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The Essence of Aerospace Power

What Leaders Need to Know

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Editorial Abstract: Handling the chaotic pace of change in the coming century will require aerospace leaders who understand how air and space fit into joint military operations. Professor Drew provides a firm grounding in this "essence" for future leaders, including the absolute requirements and limitations of aerospace power.

THE US MILITARY became the ultimate victim of its own success following quiet victory in the Cold War and thunderous triumph in the Gulf War. Political decision makers challenged the need for such a powerful military when there appeared to be no "peer competitors," and the downsizing began in earnest. The US Air Force was not spared, as its operational heart for the previous 45 years was ripped apart and replaced with smaller pieces in unfamiliar patterns. At the same time, a bewildering array of operational requirements began to stretch the reduced force to the limit. In a bitter irony for airmen caught up in the escalating operations tempo, many of these operations probably would not have been necessary during the Cold War. Victory in the Cold War seemed to confirm the old adage that no good deed goes unpunished.

The angst and confusion created major leadership challenges, one of which was the need to redefine the Air Force. But well-intentioned efforts only added more confusion to an already chaotic situation. In a

sense, we tried too hard, too often, and in too many ways. Three different Air Force vision statements appeared in just one decade: "Global Reach, Global Power" in 1990; "Global Engagement" in 1996; and "Global Vigilance, Reach, and Power" in 2000. Adding to the muddle were the newly minted Air Force "core competencies," the "basic areas of expertise the Air Force brings to any activity."[1] Unfortunately, even these were quickly amended to accommodate items apparently forgotten.

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The near-chaotic pace of change and the confusion it continues to generate present enormous leadership challenges that will likely remain with us well into the future.[2] The key to success in dealing with these challenges lies in understanding what aerospace power is all about. After a century of experience in the air and over four decades in space, how can we articulate what makes aerospace power unique? This article answers that key question by deriving and examining the "essence of aerospace power," including its absolute requirements and very real limitations. It explains how the *essence* provides the psychological and operational rationale for an independent Air Force and looks at conceptual difficulties surrounding the space portion of aerospace power. Finally, the article casts a glance at the future by noting the dilemma facing airmen as they fly into the third millennium.

Deriving the Essence of Aerospace Power

In trying to understand what airmen are all about, we must ask the critical question, What capabilities make aerospace power unique? The answer is not found in the relative advantages of speed, range, flexibility, and so forth, spawned by operating in the third dimension. Rather, what sets aerospace power apart is the product of those relative advantages, the essence of aerospace power, which holds that *only aerospace power can apply great power quickly to any tangible target on the planet.*

Parsing the Essence

Note that *aerospace power* rather than *Air Force* appears in the statement above. The *essence* of aerospace power has little to do with ownership. It exists whether one speaks of the US Air Force, aviation elements of the other services, or airpower possessed by allies and adversaries. Obviously, not every air force or aviation organization has the "full-service" force structure that can totally fulfill the *essence*.

The word *quickly* defines one of the cardinal advantages of airmen over surface forces. The speed at which modern aerospace forces can travel to any point on the globe is orders of magnitude greater than that of the fastest surface forces. No place on Earth is more than a few hours away, and traditional defensive barriers such as the great oceans no longer provide sanctuary. By the beginning of the second half of the twentieth century, airpower gave every military threat a sense of immediacy, and war became a "come as you are" affair—a situation that intensified with the dawn of space capabilities.

Perhaps the most important, and certainly the most misinterpreted, word in the *essence* is *power*. Traditionally, power has related to explosive ordnance and target destruction, nuclear weapons serving as the ultimate example. But in the post–Cold War world, the "power" most often delivered by airmen has taken the form of humanitarian aid: food, medical supplies, and heavy equipment.

Power can also include people—peacekeepers to the latest crisis, technical experts essential to an important foreign air program, or diplomats trying to avoid war. Shuttle diplomacy is a child of the aerospace age.

Power can also include information. Knowledge is the purest form of power and is the reason that overhead surveillance, reconnaissance, and intelligence-gathering efforts are so important in both war and peace. Information delivered from above can be used to strengthen a friendly regime, discredit an enemy regime, or directly attack the morale of an adversary's frontline troops. In less hostile circumstances, the information might consist of humanitarian warnings about impending natural disasters or news about disaster-relief efforts.

As for the term *target*, in the traditional military sense of the word, a target can be anything of military value to an adversary. For example, targets might be the sources of enemy military power (e.g., industrial targets), lines of communication through which military power flows (e.g., interdiction targets), or the enemy's fielded forces themselves. With regard to the last, it is worth noting that airpower can take direct offensive actions against an adversary's air forces *and* surface forces. The latter, however, can do nothing other than defend themselves against air attack—only in very unusual circumstances can they take direct offensive actions against air forces.[3] In a less traditional sense, a target can be hunger, disease, ignorance, lawlessness, or a myriad of other vexing problems.

Notwithstanding the requirements and limitations yet to be discussed, parsing the *essence* reveals that the options for using airpower are virtually unlimited, providing unparalleled flexibility. In truth, the airman's traditional axiom that "flexibility is the key to airpower" should be updated and reversed: aerospace power is the key to flexibility.

Absolute Requirements

Stunning technological progress during the twentieth century made the *essence* of aerospace power a physical reality. However, three fundamental requirements must be met before the physical reality becomes practical and useful. Left unfulfilled, any one of these three requirements is a showstopper.

The first requirement is the most obvious: the availability of appropriate kinds and numbers of air and space assets. One must understand that required air assets go far beyond airframes and munitions. Almost any nation can procure modern, sophisticated aircraft and munitions in the global arms bazaar. Infrastructure—which educates, trains, disciplines, motivates, and cares for airmen and their equipment—separates real aerospace power from high-tech flying clubs.

The second fundamental requirement is access to timely and accurate intelligence. Airpower historian Phillip Meilinger once claimed that "in essence Air Power is targeting, targeting is intelligence, and intelligence is analyzing the effects of air operations."[4] Meilinger may have engaged in a bit of hyperbole on this point, but not much. The target intelligence required is not just about technical and tactical matters such as location, construction, defenses, and so forth. Of equal importance are the strategic- and operational-level requirements to understand if, why, and to what extent operations against potential targets will contribute to the overall military effort and, ultimately, to political objectives. Strategic- and operational-level intelligence informs decisions about *what* airpower should do. Tactical-level intelligence informs decisions about *how* airpower should do it.

Part of the intelligence requirement is the need to accurately assess the results of operations. Assessing actual target damage has been difficult for airmen since the earliest days of military airpower.[5] Even with modern sensor capabilities, it remains a vexing problem.[6] The situation is further complicated by the need to assess not only tactical-level damage, but also the operational- and strategic-level effects of that damage.[7] Measuring first-order effects of aerospace operations remains a difficult and complex task. Mea-

suring second- and third-order effects is even more problematic.

The third fundamental requirement is the political will to fully exploit the *essence*. In the eyes of many airmen, political will has been their Achilles' heel. Cold War fears of nuclear escalation restrained the use of aerospace power in Korea and Vietnam. In the post–Cold War era, the fear of inflicting undue civilian casualties and the fear of losing public support have limited political will. In Operation Desert Storm, for example, the destruction of the Al Firdos bunker in Baghdad, killing many civilians hiding there, resulted in tight restrictions on subsequent bombing in the Iraqi capital. During Operation Allied Force, the need to maintain a united front provided every member of the North Atlantic Treaty Organization (NATO) the ability to virtually veto strikes on Serbian targets, thus seriously restricting NATO's aerial assault.

Disabilities, Vulnerabilities, and Limitations

The unparalleled flexibility of aerospace power does not produce unlimited military utility. Most obviously, aerospace power cannot physically seize and hold territory. Under certain circumstances, airpower alone may be able to force opposing forces to vacate territory or prevent them from entering territory. To do so, however, one must envision a situation of air superiority or air supremacy, a ground environment in which opposing forces would find concealment difficult, and an opposing force composed of "regular" forces with vulnerable lines of supply. The advent of operations such as Southern Watch and Northern Watch has led to some discussion of "air occupation" as a concept. Both of these operations met at least one of their major objectives—the enforcement of no-fly zones—but that is a far cry from "occupation" of anything other than the airspace over Iraq. Even Britain's "air control" concept used to police portions of its empire in the 1920s and 1930s, and often cited with regard to air occupation, required the coordinated use of ground forces.[8]

The most significant vulnerability of aerospace power occurs whenever aircraft leave their operating environment. On the ground, aircraft are helpless—fragile, unarmored, and unable to defend themselves. Unfortunately, combat aircraft—even in high-tempo wartime operations—spend most of their time on the ground. Their vulnerability is such that in a combat zone, one must take near-heroic measures to protect them in hardened shelters or, at a minimum, in revetments. One finds in the Vietnam War the most telling testimony to the vulnerability of aircraft on the ground. During that struggle, Vietcong and North Vietnamese sappers and mortar teams destroyed 43 percent more US Air Force aircraft on the ground than were lost in air-to-air combat, and they destroyed nearly as many Air Force aircraft on the ground as were lost to the vaunted North Vietnamese surface-to-air missile system.[9]

In addition to these vulnerabilities, aerospace power also has its limits. Three of the most important are directly related to one another. First, and most importantly, modern aerospace power is very expensive—on the order of 10s of millions of dollars per aircraft, with some even costing 100s of millions of dollars each. Their weapons can be quite pricey as well, particularly precision-guided standoff munitions.[10] Second, the combination of complexity and cost results in smaller and smaller aircraft inventories. Although modern aircraft are much more capable than their predecessors, their numbers are much more limited—and numbers do count, particularly for a global power wrestling with parallel requirements in the far corners of the globe. An aircraft can be in only one place at a time, doing one thing at a time. Further, smaller inventories magnify the importance of attrition.[11] Third, prudence dictates that expensive and relatively scarce airframes and crews should be put at risk and expensive weapons expended only against lucrative targets. As a result, high-tech precision aerial weapon systems can find themselves at a serious

disadvantage when facing adversaries employing strategies and tactics that emphasize dispersion rather than concentration of forces (e.g., insurgent strategies/guerrilla tactics).

Rationale for an Independent Air Force

Aerospace power's nearly unlimited options and unparalleled flexibility provide the fundamental and compelling rationale for an independent air force. Several of the world's great air forces, including the US Air Force, gained their independence from surface forces in order to more effectively carry out so-called independent missions—the most prominent being strategic attack. Independent missions, particularly after the advent of nuclear weapons (which some believed gave airmen a means to win wars without the aid of surface forces), provided a convenient bureaucratic rationale for an independent US Air Force in 1947. However, more than a half century of additional experience and perspective has shown that the fundamental rationale for an independent aerospace force is psychological and operational, not bureaucratic. One finds the reason for this in the very different worldviews or mind-sets of soldiers, sailors, marines, and airmen.[12] Ground forces traditionally have been most concerned about the immediate problem they confront—an understandable mind-set since most often an enemy at relatively close range does the shooting and killing. This mind-set has manifested itself in many ways. During World War II, for example, the ground officers who dominated invasion planning for D day were much more concerned about the immediate problem of securing a lodgment on the shores of France than they were about the subsequent breakout into the heart of that country. The beaches of Normandy offered favorable conditions for the amphibious assault, but the hedgerow country behind the beaches represented some of the worst imaginable terrain for breakout operations—a fact illustrated in the bloody yard-by-yard struggle through the hedgerows that lasted for nearly two months.[13] Another example found in US Army doctrine during the mid-1970s concentrated on "winning the first battle." The immediate problem, the first battle, was of most importance.[14] Only in the late 1970s and early 1980s, with the advent of AirLand Battle doctrine, did the Army look up, so to speak, and stress that what happens far beyond the battlefield is often of great importance. But even with a newfound appreciation for the "deep battle," ground-force commanders find their perceptions constrained by lateral confines that tend to channel their attention and interest. Ground commands must exist and operate "cheek by jowl" across an entire theater of operations. One must maintain clear divisions of command responsibility to prevent fratricide or counterproductive operations along command boundaries. The upshot is that ground commanders, from the corps level down, have strictly defined areas of responsibility (AOR) that generally extend considerably rearward (reflecting rear-area security concerns) and considerably forward (reflecting the newfound importance of the deep battle). Laterally, however, ground commands remain tightly constrained by the parallel AORs of their neighboring commands. This results in the so-called bowling-alley effect—long but relatively narrow AORs that channel attention and interest and thereby constrain perceptions.

The view held by airmen, because of the nature of aerospace power, is the antithesis of that held by or imposed on ground forces. An airman's—from the most junior pilot to the most senior air commander—AOR is the entire theater of operations. Airmen realize that, within political constraints, they can spread their operations across the entire theater or concentrate their operations—perhaps at one end of the theater in the morning and at the opposite end in the afternoon. Airmen also realize that, depending upon the adversary and the situation, the most important enemy targets—the destruction of which may lead to ultimate victory with the least cost—may not always be the most immediate, most obvious, or closest.

Compared to the views of soldiers, sailors have a much broader and less constrained worldview. But even their view is significantly constrained by physical and psychological realities. In terms of physical realities, a ship simply cannot sail to some places; thus, the naval worldview tends to focus on the high seas and the littorals. Also, some physical characteristics peculiar to shipborne aircraft impose limits on their capabilities.[15] Psychologically, because naval fighting ships are very expensive and difficult to replace, their protection rightfully has a very high priority, including a high priority in the tasking of naval aircraft. This defensive priority inevitably translates into reduced offensive utilization. During Desert Storm, for example, 38 percent of all "shooter" sorties flown from US Navy aircraft carriers were defensive counterair or defensive combat air patrol sorties. During the same period, only 12 percent of all shooter sorties flown by the US Air Force were defensive sorties.[16] These physical and psychological realities significantly constrain the perceptions and limit the options of sailors with regard to the use of aerospace power.

As the evidence indicates, if organized as part of a surface force and subject to the culture, customs, and mind-set of the parent surface force, airmen will be much less likely to fully and appropriately exploit the unlimited employment options available to them. Air Force leaders must understand and be able to articulate that the need to perform some mystical, "independent" mission is not the reason that a "full service" air force should be independent and coequal with surface forces. Nor is the rationale for an independent air force based on notions of a stand-alone, war-winning capability. Rather, the most fundamental and most compelling argument for an independent air force is the imperative to fully exploit the *essence* of aerospace power. Exactly the same arguments lead to the inevitable conclusion that, within a theater of operations, an airman should centrally control aerospace forces.

The Space-Power Conundrum

The term *aerospace* occurs throughout this article, yet one finds much vacillation at the highest command levels concerning the medium in which the Air Force operates. Three successive chiefs of staff went from using the time-honored appellation *aerospace* to *air and space* (which, it was said, would someday become *space and air)* and then back again to *aerospace*. Such inconstancy highlights the difficulty airmen face when considering mature airpower capabilities, the promise of space power, and the nexus between air and space power.

Space and space power are subjects of obvious and growing importance, but our consideration of them is hobbled by a dearth of conceptual thinking about the role of space in military operational matters. For much of its history, scientific wizards rather than operational warriors dominated the military-space community. As a result, military space power is still looking for its great theorist. A modern-day, space-power version of Alfred Thayer Mahan or Billy Mitchell has yet to make his or her presence felt. The problem became so painfully obvious in the latter 1990s that Gen Howell M. Estes III, then the commander in chief of US Space Command, commissioned a civilian academic to develop a space-power theory "as the opening statement in what I hope will be a meaningful debate about space power theory."[17] Unfortunately, the project fell on hard times, and the results have yet to provide the spark that General Estes sought.

Despite the paucity of general theory, space operations unquestionably have become vitally important to US military operations. Command, control, communications, intelligence, weather, reconnaissance, surveillance, global positioning, and mapping are just the most obvious areas in which space plays a major role. But even with the growing importance of space operations, how should Air Force leaders think about space power? Without some overarching theoretical framework, space and space operations remain only a collection of capabilities, albeit very important capabilities. Three sets of fundamental is-

sues must be vetted if we are to understand space power with the kind of clarity with which we now understand airpower and if we are to understand their nexus.

First, we must determine whether the *essence* actually applies to space power, as we have assumed throughout this article. Can space power "apply great power quickly to any tangible target on the planet"? Many people would answer no to this question because of political restraints on weaponizing space. Others would argue for an affirmative answer based on technical, if not political, feasibility. In either case, the question concerning the applicability of the *essence* remains assumed but undemonstrated. Or perhaps there exists a space-power version of the *essence* that differs from all other military operations, including airpower.

A second group of issues concerns the future of space power. What kinds of military operations are likely to migrate to space and why? Space may become another "battle space," or it may become only a home to military operations focused on nonlethal activities in support of combat elsewhere. The horizon is wide open on the options and ramifications of these alternative futures.

The third set of issues has to do with the relationship between space power and airpower. The defining characteristic of airpower is an operational regime elevated above Earth's surface. Conceptually, space power would seem to be more of the same at a higher elevation, a concept tacitly endorsed by the Air Force in its current (as of this writing) basic doctrine.[18] The term *aerospace*, coined in the late 1950s, echoes this same theme, as do official pronouncements such as "although there are physical differences between the atmosphere and space, there is no absolute boundary between them. The same basic military activities can be performed in each, albeit with different platforms and methods."[19] But in our conceptual thinking, can we so easily ignore the vast differences between operations in the atmosphere and in space? It is difficult to analyze these and many more issues dealing with space without a general, overarching theory of space power. The task is made even more difficult by several other factors, such as the limited experience base in military-space operations, the tight security classification concerning much of what goes on in space, and the thoroughly subdivided responsibility for space operations.[20] Thus, we have a conundrum—a jigsaw puzzle that will someday picture how space power fits or doesn't fit with airpower. Solving the puzzle represents a major leadership challenge.

Explaining Aerospace Power and the Dilemma Airmen Face

Airmen generally try to explain aerospace power by using two broad themes that seem almost frozen in time at about the middle of the last century—updated technologically but not conceptually. The first and most common theme is some version of "higher, faster, farther" that emphasizes the relative advantages of operating above Earth's surface. The new Air Force slogan No One Comes Close is the latest incarnation of the relative-advantage theme. The second theme emphasizes the lists of things that aerospace power can do. Some of the listings are quite detailed, as in the Global Reach, Global Power white paper issued in 1990. Others, such as the Air Force's core competencies, are much more abbreviated. Neither of these themes captures the uniqueness of aerospace power.

The *essence* of aerospace power, on the other hand, takes a much broader and more fundamental view, founded on the *unique* capability of aerospace power. It concentrates on concepts, possibilities, and virtually unlimited options rather than on comparisons and lists. It is instructed by the absolute requirements that make it work and is tempered by vulnerabilities and limitations. A thorough understanding of the *essence* reveals the intellectual imperatives for an independent air force and for theater-level centralized command of aerospace forces. A thorough understanding of the *essence* makes clear that aerospace power is the key to the flexibility that we will certainly require in the new world disorder. In short, the *essence* provides the

foundation for aerospace leadership in the twenty-first century.

Aerospace power would seem to have a very bright future. But dark clouds loom on the horizon. Just as an *essence* exists, so does a twofold reality that produces a dilemma airmen must face. The reality is that because aerospace power has become so valuable to so many in so many different ways, the demand for it is virtually unlimited. As noted earlier, the reality is also that aerospace resources are very limited and becoming even more limited. In sum, we have a growing supply-and-demand mismatch. All of this produces a classic dilemma for tomorrow's leaders. How can airmen exploit unlimited options and satisfy unlimited demands with increasingly limited resources? How aerospace leaders deal with this dilemma across the entire spectrum of conflict will determine much about the future of aerospace power. □

Notes

1. Air Force Doctrine Document (AFDD) 1, *Air Force Basic Doctrine,* 1 September 1997, 27.

2. With all of these challenges, it is no wonder that the Air Force chief of staff initiated the "Developing Aerospace Leaders" program, designed to ensure the production of future leaders capable of steering the Air Force through such troubled waters.

3. There are several well-known examples of such unusual circumstances. Examples of ground forces directly attacking air forces are found in the Vietnam War, in which Vietcong sappers successfully attacked a number of US air bases in South Vietnam, destroying aircraft and materiel, killing American personnel, and disrupting operations. An example of naval surface forces directly attacking an air force is found in the struggle for Guadalcanal in the Southwest Pacific theater during World War II. Japanese surface warships made nighttime raids on Henderson Field on Guadalcanal, which was within the range of heavy guns on Japanese ships sitting just off shore.

4. Col Phillip S. Meilinger, *10 Propositions Regarding Air Power* (Washington, D.C.: Air Force History and Museums Program, 1995), 20.

5. One finds countless instances of gross errors in bomb damage assessment (BDA). A classic example comes from the war in Vietnam and the effort to determine the number of North Vietnamese trucks destroyed on the Ho Chi Minh Trail as they infiltrated men, equipment, and supplies into South Vietnam. In April 1971, an Air Staff message to commanders in Southeast Asia noted that "Seventh Air Force is really concerned about the validity of the BDA reported by the AC-130 gunships in their truck killing operation. They stated all aircraft BDA for this hunting season indicates over 20,000 trucks destroyed or damaged to date, and if intelligence figures are correct, North Vietnam should be out of rolling stock. The trucks continue to roll however." Quoted in Donald J. Mrozek's *Air Power and the Ground War in Vietnam: Ideas and Actions* (Maxwell AFB, Ala.: Air University Press, January 1988), 131.

6. Two relatively recent examples illustrate the point. During the Gulf War, the Joint Chiefs of Staff (JCS)/US Central Command (CENTCOM), the Defense Intelligence Agency (DIA), and the Central Intelligence Agency (CIA) each came up with widely different estimates of the percentage of Iraqi tanks, armored personnel carriers, and artillery that had been destroyed by coalition air strikes. For example, on 23 February 1991, JCS/CENTCOM claimed that 39 percent of Iraqi tanks had been destroyed. DIA said only 16 percent had been destroyed, while the CIA claimed only 12 percent. Thomas A. Keaney and Eliot A. Cohen, *Gulf War Airpower Survey,* vol. 2, *Operations and Options: Effects and Effectiveness* (Washington, D.C.: Government Printing Office, 1993), pt. 2, p. 211, table 13. For an even more recent example, refer to the controversy between *Newsweek* magazine and NATO concerning the number of Serbian tanks, armored personnel carriers, and artillery pieces destroyed during Allied Force. For example, *Newsweek* claimed that only 14 Serbian tanks had been destroyed while NATO claimed 93. John Barry and Evan Thomas, "The Kosovo Cover-up," *Newsweek,* 14 May 2000, 23–26; and Stephen P. Aubin, "*Newsweek* and the 14 Tanks," *Air Force Magazine,* July 2000, 59–61.

7. This point is driven home by Michael R. Gordon and Gen Bernard E. Trainor in their comments on the widely differing estimates of damage done to Iraqi tanks, armored personnel carriers, and artillery (see note 6). In essence, they argue that the bar had been set too high. The goal had been to destroy 50 percent of the overall Iraqi armor and artillery, which, theoretically, was required to make the Iraqis combat-ineffective. No one's estimates came near the 50 percent level, yet "the air attacks made it impossible for the Iraqis to mount an effective defense. Airpower crippled the Iraqi war machine." Initially setting the bar too high in the Iraqi case seriously hindered the ability to estimate Iraqi capabilities prior to the start of ground operations against Iraq. Gordon and Trainor, *The Generals' War: The Inside Story of the Conflict in the Gulf* (Boston: Little, Brown and Company, 1995), 331 and 474.

8. For an excellent discussion of "air occupation," see Maj Marc K. Dippold, "Air Occupation: Asking the Right Questions," *Airpower Journal* 11, no. 4 (Winter 1997): 69–84. For a realistic look at British air-control operations, see Dr. James S. Corum, "The Myth of Air Control: Reassessing the History," *Aerospace Power Journal* 14, no. 4 (Winter 2000): 61–77.

9. Sappers and mortar teams destroyed 96 aircraft in attacks on US Air Force bases. Only 67 Air Force aircraft were lost in air-to-air combat, while surface-to-air missiles downed 110 Air Force aircraft. Walter Kross, *Military Reform: The High-Tech Debate in Tactical Air Forces* (Washington, D.C.: National Defense University Press, 1985), 98. Antiaircraft artillery was the biggest threat to US aircraft, particularly radar-guided guns ranging from 57 mm to 100 mm. Lon O. Nordeen, *Air Warfare in the Missile Age* (Washington, D.C.: Smithsonian Institution Press, 1985), 13.

10. The issue is not exactly how much aircraft cost or how much more they cost today than in the past. One can make such determinations in several different ways, using different sets of assumptions. Nor does the question concern the capabilities of the aircraft. Without question, modern aircraft are much more capable than their predecessors. But there is also no question that, by virtually any standard of measurement, modern aircraft cost considerably more than their predecessors. For a discussion of

the different dimensions and difficulties of comparing the costs of aircraft and weapons, see Kross, 24–57.

11. The decline in aircraft inventories over the past 40 years has been startling. "Snapshots" taken at 20-year intervals of bombers and fighters in the active inventory reveal the following:

	1960	*1980*	*2000*
Bombers	2,193	412	179
Fighters	3,922	2,804	1,594

See *Air Force Magazine* (almanac issue), May 1975, 137; May 1980, 162; and May 2000, 66.

12. For further explanation, see the author's article "Joint Operations: The World Looks Different from 10,000 Feet," *Airpower Journal* 2, no. 3 (Fall 1988): 4–16.

13. Russell F. Weigley, *Eisenhower's Lieutenants: The Campaign of France and Germany, 1944–1945* (Bloomington: Indiana University Press, 1981), 35. Weigley notes that "by concentrating almost all their planning effort on the assault and the immediately following buildup, the planners neglected a maze of troubles awaiting behind the French shore. The greatest trials of OVERLORD . . . were to appear when the invaders plunged inland . . . in the region of Normandy called the Bocage."

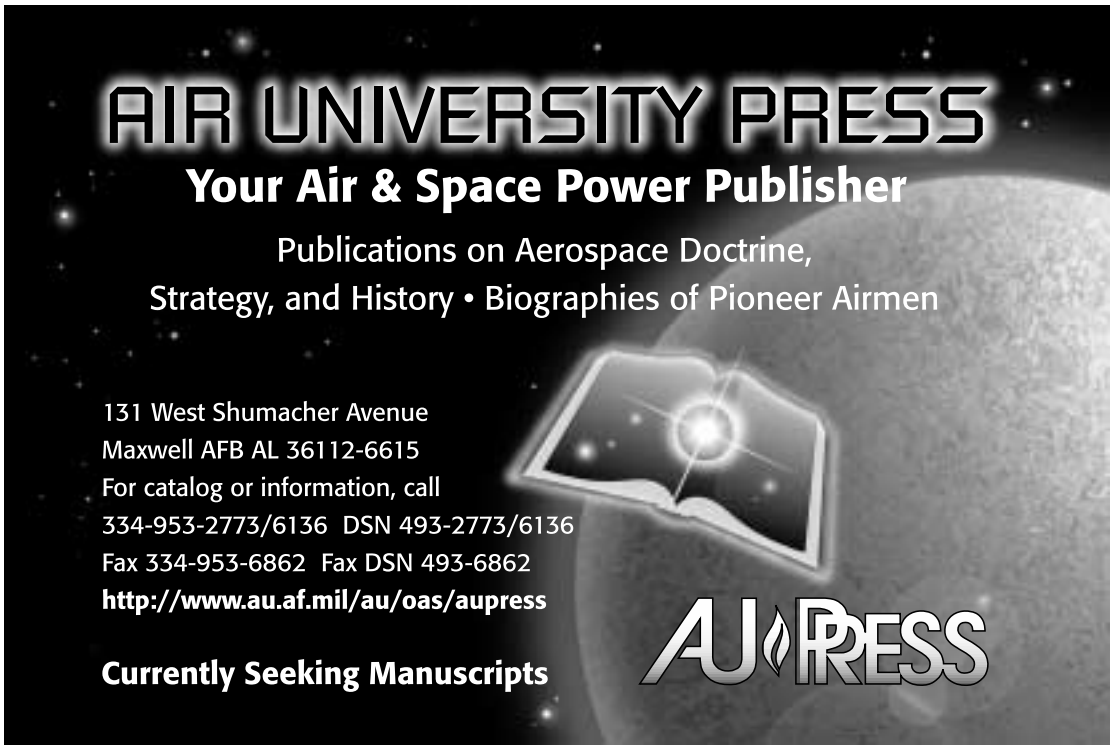
14. US Army Field Manual (FM) 100-5, *Operations*, 1 July 1976.

15. For example, because carrier aircraft must take off from and land on relatively small ship decks and must be able to "go below" for maintenance and so forth, their potential size is sharply limited; this puts limits on such capabilities as payload capacity, unrefueled range, and the like.

16. Keaney and Cohen, vol. 5, *A Statistical Compendium and Chronology*, 232, table 64.

17. Quoted in James E. Oberg, *Space Power Theory* (Washington, D.C.: Government Printing Office, March 1999), x.

18. AFDD 1, 21–22.

19. Air Force Manual (AFM) 1-1, *Basic Aerospace Doctrine of the United States Air Force*, vol. 1, March 1992, 5.

20. In addition to the Army, Navy, and Air Force, other government agencies involved in space operations pertinent to this discussion include the National Imagery and Mapping Agency (NIMA), CIA, National Aeronautics and Space Administration (NASA), National Oceanic and Atmospheric Administration (NOAA), National Reconnaissance Office (NRO), and National Security Agency (NSA). Tamar A. Mehuron, "Space Almanac 2000," *Air Force Magazine*, August 2000, 40.