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by

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Since the beginning of the age of nuclear weapons, and especially since these awesome explosives were wedded to intercontinental ballistic missile delivery systems, the dominance of the offensive application of the assorted technologies that underlie nuclear forces has scarcely been challenged. Whether popularly expressed in terms like John Kennedy's analogy that defense against a ballistic missile was akin to shooting down a bullet with another bullet or theoretically canonized in notions like Thomas C. Schelling's "hostage effect" as the prime dynamic of assured-destruction deterrence, the implicit and at times explicit assumption has been that strategies of deterrence based on offensive primacy are both immutable and even virtuous. Defense and deterrence have been viewed as opposite ends of the spectrum, with defense being ridiculed as practically unattainable and as intellectually destabilizing to the structure of deterrence.

This sort of judgment and reasoning is, and always has been, simultaneously understandable and curious. The emphasis on the deterrent imperative, propounded with force and eloquence by the late Bernard Brodie in *The Absolute Weapon* and echoed ever since, is thoroughly understandable given the destructive capabilities of even a modest number of nuclear detonations. Likewise, the judgment that meaningful defenses are impractical is also understandable. That view has its roots in the latter 1950s and early 1960s when the operational technologies around which defensive systems might be based were unavailable and, perhaps more important, when a "golden age" of theorizing was producing most of the concepts that still heavily influence our thinking on strategic weapons. That the offense was and still is dominant can scarcely be denied. What is curious, however, is that the situation has been viewed as unchangeable and especially praiseworthy from a moral standpoint.

The notion of offensive primacy requires some unravelling. At the risk of oversimplification, it can be boiled down to three interrelated propositions about nuclear weapons. The first and most basic proposition concerns the special quality of nuclear weapons: their destructive abilities are so enormous that any calculations about using them either offensively or defensively raises peculiar horrors. From this presumption has arisen the dual constructs that deterrence is best served by making the prospects of nuclear employment so horrible as to be unthinkable and that any defensive efforts, if not downright illusory, would dilute the healthy horror inhibiting the calculation of gain from nuclear weapons use.

The second proposition flows from a unique characteristic of nuclear weapons: they are inherently offensive. Although the yield of a nuclear device can be modulated to various levels of destructiveness, it is undeniable that the basic utility of nuclear weapons is that of their being agents of mass destruction through attack, an offensive mission. As weapons, they are most "useful" as the ultimate vindication of the total-war concepts that found mid-20th-century embodiment in strategic bombardment—their sole utilization over Hiroshima and Nagasaki having been the culmination of the strategic bombardment campaign against the Japanese home islands. This notion that nuclear bombs were the munition that made strategic bombardment decisive has never disappeared altogether. It should, for instance, be recalled that their employment was contemplated during the Korean conflict but was rejected largely on strategic bombardment grounds: there were very few strategic targets in North Korea against which to use them, and the limited stockpile (about 300 weapons) had to be preserved for use in Europe (where the environment was much more "target rich") in the event of a Soviet attack.[1] The conjunction between nuclear weaponry and the maturation of strategic bombardment theory in World War II has deeply influenced the way we look at these weapons, but that influence has not been systematically explicated (to begin, one might start by reversing the order of invention of the airplane and the nuclear bomb and seeing which would be viewed as the more dangerous innovation).

The third and, once again, related proposition is that offensive dominance is an enduring quality of the nuclear age. In part, this proposition flows from the second: with the limited exception of exoatmospheric ballistic missile defense using thermonuclear explosions to destroy or disable incoming enemy reentry vehicles, there are virtually no nonoffensive uses of these weapons at the strategic level (the tactical or theater level is another matter). Moreover, there is evidence to support the argument that views offensive dominance as enduring; the thermonuclear age and offensive dominance have coincided. Whether offensive dominance and the evolution of thermonuclear weaponry are causally related or no more than coincidentally related is a question that should be, but seldom has been, raised and answered. If one argues that offensive dominance will endure, however, then one must also argue that the relationship is causal, i.e., that the ascendancy of the offense is the result of the unique properties of nuclear explosives and their associated means of delivery. If such is indeed the case, advocacy of the defense is futile and ridiculous, even if it may not be dangerous, destabilizing, and heretical.

The view that nuclear weapons have lead to and perpetuate offensive dominance is deeply imbedded in most deterrence thought; and the fact that offense-based (or at least defense-abnegating) strategies and a continuing condition of deterrence have coexisted provides tremendous inertial drag against movement toward the defense, and a clinging to the belief that offensive dominance is immutable. This third assumption about offensive primacy is, however, the most assailable proposition about the effect of nuclear weapons on the offensive-defensive balance in strategy and weaponry. The assault on this premise can be mounted from two directions. The first is that such a view presents a static picture of the relationship between offensive and defensive weaponry over time, which even a cursory examination of the history of weaponry reveals as false. The second direction challenges the underlying premise that nuclear weapons have caused offensive dominance and suggests that it may be useful to view nuclear weapons as the culmination of a cycle of offensive dominance with roots


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going back at least to World War I. Clearly, the two perspectives are not mutually exclusive.

Deriving generalizations and "lessons" from military history is always tricky business, since the lessons are frequently numerous, sometimes contradictory, and often ambiguous regarding their applicability to any given situation. At that, the history of warfare seems to indicate that weapons development and strategic and tactical innovation and adaptation have generated a pattern in which the offense and the defense, over time, alternate in primacy much as a pendulum swings.[2] A new offensive weapon or technique arises that overcomes previously impregnable defenses, and the offense becomes supreme until a new defense can be devised to blunt the offense, and so on. The length of the cycles of offensive or defensive dominance have varied greatly over time, dependent on such things as the vitality of the technological system supporting change and the adaptability or resistance (more often the latter) of military leaders to such change, but the pattern has remained. The inaccuracy and slow-loading characteristics of 18th-century muskets that made close-order bayonet charges effective gave the advantage to the offense through the Napoleonic Wars, but the introduction of the rifled barrel, the breech-loading rifle, the machine gun, and entrenchments had, by World War I (more properly, the American Civil War), rendered such techniques disastrous and made the defense apparently supreme. In turn, products deriving from the invention of the internal combustion engine—notably the tank, troop carrier, and airplane—reintroduced maneuver and mobility into warfare and began the new ascendancy of the offense, of which the nuclear age is a part.

Two observations about these fluctuations in the past 200 years stand as cautionary notes in assessing the future. First, changes in offensive or defensive dominance have generally been associated with a major technological breakthrough, often accompanying the application of a new physical discovery to warfare. The musket was not a new weapon, but rifling the barrel and later adding percussive caps to bullets greatly changed its effectiveness. The internal combustion engine had first to be invented before aviation with heavier-than-air ships was practical or the highly mobile artillery effect of tanks could be applied. Similarly, the splitting of the atom and chain reaction of fission were preconditions for nuclear weapons, and current delivery methods had to await the perfection of rocketry. Each innovation dramatically changed the way warfare was conducted and thought about, and the question that must be raised is whether there is any reason to believe that equally dramatic innovations with similarly important effects do not remain to be discovered.

The second, more sobering observation is how poorly we have anticipated and adapted to these innovations. The pattern has been, in large measure, one of resistance and confusion. The frontal assault, especially against entrenchments, should have ended with the American Civil War (if not before) because of the killing range of rifled weapons, but the technique was the basic tactic by which World War I was fought. The earliest tanks were available at the beginning of World War I and were an effective means to break through the entrenchments, but they were seldom used until 1917. One must wonder how effectively the current generation and future generations of weapons will be initially employed.

The second argument against the premise that offensive dominance is an enduring quality of the nuclear age suggests, once again, that the nuclear-tipped rocket could be viewed as part of an offensive-defensive cycle rather than something apart. More specifically, it might be seen as the culmination of the rising advantage of the offense that has its roots early in the current century, notably in World War I and in the development of the internal combustion engine. Applications of that invention not only revolutionized land warfare by reintroducing a rapid mobility not tied to the use of railroads (which had been a major development in 19th-century warfare, first noted in the Crimean War), but also created the possibility of air power and hence strategic bombardment. Whatever else strategic nuclear weapon systems may be, they are forms of air power (regardless of the launching platform from which they originate, they are delivered by air), and their purpose is strategic bombardment either of military forces (counterforce targeting) or the "industrial web" that supports military forces ("soft" counterforce or countervalue targeting).

Viewing strategic nuclear weapon systems in this context suggests that they are part of the cyclical pattern of offensive-defensive dominance rather than unique. The point is not to try to conceptualize nuclear weapons as just another form of weaponry to be treated like any other weapons innovation; quite clearly their destructive capacity makes them special and obviously warrants extraordinary effort to ensure that they are never again employed in anger. Rather, the purpose is to place these weapons in the broad historical sweep of weapons development instead of viewing them as sui generis. Other forms of weapons, after all, were viewed as "ultimate" when they were developed, and some means to neutralize their effects were invariably found. If nuclear weapons seem to have so conclusively established offensive dominance, doesn't the history of weaponry suggest that the pendulum will swing and that a neutralizing defense will emerge?

Compared to conventional thought about nuclear deterrence, this is clearly heretical stuff, and doubtless the charge can be made that pursuing this line of reasoning will lead to a reduction in the awe in which we hold nuclear weapons, and hence corrode our steadfast support of deterrence theory. The objection has merit to the extent that it serves to remind us that we must never become casual in our contemplation of nuclear consequences; it is ostrich-like to the extent that we conceptualize the nuclear age ahistorically and react either by grudgingly accepting our current condition as inevitable and permanent (the balance-of-terror syndrome) or by doggedly attempting to turn back the clock (nuclear disarmament advocacy).

Though I recognize the possibility that the point may be overstated, one can say that weapon systems generally fade away either because they become dysfunctional or obsolete. In the case of mustard gas or particularly virulent botulism strains, for example, the inability to control the consequences of use could make the costs of use potentially greater than any gains. Certainly the rules of war enshrined in international conventions on what is and what is not permissible behavior during hostilities recognize this principle, and one can argue that superpower nuclear deterrence has in no small measure rested on the dysfunction of a nuclear exchange. At the same time, weapons generally fade from the battlefield when they have been superseded or have been found to be ineffectual. Countering the dread consequences of Greek fire or the longbow is, in a phrase, no longer an operational problem, although each of these weapons at one time probably seemed insuperable.

If the current ascendancy of the offense in warfare is in fact part of a historical cycle of which the major components are the fruits of the internal combustion engine and nuclear physics, is there any evidence that the pendulum is swinging back toward the defense? The question regarding defense against nuclear weapons is an open one and will be considered at some length in the succeeding paragraphs; there is, however, at least a glimmer or two to suggest that some balance between offense and defense is emerging in other categories of weaponry that have been characterized by offensive dominance.

The tank and the escorted penetrating bomber (jet now, of course, rather than piston-driven) are the most dramatic symbols of the effects of combustion-engine mechanization. When wedded with appropriate doctrine that exploited its mobility, the tank was a tremendously effective offensive weapon in World War II and the early Arab-Israeli wars. That success has spawned several generations of antitank weapons, from the simple bazooka to current state-of-the-art wire- and laser-guided antitank missiles. Much of the controversy over the Abrams tank and of the speculation over conventional war between the Warsaw Pact (which is heavily armor-dependent) and NATO (which is heavily antitank-weapon-dependent) comes down to the question of which mode of warfare, offensive or defensive, is supreme. In another offense-defense standoff, the highly sophisticated Soviet air defense system largely negates the effect of fighter escorts that made bombers efficient offensive weapon systems, and has thus spurred an equally heated controversy about the ability to penetrate to target and hence about the future of the penetrating bomber (a debate most clearly focused around the cruise missile/B1B bomber issue).

One can argue the merits of either weapon system (i.e., whether tanks or bombers are or are not becoming obsolete). The point is not which side is correct in each of the arguments at this or some other moment in time. Rather, the point is the debate itself; it provides, at a minimum, indirect evidence that the clear offensive dominance of weapon systems originating in the internal combustion engine is eroding. The question is whether that trend—to the extent there is a trend—can be extrapolated to nuclear arms. To make an assessment requires looking first at the forms the defense can take, then at the current and potential technologies that might implement those forms, and finally at the desirability and practicability of moving from the offense to the defense.

Any discussion of defense against nuclear weapons could well begin by making some distinctions about the concepts that are integral to the subject. The concept and forms that defense can take are straightforward and historically derived. Defense against any form of attack has the purpose of minimizing the effects of the attack, which is to say, the purpose of damage limitation (for this discussion, offensive forms of damage limitation, such as attacking and destroying weapons before they can be launched, will be omitted from consideration—although given certain real military considerations, one would not do so). Defensive damage limitation can take on two forms, passive defense and active defense. Passive defense is that which seeks to limit damage by increasing the target's ability to withstand the effects of an attack. There are two basic techniques to accomplish that purpose, absorption and evasion. Absorption seeks to minimize damage by increasing the physical capability of a target to accept (or absorb) the effects of an attack, while evasion seeks to protect the target by removing it from the impact of an attack (getting it out of harm's way). Active defense, on the other hand, seeks to limit damage by intercepting and destroying or disabling an attacking force before it reaches its target, thereby rendering it harmless.[3]

These distinctions are orthodox, but the special characteristics of nuclear weapon systems require us to determine anew their relevance. The characteristics, of course, are the huge explosive power of nuclear warheads and the delivery characteristics of ballistic missiles. Both the initial and residual effects of nuclear warheads are so disastrous that any defense mounted against them and their delivery systems would have to have extraordinary performance characteristics—a porous nuclear defense may be no better than no defense at all. In more specific terms, the exceptional damage that would result from a nuclear detonation raises serious questions about the efficacy of passive defense measures; there are physical and economic constraints on hardening targets (the most common absorptive technique), and one must have adequate warning to get far enough away to avoid the effects of a nuclear detonation. With regard to active defense measures, the problem arising from ballistic missile delivery, simply put, is that ballistic missiles and reentry vehicles travel very rapidly and are consequently difficult to attack successfully (adding maneuverability to the reentry vehicles compounds the problem). Although the theoretical aspects of active ballistic missile defense were solved before the first ICBM was fired successfully, the practical physical and engineering difficulties of developing a system adequate to the task continues to bedevil BMD designers.

As if all this were not complicated enough, one must make a further distinction regarding what one seeks to protect with defensive arrangements. The conventional distinction between counterforce and countervalue targets usefully describes the options. Counterforce targets are those potential targets with military value, such as military forces; military installations; militarily useful transportation networks; command, control, communications, and intelligence ($C^3I$) assets; and the industrial web necessary to support a war effort (e.g., petroleum and steel industries, and munitions plants). Two subdistinctions are often used to distinguish counterforce targets. First, counterforce targets are designated as "hard" or "soft," depending on the extent to which efforts can be or have been made to render the targets more capable of absorbing and surviving an attack. Second, targets are described as "time-sensitive" or "non-time-sensitive," with sensitivity referring to the urgency of destroying the target before it can be employed in retribution. Combining these two distinctions, an example of a hard, time-sensitive target would be a missile silo; a hard, non-time-sensitive target might be the bunker to which the President could retire to direct a nuclear war (assuming the enemy would want someone left in authority with whom to negotiate an end to hostilities); a soft, time-sensitive target would be an air base from which strategic bombers could be launched; and a soft, non-time-sensitive target could be an Army post.

Countervalue targets refer to those things that people value most, namely their lives, their homes, and their means to survive and recover following nuclear war. The purest form of countervalue target is a city. It should be added in passing that with regard to some targets, the counterforce/countervalue distinction is more seeming than real. An attack against missile silos in remote areas might be conducted with relatively few noncombatant fatalities (at least prompt fatalities), but counterforce targets like militarily related factories, air bases, and naval bases are typically located in or adjacent to population concentrations. Given the indiscriminate and widespread destructive characteristics of even a moderate-size thermonuclear device, an ambitious counterforce attack would be largely indistinguishable, after the fact, from a countervalue attack.

The problem for the defense thus boils down to answering three questions: What does one seek to defend? What forms of defense are available for those assets? And which techniques are most likely to be effective?

Passive forms of defense have had the dual but contradictory distinction of being the only forms systematically implemented and also of being subject to the most disagreement at both the theoretical and practical levels. Passive techniques to protect countervalue targets—for example, such absorptive measures as providing blast shelters for urban populations and hardening factory machinery, and such evasive tacks as developing urban evacuation plans—have been ridiculed as being impractical and ineffectual. Proponents of these techniques, collectively known as civil defense, point to the elaborate Soviet passive defense system as evidence that at least the Soviets apparently believe in their efficacy (an opinion not shared by opponents of civil defense).[4]

Passive counterforce techniques, meanwhile, have been attacked as being both ineffective and in some cases damaging to the theoretical underpinnings of deterrence. The primary method of passive absorptive defense is, of course, the hardening of land-based missile silos. This program has been in existence for more than 20 years but has recently been judged inadequate in the face of increasingly accurate, high throw-weight Soviet missiles—a situation that forms the basis of the so-called "window of vulnerability." The evasive technique of always having a portion of the B-52 force on alert and planning for the dispersal of the force to a large number of civilian airports has been the basic defense for the air-breathing leg for years, although this defense is potentially vulnerable to a Soviet attack with depressed-trajectory, submarine-launched ballistic missiles (which could reach airfields in 8 to 12 minutes, before the bombers could be airborne). The evasive techniques of concealment and unconstrained mobility, which form the basis of missile submarine invulnerability, have been opposed for land-based forces because mobile systems would be publicly unacceptable and because their effectiveness would be inversely related to their verifiability under arms control agreements.

If there is a general consensus (and there may not be), it is that passive defenses offer limited if any utility, if for no other reason than they function as a response to—and, by implication, an acceptance of—the detonation of a large number of Soviet thermonuclear warheads on or over American territory. The greatest hopes, and coincidentally the largest controversies, have surrounded active defenses, and notably ballistic missile defense. Although the controversies over BMD have been numerous, they boil down to the related questions of cost and effectiveness. The economic side of the coin is that any BMD system is likely to be very expensive. The effectiveness question asks how well (if at all) such systems would work against a Soviet attack and what would constitute acceptable performance. Response to this latter concern, which will doubtless be central to the upcoming BMD debate, will vary depending on what one seeks to protect with a BMD system.

There is a fundamental performance distinction between active defense of counterforce targets and active defense of countervalue targets, and that distinction produces a dilemma of sorts for BMD advocates in justifying deployments. Active counterforce defense, at heart, has an *incremental* performance criterion: to the extent that it works at all, it provides some protection for retaliatory systems, and each improvement in performance means an incremental increase in the number of surviving systems. One can question at what level of force protection the system's costs would be justified, but, costs aside, it is hard to deny that some protection is better than none. Active countervalue defense, on the other hand, has an *absolute* performance criterion: the system either does or does not protect the population from nuclear attack. A counterforce system that is, say, 50-percent effective means that something like 50-percent more retaliatory forces would survive than in the absence of the system, and it can be justified on that ground. But a 50-percent-effective defense of New York City might mean, indeed, only that the rubble would bounce less, and such a prospect provides scant comfort to residents and inadequate justification for the system's costs.

From the viewpoint of national security (in the fundamental terms of protecting the country and its citizens from physical attack), certainly the most desirable form of active defense is one that meets the absolute criterion of an air-tight countervalue defense, but such a system is clearly the most difficult to erect and, in a perfect sense, is probably unattainable. An incremental system is undoubtedly more practical, but it is more difficult to justify in either economic or political terms. Given the high costs involved, something that promises to work very well (ideally perfectly) is easier to sell than something that works less well. As a practical political matter, an incremental system designed to protect weapons of mass destruction is difficult for a Congressman to justify to his constituents, who are, in their own eyes, not being defended themselves. Paradoxically, those who have advocated an incremental population defense have had their difficulties, too. Their basic argument has been that a defense that would result in the survival of some larger percentage of the population would contribute to postattack recovery; the political rub is that one cannot guarantee in advance who those survivors would be.

Possibly the most important question regarding strategic defense is that of its technical feasibility to deal with not only current but future strategic offensive challenges. Two technologies now under development comprise the effort to meet both challenges: anti-ballistic missiles and the so-called "exotic" weapon-system prospects of high-energy lasers and charged-particle beams, collectively known as directed-energy-transfer weapons.

The more familiar and mature technology is that of the ABM. As stated earlier, the principles underlying the mission for ABMs were worked out before the first ICBM was fired, and they are conceptually straightforward. An ABM is itself a ballistic missile, and its job is to intercept and either destroy or disable an incoming ballistic missile. To accomplish that task, the ABM can be armed with either a nuclear or a conventional warhead (most earlier ABMs were nuclear-armed, a circumstance that created much of the controversy that surrounded their proposed deployment). The ABM warhead is exploded near the incoming reentry vehicle, thereby rendering it inoperative through heat, percussion, or radiation that either destroys it, disables its guidance or detonation mechanisms, or knocks it off course. The principle of interception, which can occur either in space (exoatmospherically) or after the reentry vehicle reenters the atmosphere (endoatmospherically), is based on the fact that the offensive missile, once fired, follows a fixed and predictable trajectory (akin to an artillery shell). To plot where a missile will be at any point in its flight thus requires a minimum of two sitings along its flight path, from which all of its future locations can be extrapolated. The task, then, is to launch the defensive missile so that it arrives at a point on that path at the same time the offensive missile does.

If, conceptually, the ABM task is simple, its execution is not. Extreme precision is needed to accomplish the mission against an attacking missile, which is flying at thousands of miles per hour and can execute an intercontinental mission in 30 to 35 minutes (the problem is even more severe against missiles launched from submarines off the coast, which have flight times of 8 to 12 minutes in depressed-trajectory launch). Modern missiles employing maneuverable reentry vehicle technology further complicate the task, since in-course adjustments in trajectory can be made to lessen the predictability of the reentry vehicle's flight path and thereby increase its chances of eluding ABMs.

The short time available for mission execution is the major problem that an ABM system must overcome. The system must be extremely quick, flexible, and precise. Particularly important are the radar systems that acquire information about an attack and the computers that must evaluate that information and then provide accurate instructions to allow timely interception. The ABMs themselves must be highly responsive (i.e., have a short launch time) and, given the kind of target coverage possible with multiple warheads, they must be capable in sufficient numbers of intercepting the multiple incoming armed reentry vehicles. A failure in any of these aspects of the overall task can result in the failure of the entire enterprise.

Beyond the difficulties inherent in ABM performance, the system must be capable of overcoming adversary countermeasures specifically designed to defeat it. Two such means are well known. The first, often considered the Achilles' heel of any BMD system, entails efforts to "blind" the system by destroying the radar and communications network necessary to acquire information on attacking forces and to relay that information to ABM support computers. The most common scenario for implementing this countermeasure involves attacks on early acquisition and relay satellites (the first link in the chain) followed either by attacks on land-based radars (the construction of which leaves them inherently vulnerable) or nuclear detonations in space, the intense light from which leaves the radars inoperative for some time. The second countermeasure entails saturation of the ABM system with so many warheads that the system is overwhelmed. This technique has been made possible through multiple-warhead technology.

Despite these formidable practical difficulties that began making their way into the ABM debate in the 1960s, research and development efforts on ABMs have continued. In the 1960s, attention was given more or less equally to exoatmospheric systems (the Spartan missile) employing multimegaton warheads designed generally for area defense (countervalue targets) and to endoatmospheric systems (the Sprint missile) designed for terminal defense of missile silos (counterforce targets). Of the current generation of ABMs, those given the best prospect for success (and certainly the most publicity) are endoatmospheric systems possibly using conventional explosives and designed as terminal defenses for land-based missiles. The most developed and well known of these systems is the Army Missile Command's Low Altitude Defense (LoAD) system, a "point" defender. This system is purportedly capable of discerning between armed reentry vehicles and decoys, of identifying those reentry vehicles actually aimed at the site being defended, and then of intercepting them at about 30,000 feet above the ground.

In the past several years, increasing interest (ranging from utter fascination to complete disdain) has been generated with regard to the BMD applications of the exotic high-energy-laser and charged-particle-beam technologies.[5] Because the weapon potential of each technology is still being developed and workable systems do not currently exist, the discussion is necessarily speculative. Both directed-energy-transfer technologies operate on the principle of focusing an intense beam of energy on a target in order to destroy it (e.g., melt a hole in the skin of the missile, causing it to self-destruct), to disable it (e.g., affect the electronic guidance system or detonation mechanism), or to knock it off course through intense atmospheric overpressure.

The word "laser" is an acronym for "light amplification by stimulated emission of radiation," and laser weapons would operate by transferring an intense light beam from the source to the target. Because it is a light beam, a laser travels at the speed of light, thereby allowing it to arrive virtually instantaneously at a target after activation; this phenomenon would negate such difficult ABM problems as having to lead the target. At the same time, however, a laser is subject to the degrading atmospheric effects on any light source (e.g., diffusion, refraction). As a result, the most promising applications of laser weapons appear to be exoatmospheric, where such degrading influences are either minimal or absent altogether.

Charged-particle-beam weapons, on the other hand, would operate by transferring an intense beam of concentrated radiation of subatomic particles (principally neutrons and gamma rays) from propagation source to target. Because the beam is, in effect, a long chain reaction from source to target, it requires physical particles with which to react along its path (such as those found in the atmosphere). In the absence of a surrounding atmosphere to allow replenishment within the beam, charged-particle beams tend to spread and become unfocused, hence ineffective. Consequently, charged-particle beams have their most promising weapon applications endoatmospherically rather than in the vacuum of space.

Although advances in these areas could have revolutionary offensive applications as well, virtually all discussions about the strategic role of directed-energy-transfer technology, especially laser technology, center on BMD missions. Space-based laser scenarios, in particular, suggest orbiting battle platforms stationed above Soviet missile fields that could intercept and destroy rising missiles during their relatively vulnerable boost phase, when the missile is still gathering speed and is incapable of evasive maneuver. In a more advanced scenario, the laser platform would be backed up by a terminal-phase land-based charged-particle-beam system capable of destroying any reentry vehicles that escape through the laser system, and the most ambitious projections call for a fully "layered" BMD system that would add conventional ABM deployments for maximum target coverage and redundancy in the event of system failure (the justification for this notion parallels that for the offensive force triad).[6]

Of all these ideas, the possibility of space-based lasers is the most strategically intriguing, because it offers the prospect of reestablishing the symmetry between attacking and defending systems that was upset by multiple-warhead technology. Much of the practical objection to BMD, after all, centers on whether any defensive system could possibly intercept all the incoming warheads released by MIRVed missiles. Boost-phase interception potentially solves this problem by attacking the missile *before* the MIRV bus has decoupled from the booster and is capable of dispensing its reentry vehicles. Aside from the fact that the missile is a larger and more vulnerable target at that stage, a "kill" during boost phase degrades the attacking force by the multiple of warheads on the missile. Even if the system is not "leakproof" (which it undoubtedly would not be), the degree to which it is effective would proportionately simplify the task for terminal interceptors, including conventional ABMs.

Despite these potentials and the well-advertised directed-energy-transfer developmental programs in both the United States and the Soviet Union, there are serious impediments to producing an effective laser or particle-beam defensive system. First, a tremendously powerful beam is needed to produce sufficient power to carry out the BMD mission. The physical size of the propagation device and the amount of fuel needed to produce an adequate beam currently requires a laser platform that literally weighs tons, and both inserting such a device into space and servicing it (e.g., replenishing fuel) are major problems. It has been suggested that the space shuttle may eventually overcome these difficulties by inserting the platform in space in parts and periodically servicing it.

The second problem, referred to earlier as a generic BMD difficulty, revolves around the need for a highly sophisticated acquisition device to accomplish the system's terribly exacting mission. As described earlier, these eyes of the system are inherently the most vulnerable, the most difficult elements to defend, and their functioning is absolutely critical.

A third impediment is that the need to defend laser platforms and acquisition and tracking systems could stimulate the arms race. As an example, one way to deal with the vulnerability of information satellites would be to place so many backup systems into space that they could not all be attacked simultaneously (which, of course, could invite a proliferation of satellite killers). It is not difficult to envision the prospect of space being cluttered with armed satellites, dummy satellites, satellite killers (themselves perhaps laser-armed), and satellites designed to destroy the killers.

Fourth, there are undoubtedly countermeasures, some foreseeable and others as yet undiscovered, that will degrade laser and particle-beam effectiveness. In addition to efforts either to blind or disable the platforms, for instance, one obvious antidote to lasers is to design missiles so that they have very shiny, reflective surfaces that do not absorb the heat produced by the light beam and hence diminish its effect.

Fifth, and finally, any BMD system is likely to be very expensive, and the more comprehensive and effective it is made to be, the higher the costs will be. No one is publicly projecting the cost of a laser platform system, but clearly it would be substantial. If the kind of redundancy projected for a layered system combining lasers with earth-based particle beams and ABMs is included in the calculus, the costs would easily become politically prohibitive and the dilemma described earlier revisited. A limited BMD system capable of point defense of ICBMs may be economically feasible but politically less attractive; a comprehensive defense may have political and strategic appeal but founder on the grounds of cost, particularly when it must compete with other priorities.

What, then, is the status and the future of strategic defense? Is the trend toward the defense real, is it inexorable, and, most important, is it desirable? This last question is clearly the most basic consideration: Would a move toward defensive dominance or at least some balance between the offensive and defensive elements of strategic nuclear forces make nuclear war more likely—or less likely? Would it weaken the structure of deterrence—or strengthen it? One can do little more than speculate on these points, of course, since there is essentially no hard evidence to support any contention about the effects. Unfortunately, debate on the issue throughout the nuclear age has been highly emotional and nearly ideological, rather than rational and dispassionate. Identifying the biases that exist and trying to strip away some of the excess and undesirable baggage that the issue has accumulated may be a precondition to answering the important questions raised above.

Defense against nuclear attack has never occupied a very respectable place in American thinking about nuclear weapons (that defense occupies a higher position in Soviet thought is one of the major stimuli to American consideration of the idea). From Brodie's seminal work to the present day, the thrust of deterrence thought has been to elevate deterrence to the primary value and to decouple the notions of deterrence and defense. Defense has, at least implicitly, been associated with warfighting, the failure of deterrence; and a whole structure of strategic thought (e.g., assured destruction) and international agreements (notably the ABM Treaty) has been erected on this distinction.

One can scarcely argue with the emphasis on deterrence as the continuing purpose of nuclear forces, but doing so does not force one to accept the decoupling of defense and deterrence nor to assume that defensive efforts detract from deterrence. Placing defense and deterrence at opposite ends of a continuum, after all, violates the traditional reasons for which political units have maintained military forces. In a deterrent role (whether called that or not), military forces threaten potential aggressors in two basic ways: by the promise of swift, even awful, retribution in the event of aggression (the punishment threat basic to assured destruction); and by successful defense, which promises a potential enemy that his ambitions will be denied (or at least raises sufficient uncertainty about attaining the goal as to make the adventure not worth the risk). But in the nuclear era, the punishment threat has been respectable and the denial (defensive) threat disreputable. One must ask why nuclear weapons have been so treated.

At the considerable risk of oversimplifying some relatively complex constructs, I would suggest that three reasons stand out. The first is the desire to ensure that nuclear weapons are treated in a special manner rather than as just another advance in man's quest for yet more efficient means to kill and destroy. This thread, as argued earlier, has been consistent and is not challenged here. But the second and third propositions are challengeable: that offensive dominance reinforced by ballistic missiles is enduring, even immutable; and that defense is unattainable. The difficulty with the second proposition is that it defies the historical swing between offensive and defensive dominance; the problem with the third is that defense *may* be becoming possible (although its practicality can be debated).

Clearly, the *prospects* of BMD are real, although the jury is still out regarding how effective BMD might become and whether that effectiveness would meet whatever criteria of success one erects. It is equally clear that defensive dominance is not inevitable: BMD systems may never become effective enough to warrant deployment; judgments based on cost or other considerations could lead to decisions unfavorable to further pursuit of BMD; or developments in offensive weaponry could render BMD systems obsolete before they are erected. The real question is whether the pursuit of BMD possibilities is worth the effort, and that, in turn, is a consideration of whether introducing a defensive component would make nuclear war more or less likely. The answer is not stunningly obvious.

There are really two considerations involved. The first is whether a defensively dominant system, once achieved, would stabilize or destabilize deterrence. The traditional answer is that it would destabilize deterrence because it would appear to reduce the potential horrors of nuclear warfare and hence make nuclear war more thinkable. At the other extreme, the absence of the attempt to defend can be viewed as irresponsible, and defensive preparation can be seen to reinforce rather than detract from the prospects of peace. Intermediate between those extremes is the position that defensive systems of whatever effectiveness (and one could never know precisely how well they would work before the fact) would add uncertainty to a potential aggressor's prospects of success and thus be dissuading. None of these three positions is completely persuasive.

A more intriguing and subtle consideration is how one would manage the transition from a purely offensive strategic system to one with a defensive element: How does one get from here to there? Such a transition could well be maximally destabilizing, regardless of the ultimate effect once the defense were in place. The most destabilizing possibility, of course, would occur if one side or the other had either a monopoly or a sizable advantage in defensive technology. In that circumstance, because the side possessing the technology would be at an enormous advantage once its defensive systems were in place, the disadvantaged party would be sorely tempted to attack before that telling advantage could be imposed against him. In a phrase, preemptive incentives would reach a peak. On the other hand, destabilization would probably be minimized if both sides had relatively equivalent technologies available at roughly the same time, in which case the problem would largely revolve around insuring symmetrical introduction of BMD systems in such a way that neither gained decisive, if temporary, advantage.

Somewhat ironically, arms control processes might offer the best hope for effecting such a transition. The irony, of course, is that proponents of arms control and proponents of missile defense have sometimes been bitter rivals, most obviously in the debate leading to the ABM Treaty. Arms control processes could, however, ease the transition toward a defensively oriented strategic system in two ways. First, progress in offensive arms limitation, and especially arms reduction, would make the defensive task more manageable. For example, President Reagan's reported Strategic Arms Reduction Talks (START) proposal of 850 missiles on each side with no more than 5000 warheads would considerably reduce the volume of incoming weapons with which a defensive system would have to cope and would obviate the common objection to BMD that any defensive system can be defeated by overwhelming it with offensive warheads.[7] Second, arms control negotiations could result in an orderly, phased introduction of defensive capabilities into each arsenal in such a way that neither side would gain a destabilizing advantage. The framework of the ABM Treaty may or may not be capable of encompassing such a transition, but the Standing Consultative Commission created by SALT I could well prove a useful monitoring device.

Interest in strategic defense clearly is rising and will be an increasing force in the strategic debate during the coming years. Defensive technology has matured since the 1960s, and the prospects of directed-energy transfer weapons could increase defensive momentum. Indeed, a major change in the conceptualization of deterrence, itself, may be in the offing.

**NOTES**

1. See, for instance, Bernard Brodie, *War and Politics* (New York: Macmillan, 1973), pp. 64-66.
2. For an excellent overview, see Bernard and Fawn M. Brodie, *From Crossbow to H-Bomb: The Evolution of the Weapons and Tactics of Warfare*, revised and enlarged edition (Bloomington, Ind.: Indiana Univ. Press, 1973).
3. For a more complete discussion, see Donald M. Snow, *The Nuclear Future: Toward a Strategy of Uncertainty* (Tuscaloosa, Ala.: Univ. of Alabama Press, 1983), ch. 3.
4. The debate over Soviet civil defense is summarized in Donald M. Snow, *Nuclear Strategy in a Dynamic World: American Policy in the 1980s* (Tuscaloosa, Ala.: Univ. of Alabama Press, 1981), pp. 151-55.
5. For an overview of these technologies, see Richard L. Garwin, "Charged-Particle Beam Weapons," *Bulletin of the Atomic Scientists*, 34 (October 1978), 24-27; John Parmentola and Kosta Tsipis, "Particle-Beam Weapons," *Scientific American*, 240 (April 1979), 54-65; Barry J. Smernoff, "Strategic and Arms Control Implications of Laser Weapons: A Preliminary Assessment," *Air University Review*, 29 (January/February 1978), 38-50; and Donald M. Snow, "Lasers, Charged-Particle Beams and the Strategic Future," *Political Science Quarterly*, 95 (Summer 1980), 277-94. *Aviation Week and Space Technology* regularly provides information regarding the status of US and Soviet programs.
6. This idea is articulated by Clarence A. Robinson, Jr., in "Ballistic Missile Defense Emphasis Urged by Teller," *Aviation Week and Space Technology*, 113 (13 October 1980), 18-20; and in "Quickened Pace Sought in Missile Defense," *Aviation Week and Space Technology*, 108 (22 May 1978), 16-19.
7. "Reagan Offering Soviet Union 2-Step Plan to Reduce Nuclear Arms," *The New York Times*, 10 May 1982, p. 12.