

Commentary: *How He Worked*

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Albert Wohlstetter (whom for brevity's sake I shall refer to simply as AW) made large contributions to U.S. national security thinking and actions from the 1950s into the 1990s – and arguably beyond – through his ideas, his research findings and those of his associates, and the activities of those he mentored. This chapter focuses on his style of work, the unusual and inventive ways in which he addressed problems of policy, and how he applied his talents to some of the most urgent and difficult issues of the nuclear era.

We know how things turned out in what came to be known as the Cold War, although disputes endure on the correctness of various decisions. (One is reminded of Zhou Enlai's answer to the question about the French Revolution: "Too soon to tell.") The challenges posed at the time were novel and of the utmost seriousness. Enormously destructive weapons had suddenly appeared, first nuclear fission ones, then even more powerful thermonuclear bombs. Key effects of these weapons were poorly known for some time, especially radioactive fallout. Although it was not a big surprise to the Manhattan Project scientists, the first Soviet atomic bomb test of August 29, 1949, was a political shock. The United States and the Union of Soviet Socialist Republics (USSR) were also developing novel delivery systems, notably long-range ballistic missiles, which when mated with nuclear warheads posed unique dangers and new uncertainties. Our security establishment was slow to understand adequately the military significance of these technological innovations. According to Tom Schelling: "I think it took the United States at least 2 decades to learn how to think about nuclear weapons policy after 1945."¹ The phrase "at least" is warranted; arguably, we still aren't quite there.

Throughout his career in strategy, AW worked to improve thinking about the role and consequences of nuclear weapons. One finding from AW's work, soon acted upon, was the need for better protection and control of nuclear forces. The U.S. Air Force had asked him and his associates to examine the large overseas base-building program for our strategic bomber force. Their investigation had consequences not only for that program, but

also for the basing and operations of the strategic bomber force at home – and for our missile forces that were to come, and for much more.

AW came to wide attention to those interested in foreign policy, especially in nuclear weapons issues, with the publication of his article, “The Delicate Balance of Terror” (1959), in *Foreign Affairs*. There, he challenged the prevailing assumption that nuclear war was impossible, or had a vanishingly small likelihood, laying out reasons why the nuclear balance was precarious and why the requirements for deterring such a war were stringent. He soon came to be described as an eminent strategist or, more dubiously in some quarters, as a “defense intellectual.”²

AW went on to become a critic of widely held views about the “arms race” with the Soviet Union in general, and the “nuclear arms race” in particular, writing in the mid-1970s that the facts of nuclear arms competition did not fit much of the rhetoric about nuclear arms racing. This led to a vigorous disputation in print. From AW’s perspective, the issues were not that dangerous “gaps” existed between American and Russian nuclear offensive forces (as American politicians often had claimed in the 1950s), or that there was an arms race spiraling out control in the 1960s or 1970s, but that relevant facts were being ignored and the wrong questions were being asked.

Efforts to understand nuclear weapons and their destructiveness led AW to try to break the pattern that had dominated air power from its inception, namely, the indiscriminate “strategic bombing” that had caused vast destruction to civilians during World War II. Over many decades, he worked to promote technologies of precision and control that would make it more possible to hit military targets without killing innocent bystanders. He saw that advances in technologies of sensing and computation could produce vast improvements in the accuracy with which munitions could be delivered. This capability began to be used near the end of the Vietnam War and was widely displayed during the Kosovo operation against Serbia and the two Gulf wars. It has transformed air operations. Hard as it might be for some people to believe, the concept of destroying military targets while sparing civilians is now at the core of American air power doctrine. The “Delicate Balance” aside, perhaps this was his most important intellectual and practical security contribution.

Throughout AW’s career, a major concern of him and his team was the future of Europe, a region seen as the main stake in the great power competition. This meant that decisions about

nuclear forces, both long range and short, needed to be viewed with the implications for Europe in mind. At the same time, he also pushed our political and military leaders to give more weight to the flanks of NATO and pay much more attention to “out of area” contingencies—or what he called “lesser excluded cases.” The 1991 Gulf War and the conflict over Bosnia and Kosovo later in the decade dramatically demonstrated the critical importance of these sorts of contingencies.

Another interest from an early date was the spread of the nuclear bomb to more countries. It was known from near the beginning of the nuclear era that the line between civilian and military uses of atomic energy was thin, but this fact was often obscured—and still is—in our policy actions. An egregious case was the Eisenhower Administration’s *Atoms for Peace* program. By actively disseminating civilian nuclear applications, the program was engaged in (as the title of AW’s 1976 *Foreign Policy* article would later put it) “Spreading the Bomb without Quite Breaking the Rules.” The U.S. government continues to behave in a wildly inconsistent way on this topic.

These and other accomplishments came from a high intelligence used in ways that were at least unusual, and in combination arguably unique. Below, I consider key aspects of AW’s style of work.

I. WORKING ON A PROBLEM, REFRAMING OBJECTIVES

It is especially important, and sometimes very difficult, to get objectives right in a policy analysis. A competent analyst who works on such a situation will try to identify available alternatives, to assess their respective costs and benefits in light of given objectives, and recommend a course of action. This is necessary, but it is often where intellectual activity stops.

It is not enough to assume a merely one-sided conflict with a potential adversary. Albert Wohlstetter sometimes used the term *opposed systems* to characterize the sort of competitive—and interactive—situation in which one actor (for instance, a government, a military organization or even a nonstate group) may try to do things that at least partially frustrate some key objectives and activities of others—and vice versa. The policy problem, objectives, and alternatives can look quite different when the game, so to speak, is seriously two-sided (or three- or four-sided), that is, when the frustrating activities are reciprocal,

and each actor is both frustrating others while being frustrated in return.³

Characteristically, AW not only addressed the policy problem as it was initially posed. He also undertook a more comprehensive inquiry to consider a fuller range of alternatives available to all relevant actors, to evaluate not only the means of policy but also the ends.⁴ Sometimes this would lead him to reframe the problem in a more fundamental way and to invent new options. More value, sometimes a great deal more, can be added to the analysis if the problem is redefined in a way that stays true to the spirit of the original question, but also brings to light more crucial yet underappreciated objectives and new ways of achieving them.

Basing and Operating SAC's Bomber Force in a Competitive Environment.

A crucial issue in the immediate aftermath of World War II was what to do about nuclear weapons. Their novelty and extraordinary destructiveness made this both urgent and difficult. By August 1949 the Soviet Union had the atomic bomb. The hydrogen bomb was in the offing, and ballistic missiles were being developed. The Red Army was in the middle of Europe. In 1950 North Korea had attacked the South with Soviet support and later that year China had intervened militarily.

The United States was making jet bombers in large numbers. From 1951, the United States built over 2,000 B-47s, a medium-range bomber with a roundtrip operating radius of 2,100 miles, while the longer-range B-52 bomber, which did not depend on overseas bases, was being developed. Aerial refueling as a means of extending the range of medium-range bombers without using overseas bases was also being developed.

The problem originally posed to the RAND Corporation by the U.S. Air Force's assistant for bases was to look at the far-flung, rapidly expanding system of bases of the Strategic Air Command (SAC) that were being built in the United Kingdom (UK), Morocco, Alaska, and elsewhere, to enable our medium-range bombers in wartime to reach the Soviet Union, return, and repeatedly go back. However, AW and his team quickly realized a critical yet underappreciated aspect of this problem: these planned bases could also be reached by Soviet bombers, a potential vulnerability made critically serious now that the USSR had the atomic bomb.

After much study and analysis, AW's team recommended stopping the elaborate program to build bases overseas and strictly limiting their use (specifically, any overseas bases surviving an enemy attack) to austere refueling points for SAC's medium-range bomber aircraft.⁵ By the end of 1955, the U.S. Air Force had accepted and begun implementing this recommendation.

Protecting Our Power to Strike Back Became a Crucial Objective.

Attention then turned to the situation of our force at home. It was assumed to be safe, but an investigation into the possibility of a Soviet sneak attack on the small number of continental bases on which the strategic force was located made that assumption look untenable. AW and his team completed an initial report on this issue.⁶ As Philip Taubman would write in *Secret Empire: Eisenhower, the CIA, and the Hidden Story of America's Space Espionage* (2003): "The report, published on April 15, 1953, stunned Gardner [Special Assistant to the Secretary of the Air Force] and other officials in Washington. . . . The lightly defended SAC bases . . . were ideal targets for atomic attack." Taubman would add: "The import was clear and breathtaking: For the first time in its history, the United States was vulnerable to a crippling attack from overseas, and would find it difficult, if not impossible, to retaliate after being struck."⁷

Over the next 3 years, AW and his team worked to understand the issues raised by SAC's potential vulnerabilities on the continental United States, and to identify—and also invent and design—ways to mitigate these vulnerabilities. This work had a large and rapid impact on U.S. decisions regarding nuclear forces.

A key idea emerging was that *relative* risk could dominate decisions in certain situations rather than the widely assumed perception of *absolute* risk. To put it another way, in extreme circumstances it could actually look less risky for decisionmakers to use nuclear weapons than not to use them. This argument was novel—and contested—but from it came the idea of protecting our power to strike back *after* a nuclear attack in order to affect the way a potential nuclear aggressor would view the relative risks of a first strike. This concept soon became an essential aspect of the U.S. military posture.⁸

More broadly, AW argued that the requirements for establishing a credible and safe nuclear deterrent were stringent and

not automatic. There were several reasons for this. One was the possibility of operational accidents (compare the August 28, 2007, loading of nuclear-armed missiles on a U.S. Air Force bomber by mistake and its subsequent flight of several thousand miles) or misjudgements higher in the chain of command.

A second reason was that whatever U.S. decisionmakers might believe about nuclear weapons and their use, Soviet decisionmakers might have a different set of beliefs. In fact, the doctrine of nuclear warfighting to win a major conflict had a strong hold there (the Strategic Arms Limitation Talks, known also as SALT, notwithstanding) until well into the 1980s, long after U.S. authorities had come to realize nuclear warfighting's futility as a war-winning strategy.⁹

The third stemmed from the perceived vulnerability of Western Europe. Although the U.S. might be able to deter a Soviet preclusive attack against its nuclear-armed strategic forces, it was far from clear that such deterrence would necessarily extend to other forms of potential Soviet aggression. The Red Army was in Europe's center and was judged to be stronger than NATO's forces.¹⁰ Our putative atomic superiority – no longer monopoly – was widely seen in American officialdom as the chief guarantor of Europe's security. But what did this mean? The answer given by Eisenhower's Secretary of State John Foster Dulles in 1954 was that the United States would respond to military provocation "at places and with means of our own choosing." He also said, "Local defense must be reinforced by the further deterrent of massive retaliatory power." This idea, which came to be known as the doctrine of "massive retaliation," implied using nuclear weapons first, yet it was also widely held in the United States, including by high officials, that nuclear weapons were unusable because of the vast devastation that would result. These conflicting views posed a difficulty that long persisted.¹¹

In the late 1950s, a then little-known professor at Harvard, Henry Kissinger, argued that it might be possible to fight a limited nuclear war in Europe, limited in the sense that it would not escalate to attacks on U.S. or Soviet territory.¹² This argument did not have much appeal in Europe, the putative war zone, nor as it turned out in Washington. AW addressed this topic in "The Delicate Balance of Terror" (the relevant passage of which deserves quoting here because, in later disputes over the nuclear "arms race," he was sometimes charged with believing in limited nuclear war as a policy goal):

Whether or not nuclear weapons favor the West in limited war, there still remains the question of whether such limitations could be made stable. . . . It remains to be seen whether there are any equilibrium points between the use of conventional and all-out weapons. In fact the emphasis on the gradualness of the graduated deterrents may be misplaced. The important thing would be to find some discontinuities if these steps are not to lead too smoothly to general war. Nuclear limited war, simply because of the extreme swiftness and unpredictability of its moves, the necessity of delegating authority to local commanders, and the possibility of sharp and sudden desperate reversals of fortune, would put the greatest strain on the deterrent to all-out thermonuclear war.

AW's skepticism about limited nuclear war *as a policy* was consistent with the crucial aim of *controlling such forces* to prevent inadvertent use by us, and to deal with first use of nuclear weapons by the Soviet Union, or later China, or any other nation with them. His answer to the Eisenhower/Dulles doctrine of "first use" by us was that the West needed to enable NATO to defend Europe with conventional forces. (However, AW did not clearly articulate a "no-first use" policy, and was later chastised for this.) The discriminate use of force, especially through a distinction between military forces to be attacked and civilian noncombatants to be avoided, became a consistent theme in his work from the late 1950s onward.

II. PAYING CLOSE ATTENTION TO THE DATA

An important aspect of Albert Wohlstetter's style is shown in the name he chose for the research organization that he created: *Pan Heuristics*, or learning about all things. The excessively ambitious "pan" part of the name was mitigated by "heuristics," an informal approach to solving problems in the spirit of being roughly right rather than being precisely wrong. The idea of "pan heuristics" speaks to AW's strong commitment to gathering and understanding as much data relevant to a policy problem as he could.

Among people who became well known as strategists, AW was probably unique in having industrial experience. During

World War II, he worked in quality control and management at a factory manufacturing power-generation equipment for Allied field communications, and after the war, in prefabricated housing design and mass-production. This trained him to pay careful attention to operations and technical data.

In a November 1968 letter to the distinguished British military historian Michael Howard, AW had the following to say about his work style in the aforementioned Base Study and Vulnerability Study:

For two years, before issuing a summary report and exposing the results to the scrutiny of experienced officers in the Air Staff, SAC and other relevant field commands, and for three years before issuing the final report, we looked systematically and in great detail at the problem of bringing bombs, bombers, bomber crews and tanker aircraft together with equipment in combat-ready condition and getting bombers to targets and back along routes that minimized their exposure to defenses. That included problems of equipment reliability, radar warning, communications and control, and above all logistics. We examined the joint effects of these many factors on “the costs of extending bomber radius; on how the enemy may deploy his defenses, and the numbers of our bombers lost to enemy fighters; on logistics costs; and on base vulnerability and our probable loss of bombers on the ground.” We did not begin with any theory about the vulnerability of SAC. The second-strike theory of deterrence grew out of this empirical study; we didn’t start with it.

If the study said nothing that was new, it would hardly have received such attention. If it had been unsound, it could not have survived the extraordinarily widespread and detailed scrutiny it was given by the responsible military men whose work – and lives – it affected.¹³

This background helps to show why AW was skeptical about the significance of claimed “bomber gaps” (assertions of American vulnerability in the mid-1950s made on the grounds that the United States allegedly had fallen behind the USSR in the numbers of bombers) or “missile gaps” (a similar assertion made,

among others, by presidential candidate Senator John F. Kennedy concerning intercontinental ballistic missiles).

AW's view was that such "gap" claims—which turned out to be false—missed the point: that it was not the "bean count" of such weapons in peacetime that mattered most, but what the balance of capabilities would look like after one side or the other had struck first. In short, one needed to consider not just raw numbers, but also the potential interactions of the two sides. This required, in part, doing as best one could to look at relevant data, recognizing that not all of it was accessible.

Learning from Many Disciplines: RAND in the 1950s.

AW felt a need to learn the basics about many fields relevant to the topics on which he was working—and he had the talent and determination to do so. The RAND Corporation of the 1950s and 1960s was an ideal environment for doing this. It had a broad mandate to explore topics that fit under the heading of national security, thanks to the wisdom of the U.S. Air Force. RAND's first president, Frank Collbohm, and his management team assembled talents in many fields: e.g., mathematics, physics, engineering, and the social sciences. RAND people did pioneering work on satellite reconnaissance, telecommunications, civil defense, game theory, applications of cost-benefit analysis, finance, and history. Two future Nobel laureates in economics, William Sharpe and Harry Markowitz, were members of the RAND staff when they did the work for which they were later honored. Many excellent scientists, physical and social, and mathematicians came as visitors for varying periods.¹⁴

From this extraordinarily favorable research environment, AW gained access to a wealth of talent in many fields—talent that for the most part was willing to work across disciplines on large, complex questions. As Andrew Marshall (who made important contributions to strategic thinking at RAND, and who has served for many years as the Director of the Pentagon's Office of Net Assessment) would later remark: "While the group of real strategists at RAND probably never numbered more than about 25 people, the overall quality, in sheer intelligence and intellectual breadth, is simply astonishing."¹⁵

From Roberta Wohlstetter, who worked as a historian in RAND's social sciences division, AW got help on many matters, including those related to organizational and psychological

aspects of behavior. It is impossible for someone outside of the family to know how much of what AW accomplished was due to her direct or indirect help. Roberta herself was an accomplished scholar whose Bancroft Prize-winning *Pearl Harbor: Warning and Decision* (1962) will long be cited as perhaps the best book ever written on military intelligence. Her 1976 study, *The Buddha Smiles: Absent-Minded Peaceful Aid and the Indian Bomb*, showed how India had exploited civil nuclear cooperation from the United States and Canada to make its bomb. (There was a flair for book and article titles in that family.) Among her many talents was that of analyzing the character and motivations of leaders. The husband-wife team also had several joint publications on Cuba, for instance.

On the occasion of awarding the Presidential Medal of Freedom to the Wohlstetters, President Reagan spoke of Roberta's intimate personal and professional partnership with AW:

I daresay that she has frankly enjoyed posing the same penetrating questions to her husband that she has to the intellectual and political leaders of the country. And that is certainly one explanation for the clarity and persuasiveness of his own voluminous words on strategy, politics, and world affairs.¹⁶

Experts Needed, but Not as Seers.

AW learned much from specialists in many fields. He saw large decisions affecting war and the conduct of operations as depending not only on political insights, but also on inputs from such experts. But he was wary of specialists who opined with an air of authority on topics outside of their expertise when they had not seriously worked on these topics.

Indeed, there were a number of physicists who knew about the confined topic of nuclear weapons and their effects, but who did not hesitate to pronounce on matters related to strategic nuclear force operations without having carefully studied these operations, and without any particular claims of knowledge as to the aims and strategy of Soviet leaders. He described such experts, especially those who distilled nuclear-age policy choices to decisions between living in "One World or None," as feeling:

charged with a prodigious mission and a great moral urgency. Spurred by an apocalyptic vision of world annihilation, they urge a drastic transformation in the conduct of world affairs in the immediate future. They have been passionately sure that the choices are stark and clear: annihilation on the one hand or a paradise on earth.¹⁷

He continued:

This vision of the responsibility of the scientists, “a greater responsibility than is pressing on any other body of men,” puts him in a very different role from the scientist as technologist or the scientist dealing by tentative and empirical methods with broader questions or cardinal choices. It is fortified ... by the related notion of the scientist as specially endowed—a seer or prophet.¹⁸

He also pointed to the rapid switch in views on fundamentals by some distinguished scientists. Advocates of building active defenses and fallout shelters against nuclear attack soon saw these things as fueling the arms race. Of course, he saw nothing wrong in principle with people changing their views. (He might have quoted, but did not, Lord Keynes: “When the facts change I change my views; what do you do, Sir”?) But these changes raised questions about their foresight, sometimes right and sometimes wrong. As a group, these scientists were not seers.

The scientist and novelist Sir Charles Percy Snow addressed the difficulty of communications between specialists in the physical sciences and the humanities in his Godkin Lecture, “The Two Cultures.”¹⁹ (Sir Charles could have included the social sciences as well.) Snow had claimed that the cardinal choices can be fully understood only by scientists, even though in “legal form” these choices are made by non-scientists exposed to advice of only a few experts.

AW was critical of Snow’s account of how Britain’s wartime leaders made decisions, countering that the reality was a good deal more complex, filled with more salient participants than Snow had allowed. More important, AW maintained that although civilian political leaders might lack expertise, they could be made to understand what was at stake in such cardinal choices.

III. BEYOND ANALYSIS TO DESIGN AND INVENTION

Only in a limited sense is the public interest served by finding the best among *established* choices. It is sometimes better to invent or design new ones. This does not come naturally to many people who are otherwise highly competent. It requires a certain mindset, akin to that of an inventor or an architect. AW had such a mentality.

Controlling Forces: Failing Safe.

Few – if any – topics since we have had nuclear weapons have been more important than the rules for launching them. In their 1956 study, *Protecting U.S. Power to Strike Back in the 1950's and 1960's* (R-290), AW and his colleagues recognized that ambiguous warning signals raised two risks for the Strategic Air Command: *false alarm*, which could lead to accidental or unauthorized uses of nuclear weapons, and *false assurance*, which could leave U.S. strategic forces vulnerable in the event of an actual attack.

To deal with these related risks, AW's team invented and then recommended a "Fail-Safe" operating procedure (later called "Positive Control") by which SAC, when confronted with ambiguous warning of a potential attack, would evacuate and protectively scramble its nuclear-armed bomber aircraft without actually committing them to combat – and without risking war by mistake. R-290 explained:

By a fail-safe procedure we mean one in which the bombers will return to base after reaching a pre-designated point en route – unless they receive an order to continue. (Without a fail-safe procedure, this initial decision comes close to being the final decision; without recall it is the final decision.)²⁰

The alternative to "Fail-Safe" was known as "Recall," in which combat-ready bombers would not only take off based on (possibly mistaken) warning, but also make their way to pre-designated targets. The only way to stop such bombers from attacking their targets would be, as this procedure's name suggests, to recall them with explicit communication. But "Recall" was fraught with dangers. AW would later recollect having said in a briefing to the Strategic Air Command, "There aren't any good ways of starting World War III, but that would surely be one of the worst."²¹

In Autumn 1957, SAC conducted a test called FRESH APPROACH, which simulated the recall of the alert force by radio (i.e., using a “fail un-safe” procedure). The after-action report was sobering:

. . . of the ten airborne alert aircraft, one experienced HF [high frequency radio frequency] failure and one failed to monitor HF frequencies as briefed. The eight remaining aircraft . . . did not receive the test message on HF. All ten aircraft received UHF contact from the 9th Bombardment Wing command post, [but] Mountain Home tower and McChord tower were not received. All UHF messages received from the 9th Bombardment Wing were *after the aircraft had struck the target* and were inbound to the local area [emphasis added].²²

SAC instituted Fail-Safe by the Spring of 1958.

It is worth noting that when the movie *Fail Safe* (1964) needed drama, it found it by showing the opposite of “Positive Control,” the possible consequence of having a “fail-dangerous” recall procedure—the procedure in place before the change in 1958 designed and recommended by the AW team. This topic, like several others dealt with by AW and team, has current salience. For example, have India and Pakistan introduced equivalent fail-safe procedures in their nuclear forces?²³

Challenge of Protecting Missiles, as well as Command, Control, and Communications.

By the mid-1950s it was becoming evident that any place in the United States could soon be reached by intercontinental ballistic missiles, then under development in both the Soviet Union and the United States. They could arrive with little warning and with no possibility then of interception. The main response of SAC to this danger was to keep some aircraft on a high state of alert, ready for quick takeoff or even aloft, in a crisis. These solutions had their problems because early warning was uncertain and keeping bombers aloft for long periods was costly. But a much more difficult question was how to base our own ICBMs. The first generation of ICBMs, *Atlas* and *Titan* missiles, were large, fragile, exposed (think of the space vehicles at the Kennedy Space Center), and vulnerable to nuclear weapons detonated even some miles away.

AW and his team sought to invent and design new ways to make U.S. strategic forces safe from missile attack. As part of their investigation into fixing the vulnerability of bombers on their bases in the United States, thought had been given to blast-resistant shelters. The first generation of enemy ICBMs was expected to be inaccurate, which meant that blast shelters, in principle, might provide adequate protection against expected blast effects. However, the prevailing view of civil engineering experts was discouraging: only 30-40 pounds per square inch (p.s.i.) of resistance to peak overpressure (that is, to the blast effects of a nuclear explosion) was thought to be feasible, a level short of adequacy, and even this would be costly.

This perceived shortfall led AW to inquire more deeply into what was known about the blast effects of nuclear weapons and the technology of blast-resistant structures. He got Paul Weidlinger, a brilliant structural engineer whom he had met in the 1940s, interested in this topic. Weidlinger soon came up with a design that could withstand peak overpressures an order of magnitude greater than most had thought possible. It turned out that while these improved blast-resistant structures could not be cost-effectively applied to aircraft or the first generation of large and liquid-fueled missiles, they could be applied to the much smaller and tougher *Minuteman* missiles by basing them underground in what later became known as "silos."²⁴

Weidlinger then came up with designs for underground silo structures that could withstand overpressures approaching 1,000 p.s.i., and later extended blast resistance to even higher levels. After the skepticism of the extant authorities on this topic was overcome, Weidlinger's design approach became the solution. It was not expected to last forever because missiles would become more and more accurate, but it was good solution for many decades (and indeed is still in use).

To take another important example, a major invention came out of a question that AW had asked of a RAND engineer named Paul Baran: "What would happen if the key switching centers of AT&T were destroyed?" Baran's answer: The total collapse of our national communications system.

Inquiries to remedy this problem led Baran in 1964 to invent the concepts of "hot-potato routing" (decentralized and distributed communications systems) and segmenting data into "message blocks" (today, packet-switching networks), two concepts that could be used to design a more robust, survivable command,

control, and communications system less prone to disruption and degradation. Baran's concepts provided the impetus for major advances in telecommunications — and contributed to what would become the Internet.

Persistent Efforts in Persuasion: Communicating the Analysis and Design's Results.

It was not AW's style to write a report or an article and simply put it in the mail. If the project was worth doing, it was worth a marketing effort. He took great pains to learn about the views and positions of the decisionmakers involved, and to design arguments that would be most effective. This meant spending a lot of time on the road, especially in Washington, but also at the Strategic Air Command's headquarters in Omaha, NATO headquarters, and elsewhere. To AW, these were not simply "briefings." For one thing, they were usually not brief; for another, these were two-way exchanges, for the presenters themselves learned much from such sessions.

AW's writings were closely reasoned, sometimes eloquent, complete with salient data. But they were not quick and easy reads. Nor was he a person of few words. Training in mathematical logic produced precision in expression, but sometimes a denseness that needed parsing. Here, too, Roberta must have been a big help.

IV. DISPUTATIONS

The Ballistic Missile Defense Dispute.

Albert Wohlstetter's works often evoked vigorous responses — some highly positive, some constructive, some hugely critical, and some scurrilous.²⁵ Consider the case of the proposed active defense against ballistic missiles (BMD) in behalf of which AW became an advocate. He had a belief that technically it could be made to work in certain situations. He certainly found the "arms race" arguments of many of the opponents of BMD objectionable. Why, in principle, should one object to being able to defend oneself against attack?

In 1969, the Senate Armed Services Committee held a debate on the pros and cons of the *Safeguard* ballistic missile defense system. The purpose of *Safeguard* was to protect *Minuteman* missiles from nuclear attack, and the debate centered on how well

such a defense might perform. AW, Paul Nitze, John Foster, and others gave detailed arguments as to why it was a good idea, and their opponents, such as George Rathjens and Jerome Wiesner, as to why it was not.

What turned out to be remarkable about this exchange was not so much its content, but the fact that the Operation Research Society of America (ORSA), at AW's request, did a study of the professionalism of his opponents' contributions. Three faculty members from the Massachusetts Institute of Technology (MIT) who had testified at the Senate hearings, including MIT's president, objected to the standing and capacity of ORSA to conduct such an investigation. ORSA went ahead anyway. It found faults on both sides of the debate, but singled out for criticism the testimony of the opponents, including those from MIT. In striking contrast, the report found "no significant defects" in AW's testimony, and cited one paper that he had submitted to the Senate Armed Services Committee as "a model for the professional and constructive conduct of a debate over important and technical issues."²⁶

AW won this debate on points, but was he right? At the time, AW's desire to establish the correctness of the principle that defending oneself is good seems to have overcome his usually sound technical and economic sense. As observed above, one might object to a specific program on grounds of inadequate cost-effectiveness. Here, ballistic missile defenses have struggled against technologically competent attackers in which the offense can adopt countermeasures (e.g., multiple independently targetable reentry vehicles, decoys) to negate them. The United States has had active defense programs under development for 50 years and has deployed some systems (one Safeguard site in North Dakota, soon demolished) without achieving notable confidence that the substantial expenditures have been worthwhile. We are still trying, now with the goal of defending against less technically advanced missiles from Iran or North Korea.

The Arms Race Dispute.

AW set off a fierce debate by questioning the existence of a spiraling nuclear "arms race" in two articles published in the mid-1970s.²⁷ Here is a small sample of the views to which AW responded: from John Newhouse, "America's forces apparently served as both model and catalyst for the Russians"; from journalist Leslie Gelb, "The common practice, as I think we all know, has been to exaggerate and over dramatize"; from Jerome

Wiesner, president of MIT and former science adviser to President Kennedy, the arms race makes “an ever-increasing likelihood of war so disastrous that civilization, if not man himself, will be eradicated”; from nuclear physicist Herbert York, who had served on the Manhattan Project and as the first director of the Livermore National Laboratory, we should “slow down the rate of weapons innovation, and hence reduce the frequency of introduction of ever more complex and threatening weapons”; from chemists George Kistiakowsky, a leading Manhattan Project participant, and MIT’s George Rathjens, “any understanding that slowed the rate of development and change of strategic systems would have an effect in the right direction.” In short, the dangers perceived by the “arms race theorists” (as AW called them) were not merely—or only—the waste of resources in adding to the nuclear stockpile, but catastrophe.

AW asked exactly what was going on in the putative “arms race.” He began by dissecting the term:

When we talk of “arms” are we referring to the total budget spent on strategic forces? The number of strategic vehicles or launchers? The number of weapons? The total explosive energy that could be released by all strategic weapons? The aggregate destructive area of these weapons? Or are we concerned about qualitative change—that is alterations in unit performance characteristics—the speed of an aircraft or missile, its accuracy, the blast resistance of its silo, the concealability of its launch point, the scale and sharpness of optical photos or other sensitive devices, the controllability of a weapon and its resistance to accidental or unauthorized use? When we talk of a “race” what do we imply about the rate at which the race is run, about the ostensible goal of the contest, about how the “race” is generated, about the nature of the interaction among strategic adversaries?²⁸

Whatever arms racing was about, AW objected to the use of such words as “explosive,” “spiraling,” or “uncontrolled” to characterize the U.S.-USSR strategic “competition” (his preferred word) in nuclear arms.

To illustrate his point, AW compared forecasts over time, and also with reality as we gradually came to understand it, of Soviet ICBMs, submarine-launched missiles, and bombers. He found indicators on the American side mostly to have peaked in the late

1950s and early 1960s, and then to have declined to the early 1970s. Given increases in these categories on the Soviet side during those years of U.S. decline, he asserted that we were not “racing” them. Moreover, he maintained that some of the technical advances had helped to stabilize the nuclear balance: the hardening of silos, permissive action links, technology that enabled warheads—and so missiles—to be smaller, hence mobile, hence safer from attack (under the sea or, in the Soviet case, mobile on land); and increases in accuracy, along with smaller missiles, that reduced potential collateral damage to civilians. Advances in technology that made for a more stable relationship were good.

AW agreed that for the United States to have more aircraft or missiles simply because the Soviets were making more of them, or were assumed to have this intention, was a bad idea. However, he argued that his opponents ignored crucial aspects of the strategic competition by assuming that a simple action-reaction process was at work, or that the Soviet Union was aiming for a small “minimum deterrent” force. Most fundamentally, he disagreed that nuclear war was impossible simply because many extremely destructive weapons existed, and worried that the nuclear postures proposed by his opponents would foreclose the possibility of limiting the scope of the conflict if war should break out.

These articles garnered support and criticism. One criticism was that he had chosen dates to favor his argument.²⁹ Among the critics, a phrase that caught on was supplied by the title of former arms control agency official Paul Warnke’s rejoinder: “Apes on a Treadmill.” It evoked the image of mindless building of nuclear forces by both sides, something that could happen only if leaders were mistakenly led to believe that they could gain an advantage over nuclear-armed opponents.

This view led to the doctrine of Mutual Assured Destruction (dubbed “MAD” by Donald Brennan), that since only a few nuclear weapons delivered on a city could produce vast damage, why, then, buy more than the number needed to assure *that* result? Arthur Steiner, a colleague of AW, identified it with two propositions: (1) Don’t attack weapons; aim at people; and (2) Don’t defend against the adversary’s weapons.³⁰ Motivations for proposition (1) might be, *don’t attack his weapons because that would be destabilizing and would lead to an arms race*; or alternatively, *don’t attack weapons because it can’t be done successfully*. Motivations

for proposition (2) might be, *don't defend because it's a bad idea*; or alternatively, *don't defend because although it might be desirable it isn't feasible*. A large problem left inadequately addressed by MAD, and often ignored by AW's critics, was how to defend Europe, which was believed to be vulnerable to Warsaw Pact conventional attack. Our policy was to use nuclear weapons first there if such an attack was succeeding. In contrast, AW held that "most of those who rely on tactical nuclear weapons as a substitute for disparities in conventional forces have in general presupposed a cooperative Soviet attacker, one who did not use atomic weapons himself."³¹ Moreover, he added:

. . . nuclear limited war, simply because of the extreme swiftness and unpredictability of its moves, the necessity of delegating authority to local commanders, and the possibility of sharp and sudden desperate reversals of fortune, would put the greatest strain on the deterrent to all-out thermonuclear war. For this reason I believe that it would be appropriate to emphasize the importance of expanding a conventional capability realistically and, in particular, research and development in non-nuclear modes of warfare.³²

This last sentence foreshadowed his long and successful campaign to improve greatly the effectiveness of conventional airpower.

Civil vs. Military Uses of Nuclear Energy: Revealing a Distinction without Much Difference.

It should not surprise that a logician would be skilled at parsing distinctions. One was the purported distinction between civilian and military uses of atomic energy. This was a highly misleading distinction as dealt with politically. It is at the heart of the international proliferation problem. Although the influential Acheson-Lilienthal Report of 1946 on the potential and the dangers of nuclear technology was initially optimistic about the possibility of making civilian nuclear fuel hard to use in bombs, its authors quickly saw the dangers and proposed that all nuclear enterprises be run by an international authority.³³ The Eisenhower Administration blurred the distinction between civil and military uses of nuclear energy with *Atoms for Peace*, a program which

accelerated the distribution of weapons-relevant civil nuclear technology and know-how widely throughout the world.

The economic benefits have turned out to be modest so far, but *Atoms for Peace* advanced the ability of many countries to make the bomb on short notice by training people in nuclear science and technology and giving them experience in handling fissionable materials. Nuclear electric power, the main civilian application, requires fissile material as a fuel, or yields it as a by-product of the reaction process, or both. For various reasons having to do with politics, both domestic and foreign, most of the countries able to make the bomb on short notice—by now a large number—have chosen not to do so. But as the cases of India (written about perceptively by Roberta), Pakistan, North Korea and (prospectively) Iran show, civilian applications can be used to advance military ones. With *Atoms for Peace*, the U.S. Government and others tried to make a distinction where there was not much of a difference. His aforementioned 1976 article on "Spreading the Bomb without Quite Breaking the Rules" described efforts by policymakers to make such unrealistic distinctions.

The Nuclear Nonproliferation Treaty (NPT), signed in 1968, incorporates the manifest tensions, not to say confusions, on this topic. It says that nuclear explosives will not be transferred (Articles I and II), that safeguards will be accepted (Article III), that all countries have an inalienable right to nuclear energy for peaceful purposes in accordance with Articles I and II (Article IV, paragraph 1), that nuclear technologies be shared (Article IV, paragraph 2), and that all parties work towards nuclear disarmament (Article VI). Article IV opened the door to acquiring weapons-related capacities, and three countries are known to have gone through it and violated their safeguards agreements: Iraq in the period leading up to the first Gulf War, North Korea, and Iran. Several that made the bomb had not signed the NPT: India, Pakistan, Israel, and South Africa (which signed the NPT after it had dismantled its bomb program).

When AW and his associates examined the problems posed by civil nuclear energy's military potential in the 1970s, those problems were not as evident as they are today. This work highlighted matters that have become of great public concern in the past decade. Inconsistencies abound. For instance, AW and his associates noted that a major mission of the International Atomic Energy Agency was to market nuclear energy around the world, notably to developing countries. To this day, the IAEA still refers

to itself, with no apparent sense of irony, as the “Atoms for Peace Agency.”

It cannot be said that the behavior of governments has greatly improved in this arena.

The Need to Use Power Discriminately: The Moral Dimension.

A theme that emerged in AW’s work from an early point was how to use military power more effectively against military forces and avoid unintended harm to civilians.³⁴ There were both utilitarian and moral arguments for this. With nuclear weapons, this was a challenge and, to some people, an oxymoron in the sense that any use of nuclear weapons, no matter how limited in scope, might quickly escalate and produce a holocaust. The predominant view was that *anything* that would mitigate the destructiveness of nuclear weapons would suggest that they could be rationally used.

The question of objectives was addressed by the American Catholic Bishops’ *Pastoral Letter on War and Peace* in 1983.³⁵ AW commented on this letter in “Bishops, Statesmen, and Other Strategists on the Bombing of Innocents” (1983), a magisterial review of central issues of nuclear strategy. He wrote:

By revising many times in public their pastoral letter on war and peace, American Catholic bishops have dramatized the moral issues which statesmen, using empty threats to end the world, neglect or evade. For the bishops stand in a long moral tradition which condemns the threat to destroy innocents as well as their actual destruction. They try but do not escape reliance on threatening bystanders. . . . The letter offers a unique opportunity to examine the moral, political, and military issues together, and to show that . . . threatening to bomb innocents is not part of the nature of things. Nor has it been, as is now widely claimed, an essential of deterrence from the beginning. Nor is it the inevitable result of “modern technology.”³⁶

He continued:

The bishops have been sending a message to strategists in Western foreign-policy establishments – and to strategists in the Western anti-nuclear counter-establishments.

It seems unequivocal: “Under no circumstances may nuclear weapons or other instruments of mass slaughter be used for the purpose of destroying population centers or other predominantly civilian targets.” Though that only restates an exemplary part of Vatican II two decades earlier, it is far from commonplace. Nonetheless it should be obvious to Catholics and non-Catholics alike. Informed realists in foreign-policy establishments as well as pacifists should oppose aiming to kill bystanders with nuclear or conventional weapons: indiscriminate Western threats paralyze the West, not the East. We have urgent political and military as well as moral grounds for improving our ability to answer an attack on Western military forces with less unintended killing, not to mention deliberate mass slaughter.³⁷

AW then criticized the bishops for adopting the position that it was acceptable for us to have these weapons but never to use them.

Having observed long ago that not even Genghis Khan avoided combatants in order to focus solely on destroying noncombatants, I was grateful, on a first look at this issue in the evolving pastoral letter, to find the bishops on the side of the angels. Unfortunately, a closer reading suggested that they were also on the other side. For, while they sometimes say that we should not threaten to destroy civilians, they say too that we may continue to maintain nuclear weapons—and so implicitly threaten their use as a deterrent—while moving toward permanent verifiable nuclear and general disarmament; *yet we may not meanwhile plan to be able to fight a nuclear war even in response to a nuclear attack* [emphasis original].

Before that distant millennial day when all the world disarms totally, verifiably, and irrevocably—at least in nuclear weapons—if we should not intend to attack non-combatants, as the letter says, what alternative is there to deter nuclear attack or coercion? Plainly only to be able to aim at the combatants attacking us, or at their equipment, facilities, or direct sources of combat supply. That, however, is what is meant by planning to be able to fight a nuclear war—which the letter rejects.³⁸

Responses were abundant and mixed. It evoked praise by such prominent people as Samuel Huntington, Aaron Wildavsky, and Brent Scowcroft (on occasion an AW target). Among the critics was the political scientist, Bruce Russett, who had been an adviser to the bishops and who wrote that AW had distorted the bishops' position, and that the final version of their letter had dropped mention of non-use under all circumstances. Russett added he wished that AW had "acknowledged the desirability of a *no-first use* posture" (emphasis added) as being consistent with the views expressed in the article.

V. RADICALLY REDUCING UNINTENDED HARM TO CIVILIANS

AW examined the history of strategic bombing, an undertaking of great imprecision such that if the target were in cities most bombs would miss it and hit civilians. This inevitable inaccuracy during World War II had led to a policy of deliberately targeting civilians, with the result that enormous destruction was done, e.g., Tokyo, Hamburg, and Dresden. Obviously, the destruction would be enormously greater with nuclear weapons aimed at civilians. AW thought planning based on MAD targeting was wrong on both utilitarian and moral grounds.

The alternative path that AW first suggested was a combination of making much lower-yield nuclear bombs and delivering them with greater accuracy against solely military targets. He observed that the thermonuclear process (as distinguished from the fission one), contrary to the initial impression that it would only enable bomb yields to be horrendously large, would actually permit bombs with much smaller weights and yields to be made.

This combination never found enough support to be carried out seriously, but a crucial extension of AW's idea did, one that he worked on for many years. It was that advances in computing and sensors might make it possible to destroy discrete targets with non-nuclear weapons. As it turned out, several technologies made this possible, as demonstrated in the First Gulf War (recall the image of a cruise missile going down a boulevard in Baghdad and turning to hit the defense ministry). Highly precise weapons were then used against Serbia in 1999 and Iraq again in 2003. Of course, the right targets had to be designated. We could now precisely hit

the wrong place, as in the bombing of the al Firdos air raid shelter in Baghdad in 1991, or of the Chinese embassy in Belgrade in 1999.

Striking evidence of official acceptance of AW's ideas on discriminate deterrence came in a Defense Department briefing on March 5, 2003, 2 weeks before the invasion of Iraq, about our "military practices and procedures to minimize casualties to non-combatants during military operations."³⁹ Such a public statement about attack criteria in a war about to occur was extraordinary; its substance was the opposite of the bombing goal against Germany and Japan in World War II. This was the message:

For each military target, the potential for collateral damage is reviewed and a decision made regarding:

- Targets likely to result in noncombatant casualties
- Targets likely to result in damage to noncombatant structures;
- Targets that affect protected sites;
- Targets that serve both a military and civilian purpose; and
- Targets in close proximity to known human shields.⁴⁰

The briefing added that the U.S. military would seek to reduce collateral damage by using smaller weapons, shifting aim points or the time attack to periods of low occupancy, as well as by dispersing of leaflets and of radio broadcasts telling people to stay away from some places. That said, the Pentagon briefing also conceded the inevitability of unintended casualties caused by technical malfunctions, human error, and the fog of war.

No doubt, there were cynics about this announcement, but the ensuing air campaign showed that it was largely carried out according to these principles. AW's long campaign to move the United States away from indiscriminate and uncontrollable military technologies had shown results.

"Never Eat an Unworthy Calorie" and Other Passions.

A recent book describes Albert Wohlstetter as "flamboyant and eccentric."⁴¹ Rather, he had standards, such as great attentiveness to food and wine. Here, his tendency towards excellence was defended with the statement, "Never eat an unworthy calorie."

His passion toward work and life was a quality to be emulated.

Flamboyant he was not. But he did stand out in a crowd, especially in later years when he had a beard and mustache. He and Roberta did much entertaining at home. As for going out, they were more likely to be found watching a jazz ensemble than visiting a nightclub. But they worked too hard to have much time for such entertainments.

They cared about literature and the arts, music, architecture, dance (their daughter Joan became a dancer—and mathematical analyst). Many of their friends, especially in New York City, Los Angeles, and Chicago, were scholars and people in the arts such as the great art historian Meyer Shapiro and the mathematical logician Willard Van Orman Quine. At RAND their friends included, among many others, sociologist Herbert Goldhamer, demographer Fred Iklé, economist Andrew Marshall, physicist Herman Kahn, economist Charles Hitch, and engineer James Digby. In Chicago one met or heard about economists Harry Johnson, Gary Becker, Milton Friedman; the sociologist Edward Shils; law professor Edward Levi (who became Attorney General in the Ford Administration); Nobel Prize-winning novelist Saul Bellow; and the remarkable polymath and social scientist (who had been at RAND) Nathan Leites.

The objects of AW's work and life were large passions, and although he tried to be fair to intellectual opponents, he didn't always succeed. Wrong-headed people could be seen as fools, and he didn't suffer fools easily. But excellence, in the end, trumped and he certainly respected it.

ENDNOTES - Rowen

1. Thomas C. Schelling, "Global Warming: Intellectual History and Strategic Choices," Remarks at the Fourth Annual Hans Landsberg Memorial Lecture, Resources for the Future, Washington, DC; December 6, 2006, available from www.rff.org/rff/Events/upload/25573_1.pdf.

2. Without doubt, the most bizarre tagging of AW was to identify him with the views of the political philosopher Leo Strauss, a fellow professor at the University of Chicago. AW must have known Strauss, but in my many years of association with AW, I cannot recall his name being mentioned once—in contrast to those of the Chicago luminaries noted above.

3. Among the many misconceptions about AW's work is that it involved game theory. It did not formally. Game theory, which was being developed at RAND in the 1950s, deals with opposing choices, but it was too underdeveloped and abstract to deal with the kinds of concrete operational problems that AW and his team had sought to address. It provided metaphors—not useful models of interactions.

4. For more on Albert Wohlstetter's methodology, see Wohlstetter, *Theory and Opposed-System Design*, D(L)-16001-1, Santa Monica, CA: RAND Corporation, August 1967, revised January 1968, available from www.rand.org/about/history/wohlstetter/DL16001.1/DL16001.1.html. AW's essay was later published as "Theory and Opposed-System Design," *Journal of Conflict Resolution*, Vol. 12, No. 3, September 1968, pp. 302-331. A version of that essay is included in this edited volume.

5. See Albert J. Wohlstetter, Fred S. Hoffman, Robert J. Lutz, and Henry S. Rowen, *The Selection of Strategic Air Bases*, R-244-S, special staff report, Santa Monica, CA: RAND Corporation, March 1, 1953, TOP SECRET, declassified on July 1, 1963, available from www.albertwohlstetter.com/writings/19530301-AW-EtAl-R244S.pdf; and Wohlstetter, Hoffman, Lutz, and Rowen, *The Selection and Use of Strategic Air Bases*, R-266, final report, Santa Monica, CA: RAND Corporation, April 1954, TOP SECRET, declassified circa 1961, available from www.rand.org/pubs/reports/R0266/.

6. See Albert Wohlstetter, Fred S. Hoffman, Robert J. Lutz, and Henry S. Rowen, *Vulnerability of U.S. Strategic Air Power to a Surprise Enemy Attack in 1956*, SM-15, Santa Monica, CA: RAND Corporation, April 15, 1953.

7. Philip Taubman, *Secret Empire: Eisenhower, the CIA, and the Hidden Story of America's Space Espionage*, New York, NY: Simon and Schuster, 2003, p. 12.

8. Despite the rapid acceptance of the need for a protected retaliatory power, the belief in using ballistic missile "launch-on-warning" responses to an attack long persisted among some high military authorities. It was a dangerous belief that entailed fast and irrevocable decisions when information was likely to be sparse and possibly wrong.

9. On this point, see Vojtech Mastny and Malcolm Byrne, eds., *A Cardboard Castle? An Inside History of the Warsaw Pact, 1955-1991*, Budapest, Hungary: Central European University Press, 2005.

10. In the early 1960s, work done under the direction of two of AW's former associates, the author of this chapter, and more systematically by Alain Enthoven in the Pentagon's Office of Systems Analysis, countered the view of Warsaw Pact conventional superiority in Europe. Eventually, this counterview became more widely accepted—notably after the rise of *Solidarity* in Poland—although preserving the traditional argument of Soviet superiority was seen by the U.S. Army as necessary for budgetary reasons.

11. One effort to deal with this contradiction was offered by Tom Schelling in a paper titled "The Threat that Leaves Something to Chance." (This paper was published as a chapter in Schelling, *The Strategy of Conflict*, Cambridge, MA: Harvard University Press, 1960, pp. 187-203.) Here, the view was that it was not rational to use nuclear weapons against an adversary that had them, but uncertainty as to what would happen if there were actually a war would induce caution all around. It was not a wholly comforting theory despite its plausibility.

12. See Henry A. Kissinger, *Nuclear Weapons and Foreign Policy*, New York, NY: Harper & Row, 1957.

13. Albert Wohlstetter, "On the Genesis of Nuclear Strategy: Letter to Michael Howard," unpublished, November 6, 1968, revised circa April 1986 with additional material and annotations by James Digby and Arthur Steiner and a prefatory note by Michael Howard, Wohlstetter Papers, Writings, Box 187, Folder 22. The annotated version of this letter is available in this edited volume.

14. The great mathematician, John von Neumann, was the stimulus for the name of an early computer at RAND, the *Johnniac*. Two economists of distinction who visited for some time were Thomas Schelling and Kenneth Arrow, each of whom later received the Nobel Prize in economics. Herbert Simon (another Nobel laureate in economics) had a long working association with RAND's Allen Newell, doing work on human problem solving.

15. Andrew May, "What Made RAND Work?" unpublished note based on discussions with Andrew Marshall, November 2006.

16. President Ronald Reagan, "Remarks at the Presentation Ceremony for the Presidential Medal of Freedom to Albert and Roberta Wohlstetter," East Room, White House, Washington, DC, November 7, 1985, available from www.reagan.utexas.edu/archives/speeches/1985/110785a.htm.

17. Albert Wohlstetter, "Scientists, Seers and Strategy," *Foreign Affairs*, Vol. 41, No. 3, April 1963, p. 471.

18. *Ibid.*

19. C. P. Snow, *Science and Government: The Godkin Lectures at Harvard*, 1960, Cambridge, MA: Harvard University Press, 1961.

20. Albert J. Wohlstetter, Fred S. Hoffman, and Henry S. Rowen, *Protecting U.S. Power to Strike Back in the 1950s and 1960s*, R-290, staff report, Santa Monica, CA: RAND Corporation, September 1, 1956, TOP SECRET, declassified circa 1960s, available from www.albertwohlstetter.com/writings/19560901-AW-EtAl-R290.pdf

21. On this topic, see Albert Wohlstetter, "SAC Test 1957 of Alert Bomber Response—Only 'Fail Unsafe'," April 29, 1985, Wohlstetter Papers, Notes, Box 102, Folder 6, Tab H, p. 3.

22. *Ibid.*, p. 4.

23. There has been public discussion of a very important but different topic: Have the Indians and Pakistanis installed Permissive Action Link (PALs) on their nuclear bombs—in effect, combination locks? For more on PALs, see Fred C. Iklé, Gerald J. Aronson, and Albert Madansky, *On the Risk of an Accidental or Unauthorized Nuclear Detonation*, RM-2251, Santa Monica, CA: RAND Corporation, October 15, 1958, esp. pp. 100-101 and 154, available from www.rand.org/pubs/research_memoranda/RM2251/.

24. Before what levels of protection were determined to be technically feasible at what cost, AW and Fred Hoffman did a set of "break even" analyses on what such protection would be worth in terms of survival of missiles. It was more than enough to fit reality.

25. For a recently published criticism, see Richard Rhodes, *Arsenals of Folly: The Making of the Nuclear Arms Race*, New York, NY: Alfred A. Knopf, 2007.

26. See "Appendix III: Treatment of Operations-Research Questions in the 1969 Debate," *Operations Research: The Journal of the Operations Research Society of America*, Vol. 19, No. 5, September 1971, pp. 1175-1237. Quoted phrases appear on p. 1217.

27. Albert Wohlstetter, "Is There a Strategic Arms Race?" *Foreign Policy*, No. 15, Summer 1974, pp. 3-20; and Wohlstetter, "Rivals, But No 'Race'," *Foreign Policy*, No. 16, Fall 1974, pp. 48-81.

28. Wohlstetter, "Is There a Strategic Arms Race?" p. 3.

29. Michael L. Nacht, "The Delicate Balance of Error," *Foreign Policy*, No. 19, Summer 1975, pp. 163-77.

30. Henry S. Rowen, "Introduction," in Henry Sokolski, ed., *Getting MAD: Nuclear Mutual Assure Destruction, Its Origins and Practice*, Carlisle, PA: Strategic Studies Institute, November 2004, p. 3, available from www.npec-web.org/Books.asp?BookID=2116845428.

31. Albert Wohlstetter, *The Delicate Balance of Terror* (unabridged version), P-1472, Santa Monica, CA: RAND Corporation, November 6, 1958, Revised December 1958, p. 17, available from www.rand.org/about/history/wohlstetter/P1472/P1472.html.

32. Wohlstetter, *The Delicate Balance of Terror*, p. 18.

33. Henry Sokolski has called my attention to a press release issued about a week after the report was released saying that "it would be unwise to rely on denaturing to insure an interval of as much as a year." See Press Release No. 235 [on the Secretary of State's Committee on Atomic Energy's *Report on the International*

Control of Atomic Energy, Washington, DC: U.S. Government Printing Office, March 16, 1946], U.S. Department of State, April 9, 1946.

34. An important vehicle for addressing this and other security issues was *Discriminate Deterrence*, final report of the Commission on an Integrated Long Term Strategy, Washington, DC: U.S. Government Printing Office, January 1988, [www.albertwohlstetter.com/writings/Discriminate Deterrence](http://www.albertwohlstetter.com/writings/Discriminate%20Deterrence). Co-chaired by AW and Fred Iklé, the Commission was made up of a distinguished set of members appointed jointly by the Secretary of Defense and the President's National Security Advisor.

35. National Conference of Catholic Bishops, *The Challenge of Peace: God's Promise and Our Response*, a pastoral letter on war and peace, Washington, DC: Office of Publication Services of the U.S. Catholic Conference, May 3, 1983.

36. Albert Wohlstetter, "Bishops, Statesmen, and Other Strategists on the Bombing of Innocents," *Commentary*, Vol. 75, No. 6, June 1983, p. 15.

37. *Ibid.*

38. *Ibid.*, p. 16.

39. "Background Briefing on Targeting," news transcript, U.S. Department of Defense, March 5, 2003, available from www.defenselink.mil/transcripts/transcript.aspx?transcriptid=2007.

40. See "Targeting and Collateral Damage," presentation slides, Central Command, U.S. Department of Defense, March 5, 2003, slide 4, available from [www.defenselink.mil/news/Briefing Slide.aspx?Briefing SlideID=90](http://www.defenselink.mil/news/BriefingSlide.aspx?BriefingSlideID=90).

41. Jay Winik, *On the Brink: The Dramatic, Behind-the-Scenes Saga of the Reagan Era and the Men and Women Who Won the Cold War*, New York, NY: Simon and Shuster, 1996, p. 50. Quoted by Rhodes, *Arsenals of Folly*, p. 111.