing high-energy ions, which can be pumped into metal surfaces or plastic surfaces and used to harden them so that they will last longer and do better work. This could revolutionize America's ability to manufacture automobiles and other machines to keep going and to have higher productivity longer and lower costs so we can once again begin to grow high-wage manufacturing jobs. And if it happens, it will happen because of the ideas that started here in the kind of partnerships we need for America's tomorrows.

And this technology was a direct outgrowth of the research done on the Strategic Defense Initiative, the so-called Star Wars initiative, which means that no matter whatever happens there and whatever happens to the final shape of that project, something good came out of it because people were looking to break down frontiers in the human mind and to explore unexplored territory.

President Bill Clinton. Excerpt from his speech at Sullivan Field, Los Alamos, New Mexico, May 17, 1993

I had invited my colleagues John Nuckolls and Al Narath from the Lawrence Livermore and Sandia national laboratories, respectively, to join me in a session with the president, Secretary O'Leary, Gov. King and our congressional delegation. I asked the president what we could do to help him with his new national agenda.

He clearly values the importance of our contributions to the nation. He stated that we will still have to take care of the defense mission. He was interested primarily in how the nation could craft a science and technology policy to allow us to contribute most effectively. The challenge, he said, is to structure the government and the funding so that we would not be inhibited by barriers within the government—such as the separation between defense and civilian research efforts. He also asked us to find ways to improve our own efficiency.

We had additional opportunities to briefly discuss advanced manufacturing, the National Information Infrastructure, biotechnology and environmental research.

The president also had us join in Secretary O'Leary's birthday celebration. He brought the birthday cake with him from Washington.

I am sure that almost all of you heard his speech. . . . It was reassuring to have him pay such a great tribute to our people and to issue us a great challenge for the future. As I have said many times before, we must change to meet these challenges—a theme the president stressed for the nation as a whole. But we've been dealt a good hand. And, the president just strengthened it.

"The Inside Story," Los Alamos Newsbulletin, *May 21, 1993*

There is a peacetime commercial mission for these labs, and there is a national defense mission for these labs, and the line between those two missions is coming down fast. And there is a partnership with the private sector which will spread and grow and strengthen America's support for and understanding of what is done here.

President Bill Clinton. Excerpt from his speech at Sullivan Field, Los Alamos, New Mexico, May 17, 1993

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“The visit to Arzamas-16 and Chelyabinsk-70 followed a visit by the Russian institute directors to Los Alamos and Lawrence Livermore national laboratories.”

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A New Era

There are many indicators of how the world has changed. Everyone has his or her favorite example of what has transpired that was unthinkable even a year ago. I have my own. After nearly half a century of the utmost secrecy, the Russians lifted the veil around their two nuclear weapons design institutes and invited the directors of their U.S. counterparts to visit.

The visit to Arzamas-16 and Chelyabinsk-70 followed a visit by the Russian institute directors to Los Alamos and Lawrence Livermore national laboratories. We visited their closed towns of approximately 100,000 residents (and were the first Americans to jog through their streets), toured their facilities and discussed potential collaborations. We explored how to combat nuclear proliferation threats; protect nuclear weapons against terrorist attacks; ensure safety during transportation, dismantlement and storage; respond to nuclear emergencies; clean up the weapons complexes; conduct joint experiments in fundamental science; and transition some defense activities to civilian technologies.

We found their institutes to be first-rate with impressive facilities and very capable people. Their interest in collaborating was genuine and expressed with a sense of great urgency. Their answer to the loss of weapons scientists and the potential proliferation of weapons knowledge was to keep them involved in challenging and purposeful work. Collaboration with U.S. laboratories is a major part of their strategy.

We found their institutes to be first-rate with impressive facilities and very capable people.

Excerpt from a statement before the Department of Energy Defense Nuclear Facilities Panel, Committee on Armed Services, U.S. House of Representatives, Washington, D.C., March 18, 1992

Beginning the Second Fifty Years

During the past fifty years we have been fortunate to receive generous government support to build and maintain one of the finest scientific institutions in the world. To fight the Cold War, we developed an incredibly broad science and technology base. We were allowed and encouraged to contribute to other important problems such as nuclear power, nuclear propulsion, alternative energy technologies, and biomedical applications. Our sponsors recognized the importance of basic research in maintaining our science and technology base. . . .

These profound changes in military and economic status require the United States to adopt a new approach to technology policy. . . .

Today, several fundamental changes strain not only the foundations of our laboratory, but also the nation's entire science and technology enterprise. The collapse of the Soviet Union has made us the world's only military superpower. At the same time the rise of Japan, Germany, and other industrial countries to economic parity means we are no longer the world's only economic superpower. These profound changes in military and economic status require the United States to adopt a new approach to technology policy. . . .

Nevertheless, there is no question that Los Alamos can develop technologies for the civilian sector, and I think we can do it very well.

The new priorities are primarily domestic and economic. Defense spending, the mainstay of the Laboratory's existence for the past fifty years and formerly the primary engine driving the nation's R&D effort, will decrease. Such fundamental changes require us to re-examine how we do science and technology in this country and how laboratories like ours should contribute to the new national order. . . .

In retrospect, defense was easy. . . . Our principal role—that of designing nuclear weapons—has been well matched to our capabilities, since from the beginning that has been our reason for being. We had the entire responsibility for the full life cycle of nuclear weapons, from generating the ideas for new designs all the way through production, deployment, and finally, to retirement. And we did not let the nation down in that process. . . .

Nevertheless, there is no question that Los Alamos can develop technologies for the civilian sector, and I think we can do it very well. But making a major impact with that technology will . . . require forging new partnerships and relationships, not just with the DOE but also with agencies throughout the government, with industry, and with universities. We will have to be quick, responsive, and flexible, and we will have to bring together the best talent. This need is no less critical today than at the beginning of the Manhattan Project. . . .

Excerpts from Los Alamos Science*, Los Alamos National Laboratory document LA-UR-93-1350, 1993*

The Challenges of Change

The Department of Energy (DOE) nuclear weapons laboratories helped to buy the time for [President Bush's] arms initiatives by providing the technical competence that has been the foundation of the nation's deterrent for nearly 50 years. Nuclear deterrence will remain a cornerstone of U.S. defense policy, and nuclear competence must be maintained to support deterrence and to assess and curtail nuclear proliferation. At the same time, national security is being viewed in a broader context, one that includes other critical national problems such as energy, environment, economic competitiveness, education, and health and human welfare. These are areas in which we can contribute to the nation's well-being, and we have already begun to contribute in many of them. The challenge will be to accelerate these efforts while continuing to provide the defense technologies for the nation's deterrent.

At the same time, national security is being viewed in a broader context, one that includes other critical national problems such as energy, environment, economic competitiveness, education, and health and human welfare.

The requisite technologies evolved from our primary role in nuclear weapons research, development, and testing. We face the challenge of integrating our technologies into the downsized nuclear weapons production complex of the 21st century and helping to ensure the U.S. technological superiority in nonnuclear defense. On the civilian side, we face the challenge of helping to develop clean, abundant energy, cleaning up and protecting the environment, teaming with industry to improve U.S. industrial competitiveness, and teaming with other federal agencies in areas such as biomedical technologies, education, and space. These challenges come to us in a federal budgetary environment that has little elasticity and that does not allow time for gradual change.

Another challenge brought about by evolving public attitudes and regulatory climates is to change our business operations so that the Laboratory will prosper in the next decade and beyond. The necessity for change was brought home forcefully by the preparation for and the actual experience of the Tiger Team inspection of the Laboratory's environment, safety, and health (ES&H) status and programs.

. . . We must reaffirm our vision of the Laboratory's role—to be a world-class laboratory solving complex problems of national importance where science makes a difference. This vision is grounded in the Laboratory's public service orientation and in our determination to remain a first-class scientific institution. We will maintain our special role in the defense arena, particularly with respect to nuclear weapons technology. However, we will increasingly use our multidisciplinary capabilities to solve problems in the civilian sector and to help develop commercial technologies.

Excerpt from* Annual Report to the Regents of the University of California, *Los Alamos National Laboratory document LALP-92-85, December 1992

At the same time, we face these challenges with the promise of a renewed relationship with the University of California, the institution that has managed this laboratory since its inception and that has done much to ensure our reputation for excellence by emphasizing research and insisting on an open environment with freedom of inquiry and expression. The University of California has also been instrumental in helping us attract and retain the best scientific and technical talent. The people of the Laboratory, their can-do attitude, and the strength of our technological base have built this institution. We have developed an environment in which individual creativity is encouraged but which also allows us to assemble teams to solve large, complex problems using the latest in science and engineering. This talent is the basis for our future.

Excerpt from Los Alamos National Laboratory Institutional Plan FY 1992–FY 1997, *Los Alamos National Laboratory document LALP-91-037, October 1991*

Fiscal Changes

By now you are all aware of the projected shortfall in next year's budget. I want to add a few observations to what you have heard. . . . The bottom line is that the president's budget submission to Congress would result in approximately 300 to 400 fewer jobs at the Lab. . . .

. . . We are struggling to preserve the necessary stewardship and nuclear competence for the nation. These losses will be partially offset by increases in technology transfer funding, stockpile surveillance programs and environmental programs. . . .

We have been bombarded by questions about the "green lab" since . . . legislation [was introduced] that could eventually convert one of the two nuclear weapons design laboratories to entirely civilian missions, with a principal focus on the environment. . . .

The proposed bill calls for the secretary of energy to study the consolidation of the laboratories, rather than legislate the consolidation. . . . [Other] legislation . . . would diversify the portfolio of all three of the defense laboratories to help with this nation's domestic and economic agenda.

> *We have been dealt a good hand and in spite of all the uncertainty I would rather play ours than anyone else's. . . .*

. . . We continue to believe that the best investment strategy for the government is to have all three labs work to reduce the overall DOE defense and cleanup budgets and have all three contribute to the domestic and economic agenda of the nation. For example, Los Alamos will have a significant environmental budget because of our cleanup responsibilities at the Lab. This year we are green to the tune of $200 million. Next year the environmental budget will increase by about 20 per cent.

Nevertheless, continued budget reductions in the nuclear weapons program threaten the current strategy. For the first time, the DOE stated in its budget submission this year that the three laboratory structure can still be maintained at . . . the proposed fiscal '94 levels, but any further reductions will require a determination whether the department can sustain this commitment. Hence, the need for the secretary's study. . . .

Next week we will celebrate the 50th anniversary with a week-long open seminar series that will examine future challenges and directions. I encourage all of you who can to attend; come, listen and join the discussion. You will get a better flavor of what challenges we face as the nation changes directions. You will, no doubt, be impressed by the enthusiasm and excitement of what is possible.

I am firmly convinced that the future is bright. . . . We have been dealt a good hand and in spite of all the uncertainty I would rather play ours than anyone else's. . . .

Excerpts from "The Inside Story," Los Alamos Newsbulletin*, April 9, 1993*

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"Since 1943 the University of California has managed the Laboratory for the federal government as a public service."

LOS ALAMOS NATIONAL LABORATORY AND THE UNIVERSITY OF CALIFORNIA

Links to the University of California

Since 1943 the University of California has managed the Laboratory for the federal government as a public service. In 1991 the University and the Department of Energy began negotiating an extension of the management contract to run until October 1997. The Laboratory benefits from the open academic environment strongly supported by the University. The free exchange of ideas nurtures creativity and encourages communication across scientific disciplines. Our affiliation with the University has enabled us to attract and retain the best talent.

Excerpt from Research Highlights 1991*, Los Alamos National Laboratory report LALP- 91-75, February 1992*

Our affiliation with the University has enabled us to attract and retain the best talent.

The new contract represents a major change in the way that UC, the Department of Energy and the Laboratory will interact. The contract was rewritten from the ground up—the most significant revision since the Laboratory was created 50 years ago. UC will take a much more active role in overseeing and managing the Laboratory. The new contract incorporates mutually agreed-upon performance standards and is designed to facilitate our achieving an appropriate balance between administrative controls and technical productivity. . . .

The new contract lays the groundwork for the future—and a basis for reinvigorating the government-owned, contractor-operated system. We are pleased that our relationship with UC is continuing. . . .

Excerpt from "The Inside Story," Los Alamos Newsbulletin*, January 28, 1993*

Campus-Laboratory Collaborations

The Laboratory continues to value—and benefit from—the many productive interactions afforded by University of California management of the DOE contract. For example, we participated in the formation of the University-wide Council on Research. We also are leading the University Campus–Laboratory Interactions Facilitation Team (UCLIFT), which was formally recognized as a committee of the Council on Research in June 1992.

Participation in these organizations has led to an increase in exchange visits by Laboratory and campus professionals; two-way exchange of seminar speakers' participation in college, departmental, and programmatic reviews; plans for jointly sponsored workshops; participation in the development of a University-wide information/data system . . . of expertise, capabilities, and facilities; development of a research-experience-based student exchange program involving a UC campus, the Laboratory, and the University of New Mexico; and planned participation in the President's Postdoctoral Fellowship Program for 1993–1994.

These activities cover a spectrum of science and engineering, including computer science, bioremediation, transportation, global climate change, environmental sciences, high-temperature superconductors, materials science, air quality, and science education. The UCLIFT network is being used as a planning and implementation unit to develop a Laboratory-funded collaborative research program modeled after the successful INCOR (Institutional Collaborative Research) and CALCOR (Campus and Laboratory Collaborative Research) programs.

Other beneficial activities include shared oversight of joint-thesis students, reciprocal visits, jointly sponsored workshops, and small research projects. Reciprocal visits by faculty members and Laboratory scientists range from a few days to a few weeks. The joint Global Climate Modeling meeting hosted by Los Alamos included two days of technical papers on climate research, with more than 60 participants. Our INCOR collaborative research involves eight campuses, over 60 students, and numerous faculty members.

These activities cover a spectrum of science and engineering, including computer science, bioremediation, transportation, global climate change, environmental sciences, high-temperature superconductors, materials science, air quality, and science education.

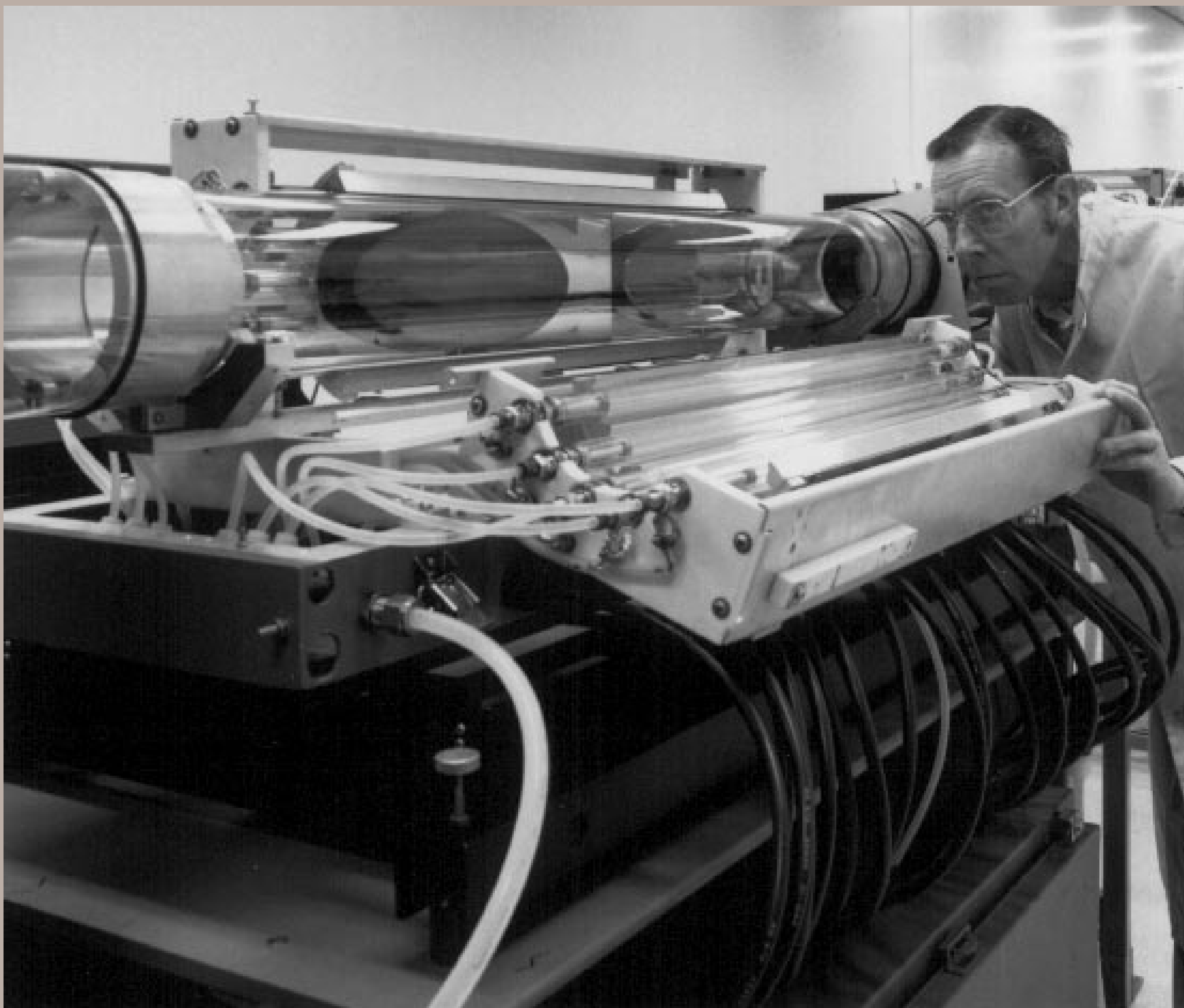
The collaborative outreach research activities of the Los Alamos branch of the Institute of Geophysics and Planetary Physics (IGPP) and other research centers are closely associated with the INCOR and other UC-Laboratory research programs.

The Laboratory-Campus Research and Development Program . . . and the University of California Personnel Assignment Program . . . , developed under the auspices of the UC contract, facilitate research interactions between Los Alamos and UC campuses. . . . The two programs provide an effective mechanism for the Laboratory and the campuses to share expertise and access the considerable resources of the University. . . .

Many less formal activities also are mutually beneficial. . . . Los Alamos has supported campus proposals for new research centers and laboratories. . . . Our Center for Nonlinear Studies supports the University-wide nonlinear science effort. . . . The Los Alamos Center for Materials Science encourages students and young faculty members to participate in the Correlated Electron Theory Program. . . . The Laboratory and the UC campuses both benefit by providing individuals to serve on each other’s advisory committees.

During 1992, almost 260 University personnel interacted with Laboratory staff as affiliates, consultants, collaborators, guest scientists, or official visitors. The Laboratory hosted 43 participants in the undergraduate student summer program; 4 interns; 41 graduate research assistants; and 36 postdoctoral research fellows. About 560 current Los Alamos employees, including 521 technical staff members, are University alumni.

Excerpt from Report to the Regents of the University of California, *Los Alamos National Laboratory report LALP-92-85, December 1992*



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"Nevertheless, it is critical for us to understand the behavior of materials and systems as close to those achieved in nuclear weapons as possible. We will have to redouble our efforts in above-ground, laboratory-scale experiments to enhance our understanding and keep our experience base to the best of our ability."

Taming the Big Bear

Our defense needs have changed dramatically. This country, with help from its allies, has tamed the big bear—and I have proof of that. . . . Our colleagues from the Russian weapons institute gave us a beautifully carved bear as a symbol of friendship and, even more symbolic, a plaque containing a piece from one of their dismantled nuclear warheads. The inscription reads, "From Russia, with love." So we've tamed the big bear, but still many dangers are lurking in the woods. People around the world face threats resulting from fractious nationalism, regional conflicts, proliferation of high-technology weapons, the breakdown of national law, increased terrorism, and increased influence of organized crime. Clearly our nation will continue to need new technology for defense. Here the federal government has the unquestioned central role, and Los Alamos must continue to play its special part in nuclear defense as well as some other defense missions.

Excerpt from Los Alamos Science, *Los Alamos National Laboratory document LA-UR-93-1350, 1993*

Retaining Stewardship

. . . We will retain the stewardship of the enduring stockpile—that is, ensure that it remains safe, secure and reliable. We must also provide the technical stewardship—that is, the cadre of experienced people and collection of facilities necessary to preserve the nuclear competence to face an uncertain future. . . . We must assure that we have done everything possible to retain confidence in the enduring stockpile for as long as possible as we transition from a testing to a non-testing environment.

Nonproliferation

. . . Countering the rising threat posed by the proliferation of nuclear weapons has become the nation's primary security issue. The lessons of Iraq are only too clearly etched in our minds. Recent revelations about close encounters between India and Pakistan that nearly turned nuclear add to the overall uneasiness. Admissions of a successful clandestine program in South Africa and the intransigence of North Korea on international inspections of its self-declared civilian nuclear facilities bring home a sobering message—this world is not yet a very friendly place. Such nuclear ambitions combined with the rampant proliferation of missiles present a clear and present danger.

. . . Countering the rising threat posed by the proliferation of nuclear weapons has become the nation's primary security issue.

However, I believe that it is the disintegration of the Soviet Union and the continuing unrest in Russia and the former republics that present the greatest immediate proliferation danger. . . . I have grave concerns over the control and disposition of the hundreds of tons of nuclear materials produced in the Soviet Union and now available in the form of returned weapons components, residues from manufacturing, spent fuel rods, and nuclear wastes distributed around Russia and the former republics. Acquiring nuclear materials has been the most difficult step for a potential proliferator. Unless stringent accountability and control can be established over all the nuclear materials ever produced in the former Soviet Union, we will enter an era of unprecedented danger.

Nuclear Draw-down

. . . The job of nuclear draw-down will be significant. Thousands of weapons will be returning from the nation's stockpile. The handling, transportation, dismantlement, storage and final disposition will require the technical expertise resident at the laboratories. Increased attention will have to be paid to minimizing wastes in each of these steps since today nuclear waste drives the cost. Nuclear draw-down also refers to the disposition of residues from past production operations and the disposal of nuclear wastes generated over 50 years of production. In fact, draw-down to me also means reducing the size of the DOE nuclear weapons production complex. The costs associated with nuclear draw-down will be substantial. The skills resident in the laboratories will be essential in controlling these costs.

The retirement of thousands of weapons in short order will pose extraordinary challenges in itself. The management of the special nuclear materials during retirement will require significant Laboratory help. Continued support of arms control and verification of agreements and treaties as well as intelligence analysis will become increasingly important. In a world with drastically reduced numbers of warheads, survivability of those remaining becomes even more important. Hence, we must continue to explore qualitative technological improvements to avoid being surprised by potential adversaries and to preserve this nation's options.

Excerpt from **Los Alamos National Laboratory Institutional Plan FY 1992–FY 1997*****, Los Alamos National Laboratory document LALP 91-037, October 1991***

Environmental Restoration and Waste Management

. . . Cleaning up the legacy of 50 years of weapons production will be prohibitively expensive using only today's technologies. The environmental restoration and waste management budget has grown dramatically. It represents half of the total DOE defense activities budget today and it is still growing. Again, the laboratories possess many of the skills to develop a more cost-effective environmental clean-up strategy.

The bottom line is that our nation can now do with fewer nuclear weapons, but we cannot afford to be less smart.

Mr. Chairman, these priorities represent a significant reorientation of our nuclear weapons program. The bottom line is that our nation can now do with fewer nuclear weapons, but we cannot afford to be less smart. There is plenty to do. We give a lifetime guarantee for the weapons we have designed, so we cannot rest until every weapon is retired and disposed of. There is also plenty of uncertainty out there for which the laboratories represent an insurance policy. . . . You asked the key question in your letter—how will we retain the necessary defense competencies in the future?

Retaining Nuclear Competencies

Our success over 50 years can be attributed to our ability to continue to attract the best talent to Los Alamos and to the nuclear weapons program. This was possible because of the solid government support for our mission and for maintaining a broad science and technology base. The work has been extraordinarily challenging, another key ingredient to attracting the best. The new priorities still require the entire set of skills and competencies. However, the intellectual challenge must now be provided by carefully constructed programs that exercise the competencies required for nuclear weapons design and engineering. . . .

Retaining competencies in a no-test environment will be especially challenging since expertise comes from experience, and nuclear testing has represented the most critical part of our experience base to date. . . .

For 50 years Los Alamos has been at the forefront of high-performance computing given the overriding importance in nuclear weapons design and analysis. Modeling and large-scale computations are critical in analyzing three-dimensional weapons systems in realistic accident scenarios to improve our confidence level in modern weapons systems. Significant advancements in modeling capabilities and computational hardware and software will be necessary to improve our ability to predict the behavior of nuclear weapons with greater accuracy than possible today.

Nuclear explosions cannot be fully simulated in a laboratory environment. Nevertheless, it is critical for us to understand the behavior of materials and systems as close to those achieved in nuclear weapons as possible. We will have to redouble our efforts in above-ground, laboratory-scale experiments to enhance our understanding and keep our experience base to the best of our ability. At Los Alamos we are constructing a new hydrodynamic test facility . . . , which will allow us to increase our fundamental understanding of implosions.

Several facilities and experimental capabilities must be enhanced to study the high-energy densities achieved in thermonuclear weapons. We are pursuing several approaches at Los Alamos including pulsed power, explosively driven, and laser driven sources. We are also using the intense power source at the Livermore Nova facility for key experiments. . . .

As long as nuclear weapons are held by other, potentially hostile, nations, our expertise in nuclear weapons technology is needed to ensure U.S. security. Our primary mission has not changed, but the priorities have changed dramatically. Today, our focus is on nonproliferation; draw-down—that is, the reduction of nuclear weapons, nuclear materials, nuclear waste, and nuclear production sites; and cleaning up the legacy of 50 years of production. The most immediate challenge is how to live with a test moratorium and an eventual test ban while assuring the safety and reliability of the enduring stockpile. We can only accomplish this goal by retaining a cadre of experienced weapons designers and engineers and by keeping them challenged with significant technological problems.

Excerpt from* Annual Report to the Regents of the University of California, *Los Alamos National Laboratory document LALP-92-85, December 1992

Countering the proliferation threat poses significant intellectual challenges. . . . In addition to proliferation detection, there are significant challenges in analyzing proliferation threats, mitigating those threats, responding to emergencies, and identifying likely nations that either threatened or may have actually used such weapons, as in an act of terrorism. . . .

Non-Nuclear Defense Technologies

Los Alamos research and development technologies will . . . continue to be tapped by the Department of Defense for the development of conventional non-nuclear defense. The synergism between our nuclear research and development technology and non-nuclear work has been demonstrated in explosives development, armor, anti-armor, advanced munitions, and computer simulations for performance, safety, and lethality. In recognition of emerging defense requirements, Los Alamos has been in the forefront in the development of nonlethal technologies and concepts. These techniques will be instrumental in providing the DoD new capabilities for force application in contentious periods as well as for peacekeeping operations. These are important programs at our laboratory and their linkage will continue as a strategic element in maintaining an effective R&D base.

Excerpt from a statement before the U.S. House of Representatives Armed Services Committee, Military Application of Nuclear Energy Panel, Washington, D.C., May 3, 1993

. . . Concerned that Iraq might deploy chemical and biological weapons [during the Gulf War], the Department of Defense asked us to develop a portable instrument capable of detecting and tracking aerosols in a battlefield environment. We did that in less than a month. The heart of the system is a light detecting and ranging (LIDAR) laser system based on portable LIDARs we developed and used for environmental and meteorological sensing.

Long before Iraqi forces actually ignited Kuwait’s oil wells, scientists were speculating about the effect the smoke from such a conflagration would have on the global climate. To study the problem, we used computer modeling capabilities developed for our research on nuclear winter. Our calculations predicted—correctly, as it turned out—that the smoke from the burning oil fields would have only local and regional effects.

Desert Storm also demonstrated that we need weapons that will protect our nation’s interest with a minimum of human casualties. We have been developing concepts for weapons systems—known as non-lethal defense—that will stop the movement of war material and attack the supporting infrastructure rather than people. These concepts can also be useful in peacetime operations such as counterdrug engagements.

We continue to work with Boeing Aerospace to develop high-power free-electron lasers useful for defense applications. Desert Storm made the nation more aware of the need for defense against short-range missiles with chemical or biological payloads that would be deployed immediately after the boost phase. A powerful laser such as an FEL could take out such a missile during the boost phase, before it releases its payload. We are collaborating with Lawrence Livermore and Phillips laboratories on the conceptual development of an airplane-based laser system to counter this potential threat.

Excerpt from "The Inside Story,"
Los Alamos Newsbulletin,
January 17, 1992

Advanced Conventional-Defense and Intelligence Technologies

. . . Political changes and advancement of technology everywhere may lead to advanced-technology threats and weapons . . . and terrorism on a scale we have not seen before. Maintaining a strong defense R&D effort that emphasizes effectiveness and quality over quantity of military hardware will help to dissuade potential future conflicts, or if necessary, to conclude future conflicts decisively and with low human casualties. . . .

Areas of present and future contributions

- **"Smart" weapons that can hit maneuvering and concealed targets**
- **Effective defenses against ballistic and theater missiles and other weapons**
- **Computing and communications hardware and software**
  - **Command, control, communications, computation, and intelligence. The "forward edge" in future military actions will be information and command networks.**
  - **Simulations of battles for training and tactical planning and simulations of the performance of new hardware for design.**
- **Intelligence, including global surveillance, and weapons expertise to avoid being surprised by advanced-technology foreign weapons**

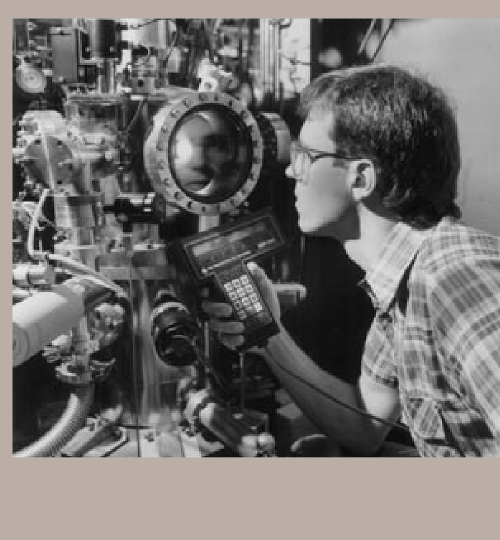
Technologies for advanced systems (nearly all have civilian uses)

- **Integrated modeling, simulation, and gaming techniques**
- **System-level integration (especially for command, control, communications, computation, and intelligence)**
- **Powerful software-generation systems**
- **Other aspects of computing**
- **Communications**
- **Electro-optics and optical electronics**
- **Space technologies**
- **Sensors**
- **New materials for structural use, electronics, and storage and conversion of energy, including biologically generated or copied materials**
- **Nanotechnology based on electronic, mechanical, and biological techniques**
- **Flexible manufacturing**
- **Unmanned automated vehicles for air, sea, and land**
- **Nonlethal weapons**
- **Stealth and counterstealth**
- **High-performance missiles**

Excerpt from Los Alamos Science*, Los Alamos National Laboratory document LA-UR-93-1350, 1993*

RN 93020 005

"Opportunities to apply their R&D to the benefit of industrial competitiveness are providing new challenges to laboratory scientists and engineers."



RN 93159 031

The Need for Change

The United States is losing ground in the international economic arena. In just a few years we have gone from a nation of surpluses to the world's largest debtor nation. The foreign trade deficit remains alarmingly high. We have lost, or are losing, major industrial markets (such as consumer electronics, memory chips, machine tools, and automobiles) to overseas competition. Moreover, the underpinning of a strong economy, the manufacturing sector, continues to erode, making a rapid recovery very difficult. The country's troubled educational system is not providing us with a technologically literate workforce. Medical research has helped to prolong life expectancy, yet we face a crisis in health care cost. . . . The role of the federal government is clearly important in the health care and education fields. It is also important in energy and the environment. Legislation such as the Clean Air Act drives energy and environmental strategies to a large extent. The government's energy research and development (R&D) investment strategy is driven by different factors than are the strategies of individual utilities or companies that answer to customers and stockholders. The federal strategy may call for R&D with critical long-term implications to the public, but with little immediate profit potential. A strong federal role in environmental matters is also important since the consequences of environmental actions transcend not only individual companies but also national borders.

Laboratories such as Los Alamos must not only enhance the nation's basic research and critical technologies capabilities, but they must find ways to weave this technological expertise into the fabric of U.S. industry to help build a lasting competitive edge.

In fact, energy, environment, and economic competitiveness are inextricably intertwined and, therefore, a federal role in these areas is necessary. However, whether the goal is producing energy, using it efficiently, cleaning up the environment, minimizing future pollution and waste, or producing quality goods that are internationally competitive, U.S. industry must accomplish it. . . .

Although many macroeconomic factors such as tax policy, trade policy, cost of capital, etc., affect economic competitiveness, technology has time and again been demonstrated to be a prerequisite for international industrial leadership. Laboratories such as Los Alamos must not only enhance the nation's basic research and critical technologies capabilities, but they must find ways to weave this technological expertise into the fabric of U.S. industry to help build a lasting competitive edge. We have a successful example in our historic relationship with the supercomputer industry. . . . [and] we have conducted several experiments in the past few years to develop industrial partnerships in other areas. . . .

Excerpt from Los Alamos National Laboratory Institutional Plan FY 1992–FY 1997,
Los Alamos National Laboratory document LALP 91-037, October 1991

The Role of the Nuclear Weapons Laboratories

. . . The U.S. government is now turning increasingly to its domestic and economic needs that in the long term may affect national security as much as do military needs. At Los Alamos we are using our special scientific and technical capabilities, built mostly on the foundation of our defense work for 50 years, to help the nation conquer some of the civilian challenges. We have performed basic research and contributed to civilian technologies for most of our 50 years of existence. . . .

It would be incredibly wasteful not to utilize the competencies of these laboratories to tackle the daunting domestic and economic problems facing this nation.

. . . Current national priorities, as well as recently introduced legislative measures, . . . encourage the laboratories to contribute to the civilian agenda, especially to enhance the economic performance of U.S. industry. . . . Under the umbrella of defense conversion we will necessarily retain traditional missions, albeit at a reduced level, and now embrace new ones. Hence, conversion to me means the Laboratory finding a new equilibrium point for the balance between defense and other emerging societal goals.

Some have claimed that the search for new missions by the laboratories is only an exercise in self-preservation. I maintain just the opposite—it is smart business practice on the part of the U.S. government. Technology continues to be the engine that will drive economic growth in the future. It is also critical to renewing the national infrastructure and in improving the quality of life of our citizens. The nation has made an enormous investment in leading-edge technologies at Los Alamos and its sister laboratories, principally for the defense of its people. At the bench-top level, most of these technologies are easily interchangeable with civilian-sector technologies; that is, we deal predominantly in dual-use technologies. It would be incredibly wasteful not to utilize the competencies of these laboratories to tackle the daunting domestic and economic problems facing this nation.

Los Alamos should be involved in those areas where our core technical competencies are needed to solve important national problems. In addition, our programs should complement those of universities and industry. Examples of important civilian R&D projects where the government is a principal driver and the DOE laboratories could play an important role are: a national communications and information network; the clean car (perhaps call it the green car) initiative designed to take the automobile out of the environmental equation and significantly enhance the fuel efficiency in the process; an enhanced national environmental monitoring and computational initiative that provides a risked-based analysis of various environmental initiatives; an enhanced human genome and structural biology program that builds the foundation for personalized medicine; a publicly acceptable nuclear energy program, perhaps utilizing accelerator-assisted fission and nuclear waste transmutation; and an enhanced science and mathematics education program including enhanced technical training of the U.S. work force.

Excerpt from "The Inside Story," Los Alamos Newsbulletin, *November 20, 1992*

Although I am convinced that the laboratories can contribute to civilian technologies, making an impact on domestic and economic problems will be a major challenge. By comparison, defense was easy. The federal government is the customer and we are particularly well matched to the needs of that customer. On the civilian side, especially if industry is the customer, our organizational experience, management and training must be changed significantly. The laboratories will be challenged to become quick, responsive and flexible in order to mesh with the very rapid cycle times and parallel research, development, and manufacturing paradigms of industry.

I see two major roles for the laboratories to contribute to the domestic and economic needs of the nation. First, we can conduct mission-oriented research that addresses overarching civilian national needs, such as clean, affordable, abundant energy; a clean environment; a refurbished public infrastructure; and affordable health care available to all. Mission-oriented research will be primarily driven by the government because the benefits to the public outweigh the benefits to individual private firms. Second, we can develop enabling technologies with commercial relevance. Such research must have industrial input and participation because it should be designed to deliberately contribute to the nation's industrial technology base.

Excerpt from a statement before the U.S. House of Representatives Armed Services Committee, Military Application of Nuclear Energy Panel, Washington, D.C., May 3, 1993

Dual-Use Technologies

. . . To successfully meet the great challenges facing our nation in . . . civilian areas, we must marshal all our technological resources. The laboratories have excellent people and world-class facilities thanks to decades of strong support for the nuclear weapons mission. They are accustomed to having full research-to-retirement responsibilities and focusing on a product. They can field teams of scientists and engineers to tackle problems large in scale (either time, scope, or complexity) where a scientific approach is required. Los Alamos has developed strong core technical competencies including [the following]. . . .

They can field teams of scientists and engineers to tackle problems large in scale (either time, scope, or complexity) where a scientific approach is required.

Nuclear Technologies. We have developed a new method of treating nuclear waste that promises to reduce the storage problem from tens of thousands of years to a few hundred. Using concepts based on powerful accelerators developed with SDI [Strategic Defense Initiative] support, we would generate copious quantities of neutrons that transmute toxic nuclear waste to more benign forms. This accelerator transmutation of wastes . . .

concept also offers the possibility of generating electricity in a safer operating regime than nuclear power reactors.

Accelerator-driven intense neutron sources also have potential applications for producing biomedical isotopes, tritium, and plutonium-238 for heat sources for NASA deep space missions. In addition, such neutron sources contribute to our understanding of materials and biological structures, and could provide facilities for the study of neutron-damage in fission or fusion reactors. The Los Alamos Meson Facility (LAMPF) will play an important role in developing such applications.

High-Performance Computing and Modeling. We will continue to collaborate with computing systems manufacturers to push the leading edge of computing and shape the computing environment of the future. Our ability to model complex physical and chemical processes and to solve large computational problems could significantly impact processing, manufacturing flexibility, and product time cycles in U.S. industry. We are developing the concept of establishing a computational test bed for industry at Los Alamos to improve U.S. industry’s utilization of state-of-the-art computational capabilities.

Advanced Materials and Processes. Synthesis and processing of advanced materials will be critically important to the competitiveness of U.S. industry. Los Alamos has extensive experience in materials science, including novel processing technologies such as microwave processing, laser welding, thin-film deposition, and plasma processing. These capabilities can support industrial initiatives in new, light-weight automotive materials, new high-temperature alloys and ceramics, and new high-temperature superconductors for power and electronics applications.

Advanced Sensors and Flexible Manufacturing. Dynamic experiments and advanced sensors (or diagnostics) have been a hallmark of the nuclear weapons program. The next era in manufacturing technologies will be that of flexible or agile manufacturing, that is, the ability to mass produce goods that are highly individualized. This will require a new generation of intelligent machine tools that rely heavily on advanced sensors and robotics. When combined with modeling and simulation of manufacturing processes and operations, these tools will usher in the new era of flexible manufacturing. Teaming the laboratories with U.S. industry will improve America’s competitive posture. We are also developing advanced sensors for monitoring climate change and characterizing industrial pollution.

Laser Beam Technologies. As a result of directed-energy research of SDI, Los Alamos has developed free-electron lasers that are more efficient, more compact, with higher power and shorter wavelength to make them very attractive as a future-generation light source for photolithography. The free-electron laser would be part of a projection soft x-ray lithography system that could produce feature sizes less than 0.1 micron, hence greatly increasing the amount of information that can be stored on a computer chip. We are working closely with U.S. industry to remain informed of alternative light source approaches and to develop much of the rest of the projection lithography system. We have also developed an extremely versatile LIDAR (laser based radar) system that can monitor pollution and is currently being used in an evaluation of Mexico City's air quality. . . .

Applications in civilian space technologies and nonnuclear defense cut across many of our core technologies. Teaming with defense contractors in advanced conventional munitions and concepts, nonlethal defense, advanced simulation and modeling, and strategic and theater defense will allow the U.S. government to leverage its defense R&D investment. Similarly, our core competencies can contribute to the new and exciting challenges in space. The Los Alamos satellite instrumentation program for arms control verification puts us at the forefront of small satellite technology for sensing global climate change and helping NASA with spacecraft technology for the Lunar Resource Mapper.

Excerpt from a statement before the Department of Energy Defense Nuclear Facilities Panel, Committee on Armed Services, U.S. House of Representatives, Washington, D.C., May 18, 1992

Working with Industry

Technology transfer evokes images of technology as a commodity; that is, something that can be bought or transferred in a supermarket style (the federal labs placing their technologies on a shelf for industry to choose). We need to view technology as more of a process that depends on people. The leading industrial companies have learned that classical, sequential technology development (starting with basic research, moving to applied research, and so on) no longer works. They have shifted to concurrent research and engineering to cut the time needed for introducing new technologies and to reduce the product cycle time.

Fierce international competition demands the adoption of concurrent methodologies that leverage the contributions of universities and federal laboratories for U.S. industry. . . .

. . . Opportunities to apply their R&D to the benefit of industrial competitiveness are providing new challenges to laboratory scientists and engineers. The laboratories have formed effective means of promoting work with industry. At Los Alamos, for example, we established an Industrial Partnership Center to enhance our interactions with industry.

. . . We are very encouraged by our initial partnership experiments in superconductivity and enhanced oil recovery, in which we pioneered the concept of industry-driven, cost-shared collaboration with industry within the DOE system.

. . . We are very encouraged by our initial partnership experiments in superconductivity and enhanced oil recovery, in which we pioneered the concept of industry-driven, cost-shared collaboration with industry within the DOE system. These concepts were incorporated into the 1989 National Competitiveness and Technology Transfer Act (NCTTA). Other significant collaborations between DOE laboratories and industry are in specialty metals processing, waste reduction, high-performance computing, and lightweight automotive materials.

Excerpts from "The Inside Story," Los Alamos Newsbulletin, *June 5, 1992*

Congress has pushed this area [of working with industry] relentlessly in the past few years. The Bush administration developed its National Technology Initiative to pursue enhanced federal-private sector collaboration. The Clinton administration begins with a starting philosophy of believing that the government not only has a role but, in fact, an obligation to foster such collaboration.

President Clinton made that quite clear in his State of the Union message. Secretary of Energy Hazel O'Leary followed up by reprogramming an additional $47 million from the nuclear weapons research, development and testing budgets to technology transfer this year.

There is no more ambiguity; the government expects us to enhance our efforts to work with American industry to improve American competitiveness in the international marketplace.

The most encouraging development over the past two years is the significant interest that industry has displayed in developing cost-shared, market-driven partnerships with Department of Energy laboratories. . . .

Cooperative Research and Development Agreements

The Laboratory has executed thirty-eight CRADAs in a wide variety of fields. The following is a sample:

- **High-speed sequencing of DNA by detecting individual base molecules with laser-induced fluorescence (Life Technologies).**
- **Removing uranium and plutonium from soil using high-gradient magnetic fields (Lockheed).**
- **Developing the next generation of models of electromagnetic processes in semiconductor chips, of large molecules (containing several thousand rather than several hundred atoms), and of global climate change (Cray Research).**
- **Constructing random-access computer memories using new techniques so that the memories do not lose information when power is interrupted (Radiant Technologies).**
- **Developing ways to produce very stiff materials for the aircraft and automotive industries by coating materials with diamond or diamond-like carbon (DuPont and Sandia National Laboratories).**
- **Optimizing complex metal-forming operations by expanding models of tool-workpiece friction and material behavior, with applications to forming aluminum sheet (Alcan) and corrosion-resistant pipe (Exxon).**
- **Developing high-temperature-superconducting materials, fabrications technology, and device applications: electronic (DuPont), microwave communication devices (Neocera).**
- **Adapting advanced pattern-recognizing neural networks for use in simplified and inexpensive quality-control systems (Ethicon).**
- **Isolating fetal cells from the mother's blood in order to test for congenital diseases without invading the womb (MediGene).**

Excerpt from Los Alamos Science*, Los Alamos National Laboratory document LA-UR-93-1350, 1993*

. . . On the basis of the competition for DOE technology transfer initiative funds, we have established that there is at least 10 times as much interest in industry than we are currently able to fund. . . .

All in all, working with industry presents enormous opportunities for the Laboratory in the next few years. . . . We can demonstrate that we can contribute to the solution of other important national problems such as the economy. We have a window of opportunity to show the nation we can help. Let's rally to seize that opportunity.

Excerpts from "The Inside Story," Los Alamos Newsbulletin*, March 19, 1993*

Los Alamos and its sister laboratories (both defense and energy multiprogram labs) can make substantial contributions to long-term industrial competitiveness by devoting up to 20 percent of their budgets to working directly with industry. But to make this work, it must first be acknowledged that the labs cannot "save" industry. We should also replace the concept of technology transfer with that of industrial partnerships—deliberate collaborations with U.S. companies driven by the needs of industry. . . .

The Computational Test Bed at Los Alamos is an example of a new type of user facility designed specifically for industry. It provides education and training as well as direct use, and it should serve as a model for other such facilities.

I envision four principal mechanisms for the DOE laboratories to work with industry on commercially useful R&D. . . .

Currently the principal mechanism for collaborative R&D partnerships is the Cooperative Research and Development Agreement (CRADA), a vehicle created by legislation. The collaboration is cost-shared, so no money need change hands. The work is driven by the needs of industry, and the industry's right to intellectual property is protected. . . . Industry not only gets a match for their R&D dollars but also buys into the Laboratory's capabilities. . . .

User facilities provide the second, very effective avenue for helping industry. Early on, national user facilities, such as accelerators and reactors, were primarily tools for nuclear and high-energy physics. More recently, nuclear reactors have been used for neutron scattering studies in materials science and bioscience. Accelerators have been constructed as sources of neutrons and x-rays for studies of materials.

Transmission electron microscopes, combustion-research facilities, materials-processing facilities, and DNA-sequence databases have all been made available to users. These facilities are very attractive to private companies and will enhance our ability to work with them. The Computational Test Bed at Los Alamos is an example of a new type of user facility designed specifically for industry. It provides education and training as well as direct use, and it should serve as a model for other such facilities.

Technology assistance is the third avenue of collaboration. . . . Much of the innovation and the job creation in this country is done by small companies. They incorporate new technology more quickly than large companies because their survival depends on it. Yet they often do not have their own research capabilities. For instance, the machine-tool industry in this country is only approximately 25 percent computerized and they need help to take better advantage of computers. We can provide that help. We could get on board with the National Institute for Standards and Technology (NIST) to work within the manufacturing extension centers. Through the nuclear weapons program and its legacy, many of our people have worked as liaisons in the DOE production plants. They developed the CAD/CAM [computer-aided design/computer-aided manufacturing] systems for those plants and could do that for industry today.

Assisting small business start-ups, or creating them, is the fourth avenue and the most direct way of introducing new technology into the marketplace.

Assisting small business start-ups, or creating them, is the fourth avenue and the most direct way of introducing new technology into the marketplace. . . . Although we have spun off thirty-eight companies in the past ten years, such start-ups have not been a large focus of ours in the past. They have, however, been successfully encouraged at universities in the areas of computer software and biotechnology. We have extensive software and biotechnology capability, and now we have a substantial environmental capability. So we view small business start-ups as a promising avenue for getting technology into the marketplace.

Clearly, there is no single magic bullet for improving the nation's economic performance. In the next few years the nation must experiment with several approaches. Progress will have to be monitored, and future funding of collaborations will have to be based on success with industry as well as the ability to demonstrate public good. But this is a very new area for the Laboratory and the government. Our emphasis should be on the creation of long-term relationships rather than on the production of short-term payoffs. We should continue to expose our industrial partners to the best of science, but we must also listen to them and allow their problems to drive our collaborative work. In the meantime the Laboratory and the government must sharpen the national missions that will account for the bulk of our work. We should also involve industry in these missions so that as we accomplish the government's goals, we also strengthen the nation's industrial science and technology base. Through fulfilling those missions, the Laboratory will also be able to sustain its core technical competencies, which, in turn, will provide the source of innovative contributions to commercial technologies.

> *Excerpts from* Los Alamos Science, *Los Alamos National Laboratory document LA-UR-93-1350, 1993*

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"The tools required for these tasks [in researching global climate change] are precisely the capabilities existing at Los Alamos: massive computational models of interacting global systems and versatile experimental and observational systems including remote sensing from ground, aircraft, and satellite platforms."

Sensor Systems

Our ability to translate science into applications was certainly demonstrated by the Manhattan Project, but there are many more recent examples. . . . We've designed over 300 [space sensors] that have worked. We have operated an accelerator in space, to the dismay of some, but to the delight of many of us. During the Gulf War we put together a LIDAR [light detection and ranging] system for tracking chemical and biological agents with lasers. We accomplished that task in seventeen days, much of it during the Christmas holidays. It was a stunning example of the dedication and technical strength of the staff. Fortunately, we didn't have to use the system in the Persian Gulf, but we turned around and used LIDAR in Mexico City and in Barcelona to monitor air pollution and in the central Pacific to make some crucial measurements for global climate modeling.

High-Performance Computing

Our strength in nuclear science and technology is unparalleled—and although things nuclear are a rather small part of the overall economic agenda, behind that strength lies a whole spectrum of expertise in mathematics, physics, modeling of complex physical systems, and large-scale computer simulation. We devote between $250 and $300 million a year to the broad subject of high-performance computing, which includes hardware, software, applications, and basic research. Having made that kind of investment, the country can expect us to be the best at applying computers to solve real problems, and we are. In the nuclear-weapons business, we've always had to outcompute everybody else in the world. . . .

Los Alamos was named one of two DOE High-Performance Computing Research centers. . . . The centers are part of an initiative to strengthen U.S. competitiveness in science and industry through the application of high-performance computing and communications technologies and to use the computer systems to solve problems of major scientific, economic and environmental importance. At Los Alamos, we will focus on a major problem in global climate modeling. An important addition to our computing capability will be the first production model of the new Connection Machine model CM-5 supercomputer, from Thinking Machines Corp. . . .

Excerpt from "The Inside Story," Los Alamos Newsbulletin, *January 17, 1992*

This past year . . . saw the dedication of the Advanced Computing Laboratory [which] will not only support our research in key areas but also reach out to the industrial and academic worlds.

The Computational Testbed for Industry encompasses the resources of our high-performance computing environment, including the technical expertise of the Los Alamos scientists and engineers who use advanced computing for practical applications. Industrial collaborations between the Laboratory and U.S. industry have been ongoing for many years. Part of the Testbed's mission is to forge, strengthen and expand these partnerships.

Excerpt from "The Inside Story," Los Alamos Newsbulletin, *January 28, 1993*

Materials Science

We invest in excess of $100 million a year in materials science and technology. Of course, some of that work is very specific to uranium, plutonium, and other materials that people hope they never have to work with, but we're also working on materials problems for novel electronic and photonic devices, for nanotechnology, for application of high-temperature superconductors, for efficient fuel cells, higher-temperature structural materials, and much more. . . . Other areas of expertise include accelerators, lasers, sensors, and dynamic experiments.

Basic Research

I am underscoring our strength in basic research because that strength underlies our ability to contribute to civilian technologies. Many in this country believe that we need less basic research and more applications. But . . . if one takes a rational look, even in the defense arena, it's clear that this country needs to cast the net as broadly as possible—investments in research must remain broad and basic.

At Los Alamos we have some of the best people, and we have some very special and unique capabilities. Consequently, investment in basic research at Los Alamos results in multiple payoffs. We do not simply publish ideas that are picked up and applied by other countries. We have the people who can translate those ideas into technology, and we've done just that over and over. Basic research is also crucial to the health of the Lab itself. It is the fountain of ideas for technology, and it is our link to the academic community. For example, aside from the good physics done at LAMPF, the Los Alamos Meson Physics Facility, that facility has provided a most important connection to the academic community. Over a thousand scientists from around the world have come to do experiments at LAMPF. Many visiting scientists come from universities to work in other parts of the Laboratory. We also have 1300 students and 200 postdocs who are our link to the future.

Translating Basic Research into Practical Technologies

The Laboratory's success in translating basic research into practical technology is demonstrated by the following examples.

- **The KIVA computer program for modeling internal-combustion engines. A spin-off from groundbreaking developments in numerical hydrodynamics, KIVA is now used by all the Big Three automobile makers to design engines.**
- **The side-coupled cavity used in high-power radio-frequency commercial accelerators. Originally designed to create intense particle beams at the LAMPF accelerator, it is now used in high-energy x-ray machines for cancer therapy and industrial radiography. . . .**
- **High-temperature superconducting cables and electronics. Building on considerable expertise in the physics of high-temperature superconductors, the Laboratory is helping a total of seventeen U.S. companies develop the technology base required for competitiveness in thin-film electronics and in electric-power transmission.**
- **Flow cytometers for biology and medicine. The flow cytometer was developed at the Laboratory in the 1960s to study the effects of radiation on cells. This instrument, which uses lasers to separate cells or chromosomes according to their characteristics, is widely used in hospitals to diagnose diseases such as AIDS and leukemia, to monitor transplants and the effects of cancer therapy, and to assist biological research in the Human Genome Project and related work. . . .**
- **Resonant ultrasound spectrometry for nondestructive testing. Invented at Los Alamos to study basic structural properties of high-temperature superconductors and other new materials, the resonant ultrasound spectrometer is now available from Quatro Corporation as a tool for nondestructive testing of high-precision objects such as ball bearings.**

Excerpt from* Los Alamos Science*, Los Alamos National Laboratory document LA-UR-93-1350, 1993

Los Alamos always has advanced and must continue to advance the frontiers of science. Nuclear physics was the exciting frontier when this laboratory began and remains a challenging and productive field. But today we're seeing an explosion of knowledge in the biosciences, materials sciences, and computing/information sciences. For that reason we hope to refocus LAMPF from a nuclear-physics facility to one aimed at two of these areas. This change will depend on upgrading the accelerator at LAMPF and creating an advanced spallation neutron source, a facility that will make the U.S. once again a world leader in the fast-growing area of neutron scattering.

I am underscoring our strength in basic research because that strength underlies our ability to contribute to civilian technologies.

Environmental Research

Environmental research, an expanding area at Los Alamos, is one of the best examples of a field in which civilian and defense needs are served simultaneously. It also has great potential for industrial spin-offs. The government will be its own customer—and the Department of Energy, in particular, a big customer. At the same time the technological developments will surely spur competitive industry in the environmental arena.

As an example of a specific, large civilian technology project suitable for Los Alamos, I would mention first the clean, or green, car. . . . There is a real possibility of designing nonpolluting automobile engines that are twice as fuel-efficient as present combustion engines. Such a development would clearly benefit the entire nation, not just the automotive industry. Another major project is the application of accelerators to the efficient destruction of plutonium, the elimination of high-level nuclear waste, and the production of energy. Los Alamos is already exploring specific systems, and they look quite promising.

Environmental research, an expanding area at Los Alamos, is one of the best examples of a field in which civilian and defense needs are served simultaneously.

Electronic Highways

The building of electronic highways across the nation that integrate computing and communication hardware and software is a realistic goal and one that will be of great benefit to business, industry, education, and healthcare. Los Alamos and its sister national-security labs have the in-depth expertise to develop and test prototypes of such systems, and I expect we will be called upon to do so.

Biosciences

Finally, I'd like to mention our growing contributions to the biosciences. Our work on the Human Genome Project, structural biology, and medical diagnostics has already demonstrated the value of the Laboratory's combined strength in biology, chemistry, physics, mathematics, and engineering.

Excerpt from Los Alamos Science, *Los Alamos National Laboratory document LA-UR-93-1350, 1993*

GenBank, the database containing base pairs, or genetic building blocks, recently passed the 100 million milestone in the number of base pairs stored. To help scientists more easily access this information, we developed an electronic format for “publishing” the data.

Congressional investigators recently concluded that the molecular analyses performed by the Laboratory’s HIV Sequence Database on behalf of the government’s investigation of AIDS transmission from a dentist to five of his patients deserve high marks. The database assists the U.S. Centers for Disease Control and Prevention in its assessment of accidental infections of lab workers working with simian viruses.

Excerpt from “The Inside Story,” Los Alamos Newsbulletin, *January 28, 1993*

Energy Research

We continued to work with the petroleum industry, providing our equipment, facilities, technologies and expertise to improve oil-recovery processes. Through better seismic survey techniques, application of ultrasonic energy to well drilling, modeling nuclear well-logging instruments to help improve their designs, and modeling the flow of oil and water through reservoir formations, we help to ensure U.S. energy security.

. . . We completed an agreement with General Motors to develop a fuel cell power system for transportation applications. We have found that the proton exchange membrane fuel cell operating on reformed methanol may be an excellent power source for electric vehicles. Eventually, an electric vehicle with a range comparable to that provided by internal combustion machines may be developed.

Our technique, comparable to making a wire out of a piece of chalk, produced continuous tapes up to 130 feet long.

Also in the field of energy, we produced a high-current electrical tape made from a new high-temperature superconducting ceramic. Our technique, comparable to making a wire out of a piece of chalk, produced continuous tapes up to 130 feet long. Tests on short sections showed that the tape comes close to meeting requirements for high-temperature superconducting tapes projected by the DOE.

Excerpt from “The Inside Story,” Los Alamos Newsbulletin, *January 17, 1992*

Global Climate Change

The observed increase in atmospheric greenhouse gases over the last century suggests the possibility of changes in the earth’s climate system. This complex physical/chemical system involves interactions among the atmosphere, oceans, polar ice, biosphere, and solid earth. The implications of possible climate change are serious enough that an international initiative has been established. This initiative includes an integrated effort on the part of most U.S. research agencies to establish the existing climate and its trends; predict climate change under various greenhouse gas emissions scenarios; and estimate the effects of altered climate on such factors as water resources, ecosystems, and energy use.

The tools required for these tasks are precisely the capabilities existing at Los Alamos: massive computational models of interacting global systems and versatile experimental and observational systems including remote sensing from ground, aircraft, and satellite platforms. Given the DOE's responsibility to formulate energy strategy, the Laboratory is aggressively pursuing research that addresses issues of global climate change.

> *Excerpt from* Los Alamos National Laboratory Institutional Plan FY 1993–FY 1998, *Los Alamos National Laboratory report LALP-92-50, December 1992*

CN 92 292

"The Tiger Team found no skeletons in our closet—not in safety and health nor in the environmental arena." A Los Alamos researcher checks equipment inside a mobile lab before testing for environmental contaminants.

Environment, Safety, and Health

The Tigers are gone. What's next? . . . The Tiger Team raised very important issues. . . . For example, it raised serious concerns in how we deal with fire lockout/tagout procedures, all of which impact worker safety. The team raised our awareness of the importance of protecting the environment. . . .

Our progress in attaining the desired environmental, safety and health culture did not go unnoticed. The Tiger Team found a healthy attitude. We identified most of the problems ourselves through our self-assessment. We have begun to lay out an action plan. None of our facilities was shut down and the Tiger Team found no skeletons in our closet—not in safety and health nor in the environmental arena. . . .

Like the rest of you, I don't enjoy getting beat up. I died a thousand deaths during the daily Tiger Team outbriefs. . . . I want to build a new way of operating our Laboratory. . . . My goal is that in five years we will not only be the finest scientific laboratory in the world, but also the best managed, most productive and most efficient—setting an example for ES&H excellence in the process. . . .

Excerpt from "The Inside Story," Los Alamos Newsbulletin, *November 15, 1991*

The Laboratory faces enormous challenges to catch up with ES&H regulations, to do business under more intense scrutiny, and to increase productivity and efficiency to stay competitive. We must strive for excellence and continued improvement in all of our operations, not just in science and technology. A quality operation—quality in everything we do—will be the hallmark of the Laboratory. Our self-assessment, prepared for the DOE Tiger Team visit, points to formality of operations and a total quality management program as the vehicles to achieve these goals.

Excerpt from **Los Alamos National Laboratory Institutional Plan FY 1992–FY 1997*****, Los Alamos National Laboratory report LALP-91-037, October 1991***

In 1991, we completed our grueling self-examination and compiled the lessons we learned from the Tiger Team visit: this past year we used a Laboratory-developed cost-risk-benefit approach, accepted by DOE, to determine how to fix our ES&H problems. Because our model compares the cost of each corrective action and the risk each problem represents to the ES&H benefits gained from fixing the problem, we can set priorities for corrective activities on a uniform basis. Using our model, we believe that we will be able to fix, without huge budget increases, the environmental, safety and health problems that were identified. This year, we plan to extend the model to all ES&H activities, comparing the corrective actions contained in the action plans to those in ES&H activities already performed in Laboratory programs.

Using our model, we believe that we will be able to fix, without huge budget increases, the environmental, safety and health problems that were identified.

Excerpt from "The Inside Story," Los Alamos Newsbulletin, *January 28, 1993*

Continuous Quality Improvement

In my view, the future poses not only a new set of programmatic challenges, but also a dramatically changed business environment, nowhere more evident than in the stringent requirements of the action plan that resulted from last year's Tiger Team inspection. We cannot meet these challenges unless we fundamentally change the way we operate the Laboratory. In this new, highly regulated environment, we need a "business revolution" so that we can give the nation the greatest value for its money while we continue to solve critical technological problems.

Our strategy was to launch what we now call our continuous quality improvement (CQI) process, a way to assess and improve our own situation. Our objective is to operate the Laboratory more efficiently and effectively. We began by studying the best business practices and CQI programs of other organizations. We are progressing slowly but deliberately, learning from others to avoid some common pitfalls. We have learned that success depends on an unwavering commitment to quality and improvement in all activities. We must demonstrate that commitment to the government and to the taxpayers if we are to retain their support.

An important part of this approach is a social contract that defines the conditions under which society allows us to operate. To fulfill our side of this contract, we must ensure that

- our science and technology enhance the long-term welfare of society,
- we minimize the negative effects of our operations, and
- we treat our employees and members of the public with respect and fairness.

This contract implies, among other things, a strong commitment to comply with all environmental laws and regulations as well as a vigorous and conscientious effort to increase the diversity of our work force. Increasing diversity requires both an active educational program aimed at the talented work force of the future and a commitment to today's work force that we will operate according to equal employment opportunity and affirmative action guidelines.

The Laboratory will also adhere to good business practices, such as

- satisfying evolving customer needs and expectations,
- setting measurable goals for all our activities,
- improving cost effectiveness, and
- continuously improving everything we do.

The new University of California (UC) contract with the Department of Energy (DOE) will provide a more productive and efficient interface between the DOE and the Laboratory.

I envision Los Alamos as a national security laboratory in the broadest sense. The value we bring to the nation will stem not just from our work—in defense as well as in such important national issues as energy, environmental protection, economic competitiveness, and the well-being of the American people—but from the way we do our work. To realize this vision, we will have to sustain the effort and dedication that we displayed during the preparations for last year's Tiger Team inspection. The challenge is a tough one, but the people and the spirit of this Laboratory, tempered over the last 50 years, will carry us through the next 50 years.

Excerpt from Annual Report to the Regents of the University of California, *Los Alamos National Laboratory report LALP-92-85, December 1992*

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"The Challenge program allows high school students to participate in computational science projects using high-performance computers."

BSM 93-006-19 L

During his visit to Los Alamos, the president met the team from Las Cruces that won the 1993 New Mexico High School Supercomputing Challenge.

DOE Science Education Center

For many years the Laboratory has contributed to science education and the motivation and preparation of future scientists and engineers through its precollege outreach programs and its postsecondary employment programs. These programs have had a significant effect on the ability of the Laboratory to maintain the excellence in its scientific and technical programs. In recent years, there has been increased national recognition of the significant role the DOE laboratories can play in this important area. In 1989, the Laboratory became one of six DOE Science Education Centers located at major national laboratories. We assume that the trend towards increased involvement and expectations of DOE laboratories in educational programs will continue into the foreseeable future. . . .

. . . There is a visible gap between programs for high school students and programs for advanced undergraduates. Some recent science education research suggests that major losses of students starting science careers occur during the first two years of college. . . . To address this perceived need, the Laboratory proposes to develop a program for college freshmen and sophomores that will bridge the gap between a laboratory program for high school students and a research experience for advanced undergraduates. Such a program might emphasize characteristics intrinsic to science that all but the most dedicated science students might find missing from their college classes—a sense of connection between what is being learned and the world at large, why scientists understand nature the way they do, and a sense of camaraderie and community.

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Excerpt from Los Alamos National Laboratory Institutional Plan FY 1992–FY 1997, *Los Alamos National Laboratory report LALP-91-037, October 1991*

HPCC Workshop

The High-Performance Computing and Communications (HPCC) Computational Science Workshop at Los Alamos offers professionals and students advanced training in high-performance computing as it applies to computationally intensive research. The workshops specifically address the three primary components of high-performance computing: methodologies, environments, and applications. Methodologies include parallel algorithms and new advances in numerical methods. Environments include technologies such as architectures, operating systems, languages, tools, visualization, and performance analysis. The third component, applications, integrates methodologies and environments to highlight the use of high-performance computing in DOE's Grand Challenge applications.

New Mexico High School Supercomputer Challenge

With HPCC support, the Laboratory's Computing and Communications Division sponsors the New Mexico Supercomputing Challenge, which is an academic-year-long competition that was initiated in 1990. . . . The Challenge program allows high school students to participate in computational science projects using high-performance computers. The Challenge is open to all students on a nonselective basis. The purpose of the Challenge is to expose students and teachers to computational subjects and experiences that they might otherwise not have. Students receive training, continuous coaching, technical support, and an opportunity to win university scholarships and savings bonds to help further their education. The emphasis is on achievement or competition at the teams' own levels. Everyone who participates in the Challenge is a winner. . . .

To improve the pipeline of the future we must reach out and promote science and math education locally and nationally. Thanks to the enlightened attitude of the DOE on educational outreach, we have dramatically increased our own educational programs.

An excellent example of the payoffs of such outreach is the New Mexico High School Supercomputer Challenge. . . . We offered the [winning] team members summer jobs at the Lab to further encourage them to pursue careers in science.

Excerpt from "The Inside Story," **Los Alamos Newsbulletin**, *May 22, 1992*

Environmental Educational Programs

The environmental programs at Los Alamos have sponsored several educational programs designed to improve understanding and appreciation of environmental issues among students. In the SWOOPE (Students Watching Over Our Planet Earth) program for elementary and middle schools, students actually measure environmental parameters and incorporate their measurements into national data bases. SWOOPE has spread well beyond New Mexico. Another program, Practical Applications for Young Science Journalists, allowed high school students to investigate environmental issues and to report their findings in newspapers.

Excerpts from Annual Report to the Regents of the University of California, *Los Alamos National Laboratory report LALP-92-85, December 1992*

SAGE: A Summer Geophysics Field Course

SAGE [Summer of Applied Geophysical Experience] is sponsored by the Laboratory's branch of the Institute of Geophysics and Planetary Physics, a research unit of the University of California. It started as a way of using our resources to give students hands-on experience in geophysics. . . .

Over the past nine summers nearly two hundred undergraduate and graduate students, and occasional industry and university faculty "students," have come to the Los Alamos area to experience three weeks of geophysics education and research firsthand. SAGE is a unique program because of the combination of instructors it provides from academia, industry, and the Laboratory; because of financial support from industry; and because of the number of different experiments students run. Students not only see how geophysicists use various techniques to explore the Earth, but they also join in that exploration. Students spend three intensive weeks immersed in lectures, field work, and data analysis and interpretation. . . .

By coordinating the SAGE program, we bring together resources from industry as well as from universities, the Department of Energy, and the National Science Foundation to train future geophysicists. The problems these geophysicists will address include a wide range of basic and applied problems in the earth sciences, especially in the fields of energy resources and environmental restoration.

Excerpt from Research Highlights 1991*, Los Alamos National Laboratory report LALP-91-75, February 1991*

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"We will increase the diversity of our applicant pools by reaching out to universities and other recruiting sources where we are most likely to find a variety of talented people."

WorkForce 2000 Council

This spring we changed the name of the Equal Employment Opportunity Council (EEOC) to the WorkForce 2000 Council to reflect the shift from a regulatory philosophy to a more positive, proactive management approach.

The name change was suggested by the EEOC members. The new council will not only address issues important to the Laboratory at large but will integrate the concerns and suggestions of the various special emphasis groups (the Women's Committee, the American Indian Council, the African American Employees Committee, the Accommodations Review Board and the Veterans Committee, and the soon-to-be-constituted Hispanic Employees and Asian American Employees committees) at the Laboratory. The Council serves as a conduit for ideas and initiatives from employees to management to encourage diversity in the work force.

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The Social Contract

As we prepare the Laboratory to meet the challenges of the future we have developed a set of guiding principles that include the value of diversity and are best expressed in terms of the Laboratory's "social contract."

The first obligation is to produce something of value to society. That's our science and technology to enhance the long-term welfare of the nation and the world at large.

The second obligation is to minimize the negative effects of our operations. That requires special attention to health and safety concerns plus respect for the environment and future generations so that we do not leave an undesirable legacy.

The third obligation is to treat employees and members of the public with fairness and a sense of justice. It is this obligation that brings out the importance of diversity in the work force. To benefit from diversity we will have to learn how to work together better. This is the challenge of the 21st century. We must strive to have a group of diverse individuals—men, women, white, black, Hispanic, Asian, disabled . . . working together as a team to eliminate gender, racial or class problems.

Managing Diversity

The increasing diversity of the work force is a fact. For example, at the Laboratory approximately 30 percent of the work force are members of minority groups and 30 percent are women. Nearly half are either women or minorities. The national and regional demographics suggest that this number will continue to increase. Hence, clinging to personnel policies and practices representative of yesterday's work force will not necessarily be successful in the future.

R. Roosevelt Thomas, Jr., a noted social philosopher, reminds us in his recent book *Beyond Race and Gender* that diversity includes everyone; it is not something that is defined by race or gender. It extends to age, personal and corporate background, education, function and personality. It includes lifestyle, sexual preference, geographic origin, tenure with the organization, exempt or non-exempt status, and management or non-management status.

Thomas maintains that managing diversity is a comprehensive managerial process for developing an environment that works well for all employees.

Let's create an environment where people are comfortable being different and where we can capitalize on those differences.

J. Robert Oppenheimer managed diversity during the Manhattan Project. He had to integrate (with Gen. Leslie Groves) the military and scientific cultures, the different nationalities of his team of scientists and engineers, and their different personal temperaments.

Today we face a very different, but no less challenging, task. We must not only redefine the Laboratory's mission for the next 50 years but find a better way to manage our assets in this intensely regulated world in which we live. We must cut the internal bureaucracy and the cost of doing business. This will require a new relationship with the government . . . and a better way of managing our people.

Our continuous quality improvement (CQI) initiative will help us accomplish this task. It's designed to get everyone involved. It should provide an environment where diversity works for us. We know that the old hierarchical management approach has not yielded optimal results. Let's take advantage of our work force diversity and, in fact, promote even greater diversity. Let's create an environment where people are comfortable being different and where we can capitalize on those differences.

Commitment to Diversity

To promote institutional change we must first change ourselves. We must recognize the benefits to the Laboratory of our own personal commitment to the advantages of diversity. It is our individual behavior that determines whether differences are respected and supported or shunned and ridiculed.

We will increase the diversity of our applicant pools by reaching out to universities and other recruiting sources where we are most likely to find a variety of talented people. We will break with traditional recruitment practices that have called for heavily defined and constricting requirements in favor of those that will attract the best and broadest potential. . . .

We must increase diversity in management positions both to promote different perspectives in this rapidly changing world and to provide an environment that clearly values diversity. We have done quite well in non-technical management positions in the past five years, but have made much less progress in technical management positions.

Diversity in the work force is promoted when practiced in selecting employment position search teams, steering teams, advisory groups, management councils, and all other assemblies that help shape the future of the Laboratory. We will continue to require diversity for such appointments.

The WorkForce 2000 Council is an excellent example of our diversity. It represents the work force of the next century. We changed the name and the structure to underscore that we are not satisfied with regulatory compliance. Diversity is one of our greatest assets. It is not a program; it is a process that we must leverage to gain strength through diversity and to prosper in our next 50 years as a great national laboratory.

"The Inside Story," Los Alamos Newsbulletin, *May 22, 1992*

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"The most revolutionary part of this plan is truly empowering our people to unlock their full potential to help shape and contribute to that future."

Unlocking the Full Potential of Our People

Last Friday I presented a vision of the Laboratory's future and a game plan of how to achieve it. It will require a reengineering of how our laboratory operates and functions. The most revolutionary part of this plan is truly empowering our people to unlock their full potential to help shape and contribute to that future.

On Nov. 8, 1991, at the Tiger Team outbrief I set the goal that in five years we will not only be the finest scientific laboratory in the world, but also the best managed, most productive and most efficient—setting an example for environmental, safety and health excellence in the process. In 1992 we started our quality journey by learning from organizations that either were going through similar changes or had already succeeded in making such changes—these include Motorola, AT&T, IBM, DEC, Xerox and, recently, Milliken & Co.

By far, my greatest revelation has been the fact that each successful organization found that to reach the next level of performance . . . [it had] to fundamentally change the responsibilities and authorities of workers. In other words, they unleashed "people power". . . .

. . . I have always thought that individuals at the Laboratory were empowered, going back to the Laboratory's university-culture origins. In our research activities, for example, empowerment seems to be the embodiment of academic freedom. But empowerment without responsibility results in anarchy. So, as we change our Laboratory's role in the post–Cold War world, we must focus much more on organizational effectiveness, and not only on individual effectiveness, personal fulfillment or goals. Every individual must share responsibility to the future of the Laboratory. There must be personal accountability at all levels. . . .

The new leadership must be distributed and shared, building such self-directed process teams of decisive, responsive, fast-acting collaborators.

The explosion and availability of information is a major reason for this kind of change. It levels out leadership. The fundamental work units change, from functional departments or groups to process teams. The new leadership must be distributed and shared, building such self-directed process teams of decisive, responsive, fast-acting collaborators. There is a greater focus on the customer and operational efficiencies. The flatter organization better aligns the organizational structure with the work flow and the direction that the customer looks at the organization. The flatter organizations have less bureaucracy, which in vertical hierarchies act as the glue to hold the organization together. Hence, there is less need for supervision—but not less need for accountability. Managers coach, rather than control. . . .

The focus also changes from activity to results. Activities are no longer taken for granted. One asks what the expected results of all activities are. The work processes are reengineered by the people who do the work. How work is organized becomes the central theme, rather than how people are organized. . . .

Accountability is built in through measurements. Your goals must stretch your abilities. Then you must measure, measure, and measure. . . .

. . . I view our quality journey as a radical change for the way we function at our laboratory. The reorganization, principally the flattening of the structure, was a necessary but not sufficient change. Empowering our people will constitute the most radical change. It will propel us to a successful future.

"The Inside Story," Los Alamos Newsbulletin, *July 23, 1993*

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