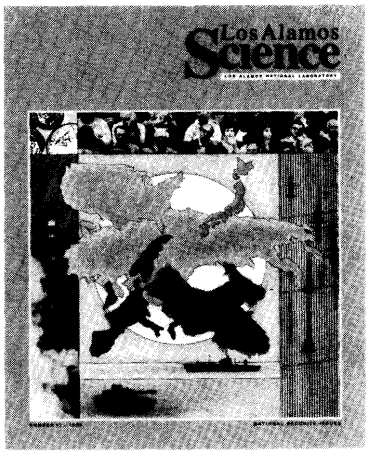
Los Alamos Science

LOS ALAMOS NATIONAL LABORATORY

NUMBER 17 – 1989

NATIONAL SECURITY ISSUES



In contrast to the postwar era in which the United States (blue) and Russia (yellow) were the two dominant powers, the rapid growth in technological, economic, and perhaps military power of Japan (green), China (red), Western Europe (brown), and other regions is making those nations into world powers as well. A conference sponsored by the Laboratory on "The Future of Nuclear Weapons—The Next Three Decades" explored this theme as well as the impact on nuclear weapons policy of public opinion (top), economic trends (upper left), military needs (left and bottom), and science and technology (right). The last theme is represented by a seismic recording of an actual underground nuclear test, a technology of key importance to verification. (Cover art by Gloria Sharp.)

Los Alamos is known worldwide as the birthplace of the atomic bomb. For the last forty-six years the Laboratory has remained the leader in development of nuclear weapon technology—leadership meant to guarantee a world safe from global conflict. The paradoxical role of nuclear weapons (peacekeeping through the threat of mutual assured destruction) is hard for any one to fathom without developing a simplistically polarized viewpoint. As the world grows more complex it appears to many that world stability must come to rest on other limits.

What will be the future of nuclear weapons? Will the public continue to support their role as a peacekeeping force? Are there any immediate alternatives? If not, can the Laboratory maintain its preeminence alongside growing perceptions that nuclear weapons may become irrelevant or too difficult to maintain?

When Sig Hecker became Director of Los Alamos in 1986, he faced the challenge of guiding the Laboratory through an evolving political climate. To understand that climate and to forge an appropriate and necessary role for the Laboratory, Sig created the Center for National Security Studies. The Center is a mini think tank that will help to shape technological decisions through careful consideration of changing political realities. One of the early projects of the Center was sponsorship of an unprecedented conference whose title, "The Future of Nuclear Weapons—The Next Three Decades," states the major concern of this institution. In the article "Debating the Future," members of the Center report on the conference with a spirit of objectivity reflecting the seriousness of the issues. They do not attempt to predict the future. Rather they set before us the many ambiguities, diverse opinions, and conflicting changes that make decision-making difficult. In response to the conference report, Sig Hecker offers his view of the role of the Laboratory-a view that will undoubtedly evolve along with the rapid changes we must all somehow adapt to. Sig emphasizes the need to maintain nuclear competence and explains in simple terms what such competence entails. We cannot take for granted the delicate fabric of working scientists and stored experience that this Laboratory represents. It has undoubtedly been a mainstay of our sense of security, and the continued health and vitality of its programs are crucial to the future of our nation.

Solving urgent national problems is the living heritage of those who work at the cutting edge of nuclear weapons technology. Among those problems is a particularly difficult one: How do we redesign nuclear weapons with the necessary confidence in performance in a time of reduced, restructured, or prohibited nuclear testing? We hope such questions will stimulate our readers to rethink the complex issues and choices presently before us.

One of the major changes occurring right now is a decreased reliance on nuclear weapons as tactical alternatives and a greater reliance on conventional weapons. The Laboratory has been involved in conventional weapons for many years, but that role is now increasing. In this issue we report on one of the areas in which the Laboratory is making a significant contribution—the area of conventional tank warfare. It is well known that the Soviet Union relies heavily on the strength of its armored forces and invests heavily in modernizing those forces at regular intervals. In contrast, the United States lags behind in deploying the technology developed at research laboratories such as Los Alamos. Don Sandstrom, the inventor of a new type of ceramic armor, reports here on the major advances in the development of materials for armored vehicles and for the projectiles that penetrate armor. In "Armor/Anti-Armor—Materials by Design," Don explains the technology, computer simulations, and diagnostic techniques used to develop the new materials. In a follow-up article Phyllis Marten and Richard Mah describe a unique collaboration between industry and the Laboratory that will facilitate the movement of those technological advances from the laboratory bench into the field. This effort is just one among a number of programs in conventional and non-nuclear weapons development in which the finely tuned expertise developed in the nuclear weapons program is being used to great advantage.

Since the topic of this issue is national security, we should point out that the concept of national security encompasses more than just weapons but rather the health of the nation. As such the Laboratory sees its role as being much broader than weapons development and includes in that role the application of science and technology to many national problems and challenges. In that vein, Laboratory scientists are tackling such topics as high-temperature superconductivity, supercomputing, the human genome, and even the AIDS epidemic, the topic of our next issue. ■

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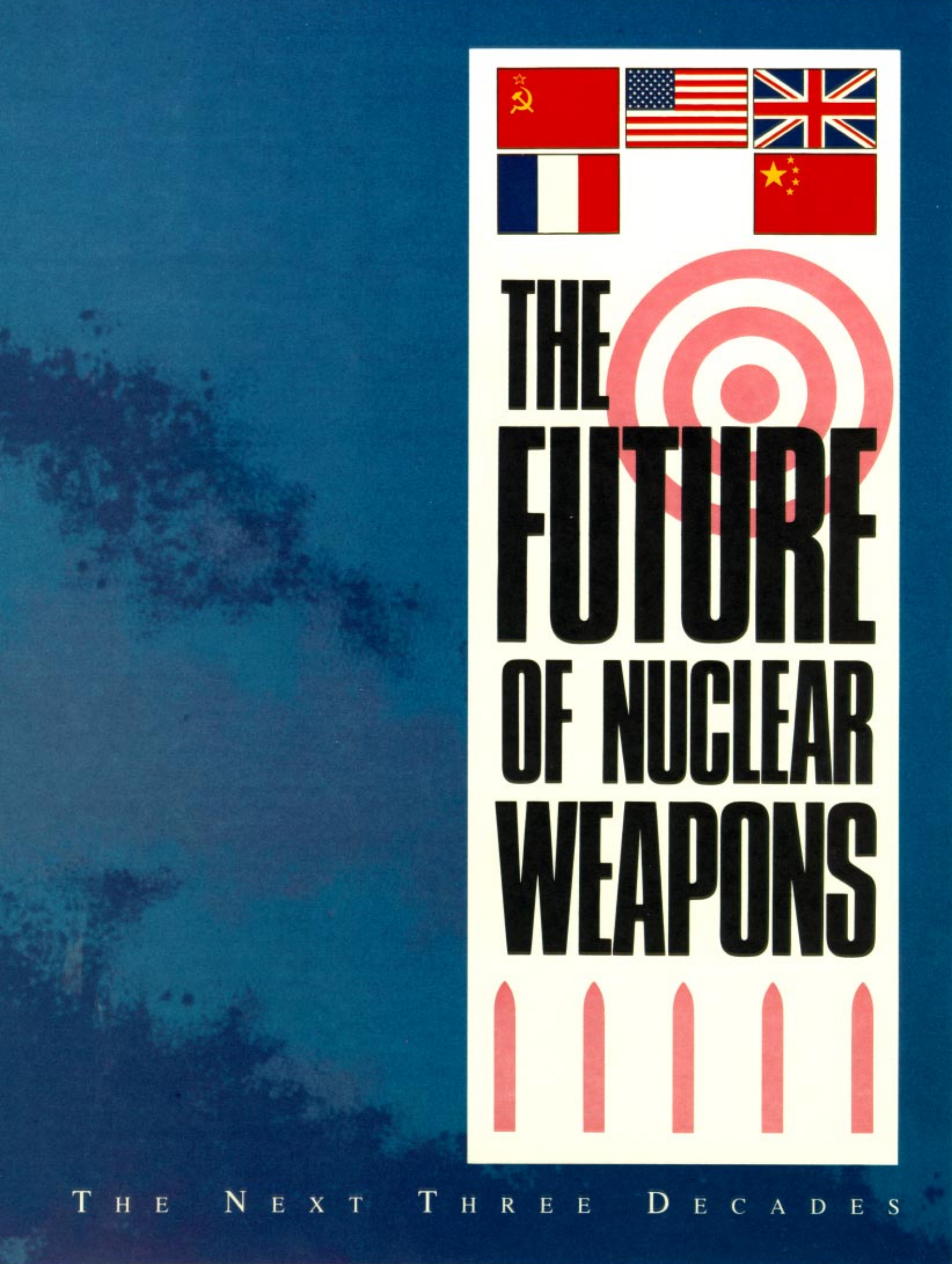

THE FUTURE OF NUCLEAR WEAPONS

THE NEXT THREE DECADES

An Introduction

by Paul C. White

Some forty-six years ago many of the best scientists in the world assembled on a mesa top on the eastern slopes of the Jemez Mountains of northern New Mexico. They arrived in a steady stream, carrying secret military orders, often traveling under code names to conceal their identities. Many of them did not know the real nature of the project they came to work on until after they had arrived. But, coming as they did from a United States and a Europe gripped in the throes of the Second World War, all of them firmly believed that they were there to undertake a scientific challenge characterized by great technical difficulty and tremendous political urgency. They had been assembled to develop a nuclear explosive, an "atomic bomb," and they absolutely had to be the first in the world to do it. If they failed and Germany developed a nuclear weapon first, then Hitler would win the war. If the New Mexico scientists won the race, then the United States and the Allies would save the world from Nazi domination.

The scientists faced an enormous set of technical challenges. To begin with, neither the physical nor the nuclear properties of the fissionable isotopes of uranium and plutonium were known. These materials wouldn't even exist, in other than laboratory samples, until they could be produced in the nuclear reactors and the isotope separation plants of the Manhattan Project. The necessary data had to be verified by experiments often conducted on minute quantities of the rare materials. Neutron transport models had to be devised, fission cross-sections had to be measured, and new diagnostic techniques and instrumentation had to be developed. To produce a nuclear explosion, the fissionable materials had to be acted upon by chemical explosives. In the case of the implosion device, the timing of explosive detonations and the focusing of the detonation waves were new hurdles that had to be overcome. These and other challenges were met by teams of dedicated scientists, working often under makeshift conditions and certainly under extreme time pressures.

One of the most significant aspects of this massive undertaking was that a successful outcome was by no means certain. No one knew for sure that a nuclear explosion could be generated, and success would come only if a whole series of technical problems could be solved. Even if solutions were found, it was not clear until late in the war whether the Germans might find them first. This uncertainty created both

Center for National Security Studies

The Center for National Security Studies exists at Los Alamos to provide the Director and the Senior Management with insight into the connections between national security policy and technology issues. In recent years the relationships between the Laboratory and its programmatic sponsors have become more and more complex. Paperwork and layers of bureaucracy interfere with clear communication and direction about national priorities. Budget actions often seem remote from the technical requirements of the Laboratory's traditional missions. The missions themselves are even being scrutinized and, in some cases, are being broadened to include technological applications in whole new arenas. In this changing world the Center tries to provide a broad perspective on policy issues related to national defense. It is hoped that this perspective will better equip the Laboratory to make decisions about technical priorities and directions.

The Center approaches this objective in a number of ways. The staff is a mixture of professionally trained policy analysts and scientists drawn on rotating assignments from the Laboratory's technical divisions. Consultants and contract personnel experienced in the assessment of national policy issues multiply the effect of the Laboratory staff. The Center uses its collective resources to study and analyze themes similar to that of the Future of Nuclear Weapons project described in the accompanying article. This research does not attempt to make technical assessments; such assessments are the responsibility of the technical programs. Rather the Center seeks to take a broad, long-range view of the ways in which policy trends at the national and international level may affect program choices. The Center uses briefings and reports to communicate the results of its studies to Laboratory personnel, and it circulates the results among the wider policy analysis community in government, military, and academic circles, as well as private industry. The Center also sponsors seminars, workshops and conferences designed to bring Laboratory personnel into contact with outside experts and to improve the Laboratory's understanding of defense policy issues. Finally, the Center acts to enhance communication between Los Alamos and other organizations, such as colleges and universities, that are studying issues of interest to the Laboratory.

In an increasingly complex world, the Center is seeking to provide the broad background that will enable the Laboratory to make the best possible technical decisions. The Center stands as a link between the internal technical community of Los Alamos National Laboratory and the external policy community that can have such a profound effect on the Laboratory's mission and programs. ■

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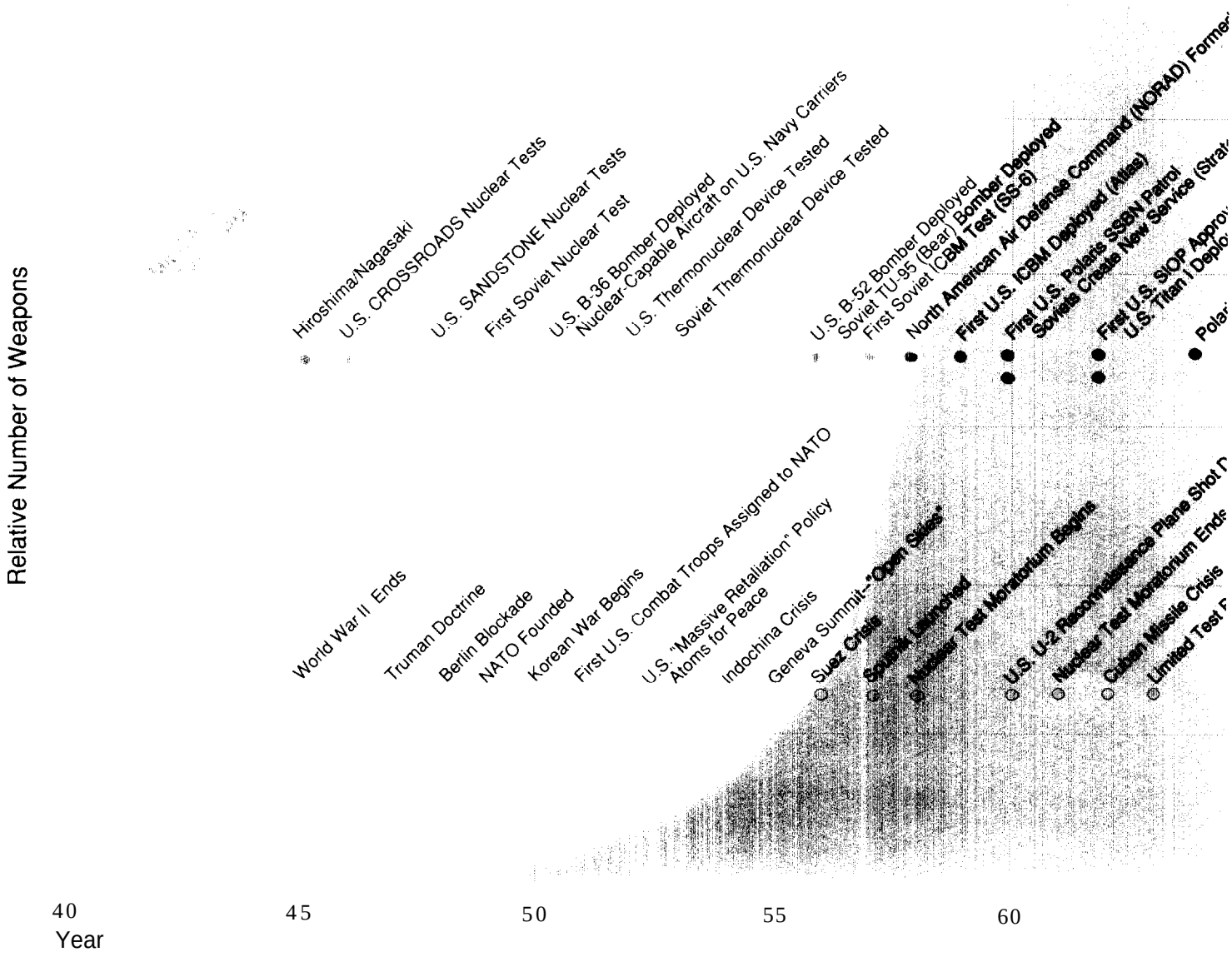
a universally shared sense of political urgency and a heightened feeling of technical challenge. The first Los Alamos scientists were charting new scientific territory, and a special combination of scientific and political motivations drove them to be first.

Their spectacular success was brilliantly apparent one July morning in the New Mexico desert. Later that summer, the first nuclear weapons were used to devastating effect at Hiroshima and Nagasaki, the first and last time nuclear weapons were ever used in war. Many have argued whether this use was ultimately necessary to end the war, but no one could doubt either the magnitude of the technical accomplishment or its significance for the future of conflict between nations.

The Present

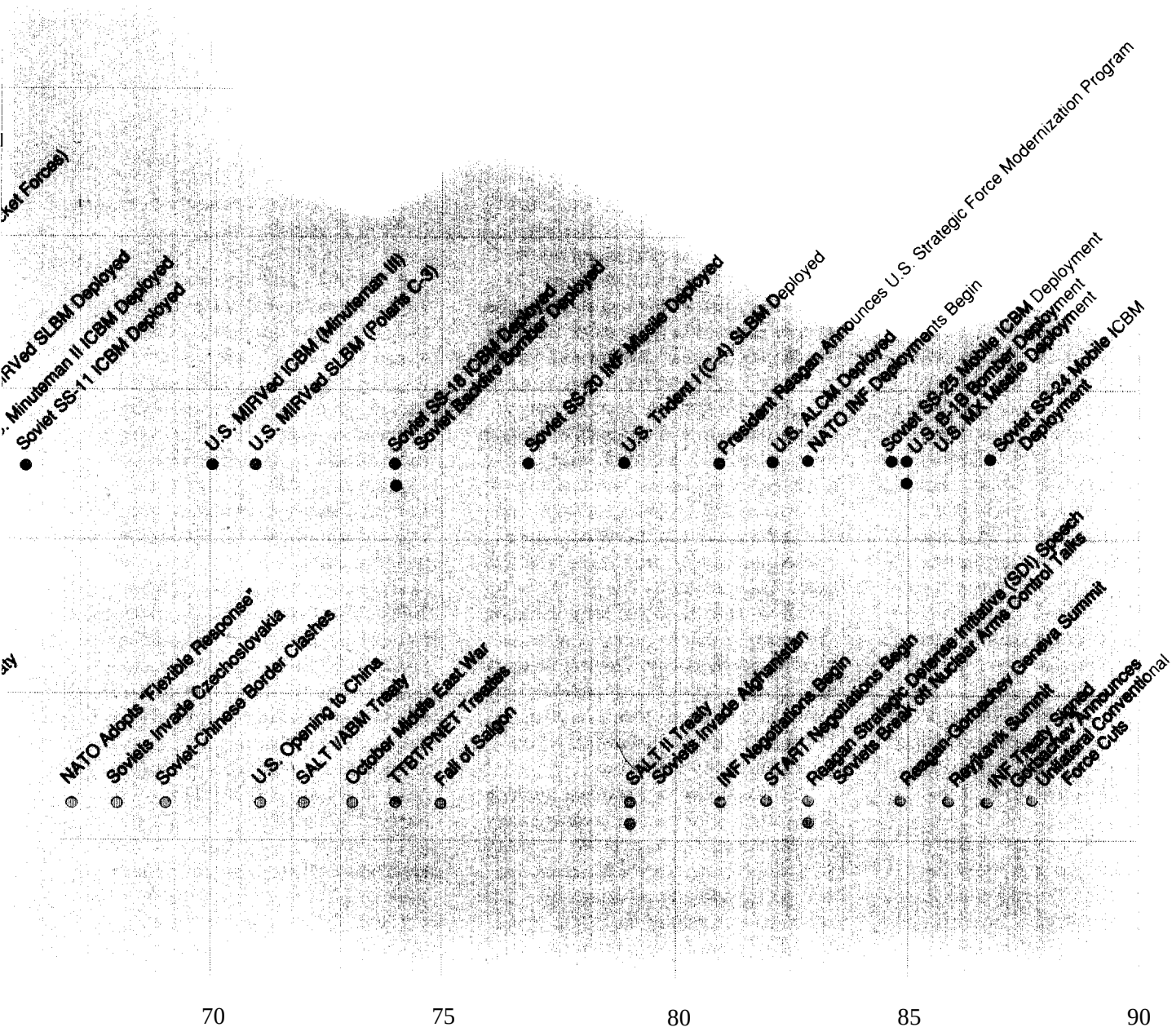
Los Alamos National Laboratory, along with its sister laboratories of Livermore and Sandia, today stands as a symbol of the continuing role played by nuclear weapons in international relations. Time and again in the years since World War II, the nation has called on its nuclear weapons laboratories to produce new technologies in support of the national security policy of deterrence. Today great nations do not use nuclear weapons to end wars but to prevent them. For example, the United States can threaten the possible use of our nuclear weapons against any adversary contemplating aggression. The threat is intended to be sufficiently credible and to suggest such unacceptable consequences that no potential adversary

THE EVOLUTION OF THE NUCLEAR STOCKPILE



would risk a significant attack against the United States or one of its allies, For nearly forty-five years this policy has been highly successful, at least to the extent that no nuclear weapons have been used since their first use, and no major conflict has erupted between the major powers.

To support the policy of nuclear deterrence, the national weapons laboratories have worked with the Depat--ments of Defense and Energy 10 design and develop nuclear weapons with a wide ranging set of characteristics. The stockpile of today (Figure) consists of a large variety of' weapons with different designs, sizes. weights. delivery modes, and yields. Such variety is intended, in part. to ensure that the deterrent forces are survivable, deliverable, and effective. Using delivery vehicles that range from submarine-launched ballistic mls-siles to air-launched cruise missiles, helps ensure that enough forces will survive to make a retaliatory strike credible, regardless of the circumstances of an attack. The spectrum of weapons yield and nuclear effects helps ensure that a nuclear strike can inflict damage that is unacceptable to a potential adversary. Over the last four decades specific requirements to meet these objectives have changed, both as national policy



has evolved and as the characteristics of potential targets have shifted.

Providing the technical resources necessary to respond to such changing requirements is one of the principal reasons for the existence of the national nuclear weapons laboratories. The laboratories support national policy, however it adapts to changing circumstances. by serving as unique sources of scientific capability. In particular, the weapons laboratories offer a broad technology base out of which new requirements can be met. Such requirements continue to include applications directly related to weapons design and effects, such as the ability to defeat newly hardened targets. There is also a continuing and, indeed, growing demand for the application of defense science insight to improved verification of arms control agreements. To respond to al1 such issues in a timely fashion. the laboratories are finding they must determine technical program priorities well in advance of the stated requirements, and in the context of a complex and changing national and international security environment.

The Future

The Center for National Security Studies was established in 1986 to help

the Laboratory properly interpret the national security policy environment within which it must make technical program decisions (see "The Center for National Security Studies"). The Center undertakes research and analysis projects that explore the long-term relationships between broad national security issues and the Laboratory's most important technical programs. The nuclear weapons program is clearly one of these, and a project known as The Future of Nuclear Weapons was one of the first studies undertaken by the Center. As noted above, many consider that the special combination of deterrence policy and nuclear weapons systems has for several decades provided a stable relationship among the major nuclear powers. However, the world has not remained static, and a number of factors have combined to raise important questions about the future of nuclear weapons and the role they will play in the world.

In the Soviet Union, for example, pressures for economic restructuring appear, at least for the near term, to be reducing the emphasis on strategic competition with the West. The resulting general appearance of reduced tensions, combined with such specific consequences as the Intermediate-range Nuclear Forces (INF) Treaty, are leading to a new debate in Western Europe about future requirements for Alliance security. Some of this discussion also derives from the increasing political and economic multipolarity of the world. Emerging economic powers in East Asia and the growing military potential of other nations are straining old alliance relationships and broadening the focus of concern about international security. Finally, public opinion, particularly in Europe and the United States, is forcing a new look at the roles of nuclear weapons and the resources required to support them.

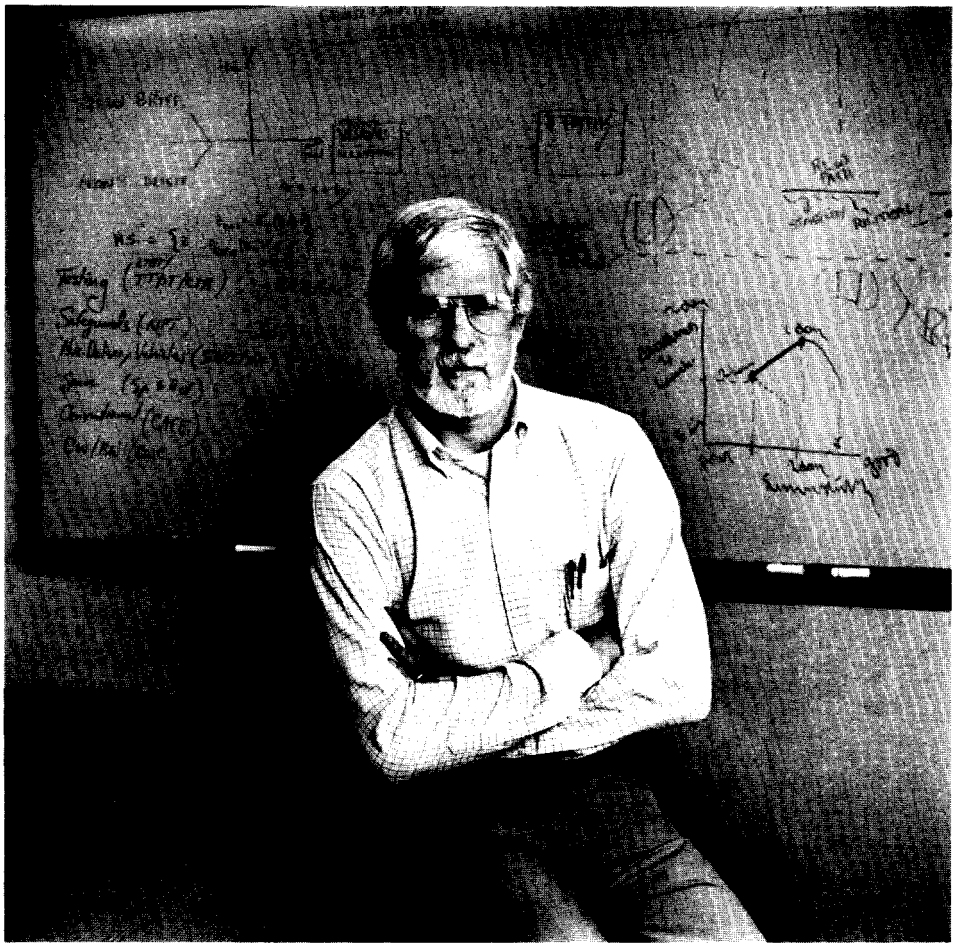
If there are major changes in the way the world and the country think about nuclear weapons, such changes would have a profound effect on the Los Alamos National Laboratory. The Laboratory has a long and distinguished history of providing the technical basis for the design, manufacture and maintenance of nuclear weapons that support the country's national security policy. About two-thirds of the nuclear weapon types in the U.S. stockpile were designed at Los Alamos, and much of the innovation that provides for improved stockpile safety and meets new stockpile requirements continues to originate here. The Laboratory has also been a source of new ideas that have enriched the scope of thinking about future nuclear weapons policy. Nuclear weapons and related programs comprise a significant fraction of the total Los Alamos budget and involve about half of the total Laboratory work force.

The possibility that national thinking about the role of nuclear weapons may change must, therefore, be an important part of the Laboratory's planning. In fact, this possibility prompted the Center for National Security Studies to undertake the Future of Nuclear Weapons project. It is hoped that the project will provide the Laboratory with the crucial background information needed to make decisions about the future character of the nuclear weapons program at Los Alamos. The questions that must be asked include:

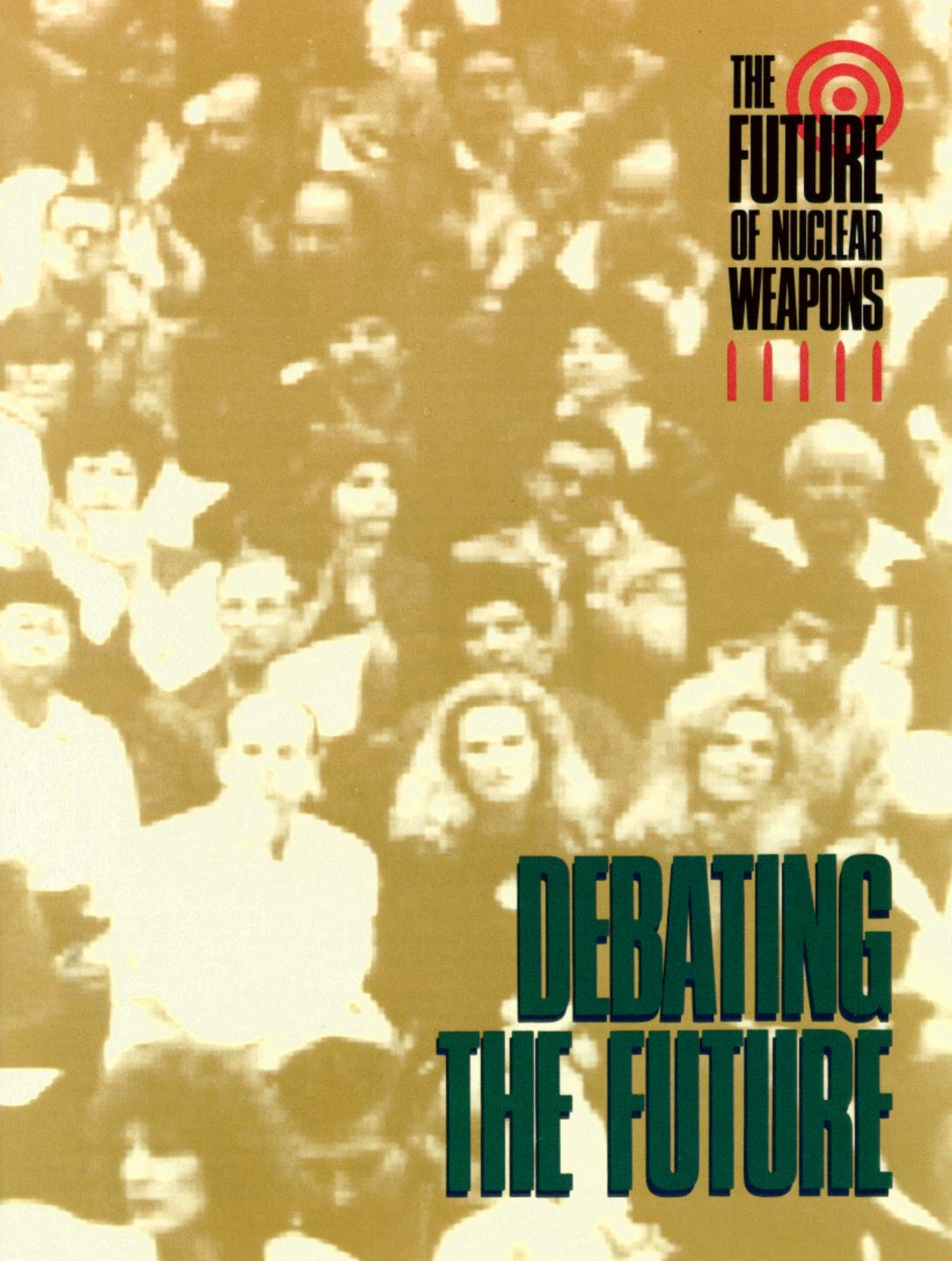
- How will the deterrence policy of the U.S. evolve over the next several decades?
- How will any shifts in that policy affect the requirements of our nuclear force structure?
- What technical demands will be placed on the nuclear weapons laboratories to support those future requirements?
- How can the laboratories best proceed now to ensure that they retain the technical capability necessary to support future U.S. nuclear policy?

A recent conference sponsored by the Center addressed some important aspects of these questions. A number of national experts were asked to assess major factors that help shape U.S. nuclear policy. They presented their preliminary analysis to a distinguished audience gathered from government, academic and military circles, and the nuclear weapons laboratories. Extensive discussion then helped to refine the thinking, and some preliminary conclusions are examined in the following article. In a third article, Dr. Siegfried Hecker, the Director of Los Alamos National Laboratory, responds to issues raised by the conference about the future role of Los Alamos. He also discusses changes that may be necessary to position the laboratory to support the national security requirements of the future. Ultimately, the Center will publish the results of the Future of Nuclear Weapons analysis as a volume in its book series *Issues in National Security.*

The early Los Alamos scientists, working under wartime pressures, clearly recognized the significance of their technical work to the nation's security. The leaders of the project, including its director, Robert Oppenheimer, met directly with the highest government officials to determine priorities and the allocation of resources. Interactions with government and with the national security environment have become more complex in the decades since. However, the importance of the Los Alamos nuclear weapons program to national security policy has in no way diminished. The Center for National Security Studies hopes that programs such as the Future of Nuclear Weapons study will help the leaders of Los Alamos to continue providing the best possible technical resources in support of the national interest. ■



Paul C. White is currently the Acting Director of the Center for National Security Studies at Los Alamos. He earned his Ph.D. in physics in 1970 from the University of Texas at Austin, where he pursued research on general relativistic transport theory and cosmology. Prior to coming to Los Alamos, he taught physics and astronomy for six years at St. Edward's University in Austin. Since joining the Laboratory he has, among other things. been the Laboratory Program Manger for Advanced Nuclear Weapons Design Technology and served as a member of the U.S. delegation to the Nuclear Testing Talks in Geneva. He joined the Center as its Deputy Director in the summer of 1986.



THE FUTURE OF NUCLEAR WEAPONS

DEBATING THE FUTURE

The past decade has seen a number of significant challenges to the role of nuclear weapons and to the security policy of nuclear deterrence that these weapons support.

Five years ago President Reagan announced his goal of making nuclear weapons "impotent and obsolete" by creating defenses against the threat posed by intercontinental ballistic missiles (ICBMs) armed with nuclear warheads. This goal has engendered within the United States an intense and continuing battle over the proper role of offensive strategic nuclear systems in a policy of deterrence.

Thus, a spirited debate has risen in the Congress, the press, and the public over recent proposals for *strategic modernization,* in which older nuclear weapons that are frequently obsolete and not fully capable of meeting new mission assignments are to be replaced with newer weapons. Such proposals raise a number of vexing questions. Are deterrence and strategic stability best served by moving to a single-warhead "Midgetman" missile, or should the United States invest in a new, land-based ICBM with the multiple warheads of a MIRV system? Should we continue to rely on fixed-silo ICBMs, or should we adopt a new generation of mobile missiles? Are cruise missiles a stabilizing or a destabilizing development? How should cruise missiles be armed? What should be done with the potential of stealth bombers?

Similar questions are being asked in Western Europe, the principal overseas location of U.S. nuclear weapons. In 1979 NATO made a "dual-track" decision to replace aging U.S. nuclear systems in Europe with newer, more effective weapons—Pershing IIs and ground-launched cruise missiles—while simultaneously pursuing negotiations with the Soviet Union to reduce or eliminate the need for such systems. However, deployment of these systems became the focus of massive street demonstrations and parliamentary debates. Such conflict challenged the basic NATO policy of relying on nuclear weapons to keep at bay aggression from the Warsaw Treaty Organization. Although the NATO modernization program was begun, it has since been reversed, as President Reagan and Soviet President Mikhail Gorbachev, in May 1988, exchanged instruments of ratification for the Intermediate-range Nuclear Forces (INF) Treaty. The treaty eliminates all Soviet and American ground-launched missiles with ranges between 500 and 5,500 kilometers and has been widely hailed as a major breakthrough in the superpower arms control process.

The central theme that emerged from the conference was that we should expect changes, perhaps significant ones, to occur in the roles played by U.S. nuclear weapons over the next three decades.

And we now seem to be entering an era with the potential for real reductions and restrictions of nuclear arms. The INF treaty may be followed by an even more significant agreement to reduce substantially long-range offensive weapons. The current negotiations in this later area are known as the Strategic Arms Reduction Talks (START). At the same time, the United States and the Soviet Union have been engaged in extensive talks about how to verify limits set on nuclear testing. The Nuclear Testing Talks resulted in two Joint Verification Experiments in August and September of 1988 that allowed weapons scientists of both sides to visit the nuclear test sites of the other and to develop methods for verifying compliance with test restraints. In addition, talks continue in Geneva on "Defense and Space" arms control—talks that consider the issue of defenses against ballistic missile attack, including defensive systems based in space.

A different kind of challenge to nuclear weapons policies arose in 1988 when safety and environmental problems began to emerge from the complex of facilities that produce weapons materials. Some people have used these incidents to question whether the U.S. can continue to support even current levels of activity in the nuclear weapons program.

We are clearly at a crucial point in the history of nuclear weapons technology.

A Public Forum at Los Alamos

The turmoil over these issues reflects a worldwide reconsideration of international security, including the role of nuclear weapons in deterring war. Thus, the time is ripe for a thorough review of the role of nuclear weapons in the defense of the United States and **our** Allies.

To consider the full range of political, military, and technological influences on U.S. national security policy—and to explore possible "nuclear futures''—the Los Alamos Center for National Security Studies (CNSS) sponsored a major conference in June 1988. One hundred and fifty persons from government, the military services, academia, industry, and the Department of Energy laboratories met in Los Alamos to review the past and to consider the future of nuclear weapons. The participants were chosen to provide the best expertise and a wide range of political views, includ-

ing those of former government officials from Democratic and Republican administrations.

This essay attempts to capture the essence of the discussion at the conference. We do not intend here to predict the future definitively or to ascribe a particular viewpoint to any, or all, of the conference participants. Rather, the purpose is to begin to think through our basic assumptions about nuclear weapons and their likely roles in the next century.

The central theme that emerged from the conference was that we should expect changes, perhaps significant ones, to occur in the roles played by U.S. nuclear weapons over the next three decades. To be sure, the conference participants acknowledged that nuclear weapons are almost certainly here to stay, in some form and in some numbers, for the indefinite future. As in the past, the United States will continue to use its nuclear capability to deter major hostile actions by the Soviet Union and possibly by other states that may themselves possess nuclear (or chemical or biological) arms. This deterrent role appears to be the essential and irreducible role of nuclear weapons in American national security policy.

At the same time the conference discussion pointed toward future arms control agreements and unilateral U.S. decisions that will most likely lead to significant reductions in the nuclear stockpile over the next few decades. In addition to numerical reductions, the United States may gradually place less political and military reliance on its long-range, or strategic, nuclear forces (Fig. 1). Finally, the United States might decide to reduce greatly or even phase out certain types of nuclear weapons. This possibility applies most notably to the so-called *tactical* nuclear weapons, such as antisubmarine weapons and nuclear artillery shells—weapons that have been designed for local use on the military battlefield.

US AND SOVIET STRATEGIC NUCLEAR FORCES

Approximate numbers of delivery systems.

	ICBM's	Submarine Launched Missiles (SLBM's)	Strategic Bombers
United States	1000	640	362
Soviet Union	1390	942	175

Fig. 1. A comparison of U.S. and Soviet strategic nuclear forces in 1987, which includes intercontinental ballistic missiles (ICBMs), submarine-lauched ballistic missiles (SLBMs), and heavy bombers. The numbers were taken from "The Military Balance, 1988-1989" (published by the international Institute for Strategic Studies, London: 1988) and "Soviet Military Power: An Assessment of the Threat 1988" (published by the U. S. Department of Defense, 1988).

To understand the meaning and implications of these themes, we will first review the current U.S. view of nuclear deterrence and the political and military utility of nuclear weapons. This background will then help us explore the critical questions examined at the conference: What roles might nuclear weapons play in future U.S. national security policy? Will these roles resemble those of the past decades, or are we moving into a different era? And what are the potential changes in the political, technical, and military environments that might bring about significant shifts in U.S. nuclear-weapon systems and deployments?

U.S. Nuclear Weapons: Today's Roles and Requirements

Discussions of the role of U.S. nuclear forces in American foreign policy and military strategy invariably invoke a single word: deterrence. The United States seeks to deter war by persuading a potential aggressor that the costs and risks of hostile action exceed any possible benefit. Because nuclear weapons are so incredibly destructive and relatively inexpensive-compared with other instruments of warfare—the United States has come to rely heavily on nuclear systems to drive home the idea that war is futile.

To back up this relatively simple con-

Because nuclear weapons are so incredibly destructive and relatively inexpensive—compared with other instruments of warfare—the United States has come to rely heavily on nuclear systems to drive home the idea that war is futile.

cept of deterrence, the United States has deployed thousands of nuclear weapons on a variety of missiles, aircraft, and other delivery systems. Some weapons are based in the United States, others on ships and submarines at sea, and still others on the territory of allies. These weapons vary considerably in yield (explosive power), range, and age (the oldest weapons now in stockpile were designed and built approximately thirty years ago). Some nuclear weapons are designed for long-range use against important political and military targets in the Soviet Union; others are intended for shorter-range employment against hostile forces in or near the actual battlefield. The U.S. military has devised elaborate plans for peacetime storage and training, crisis deployment, and wartime use of these nuclear systems.

Why has such a simple goal, deterrence, led to such a large and complex nuclear organization? The answer is that, under the general framework of deterrence, the United States makes considerable and specific political-military demands on its nuclear forces. For instance:

- Nuclear weapons must deter the Soviet Union, or any other hostile power, from attacking military targets and population centers in the United States. To ensure such deterrence the United States must be equally capable of destroying, or "holding at risk," critical military targets and urban-industrial centers in the Soviet Union.

- Nuclear weapons, in conjunction with forward-deployed land, sea, and airforces, must help deter the Soviet Union from attacking vital overseas allies and interests. The United States has explicitly or implicitly linked its "nuclear umbrella" to Western Europe, Japan, and U.S. interests in the Middle East. To ensure such *extended deterrence*, U.S. tactical and strategic nuclear forces must hold at risk the critical military targets, both fixed and mobile, that might support a Soviet campaign in the theater.

- Nuclear weapons must also reassure U.S. allies of American seriousness and responsibility with respect to allied defense. From the allies' perspective, the U.S. nuclear guarantee should be good enough to deter the Soviets but not so good as to frighten their publics or raise the prospect of "limited" nuclear wars fought on their soil.

- Nuclear weapons must not themselves be the cause of war. That is, the number, type, and peacetime operation of U.S. nuclear forces should not encourage or panic the Soviets into attacking because they must "use or lose" their own nuclear weapons in a crisis. This requirement for American nuclear forces is generally referred to as *crisis stability.*

- Nuclear weapons must be able to perform specific military operations if deterrence should fail-especially those missions that are not well suited to other types of weapons. For instance, enemy installations that have been strongly reinforced, or hardened, can only be destroyed with a nuclear explosion that is close to the target. Policy makers and military planners believe that such operational capabilities make deterrence more credible and hence less likely to fail.

Given these extensive and sometimes contradictory demands, American policymakers have sought to develop nuclear forces that satisfy a number of criteria. The criteria are survivability, flexibility, military effectiveness, affordability, discrimination, and safety and security (see box).

These attributes of U.S. nuclear forces have become very controversial over the past decade. The controversy is especially true for the characteristics that suggest the purpose of American nuclear weapons is to fight rather than deter war, that is, flexibility, military effectiveness, and discrimination. U.S. political and military officials insist, however, that deterrence and warfighting capability are complementary, not contradictory. Deterrence is said to be strengthened by capable nuclear forces that can meet aggression flexibly and effectively—without threatening to destroy enemy cities unless, of course, American cities are themselves attacked.

Future American presidents will place relatively more emphasis on the stabilizing aspects of nuclear forces and relatively less emphasis on extended deterrence, that is, on using nuclear weapons to reassure and protect allies.

The apparent tension between the evident *capability for war-fighting* and the *concept of deterrence* is, in fact, a necessary condition for maintaining a deterrent relationship. To be effective, deterrent forces must not only be capable, but simultaneously the opponent must think it credible that the forces could be used effectively in the event of war. Credibility is provided precisely by the characteristics mentioned above required of nuclear weapons *and* by the detailed preparations for their potential use. This paradox—that for a deterrent force to deter wars, it must appear ready to fight them—is inherent in the very concept and practice of deterrence and will not change as a result of arms control, unilateral force reductions, or policy shifts, short of abandoning the concept of deterrence altogether.

NUCLEAR FORCE CRITERIA

Survivability: **Nuclear forces must be survivable so they cannot be easily or promptly destroyed by an enemy attack. For instance, missiles can be made more survivable by making them mobile or placing them aboard submarine. Survivable weapons do not invite or pressure an enemy into striking first, and they do not tempt us to use them first because of a fear of Iosing the weapons in a pre-emptive attack.**

Flexibility: **Nuclear forces must be flexible so we can deter or respond to a wide variety of enemy actions, including aggression against U.S. allies. Flexibility can be enhancad, say, by designing weapons with a full range of yields and designing carriers capable of delivering those weapons to a variety of targets.**

Military effectiveness: **Our nuclear forces must be militarily effective so they can be called upon to destroy critical enemy targets if necessary. Effectiveness includes successful delivery of the weapon to the target as well as crippling the target once the weapon arrives.**

Affordability: **The forces must be affordable so that the United States can deter war without bankrupting the country.**

Discrimination: **Nuclear forces must be discriminate to minimize unwanted damage to the civil population while effectively destroying military targets. This may require tailoring the yield or the weapons effects to the particular military mission of the weapon.**

Safety and security: **Nuclear forces must be safe and secure so that we may deploy the forces without fear of damage from accidents or their use by terrorists or others for unwanted purposes.**

U.S. Nuclear Weapons: Tomorrow's Roles and Requirements

How will U.S. nuclear roles evolve over the next thirty years? The sense of the conference, although by no means unanimous, was that the United States will tend to reduce the number and scope of demands placed on nuclear weapons. It is most likely that future American presidents will place relatively more emphasis on the stabilizing aspects of nuclear forces and relatively less emphasis on extended deterrence, that is, on using nuclear weapons to reassure and protect allies.

What would this shift mean, in turn, for future U.S. nuclear requirements? The growing emphasis on stability will cause the United States to place *relatively more emphasis on the survivability, safety, and security of its nuclear weapons and less on their military effectiveness and flexibility.* In particular, less emphasis would be placed on those nuclear weapons that could target Soviet nuclear forces. (The United States, however, is unlikely to abandon *all* such military capability for a very long time, if ever.) It is not clear how much this prospective shift would affect the requirements for affordability and discrimination, although one might predict a decreased level of funding for nuclear weapons programs and somewhat less attention to discrimination.

If this apparent trend toward stability and away from military utility and flexibility does prove out, how will the United States reflect such changes in its deterrence policy? Two possible approaches were discussed at the conference: *mixed deterrence* and *countercom - batant deterrence.*

A policy of mixed deterrence would deter aggression using a mixture of nuclear and conventional weapons. The United States would retain small numbers of survivable, sea-based nuclear weapons to deter attack against its homeland by threatening the urban-industrial base (cities) of the Soviet Union and other hostile nuclear powers. Advanced conventional systems would then take over military missions formerly assigned to nuclear weapons, especially those involved in the extended deterrent role. Conventional rather than nuclear weapons would hold at risk the critical enemy military assets needed to support a campaign, such as airfields, troop concentrations, bridges, and command and control centers.

A policy of countercombatant deterrence would, the same as for mixed deterrence, reduce the mission of the U.S. long-range nuclear forces to holding the enemy's urban-industrial base at risk. However, a limited number of discriminate tactical nuclear weapons would be deployed in or near the probable theaters of military operations (such as Europe) to hold at risk the military assets needed to support a conventional invasion. The purpose of these theater nuclear weapons would be to complicate the enemy's military planning in the theater and thus enhance extended deterrence. The weapons **would** *not* be designed to fight and win a local nuclear war.

It is significant that no one at the conference explored the conditions under which the role of nuclear weapons in U.S. national security policy might in*crease.* Even though the declining defense budget was discussed, no one suggested a return to a deterrent policy based on massive nuclear retaliation, which the Eisenhower administration adopted in the 1950s in response to its perceived fiscal problems. There was also no explicit discussion of the resumption of old nuclear missions, such as a new generation of tactical atomic mines, nuclear ship-to-ship or air-defense weapons, or nuclear antitank weapons. Nor, with the exception of the possible role of nuclear weapons in a future strategic defense initiative (SDI) system, did anyone raise the prospect of new nuclear missions. Only one suggestion went against this overall trend. Several participants suggested that if hostile regional states acquire nuclear or chemical-biological weapons, the United States may need to revise its nuclear doctrine and forces specifically to deal with issues raised by such proliferation.

It is important to note that the trend to de-emphasize the effectiveness and the flexibility of nuclear weapons could shift rapidly. Many of these same sentiments about fundamental changes in U.S. deterrence policy were also widely expressed at the beginning of the Carter administration, only to be altered dramatically by events at the end of the seventies, such as the unexpected Soviet invasion of Afghanistan in 1979. Most U.S. nuclear requirements are determined by considering how much weaponry is enough to deter the Soviet Union. Thus, the future of U.S. nuclear weapons is inherently dependent on the future direction of the USSR—a direction that no one can confidently predict.

The apparent trend toward survivability and away from military effectiveness, coupled with the possibility of a sudden reversal in priorities, represents a considerable challenge to the U.S. nuclear weapons complex. Los Alamos and the other parts of that complex are necessarily committed to excellence in preserving and improving our technological base in nuclear weapons. However, if the role of nuclear weapons in U.S. national security policy is perceived as declining, public and political support of a vigorous nuclear-weapons research and development program could well decline, as public interest grows in "turning off the arms race."

The potential for politically imposed constraints on weapons research and development is particularly visible today in the international and domestic pressures for limitations on nuclear testing. Testing limits, it is argued, are a necessary complement to arms control because they would prevent the development of new nuclear-weapon technologies. From a different perspective, however, conference participants cited how the need for technical excellence, and therefore testing, will increase as the numbers of weapons are reduced and the need to avoid technical surprise increases.

However, a new and potentially showstopping factor emerged during and after the conference—severe safety and environmental problems within the nuclear material production complex. A series of reports about radioactive leaks to the environment and production facilities that are possibly damaged, as well as claims of inadequate operating procedures and management practices, have led to a virtual shutdown of critical elements of the nation's production complex. Continued uncertainty about the reliability of the operation of this vital system is sure to conflict with the need for excellence within the nuclear weapons system. There is a clear priority for technical and political action at both the national and the laboratory levels.

Political Influences

The most important trends indicating a gradual shift in U.S. nuclear roles and requirements are largely political in character. One session at the conference, for which Joseph Nye's opening remarks set the tone, explored the political influences on the future of nuclear weapons.

For instance, the current U.S. approach to nuclear deterrence-with its stress on flexibility and military effectiveness—was formulated in the context of the particular international and domestic environment that existed after World War II. The international environment was then dominated by a Soviet-American bipolar conflict, an environment in which U.S. allies and neutral states were economically and militarily weaker. The domestic American environment was marked by a bipartisan political consensus that the Soviet Union was an aggressive, expansionist power that needed to be contained, but the United States could not afford to deter Soviet aggression with *non-nuclear* defenses.

Many experts contend that this post-1945 pattern has changed substantially over the past twenty years and that it may be altered, perhaps beyond recog-

nition, over the coming three decades. For example, if the threat of aggression is reduced or becomes less Soviet-centered, or if the pattern of U.S. overseas allies is significantly altered, or if nuclear systems become comparatively more expensive, then U.S. nuclear doctrine and force structure may focus increasingly on stability as opposed to military utility. There is no certainty that any, much less all, of' these dramatic changes will occur, but the United States certainly should not assume that it will be "business as usual" through the year 2020.

The conference identified and explored four significant political factors that will, in part, drive future U.S. nuclear requirements:

- an international environment that is increasingly multipolar in political, military, and economic terms,
- the limits that U.S. and international public opinion may place on nuclear policy,
- the importance of arms control in U.S. national security policy, and
- the long-term effects of General Secretary Gorbachev's domestic reform program of *perestroika* (political, economic, and social restructuring) on Soviet military doctrine and on U.S. perceptions of the Soviet military threat.

We should also recognize that, as the world changes over the next thirty years from the familiar post-World War II pattern, our views of the utility of nuclear weapons may change as well. I think that U.S.-Soviet relations will remain a problem overtime — whenever you have great powers you are going to have to manage a balance of power–but if will not be the same problem that we see today. In addition, we are going to be faced with proliferation. The proliferation of nuclear warheads, missile capability, and biochemical capabilities to other countries (and possible terrorists) is going to create a series of defense and security problems that could make today's Soviet threat pale into insignificance. I think the greatest prospect of a nuclear weapon going off inside the United States comes from the proliferation chain rather than through the U.S.-Soviet relationship . . . /see the United States in the year 2018 as still the dominant power in the world, a power not in decline, but I see us facing much greater problems of a much more diverse sort. In that world nuclear weapons will play a role, but lesser a role than they have played thus far.

–Joseph S. Nye, Jr., Director, Center for Science and International Affairs, Harvard University, and the former Deputy to the Under Secretary of State for Security Assistance, Science and Technology, opened the session on political influences.

An increasingly complex world. By the year 2020 various nations. including Japan, China, and several Western European nations will, in all likelihood, command relatively more economic and political power than they do today. Japan, whose economy is the second largest in the world, will continue to exercise its influence. China's economy will continue to expand and may indeed rival that of Japan thirty years from now. By 1992 the twelve countries of the European Economic Community are scheduled to form a barrier-free market. They will thus confront the United States with an internal market of great strength.

Conference participants emphasized [hat, in light of these economic changes, the U.S. military alliance structure—including the American nuclear guarantee, or extended deterrence-will likely be affected in significant respects over the next thirty years. If American nuclear forces cease to be the central political and military element, in NATO strategy, the most dramatic change could be in the relationship between the U.S. and Western Europe. This shift might be brought about by unilateral American decision, the preference of more nationalistic European governments (of either the right or the left), the creation of a European defense organization with its own independent nuclear force, or,

Fig. 2. Nuclear powers (red) are countries that both possess nuclear weapons and the means to deliver them to distant targets. Other countries are known to have detonated a nuclear device but have no significant stockpile and no sophisticated delivery vehicles (blue) or are states that possess advanced nuclear technology (tan). Still other countries possess the technology to build a nuclear weapon but have apparently not done so yet.

in an extreme case, the West German acquisition of nuclear weapons.

In Eastern Asia the nations of Japan and China have the potential to become regional military powers with strategic ambitions that may not coincide with the interests of each other, the USSR, or the United States. The most extreme change in this region would be the Japanese acquisition of nuclear weapons.

United States policy toward this more differentiated world will be complicated immensely by the likelihood that at least some second-tier states—such as, Iran, Taiwan, Indonesia, India, and others—may attempt to acquire nuclear weapons (Fig. 2). (We already have evidence that "proliferation" is taking place in the form of ballistic missile technologies and in submarine capabilities.) The spread of major military systems among second-tier states will pose increasingly difficult problems for U.S. foreign and defense policies and for the continuation of extended deterrence as we have known it for the past several decades.

In short, the United States will find itself in an increasingly complex international environment where U.S.-Soviet competition will only be one of several fronts that will demand American attention.

Some conference participants did not believe that the *political* utility of U.S. nuclear weapons would necessarily decline despite the increasingly multipolar character of international politics. The thesis that U.S. nuclear forces *do* offer indirect support to U.S. regional actions—for instance, the current Persian Gulf operations—and will continue to offer such support in the future was actively debated. Another thesis suggested that U.S. nuclear forces will continue to mark the United States as the only true military, political, *and* economic superpower, thus distinguishing it from all other states even thirty years from now.

Public opinion. A major shift in U.S. nuclear policy would occur if, as some suggest, nuclear weapons become "delegitimized''—that is, if the public refuses to support any policy or military deployment that involves nuclear weapons.

Analysis of public opinion data indicates, however, that there continues to be support for the concept of nuclear deterrence in the United States and NATO countries. By the mid-fifties American public opinion had come to accept the notion of international stability through mutual deterrence, or the ability of both the United States and the USSR to inflict unacceptable destruction upon each other. This acceptance continues today. But it is also true that other aspects of deterrence-especially the so-called nuclear warfighting, which involves military effectiveness, flexibility, and discrimination—has never had clear public acceptance.

United States policy... will be complicated immensely by the likelihood that at least some second-tier states such as Iran, Taiwan, Indonesia, India, and others may attempt to acquire nuclear weapons.

Looking ahead thirty years, analysis indicates that there is no compelling reason why, if governments make the proper case for deterrence, Western publics will not continue to support nuclear weapons. Conference participants disagreed, however, over what constitutes a proper public case for nuclear weapons. A critical question arises in this regard. What circumstances might lead to a significant and permanent shift in the public perception of nuclear weapons—to the point that Western publics might reject a policy of nuclear deterrence altogether? Some at the conference suggested that a serious accident involving a nuclear weapon might trigger such an adverse public reaction. This danger makes it all the more important for nuclear weapons designers and operators to take the safety and security issue seriously.

Arms control. Many of the participants agreed that a strategic arms control agreement that would cut the number of long-range nuclear systems will be reached within the next several years. Over the longer term the case was made at the conference—not without opposition—that the arms control process will most likely support, and possibly drive, the shift from warfighting capabilities toward an emphasis on nuclear stability.

If this view is correct, future arms control policy would be aimed at restructuring nuclear forces to emphasize their survivability, thereby reducing perceptions of their possible use as weapons. This shift would be partly by design (it has been an objective of U.S. arms control policy for decades), partly by the force of technological change (the growing capabilities of non-nuclear weapons and possibly defensive systems), and partly by changing global circumstances. If long-range nuclear weapons are to be further reduced over this period, negotiations will have to include all important nuclear powers—at least France, the United Kingdom, and the People's Republic of China, in addition to the United States and the Soviet Union.

There was strong agreement at the conference that arms control, like nuclear weapons, is here to stay. Differences did emerge, however, concerning

the rate at which substantial nuclear reductions might take place (decades or much sooner?) and over factors that might cause the arms control process to take a significantly different path.

The Soviet military threat. The perception of any significant change in the Soviet military threat has historically had a great influence on U.S. nuclear doctrine and weapons development. There was a consensus among the speakers that, in the near to mid-term, Soviet President Gorbachev will try to gain a breathing space in the strategic competition with the West to free resources for his economic restructuring program. To the extent that he can maintain a focus on domestic policy, the Western perception of the Soviet military threat will undoubtedly decline—with a predictable decline in the U.S. defense budget and nuclear weapons programs.

But will the threat really decline? Will Soviet leaders actually move toward a military doctrine (as they have promised) based on "reasonable sufficiency" and defensive emphasis? Assessing these questions will be difficult, if for no other reason than because the Soviets, even if sincere, will retain for many years a very large and capable military structure.

Unfortunately, we have not yet developed a set of key indicators that will provide solid evidence of any significant shift, or lack thereof, in the Soviet military posture. In other words, we are not certain what information can be taken as evidence of a real shift from an offensive to a defensive Soviet strategy. In a speech before the United Nations General Assembly in December 1988, Gorbachev announced significant unilateral cuts in the number of Soviet forces in Eastern Europe and in the Soviet Union, but military experts still disagree as to the actual military significance of these announcements, in large part because the cuts have not yet actually occurred.

Even more uncertain is the long-term prospect for the success of Gorbachev's perestroika and the impact on Soviet foreign and military policy. We do not understand the relationship between Soviet capabilities and Soviet impulses. Would continuing Soviet economic weakness, for instance, lead to international adventurism or to retreat? Would the success of domestic economic, political, and social restructuring result in greater Soviet maturity or bellicosity?

If the conference discussion provides any indication of the U.S. judgment about these questions, the United States will probably operate, at least in the near to mid-term, on the assumption that the Soviet threat will decline. Still, the political uncertainties about Soviet behavior and goals must temper any prediction about the future of U.S. nuclear weapons and, particularly, about any decline in the roles of those weapons.

Technological Influences

A second session at the conference, opened by John Foster, was concerned with the technological influences on the future of nuclear weapons. Compared to the consensus obtained on policy influences, this session was less definite about the impact of future technology. The lower degree of consensus was true both of nuclear weapons technology itself and of the non-nuclear technologies of weapons guidance and control and weapons delivery systems that might complement or substitute for nuclear weapons missions. There was no clearly identified nuclear "technology imperative" that would substantially increase or decrease the role of nuclear deterrence in U.S. national security policy—although there might be one or two potential imperatives in the wings.

This emphasis differs from the past. During the first twenty-five years of the nuclear era, steady advancement in both nuclear and non-nuclear weapons technologies allowed very significant shifts in fundamental national security policy.

The history of nuclear weapons technology. The earliest nuclear devices were relatively crude affairs, involving large physical assemblies and inefficient use of fissile material, and they produced relatively small yields, or weapons effects. One of the first post-World War II research and development goals was to build physically small fission devices of greater efficiency with more flexibility in yield. Small fission devices resulted in a much wider choice of delivery systems than the strategic bombers required for Little Boy and Fat Man (the weapons used against Japan). Eventually, smaller warheads allowed us to deploy a number of battlefield nuclear systems, such as mines, artillery shells, missile warheads, and gravity bombs. The main deployment area for these tactical nuclear weapons was Europe, where they became a critical element in the adoption by the U.S. of an extended deterrence defense policy for our NATO allies. Also, small fission weapons deployed on short-range missiles became an early form of air defense for U.S. military forces.

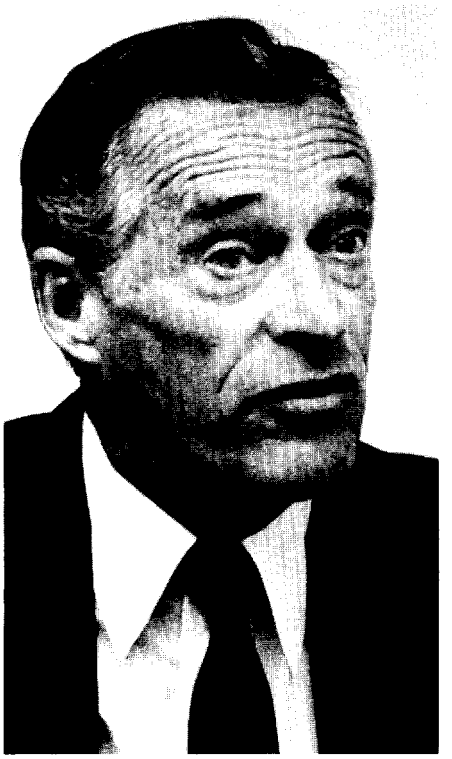
A vigorous program to engineer large-yield thermonuclear weapons occurred in parallel with the effort to develop tactical weapons. Because these large-yield strategic weapons were also very large in physical size and mass, they required delivery by large, dedicated bomber aircraft. However, the successful design of such weapons allowed the United States to adopt a strategy of massive retaliation as the principal element of its early deterrence policy.

During the 1960s and 1970s both nuclear and non-nuclear weapons technology continued to develop. In particular, we developed fairly accurate ballistic missiles and medium-yield, medium-size warheads. These warheads were

There are some inventions and needs in the nuclear weapons field that do look attractive from a technical-military point of view:

–penetrating warheads delivered by aircraft or by cruise or ballistic missiles that could penetrate, to one degree or another, into water, ice, and ground;

-directional warheads that focus either mass or energy in a particular direction with extraordinary effectiveness, which could include an x-ray laser capable of delivering intense energy on targets at great distances in space, a nuclear assembly that could deliver solid matter in intense beams preferentially in one direction, or the use of a nuclear explosive to create intense electromagnetic waves...



Unfortunately, it is my perception that the three nuclear weapons laboratories are not leaning into these opportunities as aggressively as they can or as they should. If we do not pursue them aggressively, the laboratories of other nations are likely to do so, perhaps without our knowledge. These nations could then take advantage of new capabilities and put them in the field, at which time we would be at a considerable disadvantage. So I would urge the three laboratories to get together and find ways to pursue these known opportunities more aggressively and competitively, as well as to assign teams of talented, creative individuals to explore new opportunities.

–John S. Foster, Senior Vice President, TRW Corporation and the former Director of Lawrence Livermore National Laboratory, opened the session on technological influences.

deployed on a wider array of aircraft, and they provided an early capability for both air defense and ballistic-missile defense. Further development of small-diameter thermonuclear warheads, coupled with accurately guided ballistic missiles, allowed the U.S. to create a much more survivable deterrent force. Survivability was assured by locating a significant number of the weapons on ICBMs in silos and on long-range submarine-launched ballistic missiles (SLBMs) in submarines, which are extremely difficult to locate and attack. These developments brought about a period of strategic stability, since both the major nuclear powers could back up their deterrence policies by assuring retaliation against any nuclear attack with a triad of strategic forces: bombers, ICBMs, and SLBMs.

This basic strategic stability has endured for a number of years now, but it has not meant that nuclear technology has stood still. Research and development has been devoted to extracting specialized effects from nuclear explosives so that, in some circumstances, they could be used in a more discriminating fashion. One well-known example was the development of a device, popularly known as the neutron bomb, that emphasizes the weapon's radiation output while reducing effects of the blast. Such a technology, for example, makes for a more feasible nuclear defense by NATO against massive armored attacks by the Warsaw Pact. However, political reasons have kept the Alliance from deploying weapons in Europe armed with such enhanced-radiation devices.

For more than two decades now, research and development of nuclear weapons technology has also concentrated on making nuclear weapons increasingly safe and **secure** to deploy and use operationally. To insure that no terrorist or other unauthorized use of a nuclear weapon occurs, physical and electronic protection systems called

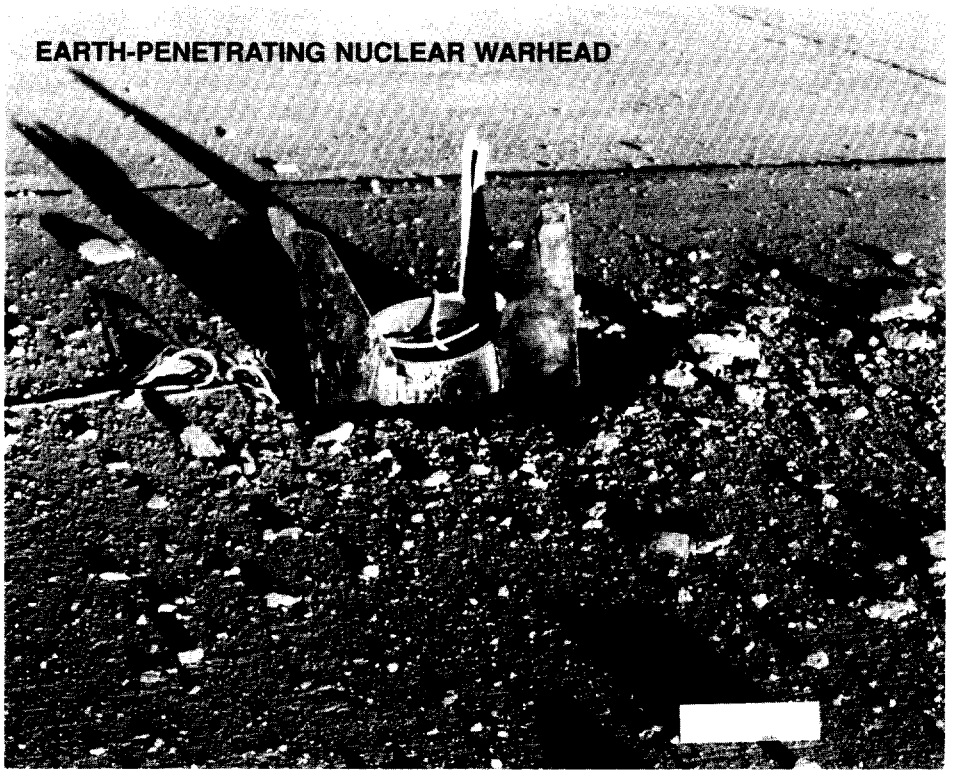


Fig. 3. Test photographs of a warhead designed to penetrate the ground before detonating. In this particular test the warhead penetrated a foot of concrete over hard dirt and came to rest almost nine feet below the top surface. In subsequent tests, an improved warhead penetrated the concrete completely.

permissive action links, or PALS, were developed that require a unique set of instructions from the correct command authority before a nuclear weapon can be used. Other safeguards and security measures have also been developed in recent years, such as warheads designed to insure that they are *one-point safe,* that is, that there is no danger of nuclear explosion even if, for example, they are dropped accidentally.

However, as important as these technology developments have been, they are not the kinds of changes that in turn create key changes in national strategic policy. As mentioned before, the sense of the conference was that no technology development seemed imminent within the field of nuclear weapons per se that would call for fundamental policy shifts. Similarly. no nonnuclear technology development, strategic defenses included, was identified that would alter the fundamental role of nuclear weapons in supporting a policy of deterrence. The feeling was that strategic defenses might alter the form of deterrent relationships but would not destroy them altogether.

The future of nuclear weapons technology. The identification of future technology directions for nuclear weapons development activities included further bolstering of the safety, security, and flexibility of nuclear weapons, thus supporting the requirements that they are safe, survivable. and effective. Three additional areas of research were mentioned that should prove fruitful to pursue in the three-decade time frame examined at the conference.

First, a number of targets in the Soviet Union already assigned to nuclear missions have become increasingly difficult (some might say impossible, in certain cases) to threaten with existing nuclear systems. This difficulty is true for many fixed military targets and for mobile missiles. Also, a number of the emergency command centers for the political and military leadership of the Soviet Union have been moved to sites deep underground, which makes them difficult both to locate and to attack. These trends indicate the utility of a "hard-target kill" capability for nuclear

forces, which, if the U.S. elects to pursue the option, will probably be gained through a combination of new warhead designs (Fig. 3) and different delivery systems.

Next, continued work on ways to channel the output of nuclear weapons into forms of directed energy is still useful, particularly for ballistic missile defense or anti-satellite applications. The popular press has focused almost exclusively on the attempts to create a nuclear-driven x-ray laser, but there are other possible ways to use the unique power and energy forms available from nuclear explosions.

The third suggestion is related to the use of special nuclear effects. Military forces, and the civilian societies and economies they are designed to protect, are becoming increasingly dependent upon electronic components. Finding ways to use the effects of nuclear weapons against these capabilities may be an increasingly interesting role for the nuclear weapons research and development community.

An important note here is that while these potential developments in nuclear technology could greatly enhance military effectiveness, they would, at the same time, tend to reduce the survivability of nuclear forces on both sides. Such technological trends work against the emphasis on stability indicated by the political trends.

The past history of nuclear weapons technologies constitutes a steady evolution in capability, military effectiveness, and special-purpose applications. Presently, directed energy is a discontinuity in that evolution and a technology in search of a policy niche. As such, it has the *potential* for making major differences in strategy. In the future we may expect to see further such technological discontinuities emerge. The conference also explored the technological future of other types of military systems. Many of these advances may be dramatic, especially those in the areas of missile and aircraft propulsion, automation, sensors, guidance, C^3I (command, control, communications, and intelligence), stealth, and protection and countermeasures. The overall trend is clearly toward non-nuclear standoff weapons with autonomy, long range, high accuracy, and high lethality; toward C^3I systems with long-range, accurate, all-weather capabilities; and toward computer-assisted decision making for both manned and autonomous systems and command centers. These changes in non-nuclear weapons technologies, over time, will revolutionize the conventional battlefield-a revolution that involves not just a single breakthrough but rather the steady development of many advanced technologies.

> Directed energy has the potential for making major differences in strategy.

Of particular interest are the non-nuclear weapons that might eventually be substituted in some, if not all, military missions now requiring nuclear weapons. For example, rather than using a nuclear weapon to destroy a large, fixed target complex, such as an airfield, extremely accurate guidance and advanced non-nuclear munitions could be used to selectively destroy critical nodes within that complex. However, the technical problems associated with the effective use of long-range conventional systems on *mobile* targets, such as a column of tanks, may remain intractable for decades. Also, advanced conventional weapons will never be able to duplicate the political and psychological effects caused by the sheer destructiveness of nuclear weapons-effects that presumably enhance deterrence. The question of the cost effectiveness of such non-nuclear alternatives to nuclear weapons is also unresolved and may be significant.

Strategic defenses, such as those proposed under President Reagan's SDI program, were not discussed extensively at the conference. This lack of discussion is itself significant, because SDI was initially proposed to change dramatically, and even eliminate, the future requirement for nuclear weapons. The consensus from the discussion that did occur was that strategic defenses, if deployed over the next several decades, will probably not play a leading role in the long-term evolution of U.S. nuclear policy and forces. Rather, any defenses are likely to be limited because they would be intended to enhance a deterrence policy based, as it is today, on the threat of nuclear retaliation.

Thus, technological trends were not seen to have as clear and as significant an impact on future national policy as political trends. This feeling appeared true even for SDI technology and ran counter to the previously strong historical impact of technology on policy.

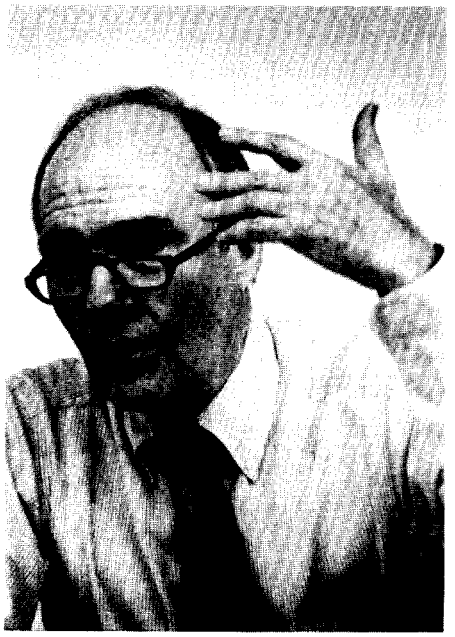
Military Influences

A session opened by Brent Scowcroft dealt with the military influences on the future of nuclear weapons. To under-

> Technological trends were not seen to have as clear and as significant an impact on future national policy as political trends.

A new phase in the military evolution of nuclear weapons could be driven by ongoing improvements in weapons system accuracy. Improved guidance holds out the promise of accomplishing the same missions with smaller nuclear weapons so as to avoid collateral effects. It also raises the issue of whether it will be possible to use conventionl weapons for some targets that have previously required nuclear weapons . . . I certainly agree we should attempt to avoid unnecessary collateral damage, and I think that substituting non-nuclear for nuclear warheads probably has a good deal of utility, especially in the European context. But it is not at all clear that this represents a truly significant development in our views about nuclear weapons and deterrence...

Arms control is likely to have a major military impact on nuclear weapons' requirements. Since about 1950, we have been trying to bolster the credibility of deterrence in Europe. By stationing battlefield weapons in Europe, changing to flexible response, deploying the INF forces, and so on,



our consistent purpose has been to make deterrence as strong as possible. It seems to me, however, that many of the arms control schemes being advanced today have the opposite intent—their purpose is to determine how much we can "shave off" deterrence without getting to the point that it fails. That is my principal complaint about the INF Treaty: not that it is a disaster in itself, but rather that it takes us in the wrong direction.

Arms control reductions may force us to think seriously about how we wish to target the remaining forces. If we really do limit the number of nuclear weapons significantly, we may have to look at targeting from a rather different perspective than we have over the past several decades, The target planners would have to return to first principles and ask themselves what they absolutely must be able to hold at risk to make deterrence as strong as possible-and, if deterrence fails, what they must strike to achieve U.S. objectives.

If both sides continue to develop survivable nuclear force structures, this will also raise similar questions about targeting. For example, the continuing Soviet deployment of mobile, survivable ICBM forces will challenge our traditional notions of counterforce. What do we target then? Are we thrust back to an assured destruction targeting policy? Should we target the Soviet leadership and, if so, at what stage of a conflict? Should we try to separate the leadership from the control of its military forces by attacking the command and control systems? Should we concentrate more on targeting conventional forces, such as army units moving out of garrison? These will be critical issues for at least the next ten to fifteen years, if not beyond.

—Brent Scowcroft, former Chairman, President's Commission on Strategic Forces, opened the session on military influences; he more recently has become Assistant to the President for National Security Affairs.

stand what some of those influences are, one must first understand how the military itself views nuclear weapons.

The American armed forces, quite reasonably, approach the issue of nuclear weapons from a military perspective: how can these weapons assist the military in achieving the peacetime and wartime objectives required of them under American national security policy? Such attributes as effectiveness, flexibility, and, to some extent, discrimination thus rank high when the services consider deploying nuclear weapons systems.

In addition, the particular services have vested institutional interests in maintaining certain types of weapons systems. The Air Force and the Navy devote significant portions of their budgets to what might be called national, or strategic, nuclear forces—the Strategic Air Command (SAC) and the Navy's strategic missile submarine force. Both services are committed to maintaining their "fair share" of those forces, whatever unilateral force structure decisions or arms control agreements the U.S. government might make. Finally, the U.S. military supports nuclear deterrence and the deployment of nuclear weapons because the services have neither the resources nor the plans to fight a massive, global conventional war with the Soviet Union. The Army, in particular, has no interest in fighting a replay of World War II, which might be the only realistic alternative military strategy if nuclear weapons did not exist. U.S. nuclear weapons, by deterring the Soviet Union, eliminate this possibility.

The U.S. military supports nuclear deterrence and the deployment of nuclear weapons because the services have neither the resources nor the plans to fight a massive global conventional war with the Soviet Union.

Over the past thirty years, however, parts of the U.S. military have had difficulties attempting to integrate nuclear weapons into their operational concepts and plans. This is especially true for the tactical (short-range) nuclear weapons. The services-fortunately-have no "real world" experience with nuclear weapons, and they find it difficult to predict the course and outcome of any war in which such weapons are used. The Navy, for instance, is particularly reluctant to plan for any limited nuclear warfare at sea, having concluded that enemy use of nuclear weapons would make traditional surface naval missions impossible to carry out.

What implications do these ambivalent military perspectives—implications which could not be explored fully in the conference—have for the future roles and requirements of nuclear weapons? Judging from the views of the speakers, who were not official representatives of the respective services, some of the implications are the following:

- The U.S. Air Force will likely be interested in maintaining a strategic nuclear force structure very similar to that in place or planned today. This structure is a mix of fixed and mobile ICBMs and of bombers that penetrate enemy territory or that stand off outside the borders and release missiles directed at the targets. The Strategic Air Command will likely attempt to develop a significant non-nuclear role beyond its current nuclear assignment that would use long-range bombers, such as the B-52, to deliver conventional bombs and standoff missiles.
- The U.S. Navy will probably continue to support the deployment of submarine-launched ballistic missile forces but will tend to resist and decrease other nuclear roles that interfere with normal fleet operations. For instance, the shipboard and submarine deployment of tactical nuclear weapons for use at sea makes it very difficult for the Navy to conduct its more traditional missions, such as sea control. The future nuclear role of naval aircraft also remains uncertain.
- The U.S. Army is not likely to change its view of the importance of nuclear weapons as a deterrent over the next several decades. The Army anticipates a decrease in the number of stockpiled nuclear weapons and will likely support significant increases in the military effectiveness of nuclear warheads with the same or better level of discrimination. The Army will have an interest in developing further options for its nuclear artillery systems and will support the modernization of air-carried theater nuclear systems,

The services–fortunately—have no "real world" experience with nuclear weapons, and they find it difficult to predict the course and outcome of any war in which such weapons are used.

The conference discussions begged a critical military (and technical) question that seems to be at the heart of our cur-

rent strategic uncertainty about nuclear weapons: whether and how to target Soviet nuclear forces? Such targeting is called the *counterforce* mission.

With respect to its long-range nuclear forces, the United States, at present, places highest priority on their counterforce mission. We have already noted the long-term political trends that, in the name of stability, work against a continuation of the counterforce mission, but there are also legitimate military and technical reasons to question the viability of that mission. Soviet nuclear forces are becoming ever more difficult to locate and destroy promptly because they are being made mobile on land and in the air or are being concealed aboard submarines. If the United States continues to target Soviet nuclear forces, it must invest considerable resources to discover and deploy a military-technical solution to this problem.

Any move away from counterforce targeting, whether mandated by political or technical pressures, would represent a significant shift in military emphasis for nuclear weapons. In this case, would the United States be forced to emphasize nuclear roles and requirements based solely on attacking enemy cities? Or are there other missions—for instance, targeting general purpose forces or command and control centers—that might redefine the military effectiveness criteria for long-range nuclear forces? To further complicate the issue, although effective counterforce operations do not appear technically feasible for either side in the foreseeable future of five to fifteen years, such a judgment may not hold over the thirty-year period of this study.

Thus, a certain amount of ambivalence clouds our view of the military trends and influences. In part, this is due to the fact that all forces bearing on the future of nuclear weapons—whether they be of a political, technological, or military nature—are intertwined, the one with the other. Some of the ideas expressed at the conference about how the various facets of this global problem will unwind were controversial. Such controversy was expected and encouraged because, above all, the conference was designed to stimulate the right kinds of questions about the future of nuclear weapons. ■

Further Reading

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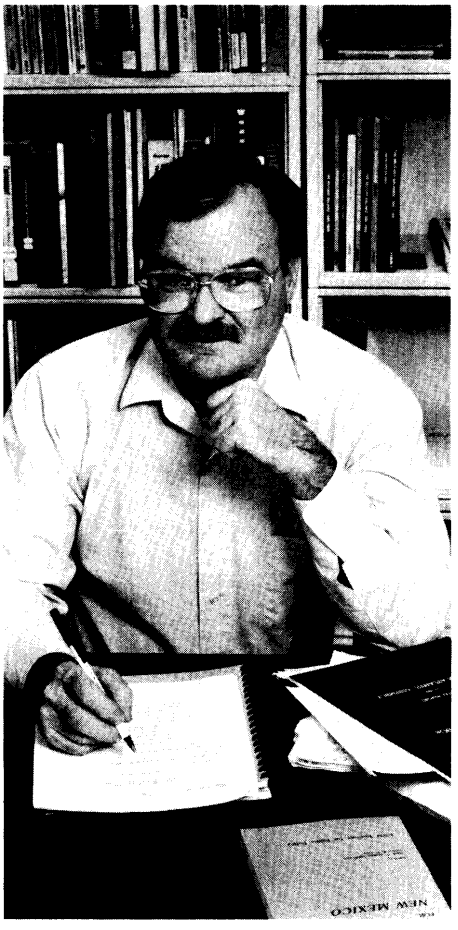

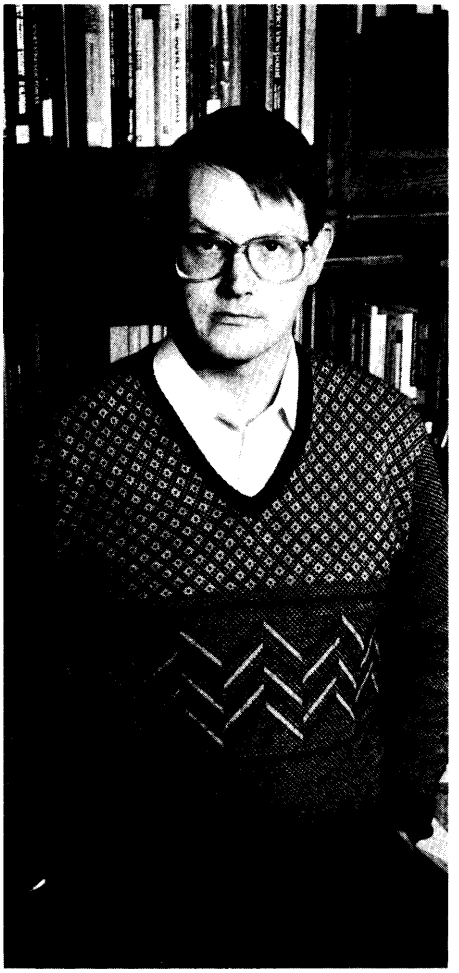

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