SDI: THE CLOUDED VISION

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I. OVERVIEW

A. The Evolution of a Strategic "New Thinking"

Reflecting on the devastating capabilities of a single nuclear bomb, Albert Einstein warned that "as we drift toward unparalled catastrophe. . . a new kind of thinking is essential if mankind is to survive." The dual U.S.-Soviet possession of nuclear weapons has required, as part of this "new thinking", an unconventional calculus in figuring the military utility, if any, of these devices. This was clearly manifested in the U.S. decision that it lacked any militarily decisive nuclear advantage during the 1962 Cuban missile crisis despite a seventeen-to-one numerical superiority. Confronted with mutual vulnerability, both sides spent the next decade vigorously researching defensive measures, particularly ballistic missile defenses (BMD). The prospect of an offensive-defensive arms race convinced the United States and the Soviet Union to agree, through the 1972 Anti-Ballistic Missile (ABM) Treaty, "that effective measures to limit ABM systems would be a substantial factor in curbing the strategic arms race and would lead to a decrease in the risk of outbreak of war involving nuclear weapons." The United States, through four subsequent administrations, has recognized the operational reality of mutual nuclear vulnerability while maintaining a substantial ABM Treaty-compliant research effort to investigate any promising BMD technologies and guard against a Soviet "breakout".

President Ronald Reagan drastically altered the nature of the United States' BMD efforts on March 23, 1983, by calling on scientists to "render nuclear weapons impotent and obsolete." Defense Secretary Caspar Weinberger elaborated on Reagan's own version of the new thinking four days later, asserting on the National Broadcasting Company's "Meet the Press" that "[t]he defensive systems that the President is talking about are not designed to be partial . . . [but] thoroughly reliable and total. I don't have any doubts about our ability to do it." Thus were sown the seeds of the Strategic Defense Initiative (SDI).

Congress has responded by approving a huge growth in spending for BMD research and development, quadrupling funding from one billion dollars in 1984 to four billion dollars in 1988. Ostensibly conceived as a long-term research program, the SDI officially became an acquisition program in September 1987 when the Defense Department approved a plan for rapid "Phase I" deployment in the 1990's of a strategic defense system composed of hundreds of space-based and ground-based interceptor rockets. Falling far short of the "total" population

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shield envisioned by President Reagan, the goal of the proposed system is to partially protect military installations such as intercontinental ballistic missiles (ICBMs), thereby "complicating" Soviet attack plans. The deployment of such a system, however limited in effectiveness, would violate the 1972 ABM Treaty's prohibition on space-based BMD components. In fact, the Treaty is already being threatened by SDI-related space-based testing, by Reagan Adminstration attempts at treaty reinterpretation and by mutual charges of violations by the superpowers. Under pressure from critics, including many in Congress, the Defense Department is currently reconsidering the Phase I plan.

After five years and more than thirteen billion dollars in SDI funding, the nation's strategic nuclear policy is at a crossroads. With the ABM Treaty and the Strategic Arms Reduction Talks (START) hanging in the balance, Congress and the Bush Administration must decide the role of strategic defenses in our national security. A prudent decision must be based not on rhetorical fantasy but on realistic, objective analyses of foreseeable capabilities, costs, possible Soviet responses, the impact on stability and arms control as well as strategic alternatives.

As a starting point, policymakers would do well to take lessons from the history of BMD development and from relevant past arms control decisions.

B. From Sputnik to MIRVs

The United States woke up to the threat of nuclear-armed ICBMs following the Soviet launch of the first space satellite, *Sputnik*, in 1957. The nation responded by quickly matching perceived Soviet ICBM capabilities, while both sides began researching methods of BMD.

An ICBM can be attacked, theoretically, during any of its four flight phases: (1) the boost phase when the booster rocket is thrusting the payload out of the atmosphere (lasting three minutes or less for modern rockets); (2) the post-boost phase (three to five minutes) when the "bus" separates from the burned-out booster and releases its warheads and penetration aids (decoys, electronic "chaff") designed to confound defenses; (3) the midcourse phase (fifteen to twenty minutes) when the warheads and penetration aids travel ballistically in free flight through space at roughly five miles per second and (4) the terminal phase (one-half to one minute) in which the warheads (re-entry vehicles) and penetration aids descend through the atmosphere to the target below.

For an effective defense, it is most desirable to attack the ICBM during the boost phase while it still carries all of its warheads and penetration aids. The booster also emits a fiery exhaust plume making it easier to track. Not surprisingly then, one of the earliest BMD efforts involved Ballistic Missile Boost Intercept (BAMBI), a system employing hundreds of space-based missiles carrying infrared homing devices. Work on BAMBI was aborted in 1962 due to its lack of cost-effectiveness and vulnerability to simple anti-satellite weapons (ASATs) including "space mines" designed to home in on and destroy military satellites.

Work continued in the United States on a system of ground-based nuclear armed interceptors—specifically, the so-called Sentinel system, later renamed Safeguard. Largely in response to the deployment of a similar system around Moscow, the United States introduced the multiple warhead ICBM (the multiple independently targeted reentry vehicle, or MIRV) in 1970 with the Soviets following suit five years later. The deployment of MIRVs gave the United States the ability to overwhelm the ground-based Soviet ABM system. It also precipitated a huge escalation in warheads on both sides while increasing the danger of preemptive strikes: a defensive deployment had naturally induced an offensive response.

C. The ABM Treaty

The United States and Soviet Union signed the ABM Treaty in 1972, jointly recognizing the reality of mutual vulnerability and the need to restrict defenses in order to limit the buildup of offensive retaliatory-deterrent forces. The Treaty, which was overwhelmingly ratified by the United States Senate later that year, was thus a vital ingredient in the Strategic Arms Limitation Talks (SALT) process which, while flawed, imposed mutually agreed-upon restraints on the arms race and provided important verification, confidence-building and dispute-resolution provisions.

The ABM treaty does allow for a single-site deployment of one hundred ground-based interceptors. Such a system can be easily overwhelmed by a combination of saturation and penetration aids such as decoys, chaff and radar jamming. This vulnerability led to the United States dismantling of its ABM Treaty-allowed Safeguard system shortly after its deployment in 1974. The situation is the same today for the Safeguard-like system deployed around Moscow. According to congressional testimony in 1987 by Lawrence Woodruff, then Deputy Undersecretary of Defense for Strategic and Theater Nuclear Forces, "the Soviets have been developing their Moscow defenses (which are permitted by the ABM Treaty) for over ten years at a cost of billions of dollars. For much less we believe we can still penetrate these defenses with a small number of Minutemen missiles equipped with highly effective chaff and decoys. And if the Soviets should deploy more advanced or proliferated defenses, we have new penetration aids as countermeasures under development... .[including] a new maneuvering reentry vehicle that could evade interceptors."

The mere possibility of extensive ABM "breakout" drives both sides to research defenses and offensive countermeasures. The historical and technically simplest response to deployment of extensive defenses would be an offensive overcompensation to restore critical strategic deterrence capabilities perceived as lost to the defense. This defense-induced deterrence instability was recognized by four successive administrations, both Republican and Democratic, each of which agreed that the ABM Treaty as signed in 1972 was vital to our national security.

II. THE REAGAN YEARS: SDI

A. The "Vision" is Born

President Reagan and his closest advisors came into power with a radically different view of the strategic balance and strategic defenses. This was clearly reflected in the 1980 Republican platform which called for regaining "overall military and technological superiority over the Soviet Union" and the development of "more modern" ABM systems. High Frontier, a space-defense lobby group led by retired Army Lieutenant General Daniel Graham, soon unveiled its proposal: a "global ballistic missile defense system" consisting of hundreds of orbiting satellites carrying interceptor rockets, which would supposedly use "off-the-shelf technology" and become deployable in less than five years, all at a projected cost of ten to forty billion dollars. High Frontier found an appreciative audience in both Congress and the White House. Conservative Congressman Newt Gingrich (R-Ga.) praised the concept as "absolutely necessary to our survival. . .[and giving] us a chance to move past the Russians." Then Vice President George Bush in 1983 enthused that "a lot of good thinking has gone into the High Frontier approach." However, the United States Air Force Space Division had concluded in 1982 that the High Frontier concept—basically an updated BAMBI—"ha[d] no technical merit and should be rejected." A separate analysis concluded, "[i]t is the unanimous opinion of the Air Force technical community that the High Frontier proposals are unrealistic regarding state of technology, cost and schedule."

At the same time, President Reagan was being personally lobbied on the need to develop exotic directed energy weapons (*i.e.* lasers and particle beams). Edward Teller, the Nobel Prize-winning physicist joined three longtime Reagan friends (the "kitchen cabinet" of businessman Karl Bendetsen, rancher-oilman William Wilson and brewer Joseph Coors) to personally inform Reagan of the need for the development of high-tech weaponry to counter Soviet missiles. Another group, led by Senator Malcolm Wallop (R-Wyo.) was pushing for development of the space-based High Frontier and its chemical laser concept, touting a pop-up short-wavelength X-ray laser powered by a nuclear explosive.

Opposing these laser-weapon promoters was the Defense Department's Science Board and the President's own Science Council. In 1981 the Science Board concluded that "[i]t is too soon to attempt to accelerate space-based laser development towards integrated space demonstration for any mission, particularly ballistic missile defense." Two years later, on the very day of President Reagan's startling "Star Wars" speech, Air Force officials testified before the Senate, recommending against accelerating the space-based laser program on technical grounds. At the same time, a year-long White House Science Council study of emerging defense technologies (including the X-ray laser) delivered a report to the presidential science advisor George Keyworth. The report, which Reagan apparently never saw, stated emphatically that there were no technologies on the horizon promising a change in strategic balance.

It was against this backdrop that President Reagan presented his program to redefine strategic doctrine by making nuclear weapons "obsolete." The proposal flew in the face of technical analysis and advice. It was made without consulting U.S. allies or senior Defense Department officials, not even the Pentagon's highest ranking scientist, Undersecretary for Research and Engineering Richard DeLauer. Hearing of the plan the day before the speech, DeLauer is reported to have exploded in disbelief and concluded that Reagan and his top policy advisors did not understand what they were proposing. (For a recounting of this situation, see Hedrick Smith's *The Power Game*, published in 1988.) It seems to clearly have been, as former presidential science advisor Herbert York suggested, "[a]n instance of exceedingly expensive technological exuberance sold privately to an uninformed leadership by a tiny in-group of especially privileged advisors."

B. The Vision Blurs

What the President was proposing (at least publicly) amounted to a radical shift from the strategic doctrine of deterrence based on mutual vulnerability, to a security posture that he claimed "did not rest upon the threat of instant U.S. retaliation. . . .Wouldn't it be better to save lives than avenge them," was his emotionally appealing vision. Actual escape from the "immoral" doctrine of deterrence requires confronting the entire arsenal of ever-evolving delivery systems, including land- and submarine-launched ballistic missiles, intercontinental bombers, and air- and sea-launched cruise missiles. The ballistic missile defenses specifically mentioned in the President's speech would address only a portion of Soviet or U.S. nuclear capabilities. It was only after publicly stating his goal (however ill-defined) that the President appointed three panels to assess the feasibility of achieving it. Again, only ballistic missile defenses were addressed—it seems only Soviet ballistic missiles were to be made "obsolete." The findings of the panels, however, were far from an endorsement of this limited goal.

The Defense Technologies Study Team, or Fletcher Panel after its chairman, James Fletcher, outlined the problem's magnitude. Constructing an "effective defense" would require intercepting thousands of Soviet missiles in their boost phase before they release their thousands of warheads and hundreds of thousands of decoys. Interception in the critical, but brief, boost phase would require space-based defenses orbiting above the U.S.S.R. and would involve "critical technologies" that the panel estimated would take ten to twenty years to research and develop, with no certainty of success. Battle management would also be daunting, requiring "very large [on the order of ten million lines of code] software that operates reliably, safely and predictably. . .[and remains] maintenance-free for ten years. . . ." The panel also touched on the obvious problem of survivability and crisis stability. Its report concluded that "survivability is potentially a serious problem for the space-based components." The defenses themselves, along with critical command and communication satellites, would be easier targets than ballistic missiles. The panel added that "the mutual occupancy of space by both sides is potentially an unstable situation," recognizing that the mutual possession of effective defenses and/or anti-satellite weapons would award a huge advantage to the side striking first in a time of crisis—hardly a desirable situation. The panel noted that protecting the defenses themselves from attack could require massive shielding and suggested as "feasible sources. . . . material from the lunar surface or from asteroids [which] can be brought to the vicinity of the Earth." It is certainly no surprise that the panel reportedly concluded that "it is not technically credible to provide a ballistic missile defense that is 99.9 percent leakproof." Still, in his report to the Senate, Chairman Fletcher stated in sufficiently ambiguous language that "by taking an optimistic view. . . we concluded that a robust BMD system can be made to work eventually."

The two other presidentially appointed panels were assigned to study the policy implications of new defense technologies. The Miller Panel, named after Frank Miller, its chairman, issued no public report. The third group, the Future Security Strategy Study Team or Hoffman Panel after chairman Fred Hoffman did issue a report. In it, the panelists paid little attention to the prospect or implications of near-perfect defenses, instead concentrating on enhancing deterrence through "partial systems—with more modest technical goals."

C. Double Vision

In March 1984, Defense Secretary Weinberger released summaries of the Fletcher and Hoffman Reports with the Reagan Administration's conclusion that "a robust BMD system can be made to work eventually." To this end, the administration announced a five year research program—a fraction of the ten to twenty years deemed necessary by the Fletcher panelists. The SDI program was officially born. The strategic and technical goals of the program, however, remained confused: Was it a program to replace "mutual assured destruction" by "mutual assured survivability" as suggested by former Strategic Defense Initiative Organization (SDIO) director Lieutenant General James Abrahamson to a British Broadcasting Corporation interviewer in 1984? That is, was its purpose to develop the population shield repeatedly alluded to in public by the President—recalling again that SDI deals only with ballistic missiles? It seems so. "This is an opportunity to devise and ultimately deploy a system that can indeed render impotent nuclear weapons and remove that shadow and that fear from the Earth for the first time since these nuclear weapons were developed ' said Defense Secretary Weinberger to the National Press Club on May 1, 1984.

Nonetheless, while they were touting the protection of civilian populations, both Weinberger and Abrahamson were also conceding that an "intermediate goal" of SDI would be to erect a partial defense to protect U.S. retaliatory forces. This, of course, would have the purpose of enhancing deterrence rather than replacing it.

Was this limited goal of enhancing deterrence with a partial BMD strategically sound? Was it necessary? The four previous administrations had all agreed on the destabilizing nature of BMD. The Fletcher Panel warned of the destabilizing effects inherent in mutual deployment of space weapons. President Reagan had requested in 1983 that the Commission on Strategic Forces—the Scowcroft Commission—review the administration's proposals for strategic defense. The Commission concluded that "research permitted by the ABM Treaty is important in order to ascertain the realistic possibilities which technology might offer, as well as to guard against the possibility of an ABM breakout." This was precisely the view of the four previous administrations. The Commission also warned that "[t]he strategic implications of ballistic missile defense and the criticality of the ABM Treaty to further arms control agreements dictate extreme caution in proceeding to engineering development in this sensitive area." The Commission further examined the United States' retaliatory deterrent capabilities, including the threat to our land-based ICBMs, the so-called "window of vulnerability." It concluded that "to deter such surprise attacks, we can reasonably rely both on our other strategic forces and on the range of operational uncertainties that the Soviets would have to consider in planning such aggression." To deal with the perceived threat to land-based missiles, the Commission recommended a combination of mobile ICBMs and arms control measures. Released in March 1984, the Scowcroft Commission report opposed even the reduced goal of the SDI program—protecting retaliatory, ground-based ICBMs with deployment of BMDs. Again, however, it seems that sound strategic analysis and advice was ignored.

In an attempt to clarify the strategic and technical questions relevant to SDI, the congressional Office of Technology Assessment (OTA) commissioned a 1984 background paper by physicist Ashton Carter. Carter noted that the strategic vagaries of the SDI program inhibited any assessment of progress toward a specific goal. He also pointed out the critical importance of distinguishing between capabilities at the device and system levels. For instance, hit-to-kill interceptors designed to obliterate reentry vehicles by means of nuclear-tipped missiles were proven possible in the 1960's. But devising a system to manage and accomplish the interception of thousands of vehicles in the midst of hundreds of thousands of decoys while dealing with chaff, radar jamming, nuclear bursts and attacks on communication centers and defensive components themselves is an entirely different task. This is a point consistently missed or ignored by SDI advocates.

The Carter Report also addressed an obvious truth which has been exploited by Star Wars advocates from Weinberger to the newest oft-quoted "authority" techno-thriller author Tom Clancy. To wit, no one can "prove" that some unknown, future technology will not enable a near-perfect protection of the U.S. population from future Soviet ICBMs—just as one cannot "prove" the nonexistence of the unicorn. Weinberger, Clancy and others have used this truism to dismiss critics of the astrodome vision of SDI as "nay-sayers" comparable to those who doubted mankind's ability to fly, reach the moon or build the atomic bomb. Their faith in American technology borders on the theological, and was perhaps best summed up by fellow believer Abrahamson: "I don't think anything in this country is 'technically impossible.' We have a nation which indeed can produce miracles."

Such reasoning betrays three serious misunderstandings about the prospects for a near-perfect defense. First, there is a critical difference between, on one hand, overcoming the predictable, testable, well-characterizable constraints imposed by nature and, on the other, absolutely defeating the efforts of an equally resourceful, reactive adversary. Second, any technical breakthroughs achieved by defenders are, ultimately, at least likely to aid aggressors in attacking and defeating the defense. The awesome power of the hydrogen bomb has already stacked things in favor of the offense. The possible future development of the nuclear powered X-ray laser might well turn out to be a greater boon for strategic offensive systems than for defensive ones. And third, in trying to assess the effectiveness of a defense, one is not confronting a static, well known quantity, but rather a dynamic, evolving threat of uncertain capabilities, which will be attacking under untestable circumstances.

Thus, while not being able to "prove" anything, the Carter Report, in agreement with the conclusions of its predecessor panels, found no foreseeable technology holding promise for a perfect or near-perfect ABM defense. Indeed, it made the further, important recommendation that the prospect of a perfect or near-perfect defense is so remote that "it [should] not serve as the basis of public expectation or national policy."

As for limited defenses, the Carter Report agreed with the Scowcroft Commission in questioning the wisdom of their development and pointed out that in assessing any possible system one must consider vulnerability of all the components, susceptibility to future Soviet countermeasures, and cost effectiveness relative to these countermeasures. It is also noted the possibility of a dangerous combination: Advanced BMD concepts and future anti-satellite (ASAT) systems could give either side the capacity to preemptively attack critical space-based systems including command, control and communications satellites. A more comprehensive OTA study, *Ballistic Missile Defense Technologies*, followed the Carter Report and supported its conclusions, specifically noting that assured survival of the population appears to be impossible if the Soviets opt to go after civilian targets. This study, too, found that the degree of effectiveness of any planned ballistic missile defense system is impossible to gauge in advance, requiring much greater knowledge of sensors, command and control, systems architecture, survivability, computer software and countermeasures than is currently available. The OTA report stressed the importance of both sides' compliance with the ABM Treaty, and recommended that all research be carried out in accordance with the Treaty guidelines.

The conclusions and recommendations of the Scowcroft, OTA and other studies went largely unheeded—the precise fate of previous Defense Department Science Board and Presidential Science Council reports. Instead, the confused promotional rhetoric continued to escalate, along with congressional funding. And by 1985, the officially stated "central purpose" of SDI had become, as a Defense Department report to Congress put it, "not to replace deterrence but to enhance it." This meant that, for the foreseeable future, "offensive nuclear forces and the prospect of nuclear retaliation will remain the key element of deterrence," in the words of a May 1985 SDI National Security Decision Directive.

On the other hand, Secretary Weinberger stated in a 1986 report to Congress that "the defense that might evolve from the research program will not be intended to defend our strategic weapons systems." As Keyworth told a audience of aerospace contractors in late 1985, "[it is in p]rotecting people [that SDI] holds out the promise of dramatic change. This clear purpose of the President has been repeated time and time again by Cap Weinberger, [then National Security Advisor Robert] 'Bud' McFarlane and myself." Defense industries quickly lined up in support of the program. SDI cost estimates, including that of James Schlesinger, former Secretary of Defense under Presidents Richard M. Nixon and Gerald R. Ford, ran into the trillion-dollar range for full scale development and deployment. This figure looks increasingly prescient today when contrasted with the fifty to 100 billion dollar "cost-goals" consistently advanced by SDI advocates.

III. THE HYPE

A. Technological "Breakthroughs"

The lack of coherent, compelling technical and strategic arguments for SDI drove the SDIO into a public relations campaign designed to demonstrate various "breakthroughs"in BMD devices. (It is worth noting that the displayed breakthroughs were always in SDI-related devices, not in BMD systems.) In June 1984, a $300 million effort culminated in the highly touted Homing Overlay Experiment; this was a single successful—after three failures—exo-atmospheric interception of a dummy warhead by another missile. While the experiment succeeded in demonstrating the United States' capability to sometimes intercept a reentry vehicle with a non-nuclear missile under controlled circumstances, it bore scant resemblance to the overall system required to defeat an actual attack, as noted above.

One year after the Homing Overlay trials, the SDIO bounced a low powered laser beam off a mirror on the space shuttle. This proved nothing new, but it generated favorable press response including television coverage and newpaper headlines hailing the "success of Star Wars."

But perhaps the most effective manipulation of public perceptions and expectations came in September 1985, with the demonstration of a chemical laser at the White Sands Missile Range in New Mexico. The inefficient, long-wavelength chemical laser had been downplayed as a possible space-based BMD concept two years earlier because of the unwieldiness of its huge but delicate mirror network and because of the tons of fuel it would require. These features make it a large, expensive, vulnerable target and a better candidate for a ground-based weapon against space-based components. For the public demonstration, a stage of a retired Titan booster was strapped down with high-tension cables. A laser was then focused on the "missile" until the cables snapped and the booster flew apart, giving the impression that it had exploded. SDIO-supplied videotapes of the event were dutifully shown on the television networks, with no explanation of what had really happened or what had been proved. Lasers had long been able to burn holes in metal. "It demonstrated the lethality of this technology," Abrahamson told Congress. In public, it was hailed as a "world-class breakthrough."

The X-ray laser promoters were not to be outdone. In 1983, Teller wrote to Keyworth that "we are now entering the engineering phase of X-ray lasers." This was a gross exaggeration and still not true five years later. In December 1984, Teller told high-level Reagan Administration officials that the new "super Excalibur" X-ray laser concept could make these weapons many times more powerful than ordinary nuclear weapons so that "a single X-ray laser module the size of an executive desk. . . could shoot down the entire Soviet land-based missile force." Teller then wrote to McFarlane that he wished "to prevent. . . any possible forthcoming agreement with the Soviets. . . that might impede our work." Teller protege and fellow Livermore scientist Lowell Wood advanced their cause with an April 1985 briefing of the current director of the Central Intelligence Agency (CIA), William Casey, entitled, *A Technological Race for the Prize of the Planet.* Keyworth chimed in, telling a Livermore audience in 1985 of the possibility that "a single X-ray laser could defend against the USSR's entire offensive forces and thereby make it unrealistic for the Soviets to counter with an arms race." Finally, in October 1985, Roy Woodruff, director of the Livermore X-ray laser program, resigned over his thwarted attempts to correct such "overly optimistic and technically incorrect" misrepresentations by his fellow scientists.

B. The "Red Shield"

Promotional hype surrounding the "incredible innovations" and the "incredible pace" of technical progress in SDI has been complimented by another hype: fear of an impending "Red Shield" which would effectively disarm the United States by creating a "Star Wars gap." The need to counter such an ominous threat became a major ingredient in the "why" of SDI.

The 1983 edition of the Defense Department publication *Soviet Military Power* devoted only four paragraphs to Soviet improvements in early warning radars and in the Moscow BMD system sanctioned by the ABM Treaty. It mentioned no possibility of a Soviet ABM breakout. The Pentagon's 1984 edition, which followed Reagan's speech and the subsequent storm of criticism, suddenly concluded that the Soviets could deploy a national ABM system within a decade. The following year, the State Department Report to Congress on Soviet Non-compliance with Arms Control Agreements charged that the Soviet Union "may be preparing an ABM defense of its territory." The main element in the Reagan Administration's argument was the Soviet's construction of a phased-array (electronically steerable) radar at Krasnoyarsk, in central Siberia. This radar is the sixth in line of the "*Pechora*-class" of large phased-array radars under construction in the Soviet Union. The previous five radars are situated along the country's periphery and oriented outward for early warning purposes, as permitted by the ABM Treaty. The Treaty generally prohibits, however, such a radar from covering the interior of a party's national territory due to its potential for BMD battle management.

The Krasnoyarsk system is located several hundred miles away from the border of Mongolia and points northeast to the Bering Sea, covering a large area of Siberia. This is in clear violation of the ABM Treaty's restrictions on early warning radar placements. While neatly filling in a gap of coverage left by the previous five early warning deployments, the Soviets attempted to pass the Krasnoyarsk radar off as a space-tracking station. SDI advocates have insisted instead that it is an ABM battle management radar and a key component in an imminent Soviet breakout from the ABM Treaty. This was contradicted by a 1984 CIA report concluding that the *Pechora*-class radars (including the Krasnoyarsk) were low frequency radars suitable for long-range early warning detection and "not well designed" for ABM battle management. The CIA report pointed out the radar's susceptibility to nuclear-burst blackout, its vulnerability to direct attack and, finally, that the location and orientation were not appropriate for the defense of nearby missile fields. CIA officials testified to Congress in 1985 that "these radars. . . are large, fixed installations vulnerable to attack."

A United States congressional delegation to the Krasnoyarsk site in 1987 supported the CIA's findings. The visit confirmed that the radar was designed to operate at low frequencies, was shoddily constructed and not hardened against attack. The congressmen concluded, as did the CIA, that it was constructed for early warning and not for ABM battle management as claimed by SDI advocates. Due to its location, it is a violation—however militarily insignificant—of the ABM Treaty and should, as the Reagan Administration insisted, be dismantled. The Soviets, for their part, have repeatedly offered to dismantle it in exchange for the dismantling of the disputed U.S. early warning installations in Thule, Greenland and Flyingdales, England—debatable violations of the ABM Treaty but certainly ones which we would push for if the roles were reversed. Gorbachev made the most recent offer to dismantle the Krasnoyarsk site while during a speech before the United Nations in December 1988.

Along with their unfounded charge that the Krasnoyarsk radar is a potential component in an imminent Soviet ABM system, SDI's proponents have made exaggerated claims of Soviet progress in BMD technologies. Reagan Administration officials, including Weinberger and former Assistant Secretary of Defense for International Security Policy, Richard Perle, repeatedly claimed in 1985 and

1986 that the Soviets were up to a decade "ahead [of the United States] in the deployment and technology of strategic defense." Weinberger and Abrahamson both claimed that the Soviets were "clearly ahead" in the area of chemical lasers. These claims are flatly contradicted by the findings of the Defense Department which holds that of the twenty technologies critical to ballistic missile defense, the United States leads in fourteen and is roughly abreast of the Soviet Union in the other six. Abrahamson himself admitted that "in the technologies needed for a broader defense—such as data processing and computer software—we are far, far ahead." SDIO's most recent report to Congress estimates that the Soviet Union lags ten years behind in critical sensor technologies.

All this has not deterred SDI advocates such as Robert Jastrow of the pro-SDI Marshall Institute and then Congressman Jack Kemp (R-N.Y.) from sounding the "breakout" alarm. Jastrow alleges in the February 13, 1987 edition of *National Review* that a Soviet plan for nationwide ABM deployment in the early 1990's "gives the United States about five years before our nuclear deterrent is emasculated." The United States must, he pleads, deploy defenses immediately—without, in the words of Kemp, "researching the problem to death." Such hysterics, which are typical of many of SDI's promoters, have no basis in technical or strategic reality.

Statements of Soviet spending for strategic defense have also been misleadingly cited by SDI's proponents. In promoting more money for SDI, the Reagan Administration often cited the estimated $20 billion spent annually on Soviet strategic defenses—the above-mentioned "Red Shield." However, any estimate of Soviet spending is necessarily highly conjectural. These estimates, moreover, include the Soviet's annual fifteen to eighteen billion dollars for air defenses. Sayre Stevens, a former CIA deputy director for intelligence, explained the huge Soviet air-defense effort in a 1984 Brookings Institute paper, *Ballistic Missile Defense*. It is a reaction to "the terrible air raids that the Russian people suffered during World War II. . .[resulting in] the commitment by the Soviet leadership to protect the homeland from the terrible ravages that it had suffered, a commitment made stronger by perceptions of Soviet unpreparedness at the onset of the war." Despite this effort, the United States Air Force remains confident in its ability to penetrate Soviet defenses. As Lawrence Woodruff testified to the House Armed Services Committee in March 1988, "The low-observables technology will enable our bombers and cruise missiles to penetrate Soviet defenses for the foreseeable future." So the massive Soviet spending to upgrade the Moscow ABM defenses has apparently been futile.

The Soviet Union obviously maintains a large BMD research program in addition to its Moscow defenses. There is no basis however, for alarmist warnings that the Soviets are about to deploy a nationwide BMD system, or anything comparable to the United States' SDIO programs. Such a Soviet effort would require a multi-layered defense including orbiting space-based weapons and sensors. The SDIO's own analysis concludes that the Soviet Union lags far behind in the critical technologies necessary to attempt a nationwide missile defense.

The United States has long had a robust BMD research program of its own. Before 1983, funding stood at roughly one billion dollars per year. However, in the past five years the SDI program has been characterized by greatly accelerated spending driven by false images of a population shield, by manipulative misrepresentations of U.S. technological "breakthroughs," and by wild exaggerations of Soviet capabilities. The calm, reasoned analysis of such strategic and technical bodies as the Scowcroft Commission and OTA have meanwhile been largely ignored by policymakers.

The Bush Administration and Congress together face key policy choices regarding BMD testing, development and possible deployment. Prudent decisions must be based on a realistic analysis of all relevant technical and strategic considerations. These must consider any contemplated system's impact on deterrence and crisis stabilization in general, and on the ABM Treaty and START talks in particular. These considerations are defined and developed in the following sections.

IV. TECHNICAL AND STRATEGIC CONSIDERATIONS OF BALLISTIC MISSILE DEFENSE

A. Capabilities and Vulnerabilities of Several Proposed Systems

1. Directed Energy Weapons

Directed energy weapons, including lasers and particle beams, are expected to play a leading role in any possible defense against Soviet ballistic missiles. This expectation moved the American Physical Society (APS) to initiate an exhaustive and detailed study on the science and technology of directed energy weapons. It was conducted by a group of leading scientists from major universities and from governmental and industrial laboratories, including the Air Force Weapons Laboratory, the Sandia National Laboratory, the Lawrence Berkeley Laboratories and Bell Labs. The scientists, many of whom were actively engaged in SDI research, received complete access to classified SDI information. Their conclusions, as described in the July 1987 *Reviews of Modern Physics*, were unanimous.

On specific technologies, the report found:

— Most [of the] crucial elements required for a [directed energy weapon] system need improvements of several orders of magnitude" before their suitability as BMD components can be evaluated.

— Chemical lasers are very problematic in terms of increasing power, space-based feasibility and survivability.

— The eximer laser shows somewhat greater promise, but will require an improvement in power of at least four orders of magnitude (ten thousandfold).

— Free-electron lasers are also more promising, but they will need improvements in power and the "validation of several physical concepts."

— Nuclear powered X-ray lasers still "require validation of many physical concepts" before their potential as BMD components can be evaluated.

— Many performance aspects of the neutral particle beam must be improved by several orders of magnitudes to merit effective use as a BMD device. Such devices could be used only in the emptiness of space due to atmospheric interactions. Use of the neutral particle beam for interactive discrimination—that is, identifying the warhead in a sea of lighter decoys during the midcourse phase—also requires many further developments such as fast, accurate beam "steering" for rapid retargeting.

— Electron beams, or any charged beam, encounter difficulties due to the earth's magnetic field—it deflects the beams. Such beams also will demand improvements in power and propogation distances, again, of several orders of magnitude.

— Sophisticated "phase correction techniques" must be developed to enhance the beam character of current laser devices. These techniques, demonstrated at low powers, must be scaled up by many orders of magnitude. Such an extension to high power has yet to be demonstrated.

— Further correction techniques, again unproven at high powers, will be needed to correct for atmospheric propogation in the case of ground-based lasers.

The APS report noted that scattering in the atmosphere restricts the minimum altitude at which a space-based laser can attack a rising ICBM in the critical boost phase. This severely limits the capabilities of space lasers, particularly a pop-up X-ray laser, in attacking future fast-burn boosters. Adverse weather conditions can drastically degrade laser beam propogation.

The APS report also detailed the serious problems which remain for optical mid-course tracking and discrimination of warheads-especially as they travel in a veil of decoys through space at roughly eight kilometers per second. In addition, the large housekeeping power requirements for the operation of the many contemplated space platforms probably require a number of orbiting nuclear reactors.

The physicists found the essential matter of survivability to be "highly questionable." Many space-based components would have damage thresholds far lower than the hardened boosters, post-boost "buses," and reentry vehicles they are attempting to destroy. The optical mirrors, sensors and radar dishes are particularly sensitive—and they would be completely exposed during times of engagement or alert. As such, these components would be very susceptible to attack by ground- and space-based directed energy weapons, space-based rockets, space mines and ASAT weapons based on the ground. To compound their vulnerability, space platforms move in predictable orbits; this allows relatively easy targeting. These factors all contribute to making space-based BMD components easier to attack than ballistic missiles themselves.

Finally, the APS report observes that, due to the long time required to develop and deploy an effective ballistic missile defense, the offense will have a considerable time to respond with countermeasures. These would include, of course, direct attacks on the defenses themselves. Any system must therefore be designed to counter, not only today's threat, but a myriad of potentially unpredictable future threats. An understanding of the individual component's survivability, and of the possible countermeasures a defense may face, becomes absolutely essential when assessing the technical feasibility and cost-effectiveness of directed energy weapons for BMD.

In summary, the APS panel concluded, "We estimate that even in the best of circumstances, a decade or more of intensive research would be required to provide the technical knowledge needed for an informed decision about the potential effectiveness and survivability of directed energy weapons systems. In addition, the important issues of overall system integration and effectiveness depend on information that, to our knowledge, does not exist."

The plethora of difficulties to be overcome in this area led former Defense Secretary Harold Brown to comment recently that "directed energy weapons [as

BMD components] seem more difficult than they did five years ago." Despite this—or more likely because of this—the last two years have seen a shift in SDI funding priority away from the original purpose of SDI-long-term research-and into the development of interceptor rockets for "early deployment." Development of directed energy weapons for BMD has simply become too hard, and the potential results have become too distant in time to wait for.

2. Space-Based Interceptors

Any effective BMD system must be able to attack an ICBM during its brief five-minute boost stage before it releases its warheads and penetration aids. "Of all the layers, the first is the most important—that's the boost phase architecture," as Abrahamson has noted. Technicians havs repeatedly considered and rejected space-based interceptor rockets as ineffective boost-phase BMD weapons—from BAMBI in the 1960's to High Frontier in the 1980's. Independent and government studies, except those done by High Frontier and the Marshall Institute, have consistently shown the vulnerability and futility of such systems. A recent study by the Strategic Defenses Group at Lawrence Livermore National Laboratory, published in the July 1987 *Energy and Technology Review*, concluded that an orbiting armada of several thousand space-based interceptors, as proposed by the "Phase I" plan, would be at best twenty percent effective against a projected mid-1990's Soviet ICBM fleet of 14,000 warheads. This assessment was made assuming no Soviet attack on the space-based defenses, a ninety percent "kill" probability for each inceptor, perfect battle management and a prompt interceptor launch twenty seconds after commencement of the Soviet attack. This scenario left no time for the human decisionmaking which would actually be critical under such circumstances, in case of false alarm.

The Strategic Defense Group study further showed, in agreement with earlier studies, that space-based interceptors would fail completely against a responsive Soviet deployment of fast-burn boosters which would leave less than ninety seconds in which to react. This technology is well within Soviet capabilities. Former SDIO official Louis Marquet attested to this point in 1987, saying "fast-burn boosters. . . could rise up and deploy their vehicles before [space-based] kinetic energy interceptors could reach them." Any deployment of space-based interceptors would leave the United States with an expensive, ineffective, hair-trigger system which may pressure the Soviets into an even greater expansion and modernization of their ICBM forces.

"The vulnerability of space-based interceptors has presented scientists with an unsolved problem ever since the early days when it helped contribute to the cancellation of the 1960's BAMBI program. No one has come up with a method to confound even such simple threats as space mines. A 1988 OTA report, *SDI Technology, Survivability and Software* concluded that "direct-ascent nuclear anti-satellite weapons [nuclear ground-launched missiles] would pose a significant threat [to space-based interceptors]." In addition, the OTA found that [t]here has been little analysis of any kind of space-based threats to BMD system survivability. . . . In particular, SDIO and its contractors have conducted no serious study of the situation in which the United States and the Soviet Union both occupied space with comparable BMD systems." This was the potentially explosive situation warned of by the Fletcher Panel some four years earlier. The whole situation was best summed up by Livermore scientist George Miller: "[The] survivability of objects in space. . . has not even been conceptually solved."

3. *Battle Management*

The problem of managing the huge network of command, control and communications features involved in an effective BMD is often regarded as the most daunting one of all. This network would be tasked with detecting, tracking and discriminating between hundreds of thousands of rapidly moving targets and of directing the battery of BMD weapons in a coordinated attack on this dynamic array of targets. All this would take place in an environment of nuclear bursts which would include attacks on the defensive command and control components themselves. The OTA concluded that "[n]o adequate models for the development, production, test and maintenance of [command and control] software for full-scale BMD systems exist." It would be a system of complexity well beyond anything in existence.

Due to this complexity, there would always remain questions as to its dependability in a crisis. The OTA noted that even existing large software networks, such as the U.S. telephone system, became reliable only after long operation and continued modification. In the end, the OTA concluded that "there would be a significant probability. . . that the first (and presumably only) time the BMD were used in a real war, it would suffer a catastrophic failure." A Pentagon official responsible for SDI command, control and communications put it even more bluntly by noting recently, "SDI command and control is a total and complete disaster. . . .[W]e [have] spent $600 million and have nothing to show for it. We can't show, except for what I call view-graph engineering, how it is supposed to work even for [the SDIO's early deployment plan,] Phase I." For details of this interview, see the House Democratic Caucus May 1988 staff report on SDI.

B. Costs

The accelerating costs of SDI have consumed over thirteen billion dollars over the past five years—this in times of tighter budgets and huge deficits. SDIO claims it will need another forty-five billion dollars through 1993 in order to make an "informed decision." Estimated costs of achieving Phase I deployment have also escalated. Abrahamson, then SDIO director, testified in March 1987 that Phase I deployment would cost forty to sixty billion dollars. It rose to $70-100 billion by September 1987 for "an initial, partially capable but very impressive deployment." By February 1988, the cost "estimate" had reached seventy-five billion dollars. This estimate was for development and deployment only of Phase I technology. It did not include additional billions to be spent on directed energy weapons and other advanced technologies. Regular maintenance and operational costs of any deployment will no doubt add an additional several billion dollars per year. Cost estimates for the follow-up "Phase II" system, which conceptually will include space lasers, state-of-the-art sensors and interceptor rockets, run into the $500 billion range. The total life cycle costs for these dubious systems would likely approach one trillion dollars. But all these BMD expenditures would still not address the threat posed by the ever-evolving Soviet bomber, air- and sea-launched cruise missile forces. Defenses against these, if they are ever made feasible, might well cost as much as SDI.

C. Space Launch Considerations

Any attempt to deploy and maintain space-based battle stations will require a huge increase in U.S. launch capacity. The United States launched roughly 350,000 pounds into orbit in 1985, the year before the Challenger tragedy. SDIO estimates SDI deployment will require lifting up to five million pounds into orbit annually. To meet its cost and schedule goals, SDIO would need to increase U.S. launch capacity by more than tenfold while decreasing launch costs by a factor of ten. The Air Force is understandably pessimistic about this. Deployment would inevitably increase SDIO's competition with other military, scientific and civilian payloads for available cargo space.

D. Crisis Stability and Deterrent Effect

It grew to be accepted, even within the Reagan Administration, that near-perfect defenses will be unattainable for the foreseeable future, if ever. One must judge SDI deployments, then, on the merits of a limited BMD. Any defensive deployment, whether ground- or space-based, naturally induces uncertainty in the offensive retaliatory deterrent capabilities of the opposition. This pressures a response to restore capabilities perceived as lost to the defense. This kind of instability, and the worries it creates, motivated the ABM Treaty.

The Soviets could respond to a U.S. BMD deployment in a number of ways. These would include deploying offensive countermeasures such as fast-burn boosters, penetration aids and ASAT weapons, all of which could defeat any foreseeable U.S. defenses at a fraction of the cost of SDI. They could also choose to further expand their bomber, and air- or sea-launched cruise missile capabilities. The responsive deployment of ASAT's would be particularly destabilizing, threatening critical communications satellites as well as space-based BMD components.

As the Soviets are no doubt aware, limited U.S. defenses would be much more effective against a depleted, "second strike" retaliatory ICBM attack. That is, the unilateral deployment of defenses by the United States could reasonably be seen by the Soviets as tantamount to the development of a U.S. first strike potential. This would put great pressure on the Soviets themselves to preempt in times of crisis.

President Reagan himself noted this in his original "Star Wars" speech of March 1983, saying, "I clearly recognize that defensive systems have limitations and raise certain problems and ambiguities. If paired with offensive systems, they can be viewed as fostering an aggressive policy, and no one wants that." There is, of course, no plan for the United States to rid itself of its offensive retaliatory deterrence forces.

The mutual deployment of space weapons and ASATs also poses obvious problems for crisis stability. Again, such a deployment would create a great incentive for a first strike. Incredibly, neither the SDIO or its contractors have seriously studied this issue, according to the latest OTA report.

The profound effect of BMD deployments and ABM Treaty abrogation on Europe and on the NATO Alliance must also be considered. The development and deployment of U.S. and Soviet defenses would induce uncertainty in the independent deterrent capabilitites of Great Britain and France. Doubt would also rise in the concept of extended U.S. deterrence in Europe. These uncertainties would grow along with U.S and Soviet BMD capabilities. The development of BMD technologies could conceivably trigger a competition to deploy defenses against tactical ballistic missiles and air defenses throughout Europe. This would further erode the western European nuclear deterrent. These developments would severely strain the NATO alliance—not to mention member nations' budgets-and jeopardize the current progress in diffusing East-West tensions.

E. Strategic Options

The latest justification for the deployment of limited defenses is to enhance deterrence by "confusing" Soviet war planners, thereby adding an element of uncertainty to any Soviet possible preemptive attack. As Woodruff has pointed out, our vast and varied retaliatory capabilities, coupled with the huge operational uncertainties already inherent in any such Soviet plan, make the addition of any extra "confusion" highly superfluous. Incentives to preemption will be far more effectively reduced through thoughtful arms control agreements eliminating "first-strike" weapons such as high-accuracy MIRVs.

Quite contrarily, the deployment of BMD by the United States would add to the growing uncertainty and instability in space. As noted, any technology developed and deployed for BMD purposes would more likely be effective against space assets such as communications and control satellites. This would also be the likely result of any limited systems ostensibly designed for protecting against accidental launch. (Accidental launch is a problem better addressed through a cooperative program to deploy post-launch vehicle destruction systems similar to those on most U.S. civilian and test rockets.) Both the United States and the Soviet Union have grown increasingly dependent on satellites for early warning of attack, as well as for communications, intelligence and arms control verification. The development of BMD technology, with its inevitable ASAT potential, directly threatens these functions and thus adds to crisis instability. This is also another good reason to strictly adhere to the ABM Treaty.

To remain effective, the ABM Treaty must be updated and strengthened to eliminate the ambiguities—and possible loopholes—created by evolving technologies. Advances in radar and sensor technology have blurred the lines between Treaty-prohibited ABM components and legitimate communications and early warning systems. Even the definitions of the key terms like "research and "development," "ABM component," "ABM-capable" and "testing in an ABM mode" must be clarified, as the Soviets have requested, in order that strict and verifiable limits can be set.

Research programs permitted by the Treaty should return to their pre-1983 purpose of rigorously, yet calmly, investigating the long-term potential of emerging technologies for both defenses and countermeasures. The countermeasures effort has been a miniscule and diminishing priority of SDI. This has prevented a complete, honest appraisal of the effectiveness of technologies emerging from our own research. It has denied the United States measures which might be needed to counter the Soviet efforts about which the Reagan Administration spoke so ominously. The neglect, under the SDI program, of the critical questions of BMD survivability and BMD's effect on crisis stability also require attention.

V. CONCLUSION

The Defense Acquisition Board's approval in 1987 of SDIO's Phase I deployment epitomized the dogmatic, self-promoting approach to BMD characteristic of SDI since its misconception six years ago. The approval was given despite the conclusions of the Defense Department's own Science Board that the plan was so "sketchy" that neither its price nor effectiveness could be determined. Typically, these criticisms were omitted from the version of the report advanced to the Acquisition Board. This omission was consistent with previous Reagan Administration and SDIO responses to the wealth of critical and objective research which has been performed within and outside the government over the past six years. As then Defense Secretary Weinberger stated in 1987, "The basic decision that [the United States] wanted to deploy [SDI] has been made long ago." In conjunction with the Phase I decision, $600 million in contracts were awarded for development of space-based interceptors. Current reconsideration of this "plan" provides the latest illustration of the spasmodic nature of the program's spending and management.

McFarlane, in the Fall 1988 issue of *Foreign Affairs*, saw the "Star Wars" debate becoming polarized between "the romantic and manipulative hyperbole of the [Reagan] Administration"—of which he was an important part—and "the flatly dismissive rhetoric of scientists who should have known better." The point is they *did* know better. They realized that the reality of U.S.-Soviet mutual nuclear vulnerability will endure for the foreseeable future despite the Reagan Administration's "reckless words and loose rhetoric" regarding the "immorality of deterrence," in the words of former Secretary Schlesinger. These "flatly dismissive" scientists, many of whom have worked all their careers on defense-related programs, some of whom even took part in the Manhattan Project, have pretty much always supported a healthy BMD research program. The scientific community was very supportive of BMD research as it existed under four presidential administrations previous to Reagan's. However, the scientists recognized, as did the politicians, that any BMD deployment would have severely adverse effects on deterrence and crisis-stability. Hence their strong support for a viable ABM Treaty.

In SDI they rightly smelled a rat, a program which has been technically and strategically misguided from the beginning—a triumph of dogma, ideology, and "manipulative hyperbole" over well-reasonsed analysis.

Recent ad hoc rationalizations that SDI has produced commercial "spin-offs" made while the Reagan Administration was coercing the Soviets into further arms control talks, have been particularly lame. A program to spend billions of dollars per year on exotic-weapons research and development should be judged by its impact on national security. It is unquestionably a most inefficient way to fund non-military research and development. Weapons research diverts private and government resources, both minds and money, from far more productive commercial and scientific efforts. Any attempt to give another impression is simply more deceitful rhetoric. Such conduct is particularly deplorable in these times of concern about U.S. economic competitiveness.

As for pressuring the Soviets on arms control, Soviet leader Gorbachev has had proposals for strategic reductions on the table since he took power in 1985.

The SDI program and its threat to the critical ABM Treaty has been a constant and major impediment to progress. The Soviets recognize that meaningful, lasting reductions are impossible without resolving the SDI-ABM issue. The United States has been "kicking the can down the road"—to borrow the phrase of arms negotiator Max Kampelman—and squandering billions of dollars while doing it. One hopes the Bush Administration and the new Congress will "know better."