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While we may disagree with the implications of what strategy deters, a nuclear strategy must deal with the real emergence of an uncertainty in the strategic environment. Strategies and patterns of force must flow from a concept of what deters, given the physical environment, and must be devised and procured relevant to current and future realities.

STRATEGIC UNCERTAINTY AND NUCLEAR DETERRENCE

by

Donald M. Snow

Disagreement abounds over the state of the thermonuclear balance, the adequacy of American nuclear forces to deter a potential Soviet aggression or to carry out their assigned mission should deterrence fail, and about the propriety of American nuclear strategy to underpin the deterrent condition. Extraordinary claims and warnings are heard about the purported ability of the Soviet Union to destroy the U.S. fixed-site land-based ICBM force in the early 1980s and the consequent need for alternative ICBM basing[1] and about the need for alternative deterrent strategies, possibly most dramatically represented by Colin S. Gray's recent advocacies of a "war-fighting" strategy[2] and the Carter administration's announcement of a limited counterforce targeting policy (Presidential Directive 59).

This intellectual turbulence has been caused by important changes in the operational environment in which strategy and forces are fashioned. The pace of change has been dynamic and its effects very difficult to analyze and interpret. Differences of opinion in what these changes portend play a large part in the strategic and force configuration recommendations that analysts advocate. Two sources of change are particularly prominent and, because of their importance, require summary examination: the evolving Soviet threat and weapons technology developments.

Concern about Soviet nuclear capabilities stems from the force expansion and modernization program that the U.S.S.R. began in 1967.[3] The Soviets moved from strategic inferiority in the early and middle 1960s to parity and by most measures superiority today. Expansion has occurred in both ICBMs and SLBMs, with particular emphasis on third- and fourth-generation ICBMs (notably the SS-17, SS-18 and SS-19, NATO designations of their three most recently deployed liquid-fuel intercontinental rockets). Alarm has arisen over vigorous MIRVing and accuracy improvements in their large payload missiles, because such advances on their greater throw-weight rockets potentially endows these weapons with counterforce capability against American ICBMs.[4] These concerns form the basis of the ICBM vulnerability debate and advocated need for the MX missile deployed in a supposedly survivable basing mode.

The major concern about the Soviets is why they have developed the forces they possess. The question is contentious, but one thing is for sure. The Soviet force expansion produced a configuration and capability far in excess of the needs for an assured destruction employment strategy. The possibility that some other motive than assured destruction guided the Soviets shocked many observers who believed the Kremlin had been "educated" to accept American views about nuclear stability. The result was a concerted effort to try to assess Soviet intentions, using evidence from the publicly available literature (in military journals and the like) and pronouncement of leading Soviet spokesmen. Viewing this complex of sources over time and across commentators, this mode of analysis has revealed that the Soviets conceive nuclear weapons very differently from the way Americans do. Rather than basing deterrence in something like assured destruction, the Soviets argue deterrence is maintained by the Soviet ability to fight and win a nuclear war *should deterrence fail*. From this construction, Soviet emphasis on counterforce targeting, preemptive attacks, close integration of conventional and nuclear forces, and civil defense follow.

The degree of alarm this revelation engenders differs among observers and depends on which Soviet spokesmen one emphasizes. Soviet military writers emphasize how the U.S.S.R. plans to fight, win and survive a nuclear war should one begin, and those analysts who find Soviet intentions particularly ominous tend to emphasize this literature (the Soviet civil defense debate is a bellwether).[5] Soviet political leaders, ever since the "peaceful coexistence" enunciation at the 20th Congress of the CPSU in 1956, have emphasized the necessity of avoiding nuclear war. Analysts who make primary reference to these sources tend to downplay the importance of Soviet declaratory policy and to point out the difficulties of inferring intentions from capabilities.[6] Lacking direct access to Soviet nuclear intentions, the debate continues inconclusively.

The fruits of technological development have also stimulated debate. The seminal technological event was the advent of the multiple independently targetable reentry vehicle (MIRV).[7] MIRV allowed warhead proliferation without increasing the number of strategic launchers, and permitted greater target coverage, including both countervalue and counterforce targets. MIRV thus made consideration of attacking retaliatory systems attractive by upsetting the symmetry between attacked and attacking systems (i.e., one could attack several retaliatory systems with a single launcher). Improvements in guidance technology increased missile accuracy, making more serious the ICBM vulnerability problem.

Projected breakthroughs in ballistic missile defense (BMD) through laser and particle-beam technologies would add yet another dimension to this problem.[8] The result of these changes has been to leave nuclear strategy in a state of confusion and disarray for the last decade. The debate has taken assured destruction theory honed in the 1960s as the base and has either attacked its adequacy and attempted to provide an alternative or has tried to modify the basic strategy to changed conditions. What has emerged has been a series of partial, piecemeal, and often "quick fix" solutions rather than a clear and thoroughly articulated alternative strategy.[9] In the wake of SALT I and the Jackson amendment to its ratification, the term "essential equivalence" entered the lexicon. In 1973, then Secretary of Defense James Schlesinger added the notion of limited nuclear options (LNOs), a throwback to the controlled response idea introduced by Robert S. McNamara in 1962.[10]

The Carter administration repackaged this melange of ideas and partial strategies under the umbrella of a concept coined in 1965, the countervailing principle (the term originally appearing in a research contract report to the Secretary of the Air Force in 1965[11]). As will be argued later, it may prove prophetic that this "principle" originally occurred in a discussion of American response to ABM deployment or adoption of a counterforce targeting strategy. Elevated and elaborated, the principle has become the countervailing strategy, as summarized by former Secretary of Defense Harold Brown:

> Our potential adversaries must be convinced that we possess sufficient military force so that if they were to start a course of action that could lead to war, they would be frustrated in their effort to achieve their objective or suffer so much damage that they would gain nothing by their action . . . . [O]ur adversary would recognize that no plausible outcome would represent a success—on any rational definition of success.[12]

This statement synthesizes previous strategies. The United States must be able to counteract (countervail) Soviet aggression across the range of provocations (limited nuclear options), up to and including a general exchange (assured destruction). Essential equivalence is defined implicitly as the capacity to carry out proportional countermeasures denying the Soviets the ability to calculate gain. The targeting philosophy adopted in Presidential Directive 59 publicly endorsed the counrerforce orientation of the 1975 Single Integrated Operations Plan (SIOP) and basically implements the limited options strategy.[13] As Brown himself admitted, "In certain respects, the name is newer than the strategy."[14] These formulations have a certain shopworn character. The question is, need this be the case?

My own answer to the question is in the negative. There has been an avoidance of questioning the assumptions on which nuclear srrategy has been based, although events make such an examination appropriate and necessary. The current debate on employment (military) strategy and force composition obfuscates the discussion by leaving those underlying assumptions implicit and unchallenged. Because most discussions have skirted these assumptions, it is worth briefly reviewing them. In essence, the underlying assumprions of assured destruction (and, in the absence of a clearly defined alternative, MAD remains the standard) are an admixture of strategic bombing theory, awe over the destructive capability of nuclear weapons (especially after the introduction of thermonuclear warheads) and resignation to the reality of ballistic missilery.

The late Bernard Brodie described the legacy of strategic aerial bombardment on nuclear strategy.[15] Pointing to such interwar advocates of such theorists as Douhet, the notion arose that bombardment could bypass normal military operations and attack directly the will and ability of the enemy to resist. Although the evidence from the European theater was ambiguous on this contention, the atomic bomb and its employment against the populations of Hiroshima and Nagasaki seemed to vindicate the airpower theorists. Aerial bombardment is inherently an offensive activity, and bombardment theory began to shift doctrine about military employment from the traditional superiority of the defense toward superiority of the offense. The greatly enhanced destructive power of thermonuclear warheads made the failure of the defense all the more crucial, and the advent of ballistic missilery completed the rise of offense over defense.

Both technological innovations were traumatic and, in combination, helped shape a consensus that deterrence was the prime, if not sole, purpose of nuclear weapons. Thermonuclear weapons increased the damage even a relatively few nuclear weapons could do to the point that "the devastation they would bring if fired would make a mockery of any political goal their use had been intended to achieve,"[16] and these weapons were considerably more compact than earlier nuclear weapons, creating the prospect of delivery by ballistic missiles. Successful ICBMs completed the offense's ascendency, because it was believed that there could be no effective defense against ballistic missiles.

The sure knowledge of devastation meant that the only way to avoid a nuclear holocaust was to prevent the employment of nuclear weapons at all. Deterrence became the goal, and in trying to make the best of a bad situation American strategists evolved the assured destruction concept as the heart of strategy. The heart of assured destruction is Thomas C. Schelling's "hostage effect,"[17] the realization that, in a world where nuclear weapons can be hurled against a population with no prospect of self-defense, target populations are the hostages to the nuclear whims of those possessing the capability. The idea was to make the prospect of a nuclear attack so horrible that a state would not provoke such an attack under any circumstance. The emphasis was placed on the threat that an attack would cause an assured destruction retaliation, thus making the initial attack suicidal.

The key element in this formulation is the *assuredness* of retaliatory devastation. If both the Soviets and the United States know *with certainty* that an attack will result in a crushing counterattack, then neither can ever calculate advantage from initiating a nuclear war and both are deterred. For this absence of incentives to start a nuclear conflict to operate effectively, two conditions that were part of the environment of the 1960s had to be operative.

First, retaliatory forces had to be invulnerable to attack to guarantee their availability should the need arise. To this end, efforts were made to make forces invulnerable (e.g., placing missiles in concrete-reinforced silos and on submarines), and early missiles were too inaccurare to attack protected forces with any reasonable prospect of destruction anyway. Second, surviving retaliatory forces had to be capable of reaching their targets to carry out their retributive function. The ballistic missile's invulnerability to defensive countermeasures seemed to guarantee this. What emerged was a deterrence system based upon the assurance, or certainty, that the use of nuclear weapons would be catastrophic for the initiator of nuclear violence as well as the victim. Knowing that one's own society would be destroyed if one crossed the nuclear threshold made it impossible to calculate gain and hence maximized disincentives. The certainty that one was committing suicide acted as the primary deterrent.

This formulation has always had critics. The strategy has been described as macabre, even genocidal,[18] in its implications. Questions have been raised about whether assured destruction is good for anything but threatening an opponent, possibly best summarized in Richard Rosecrance's statement of the *exante-expost* dilemma.[19] Collins agrees that the threat is only believable against an all-out Soviet attack: "Historical precedents suggest the survival of the state surpasses all other priorities. Threats that risk suicide for anything less strain credibility."[20] There is another level emerging at which the formulation of strategy is being challenged: the assurance of what the outcome of nuclear conflict would be. Indeed, it is the central contention here that the certainty that has underlaid strategic formulations is giving way to a condition wherein uncertainty in strategic calculation is the dominant reality.

The Uncertainty Factor. Although assured destruction appeared to replace calculation of gain with the certainty of a lethal response to aggression, sources of uncertainty have always been present at the edges of this strategy. Uncertainty has always played an important role in military affairs, including nuclear planning, and these "traditional" sources of uncertainty merit brief review. At the same time, emerging weapons technologies heighten the effect of uncertainty and potentially elevate uncertainty to the level of central reality. Most notable among these technological trends are improving ballistic missile accuracies and ballistic missile defenses.

"Traditional" Sources of Uncertainty. The conduct of warfare has always contained uncertainties. The decision to engage in military hostilities requires assessing likelihoods of success, including weighing imponderable factors, not the least of which is the influence of weapons systems previously unused in combat. In specific nuclear terms, there are conceptual uncertainties about basic concepts and dynamics relating to nuclear balance and even about the physical effects of nuclear weapons employment.

Whenever any weapons system is initially employed in battle, its effect is to some extent unknown. If there has been any consistent pattern in the 20th century, it has been to estimate inaccurately what the effect will be.[21] The history of the bomber airplane, particularly in speculation about the role aerial bombardment would play in World War II, is indicative. Although the bomber ultimately played an important role in concluding that conflict, it was only after considerable adjustment of expectations based on operational experience.[22] This difficulty of prediction arises because a new weapons' effectiveness is no greater than the ability of its human operators. As Panofsky puts it: "Those who demand certainty of performance and reliability in military weapons tend not to acknowledge the least reliable and predictable component of military conflict, which is *man*." (Emphasis in original.) This is particularly a problem with new weapons qualitatively different from their predecessors, as nuclear weapons certainly are. As Panofsky suggests, "The unpredictability of behavior of human populations under stress, the vastness and uncertainty of the large-scale effects of nuclear weapons, and above all the abilities of 'rational' governments to control the course of a nuclear conflict all tend to submerge the importance of formal doctrine or goals."[23]

The suggestion about human behavior in a nuclear environment is indicative of the uncertainty we have generally about the basic concepts and dynamics regarding nuclear deterrence; the empirical base on which "theory" about human behavior in a nuclear conflict is founded is exceedingly thin.[24] Moreover, the study of deterrence is dedicated to avoiding enlarging that base, as only the failure of deterrence can provide authoritative information on key points. Thus, high-sounding concepts are only hypothetical constructs for which virtually no reliable evidence is available. This problem pervades the strategy that is based upon these constructs.

Despite elaborate studies,[25] there is great uncertainty about the physical effects of nuclear weapons usage. Arsenals are enormous, and even though not all weapons are available for use and some would be destroyed, the result of employing those available would be enormous and is a further source of uncertainty. Adding the combined superpower strategic arsenals aimed at one another (about 15,000 warheads) to their reported "tactical" arsenals in Europe (reported at around 7,000 warheads for the United States and about half that many for the U.S.S.R.) results in an awesome potential rain of destruction even if only some are available at any time. Despite elaborate studies of weapons effects, there is no realistic way to judge the physical results of unleasing these arsenals.

This very real uncertainty is beclouded in at least two ways. First, estimates of weapons effects based on nuclear testing data appear so elegant and precise as to defy either refutation or questioning when extrapolated. It is, in other words, very difficult to deal with the mathematical precision that these calculations produce. Second, the results are generally so horrible that people avoid thinking about them. Shrouding bomb effects with antiseptic notions like "blast overpressure" and "thermal" effects obscures the absolute horror that would be inflicted in a nuclear exchange. The massive detonation of nuclear arsenals into which an exchange could devolve goes beyond our theoretical understanding. Testing data can reveal the effecrs of a single nuclear weapon delivered at a given place and we can extrapolate those effects to the use of a few weapons without overly prostiruting its assumptions. At the same time, no models in which one has any reasonable level of confidence exist that allow estimation of the effects of using several thousand weapons in a more or less concentrated area. The effects curve is undoubtedly not linear, but no one can more than causally speculate on the curve's actual shape.

An example relevant to the next section illustrates the point. To provide a "survivable" basing mode for the new MX missile system, the so-called multiple protective shelters (MPS) system, in which 200 missiles are shuttled among 4,600 locations, has been proposed. The deterrent logic is that the Soviets could only destroy MX by launching warheads against all the shelters. The system dissuades attack because the number of warheads that would have to be launched against it would be so large as to leave Soviet reserves depleted so that the postattack balance would overwhelmingly favor the United States. Thus, deterrence is premised on making it too expensive to attack the missiles.

Implicit is that the Soviets can destroy MX-MPS if they are willing to incur the costs. To do so would necessitate hurling at least 4,600 warheads at the MPS fields, an attack of unprecedented proportions whose desrructiveness would be almost incomprehensible. What would the physical effects be? Would the force disrupt rhe atmosphere, affecting the ozone layer, the jet stream, or possibly wind current patterns? Would the crystallization of much of Utah and Nevada, including their mineral contents, cause changes in the earth's gravitational fields? Could the force of such an explosion affect the earth's rotation or attitude? What effecrs on the world's weather would the resultant dust cloud have? An all-out attack on *Minuteman* silos spread across several states could have any of these effects: against MPS the effects would be physically concentrated and magnified.

These questions affect the ability of man to survive after a nuclear exchange, and their answers could prove critical ro determining whether initiating a nuclear exchange would ever make any sense. Unfortunately, rhe answer is that we do not know. There is certainly no equivalent phenonmenon in nature from which to draw analogies, and extrapolation from existing testing data is tenuous at best. All that can be said is that such an event would be unprecedented. What cannot be predicted is what the consequences would be.

New Tcchnological Sources of Uncertainty. Nuclear scenarios and appropriate strategies for the 1980s and beyond are faced by emerging technological capabilities which, despite other claims made for them, compound uncertainty. The two most prominent technological trends have been increased missile accuracy to counterforce capability and potential breakthroughs in ballistic missile defenses. Each represents a qualitative improvement in weapons systems sophistication, but their effect on nuclear strategy depends upon great precision in performance with little tolerance for error. The ability to accomplish the necessary performance characteristics introduces a new source of uncertainty, which will be described as the "targeter's dilemma."

Missile Accuracy and ICBM Vulnerability. Increasing Soviet missile accuracies have caused a great concern in the American strategic studies community and are part of a broader trend poinred out by Brodie some years ago: "If there is any single trend that seems to dominate in weaponry, it is for missiles of all kinds to become more accurate and more deadly."[26] Specifically, increased accuracy theoretically allows targeting of the easiest retaliatory system at which to aim: the fixed-site, land-based ICBM force. To understand the problem created by this theoretical capacity requires asking first what the capability's value is, which, in turn, defines the requirements for so-called "hard" counterforce capability. Those requirements highlight the uncerrainty that attainment of the capability represents.

The most obvious reason to attain counterforce capability is to threaten credibly to destroy that portion of an enemy's retaliatory forces under threat or to be able to destroy those capabilities before they can be used against you. Thus, the purpose of a counterforce capability is either to degrade substantially or disarm an opponent, thereby effecting damage limitation on your side. This ultimate goal of damage limitation can be achieved in two ways. The most obvious is to disarm an opponent so that no forces remain to inflict damage on you. Failing in that, the purpose is to degrade an enemy's force to the point that after an attack, the adversary will conclude that he is disadvantaged in remaining forces and will thus be self-deterred. In either case, success is measured by how much of the adversary force you can destroy. Given arsenal destructive characteristics, a relatively small residual force can do a great deal of damage. Thus a high degree of confidence in counterforce capability is necessary to make the strategy attractive.

From this perspective, precision in execution and high belief in that precision are the necessary preconditions in convincing leaders to accept the strategy. Conversely, uncertainty about the ability to succeed makes the strategy less appealing by raising the prospects of remaining retaliatory force after an attack. Secretary Brown admitted in 1978 that uncertainty is a key element in the vulnerability issue: "In recognizing that the MINUTEMAN vulnerability problem is a serious concern for us, we also realize that the Soviets would face great uncertainties in assessing whether they would have the capability we fear—and still greater uncertainries as to its military and political utility."[27]

The heart of uncertainty regarding counterforce capability is that it is a theoretical rather than a demonstrated capability. The capability is theoretical in that neither side has nor ever will conduct realistic tests of the ability to mount a massive attack on missile fields. Rather, the capability must be extrapolated from numerically limited test data which are themselves questionably isomorphic of the "real thing."

There are two key elements in determining counterforce capability: the accuracy of rhe weapons system and whether it explodes where it is intended ro. The heart of accuracy lies in the concept "circular error probability" (CEP), defined as the radius around the targer in which one has a 50 percent confidence rhat a warhead will land. CEP is measured in fractions of miles, and is the denominaror in formulas calculating the lethality of weapons. Reduction or increase in CEP can rhus have a dramatic effect on lethality calcularion. CEP as a confident measure of kill probability (either single-shot or cumulative) is a questionable calculation base for two reasons.[28]

The first problem is that CEP is a statement of statisrical probability which says something like "if you fire a large number of warheads at a target, 50 percent will fall within the designated radius." A statement of sraristical probability says *nothing* about whether a single launch will land within the radius (or the second, as implicitly assumed in cross-targeting, which assumes one can dramatically improve kill probabiliries by dedicating a second warhead at a target).

Additionally, there is reason to question the precision of the test data on which CEP is based as it would apply to a real exchange. The United States, for instance, has never tested a missile armed with a nuclear warhead. Testing by both sides is generally done over east-west tesr ranges and largely over land, whereas a nuclear exchange would be north-south over the North Pole and thus the Arctic Sea. Although there are theoretical data indicating likely success for missile flights in these circumstances, success is undemonstrared. For example, flight over water can pose unique gravitational problems: "The accuracy of a missile depends on the precise gravitational field through which it flies. Since the land is far more rigid than the sea, this field is much less affected than by tides raised by the moon and the sun in an ocean environmenr."[29]

The second calculation problem is fratricide, the possibility that the effects of previous nuclear explosions over a target area will disable subsequent warheads heading for the same area.[30] The problem is acute in calculating an attack against missile silos, because a large number of warheads, fired in barrages, would have to be directed at these complexes in close sequence. Inirial attacks would produce considerable nuclear effect in the upper atmosphere through which subsequent warheads would have to penetrate: heat, blast, radiation, and debris. The effect is difficult to predict because fratricide effects have only been observed underground. Calculations rells us that fratricide will occur, but "since there have been no atmospheric nuclear tests since before multiheaded missiles were invented, neither superpower knows for sure if the first warhead will disorient its brothers."[31]

None of these problems would be overly important against "soft" counterforce or countervalue targets, given the desrructive capacity of nuclear weapons. Against hardened retaliatory forces, failures in precision can result in great amounts of retaliatory power being released because of error.

Ballistic Missile Defenses. The idea of ballistic missile defense has begun to find its way back into strategic discussions. This reemergence is partly the result of continuing advocacies by apologists who never accepted the idea of abnegating the defensive function and of ongoing improvements in ABM technologies. The increasing possibilities of dramatic breakthroughs in exotic

BMD technology, notably lasers and particle beams, offer the potential of dramatic improvements in defense against a missile attack. Advocacy of BMD more went underground than disappeared in the wake of the ABM debate. Research and development of ABM systems have been ongoing, and there has been considerable progress in such areas as radar tracking and discrimination between actual attacking missiles and decoys. The result has been the emergence of theoretically effective missile defense systems, notably the proposed LoADS (Low Altitude Defense System), a "hard-point" defender intended for interception of ICBMs aimed at MX missiles in the MPS configuration. BMD advocacy has been further stimulated by defensive applications of directed energy transfer weapons research.

When the ABM debate occurred, three related arguments were made against active missile defenses. The first was the effecriveness of the systems. Wide disagreement among experts about how well ABM would work left a lingering public doubt. Second, cost estimares for erecting an ABM defense were quite high and seemed a particularly quesrionable investment for a system of dubious effectiveness. Third, and emerging primarily from assured destruction advocates, was a concern that defenses would be destabilizing. According to this objection, ABMs potentially weaken the hostage effect by raising the possibility of surviving nuclear war. Just as ICBM vulnerability made retaliatory system survivability questionable, missile defense challenges penetrability and retribution. In either case, the *certainty* of disastrous effects from launching a preemptive attack is weakened.

The attractiveness of BMD depends on how effective such a system must be to become worthwhile. The answer to that question depends on what one seeks to defend with BMD. The distinction, of course, is between population and retaliatory systems protection, and the operational requirements vary depending on the target one seeks to protect.

The requirements for defending retaliatory forces are less stringent than those for population concentrations, particularly given the size of modern arsenals. The reason is straightforward: to avoid urban destruction, a defense must be virtually perfect, inasmuch as the failure to intercept even a single incoming RV can result in massive destruction. Thus, population protection with active defenses has absolute requirements: one either can or cannot protect the population from attack. If one cannot guarantee population protection, the effort is questionable, especially if the costs are substantial (which they invariably are). Retaliatory systems defense, on the other hand, is an incremental proposition. Because the purpose of attacking retaliatory systems is rheir maximum degradarion (ideally to the point of disarmament), any interception of incoming RVs contributes incrementally to force survivability and hence availability for retribution. The greater the incremental contribution and hence the amount of retaliatory force surviving, the greater the deterring effect on a potential attacker.

Within this context, BMD advocacy is moving in two directions. Reflecting the technological state-of-the-art, short-term advocacies center on so-called "hard-point" defense: "A point defense, to protect a missile silo (for example), would consist of short-range missiles deployed near the rarget and intended to counrer only rhose warheads that appeared to be jeopardizing the target."[32] The LoADS projecr is a prime example and has been suggested as a solution to the ICBM vulnerability problem. Longer-range advocacies center on defensive applications of the so-called "exotic" DET technologies. Although actual deployment of these technologies is probably a decade or more away, they have been the subject of great acclaim and reservation.[33] Much of the debate centers on uncertainty about the final outcomes of developmental processes, because "it is characteristic of exotic systems that they probably do not work at all, but if by any chance they do work they may be spectacularly better than conventional ones."[34] Optimistic projections assign DET weapons comprehensive counterforce and countervalue defensive roles. These assessments feature space-based DET platforms engaging in boost-phase interception of rising missiles because "of the vulnerability of missiles at this srage"[35] (before they have reached maximum speed and can maneuver effectively). Some proposed schemes combine point defenses composed of DET-based weapons or conventional or nuclear-tipped ABMs with space-based systems in a "layered" defensive system.

The emergence of truly effective (in a population protection sense, essentially airtight) BMD would indeed revolutionize strategic thinking. Formidable problems in areas such as radar detection, tracking and protection (the "eyes" of a defensive system always being their most vulnerable element) must be overcome, as well must the challenges posed by countermeasures to whatever capabilities emerge. Even if all the formidable difficulties are surmounted (which is by no means certain), ballistic missile defenses will share a common problem with projections regarding missile accuracy and counterforce capability.

That problem is that the effectiveness of BMD will also be theoretical and not demonstrated. As systems are developed, the testing will always be limited and incomplete, as with ICBM testing. A laser device, for instance, may repeatedly show the capability to destroy a handful of incoming reentry vehicles, but does that mean the results can be extrapolated to predicting success if thousands of warheads were incoming? The answer is that we can only really know by conducting realistic tests on a scale that is impractical on cost grounds alone.

The result is that there would always be subsrantial uncertainty about the actual performance of a BMD system. Some degradation would seem almost inevitable, because "rhe whole of the immensely complex system would have to function almost perfectly on the very firsr occasion on which it was used, without any possibility of full system trials."[36] Some loss of effectiveness may be tolerable when dealing in an incremenral prorection situarion, but would be unacceptable in population protection, with its absolute requirements.

The Targeter's Dilemma. The calcularion of the outcomes of nuclear weapons employment is a special problem of the targeter. Targeting provides the operational answers ro what national policies can and cannot be implemented through various patterns of weapons employment and what can and cannot be achieved through nuclear weapons employment. The key targeter's concept in these estimations is damage expectancy (DE), rhe likelihood that a weapon will destroy its targer. DE is the producr of the probability of arrival (PA) of a weapons system to the targer area and the probability of target destruction (PD) and is calculated by the formula:

$$DE = PA x PD$$

The PA and PD factors in the formula, in turn, are compound expressions. Examining the composition of each factor and the whole reveals the very real uncertainries which make up the targeter's dilemma.

Probability of arrival (PA) comprises four factors and can be expressed by rhe formula $PA = WSR x WR x PLS x PP$. WSR (weapons systems reliability) refers to the working order of the delivery system. The ability of a rocket to ignite, escape its silo or missile tube, and adopt the proper trajectory and posr-boost phase atritude are operations that must occur properly for a system to be reliable. Weapon (or warhead) reliability (WR) refers to the warhead itself and whether it will detonate. Periodic checks are made against materials degradation, but such testing is highly selective. The physical state of the entire warhead inventory is unknown at any time, but is extrapolated from test/observation data. Prelaunch survivability (PLS) is the ability of a system to remain operable after an attack and is the targeter's operationalization of the vulnerability issue. Probability of penetration (PP) is the ability to overcome any active defenses and is the obverse of the effectiveness of ballistic missile or air defenses.

The other factor is probability of target damage (PD). PD is a function of two elements: the lethality of the weapons (see note 28) and the resistance (or hardness) of the target. Lethality varies depending on the type of target (e.g., blast overpressure against structures, radiation against people) and is related directly to target hardening. The combination of yield and accuracy determines the likelihood a target will be destroyed, with particular emphasis on accuracy. The prime means of determining accuracy is CEP, with the resulting uncertainty that enters into the calculation process.

Several things affect the ability to calculate likelihoods of mission accomplishment. First, the formula is multiplicative, with all factors expressed as percentages. The upper limit of a damage expectancy is 100 percent or unity (1.0) if all the probabilities are unity. If any or all factors are less than unity, the multiplicative nature of the formula makes the effect on overall damage expectancy progressive. Second, this multiplicative nature of the process means that a large decrease in *any* factor in the formula will have a dramatic effect on overall damage expectancy.

The ICBM vulnerability issue illustrates these points. For instance, if one is calculating the damage expectancy of the ICBM force against its targets and assumes a Soviet preemptive launch against the ICBMs would knock out 75 percent of them, then PLS for that force element is 25 percent, and damage expectancy is only one-quarter what it would be otherwise. Because a statement of statistical probability is invalid for any individual instance, the methodology can be applied validly only to an aggregate of weapons systems. Thus, the likelihood that a given warhead will land within the CEP is either 100 percent or zero percent (it either will or will not), but one cannot predict in advance into which category a particular warhead will fall.

Third, the basis for DE formula elements is sample data which is assumed to be representative but may or may not be so. Thus, some percentage of warheads is examined periodically for reliability, and the percentage found reliable forms the basis for calculating WR for any given warhead. Sampling techniques allow a high degree of reliability within some confidence interval that the sample represents the universe, but a precise isomorphism is not possible.

If calculating DEs for our own systems is fraught with uncertainties, the process for estimating Soviet force effectiveness is even more difficult. The weighing of factors in one's own formula is at least based on observation and testing, but the assignment of values to Soviet force characteristics is based on less precise information. The Soviets do not, for instance, allow us to examine the warheads on their missiles for reliability, so we have less than perfect information on which to assign a WR value to Soviet forces. This is a crucial point when one considers that the frequent assertions of U.S. ICBM vulnerability are based on damage expectancy calculations that we assign to Soviet forces.

The new technological capabilities already discussed compound these uncertainties. If recent statements by Secretary Brown and others are to be believed, PLS for American ICBMs is becoming virtually nil, but such assessments are in turn based upon damage expectancies, based on theoretical calculations. Within these circumstances, what PLS can be assigned to the ICBMs in which one would have confidence? Similarly, any developments in BMD directly affect PP, and the deployment of a BMD system would require a reduction in PP (which, in the absence of BMD, is 1.0). But, because reliable test data against a large-scale attack will always be unavailable, what magnitude of reduction should there be? Neither question can be answered with high confidence. There is, however, considerable disagreement over the most appropriate and effective strategies to carry out the political purpose and over appropriate action should deterrence fail. The Soviets maintain that deterrence of an American nuclear aggression is accomplished through our sure knowledge that they would prevail in the ensuing war (the vaunted war-fighting and war-winning strategy). Until recently, the United States has countered with the proposition that assured destruction deters a Soviet aggression. The U.S. strategic debate has hinged on the credibility of the assured destruction threat. There is growing agreement that assured destruction no longer forms an adequate deterrent base. What has emerged is a new and purportedly more realistic base to avoid the onset of nuclear conflict under the countervailing strategy concept.

This "new" strategy is a lineal and nearly literal descendant of controlled response under the early Kennedy administration and Secretary Schlesinger's limited nuclear options strategy in the early 1970s. It posits deterrence in a slightly different mode than has previously been the case, following closely from Collins' description of "sound deterrence," which "confronts foes with irrefutable indications that net gains will be less or net losses more than they would expect by refraining from some given move."[37] Faced with a broad range of possible Soviet provocations and formidable forces, this definition is translated into a strategic imperative to deal with situations that could lead to war. As Secretary Brown puts it, "Crisis stability means that even in a prolonged and intense confrontation the Soviet Union would have no incentive to initiate an exchange, and also that we would feel ourselves under no pressure to do so."[38]

The underlying principle of this deterrence conception is not remarkably different from that which it supersedes: creating an assuredness that no conceivable Soviet action can succeed. Translated to the operational level, Gray captures the underlying philosophy of this view: "*One of the essential tasks of the American defense community is to help insure that in moments of acute crisis the Soviet general staff cannot brief the Politburo with a plausible theory of military victory.*" (Emphasis in original.)[39]

One can, and many do, disagree with the implications of this reconstruction of what strategy deters, particularly when that strategy is translated into a war-fighting military strategy or a counterforce targeting priority, as

BIOGRAPHIC SUMMARY

Donald M. Snow, Associate Professor of Political Science at the University of Alabama and Visiting Professor of National Security Affairs at the Air University, received his Ph.D. at Indiana University. He has recently published *Nuclear Strategy in a Dynamic World: American Policy in the 1980s* and has edited and contributed to *Introduction to World Politics: A Conceptual and Developmental Perspective* and *Readings in Nuclear Strategy Making.*

announced in PD-59. More basically, however, nuclear strategy must deal with the very real emergence, through advancing military capabilities, of the influence of uncertainty on the strategic environment. Gray's imperative is the obvious goal. The question is how to achieve it. One answer is the buildup of American strategic forces as broadly advocated and as supported by adherents of a war-fighting strategy. Another answer, possibly in conjunction with the first, is to emphasize the targeter's dilemma and the possible consequences of being wrong. Strategies and patterns of force must flow from an overall conception of what deters given the physical environment. Strategy and forces fashioned in a situation where certainty was the prevailing reality may not prove adequate in an increasingly uncertain world. It is imperative that underlying premises be examined before strategies are devised and forces procured that may or may not prove relevant to current and future realities.

NOTES

1. The issue of ICBM vulnerability has been treated extensively in the recent literature. I have addressed the issue in *Nuclear Strategy in a Dynamic World: American Policy in the 1980s* (Tuscaloosa: University of Alabama Press, 1981), pp. 96-99 and 205-216 and in "ICBM Vulnerability, Mobility and Arms Control," *Air University Review* (forthcoming). Colin S. Gray has been a leading clarion of the danger, represented by his "The Strategic Forces TRIAD: End of the Road?" *Foreign Affairs*, July 1978, pp. 771-789, and *The Future of Land-Based Missile Forces*, Adelphi Papers, no. 140 (London: International Institute for Strategic Studies, Winter 1977). Articulate, but somewhat technical, expressions of some skepticism, include John D. Steinbruner and Thomas M. Garwin's "Strategic Vulnerability: The Balance between Prudence and Paranoia," *International Security*, Summer 1976, pp. 138-181; and more recently, Bruce William Bennett's *Uncertainty in ICBM Survivability*, Rand Paper Series No. P-6394 (Santa Monica, Calif.: Rand, October 1979). For more descriptive discussions, see U.S. Congress, *Counterforce Issues for the U.S. Strategic Forces* (Washington: Congressional Budget Office, January 1978); and Deborah Shapley, "Technology Creep: ICBM Problem a Sleeper," *Science*, 22 September 1978, pp. 1102-1105.

The MX issue has also received considerable attention. My own views are in "The MX-Basing Mode Muddle: Issues and Alternatives," *Air University Review*, July/August 1980, pp. 11-25. For representative advocacies of the system, see Colin S. Gray, "The MX ICBM: Why We Need It," *Air Force Magazine*, August 1979, pp. 66-68, 71; Lawrence J. Korb, "The Case for the MX," *Air University Review*, July/August 1980, pp. 2-10; and Edgar Ulsamer, "A Solid Case for the MX," *Air Force Magazine*, April 1980, pp. 29-35. For more skeptical views, see, for instance, Desmond Ball, "The MX Basing Decision," *Survival*, March/April 1980, pp. 58-65; William H. Kincade, "Will MX Backfire?" *Foreign Policy*, Winter 1979-1980, pp. 43-58; and Paul D. Zimmerman, "Will MX Solve the Problem?" *Arms Control Today*, January 1980, pp. 6-8. For a description, see U.S. Congress, *The MX Missile and Multiple Protective Structure Basing: Long-Term Budgetary Implications* (Washington: Congressional Budget Office, June 1979).

2. Gray has presented his ideas recently in "Nuclear Strategy: The Case for a Theory of Victory," *International Security*, Summer 1979, pp. 54-87; "Targeting Problems for Central War," *Naval War College Review*, January-February 1980, pp. 3-21; and (with Keith Payne), "Victory is Possible," *Foreign Policy*, Summer 1980, pp. 14-27. P.D. 59 was referred to by Secretary Brown in his speech at the Naval War College Convocation in August 1980. See Harold Brown, "Remarks at the Convocation Ceremonies for the 97th Naval War College Class, Naval War College, Newport, Rhode Island," (Washington: Office of Assistant Secretary of Defense (Public Affairs), August 20, 1980).

3. This subject has produced a torrent of literature in recent years. My own view and conclusions can be found in *Nuclear Strategy in a Dynamic World*, Chap. 5 and pp. 216-223. A sample of authors and points of view includes: Robert L. Arnett, "Soviet Military Doctrine: Views on Nuclear War," *Arms Control Today*, October 1978, pp. 1-3; Les Aspin, "Putting Soviet Power in Perspective," *AEI Defense Review*, v. 2, no. 3, 1978, pp. 3-14; David J. Cabe, "Russian Military Doctrine: A Fresh Look," *Air University Review*, September/October 1978, pp. 19-27; John Ericksen, "Soviet Military Policy in the 1980s," *Current History*, October 1978, pp. 97-99, 135-138; Leon Gouré, et al., *The Role of Nuclear Forces in Current Soviet Strategy*, (Miami, Fla.: Center for Advanced International Studies, 1974); Colin S. Gray, "Soviet-American Strategic Competition: Instruments, Doctrines and Purposes," in Robert J. Pranger and Roger P. Labrie, eds., *Nuclear Strategy and National Security: Points of View*, (Washington: American

Enterprise Institute for Public Policy Research, 1977), pp. 278-301; William D. Jackson, "The Soviets and Strategic Arms: Toward an Evaluation of the Record," *Political Science Quarterly*, Summer 1979, pp. 243-261; C.G. Jacobsen, "Soviet Strategic Capabilities: the Superpower 'Balance,'" *Current History*, October 1977, pp. 97-99, 134-136; T.K. Jones and W. Scott Thompson, "Central War and Civil Defense," *Orbis*, 1978, pp. 15-36; Benjamin S. Lambeth, *The Elements of Soviet Strategic Policy*, Rand Paper Series, No. P-6389 (Santa Monica, Calif.: Rand, September 1979); William T. Lee, *Soviet Defense Expenditures in an Era of SALT*, USSR Report 79-1 (Washington: U.S. Strategic Institute, 1979); Michael MccGwire, "Soviet Military Doctrine: Contingency Planning and the Reality of World War," *Survival*, May/June 1980, pp. 107-113; Richard Pipes, "Why the Soviet Union Thinks It Can Fight and Win a Nuclear War," *Commentary*, July 1977, pp. 21-34; and Jack Snyder, "The Enigma of Soviet Strategic Policy," *The Wilson Quarterly*, Autumn 1977, pp. 86-93.

4. Throw-weight (or payload) is that part of a missile above the last booster. Counterforce (or hard-target kill) capability is the capacity to destroy military targets that have been hardened against attack, as in missile silos.

5. The debate over the effectiveness of Soviet civil defense programs and how seriously the Soviets take them has been heated. T.K. Jones and Leon Gouré have been leading apostles of the problems created for the United States and a range of experts have attacked these conclusions. For a summary of these positions, see Fred M. Kaplan, "The Soviet Civil Defense Myth," *Bulletin of the Atomic Scientists*, March, 1978, pp. 14-20, and "The Soviet Civil Defense Myth: Part II," *Bulletin of the Atomic Scientists*, April 1978, pp. 41-48 for the negative arguments; and Leon Gouré, "Another Interpretation," *Bulletin of the Atomic Scientists*, April 1978, pp. 48-51 for the positive position.

6. For a particularly eloquent analysis, see Raymond L. Garthoff, "On Estimating and Imputing Intentions," *International Quarterly*, Winter 1978, pp. 22-32.

7. For a particularly thorough analysis, see Ronald L. Tammen, *MIRV the Arms Race: An Interpretation of Defense Strategy* (New York: Praeger, 1973). The decision process leading to the MIRV decision is well chronicled by Graham T. Allison, "Questions About the Arms Race: Who's Racing Whom? A Bureaucratic Perspective," in John E. Endicott and Roy W. Stafford, eds., *American Defense Policy* 4th ed. (Baltimore: Johns Hopkins University Press, 1977), pp. 424-441. Another good overview is Herbert F. York, "The Origins of MIRV," in David Carlton and Carlos Schaerf, eds., *The Dynamics of the Arms Race* (New York: Wiley, 1975), pp. 23-35.

8. Progress in U.S. and Soviet laser and particle-beam programs has been closely monitored in a series of articles by Clarence A. Robinson, Jr. in *Aviation Week and Space Technology* since 1978. My own analysis can be found in "Lasers, Charged-Particle Beams and the Strategic Future," *Political Science Quarterly*, Summer 1980, pp. 277-294; and "Over the Strategic Horizon: Directed Energy Transfer Weapons and Arms Control," *Arms Control Today*, November 1979, pp. 1, 8-9.

9. For a survey of the evolution of American nuclear strategy, see my *Nuclear Strategy in a Dynamic World*, chap. 3. The sweep of postwar strategic evolution prior to the Carter administration is thoroughly covered in Jerome H. Kahan, *Security in the Nuclear Age: U.S. Strategic Arms Policy* (Washington: Brookings Institution, 1975). Harland Moulton's *From Superiority to Parity: The United States and the Strategic Arms Race, 1961-1971* (Westport, Conn.: Greenwood Press, 1971), remains the best analysis of the crucial events and forces of the 1960s.

10. A clear statement and justification of LNO is in Lynn Ethridge Davis, *Limited Nuclear Options: Deterrence and the New American Doctrine*, Adelphi Papers, no. 121 (London: International Institute for Strategic Studies, Winter 1975/1976).

11. See "Alternative U.S. Strategies and America's Future," *Foreign Policy Research Institute* Contract AF 49 (638)-1249 (Philadelphia: University of Pennsylvania, 1965).

12. Harold Brown, *Department of Defense Annual Report, Fiscal Year 1981* (Washington: U.S. Govt. Print. Off., 29 January 1980), p. 65.

13. See Desmond Ball, "Research Note: Soviet ICBM Deployments," *Survival*, July/August, p. 167.

14. Brown, *Annual Report, FY 1981*, p. 66.

15. See particularly Bernard Brodie, *Strategy in the Missile Age* (Princeton, N.J.: Princeton University Press, 1959).

16. Michael Mandelbaum, *The Nuclear Question: The United States and Nuclear Weapons, 1946-1976* (London: Cambridge University Press, 1979), pp. 105-196.

17. See particularly Thomas C. Schelling, *Arms and Influence* (New Haven, Conn.: Yale University Press, 1966).

18. Philip Green, *Deadly Logic: The Theory of Nuclear Deterrence*, (Columbus: Ohio State University Press, 1966).

19. See "Deterrence in Dyadic and Multipolar Environments," in Richard Rosecrance, ed., *The Future of the International Strategic System* (San Francisco: Chandler, 1972), pp. 125-140. I have tried to summarize the more conventional objections to MAD in "Current Nuclear Deterrence Thinking: An Overview and Review," *International Studies Quarterly*, September 1979, especially pp. 461-473.

20. John M. Collins, "Principles of Deterrence," *Air University Review*, November/December 1979, pp. 17-26.

21. For a fascinating account of the influence of weaponry on warfare through history, see Bernard and Fawn Brodie, *From Crossbow to H-Bomb: The Evolution of the Weapons and Tactics of Warfare*, revised and enlarged edition (Bloomington: Indiana University Press, 1963).

22. The multiple changes that had to be made in British bombing strategy because of overestimates of bomber effectiveness are well catalogued in Max Hastings, *Bomber Command* (New York: Dial Press, 1979).

23. W.K.H. Panofsky, *Arms Control and SALT II* (Seattle: University of Washington Press, 1979), pp. 24, 6.

24. See Donald M. Snow, "Deterrence Theorizing and the Nuclear Debate: The Methodological Dilemma," *International Studies Notes*, Summer 1979, pp. 1-5.

25. The classic study of weapons effects is Samuel Glasstone, ed., *The Effects of Nuclear Weapons*, revised edition, (Washington: U.S. Govt. Print. Off., 1964).

26. Brodie, p. 308.

27. Harold Brown, *Department of Defense Annual Report, Fiscal Year 1979* (Washington: U.S. Govt. Print. Off., 1978), p. 63.

28. The formula for the lethality (k) of a single warhead is:

$$K = \frac{Y^{2/3}}{(CEP)^2}$$

where Y is the yield of the warhead. Obviously, squaring the denominator of a fraction, as CEP is expressed, dramatizes its effect.

29. Zimmerman, p. 145.

30. Discussed particularly well in Steinbruner and Garwin.

31. Aspin, p. 7.

32. W.F. Biddle, *Weapons Technology and Arms Control* (New York: Praeger, 1972), p. 166.

33. Much of this debate is summarized in Snow, "Lasers, Charged-Particle Beams and the Strategic Future."

34. Freeman J. Dyson, "Defense against Ballistic Missiles," in Eugene Rabinowitch and Ruth Adams, eds., *Debate the Antiballistic Missile* (Chicago: Bulletin of the Atomic Scientists, 1967), p. 15.

35. Biddle, p. 160.

36. *Ibid.*, p. 185.

37. Collins, p. 22.

38. Brown, *Annual Report, FY 1981*, p. 69.

39. Gray, "Nuclear Strategy: The Case for a Theory of Victory," p. 56.