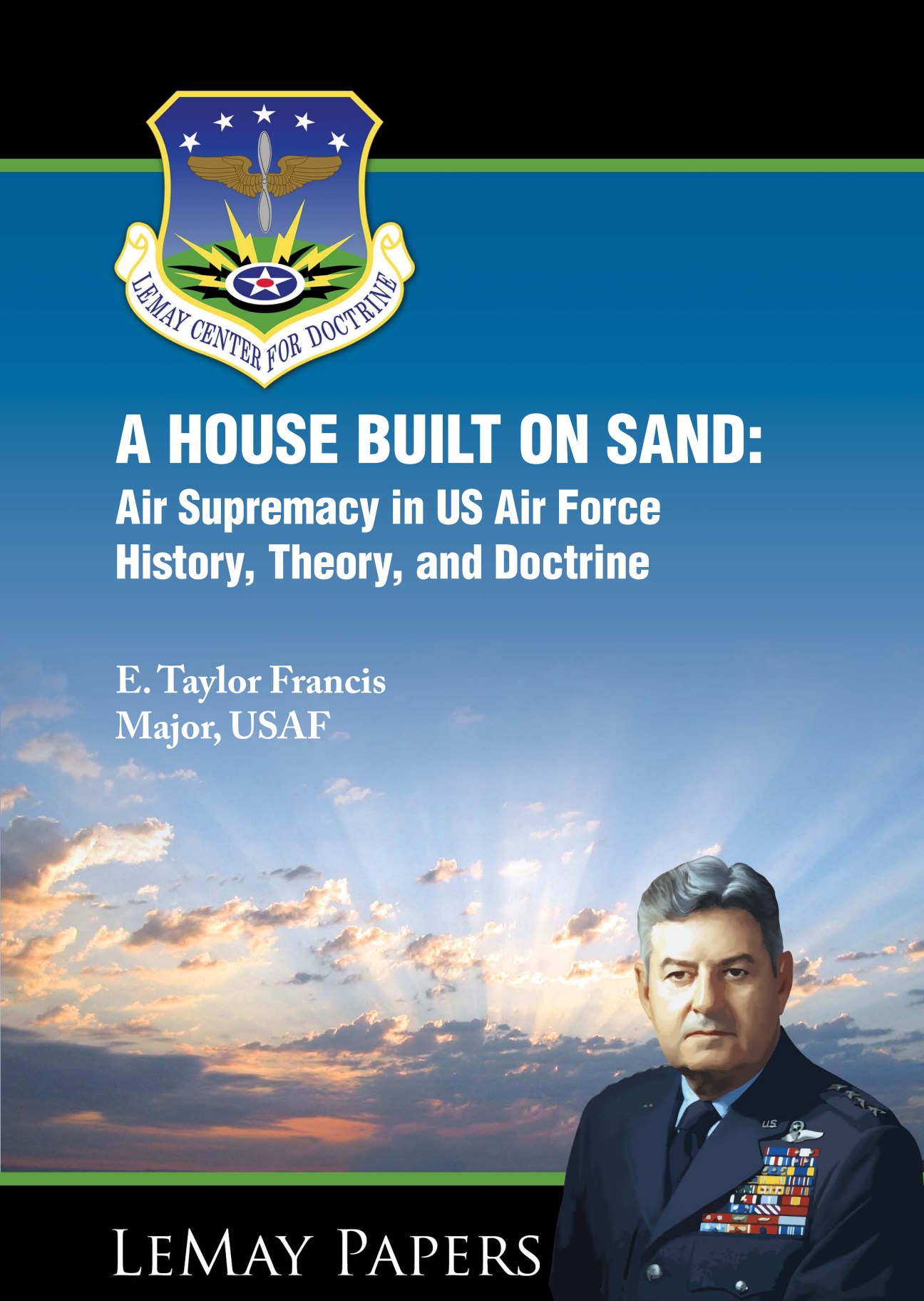
A HOUSE BUILT ON SAND:

Air Supremacy in US Air Force History, Theory, and Doctrine

E. Taylor Francis
Major, USAF



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Contents

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Author's Notes

The nature of this monograph and research topic requires that I make certain grammatical choices. I believe it is worthwhile to discuss them briefly to alleviate any potential confusion on the part of the reader. To begin with, historically, authors have written the term airpower as either one word, as I have, or as two words ("air power"). The consensus today is to treat airpower as one word, and that is how published Air Force doctrine presents it. Thus, I write airpower as one word throughout the monograph. However, if I quote an author who wrote airpower as two words, I maintain fidelity to its original form. Other terms have similarly evolved. As late as 1931, control of the air, air superiority, and air supremacy were considered interchangeable terms of equivalent meaning. Today, control of the air is used to describe a spectrum ranging from air parity to air supremacy. Air superiority and air supremacy are also considered to be distinct terms with unique definitions in present doctrine. When quoting or referencing other authors, I use the words as the author intended. In my writing, I stick to doctrinal meanings as much as possible. In situations where doctrinal definitions constrain more than they clarify, I use generic terms, such as "command of the air" or "control of the air domain." Finally, I use the word "Air Force" in this monograph to mean "US Air Force." On the rare occasion, I mention another country's air force; I make the distinction explicit. Since this monograph only concerns the US Air Force, it seems unnecessarily repetitive to state it every time. I hope these minor clarifications guide the reader, alleviate confusion, and aid in the understanding of my intent, research, and conclusions.

Abstract

In just over a century, aviation has progressed from a military afterthought to a central component of military operations. In that time, airpower has undergone exponential technological growth. Early aviation pioneers would scarcely recognize the fifth-generation aircraft being produced today. Some consistencies remain, however. Among them is the recognition that air supremacy is an essential first step in the conduct of military operations. From the beginning, airpower advocates maintained that the full strength of air and land forces could not be brought to bear until after they gained air supremacy. This was an accepted norm of airpower thinking with few outlying exceptions. The pressing issue was not if air supremacy should be achieved, but how it was to be accomplished or if it was even possible.

The US armed forces today acknowledge the necessity of air superiority, at a minimum, before operations can begin. The ultimate goal is to achieve air supremacy to facilitate freedom of maneuver for US ground and naval forces. Given the importance of the control of the air, this author's research goal was to determine the degree to which the history, theory, and doctrine of the US Air Force prepare it to obtain air supremacy against a peer or near-peer adversary in a present or near-future conflict. Research results suggest that air supremacy, in this case, should not be anticipated or expected. The Air Force is highly proficient at the tactical level but lacks the historical, theoretical, and doctrinal foundation on which to construct a campaign that guarantees success.

This work uses a qualitative research method to investigate airpower theory and doctrine in the US Air Force since its inception as the US Army Air Corps in 1926. It supplements these examinations with historical case studies and vignettes from significant conflicts involving the US Air Force. More considerable attention is given to those conflicts in which aerial combat played a larger role, and air supremacy was not a given. World War II receives special attention in the monograph because of its unique historical position as the only war in which the United States competed against peer adversaries for air supremacy. It concludes by assessing the present state of the US Air Force with regards to problems that must be considered and addressed before any large-scale conflict. The US Air Force will likely not be able to preserve the current and comfortable state of US air supremacy unless it challenges its status quo assumptions.

Introduction

Without air supremacy, I wouldn't be here.

—Dwight D. Eisenhower,
Normandy, France, 1944

An ever-growing body of knowledge and technological advancements accompany time's ceaseless procession. Some new technologies, the Roman *Corvus* or the Paixhans gun, for example, are designed for specific military goals.[1] Others, such as the automobile or the rifled musket, are quickly adapted for military use. The airplane fits neatly into this second category. Following the first short flights at Kitty Hawk in December 1903, militaries around the world adapted the Wright Flyer and subsequent models for use in combat operations. In fewer than four years, aviation in the United States went from a 120-foot flight on a dune to the establishment as the Aeronautical Division of the US Army Signal Corps via official order on 1 August 1907. Seven years later, in 1914, federal law created the Aviation Section of the Signal Corps, marking the statutory inclusion of airpower into the military organization.[2] The quick and successful adaptation of new technology by the armed forces is rather mundane, but the power of the airplane lies elsewhere. Unlike previous technologies that changed warfare on land or at sea, the aircraft introduced a new warfighting domain and induced a fundamental modification in thinking about war.

Two major challenges accompanied the seismic shift in military capability. The first was organizational and continued until the *National Security Act of 1947* established the US Air Force. [3] The second, and more relevant here, concerned the employment of airpower in support of military objectives. The theory and doctrine surrounding aviation employment and the interaction between the two soon became dominant threads in military conceptualization. Giulio Douhet introduced the first holistic theory of airpower with his seminal 1921 work, *The Command of the Air*. It was followed by Billy Mitchell's *Winged Defense* in 1925. Their ideas were supplemented by other theorists and military leaders, such as Hugh Trenchard in the British Royal Air Force and a host of theoreticians at the US Army Air Corps Tactical School (ACTS). These great minds all assumed different postures, but over time two primary paradigms emerged in both airpower theory and doctrine—the decisive power of strategic bombing and the essential nature of air supremacy.

Regarding strategic bombing, Douhet wrote, "in general, aerial offensives will be directed against such targets as peacetime industrial and commercial establishments; important buildings, private and public; transportation arteries

and centers; and certain designated areas of the civilian population as well."[4] American airpower theorists mirrored Douhet's sentiments. Mitchell claimed, "To gain a lasting victory in war, the hostile nation's power to make war must be destroyed—this means the manufactories, the means of communication, the food products, even the farms, the fuel, and oil and the places where people live."[5] Building upon these ideas, along with the experiences of World War I, the ACTS's leading thinkers drove the development of theory and the creation of airpower doctrine in the first half of the twentieth-century. The aptest synopsis of their ideas is, "the most efficient way to defeat an enemy is to destroy, by means of bombardment from the air, his war-making capacity."[6] In the lust for strategic bombing, doctrine lost a critical aspect of Douhet's and Mitchell's thinking, the idea that air supremacy preceded the strategic bombing campaign. Douhet detailed the necessity of "destroying the mobilization, maintenance, and production centers of Nation B's aviation" to provide "complete liberty of action to strike at will, with no risk to itself, over all the enemy's territory, and quickly bring him to his knees."[7] In the same vein, Mitchell explained that an enemy's production and will to fight could be destroyed by air "in an incredibly short space of time, once the control of the air has been obtained."[8] Control of the air has been a core concept of airpower theory since its inception.

Over the years, new airpower theorists emerged accompanied by the new doctrine, but the two driving factors remained unchanged. The significant thrusts of airpower theory and doctrine continued the importance of strategic bombing and the inviolability of air supremacy as a tenet. Air supremacy's theoretical importance varied over time, but in practice, it played second fiddle to strategic bombardment until and unless circumstances forced a change. In the early days of airpower theory, the only impediment to air supremacy was the adversary's aviation forces. Technologies such as radar did not exist, and air defenses were minimal. The greatest threat came from pursuit aircraft, which were often devoted to supporting ground forces or could be overcome, at least in theory, through superior numbers of bombers with defensive armament. Thus, leading minds, such as Douhet, Mitchell, and Trenchard were able to assume that command of the air would be a given following the nullification of an enemy's pursuit aviation. For these theorists, although air supremacy was essential, it was also expected. In time, technological advancement changed the nature of aerial combat, but simultaneous changes in theory and doctrine were not forthcoming. Later theorists, such as John Warden, again emphasized the preeminence of command of the air but failed to offer much of substance with regards to its attainment. The lack of material found in theory is mirrored in doctrine. Control of the air is discussed at length

doctrinally but without much depth or consideration for what might be required to gain complete air supremacy.

In addition to its theories and doctrine, the history of US airpower played a significant role in its perception and treatment of air supremacy. In World War II, the US Army Air Corps, along with the Royal Air Force, encountered a comparable foe in the German *Luftwaffe* and a formidable opponent in the Imperial Japanese Army Air Service. The battles that ensued in the European and Pacific theaters determined who would control the skies. They were battles for air supremacy that could have been defining moments for the concept. They were moments in which theorists and doctrine writers alike should have examined and wrestled with observations and conclusions to understand the phenomenon of air supremacy better. Instead, World War II aerial warfare became a war of attrition, and the massive industrial and demographic advantages of the United States slowly wore down its adversaries' opposition. Thus, those responsible squandered a valuable learning opportunity. Other than World War II, the United States has not found itself in a situation where it actively engaged in significant combat against a peer adversary for control of the air. In Korea and Vietnam, there were aerial engagements, but they often occurred at the tactical level, and the overall air strategy focused on strategic bombardment. From Desert Storm in the early 1990s to today, the United States gained and maintained air supremacy almost immediately. The lack of peer-to-peer aerial combat for over 70 years impacted the development of airpower theory and doctrine dramatically and detrimentally.

The modern US military is transforming, and the concept of multi-domain operations (MDO) is currently the focus of military strategists and planners throughout the Pentagon. The US military's history is dotted with examples of MDO, such as the D-Day landing at Normandy or the South Pacific campaign during World War II. In the past, the services produced multiple volumes of doctrine attempting to bridge the gap between different domains; examples include the AirLand Battle doctrine of the early 1980s and the AirSea Battle doctrine of the 2000s. The focus now is to operate simultaneously across all warfighting domains—air, land, sea, space, and cyberspace—to create decisive effects to defeat the enemy. A key component of current and future military doctrine is the assumption of air supremacy. It provides the foundation upon which the armed forces construct the rest of their operational campaigns. In the future, air supremacy is likely to be equally or even more critical than conceived of today to allow for action across multiple domains synchronized in time and space.

The problem is that the Air Force has never fully explained in doctrine what will be required to gain and maintain air supremacy against a peer adversary.

Further, historic evidence offers little in the way of comparable examples from which to conclude. The events and industrial buildup both before and during World War II were unique to the United States at the time and cannot be replicated today. Outside of WWII, large-scale aerial engagements with peer adversaries do not exist in the Air Force's history. The result is that assumptions are governing large parts of Air Force doctrine and airpower theory, and air supremacy in a future war with a peer adversary is far from assured. Everything hinges on the level of control of the air that the Air Force can provide. If air supremacy cannot be guaranteed, the ramifications for future American wars are massive. Strategists, theorists, and military experts have written on America's future wars and predicted how they believe events will unfold. However, there is limited research on the role of airpower theory and Air Force doctrine in terms of how they shape the current understanding of both control of the air and gaining air supremacy. The essential nature of air supremacy to US military operations makes it imperative that military and civilian leaders understand the costs of its establishment, and that they are willing to incur those costs. This paper posits that Air Force doctrine and airpower theory do not sufficiently or realistically address gaining air supremacy against a peer foe. In addition, the Air Force's history fails to provide a comparable example of what it would face in peer-to-peer combat today. The confluence of these inadequacies in history, theory, and doctrine leaves the Air Force ill-prepared to gain air supremacy against a peer adversary today or in the near future.

Methodology and Structure

Modern militaries are shaped by their theory, doctrine, and the context within which the two influence one another. Often, as theorists expound upon their ideas, the doctrine is attuned to the prevailing theories of the day. At other times, "doctrine seeks to deal with new phenomena for which theory has not yet been well developed."[9] In those cases, doctrine may be the impetus for the new theory. Occasionally, doctrine and theory suffer a reduction in influence because of the time, place, or culture in which war occurs. In the information age, technologies and situations can change so rapidly that battlefield adaptation precedes the attendant theoretical and doctrinal changes. Nevertheless, even when codified theory and doctrine are nonexistent, an interplay still occurs between the ideas, concepts, and best practices passed from one generation to the next. In other words, less refined forms of theory and doctrine are present in warfare, even if unacknowledged.

This paper defines theory as a guiding principle or set of principles that attempts to provide explanatory structures about phenomena in reality. Theory

attempts the Sisyphean task of replicating reality and, thereby, making the future predictable. Despite its chronic and unavoidable shortcomings, "it performs several very useful functions when it defines, categorizes, explains, connects, and anticipates."[10] Doctrine is more concrete. Everett Carl Dolman explains, "It is the intent that doctrine will assist the military leader in making the *best* decision, the one that will ensure victory."[11] Air Force doctrine discusses the role of theory in doctrinal development but notes that theory alone should not dictate doctrine and emphasizes that current doctrine "does not present a comprehensive theory for airpower."[12] Thus, theory, doctrine, and their historical interaction must all be considered to understand the US military's current conceptualization of airpower.

Qualitative research undergirds this monograph, though the author incorporates quantitative data where it facilitates comprehension. The monograph begins with a doctrinal survey that traces control of the air through its century-long development. Throughout the first two sections, the author intersperses historical case studies and vignettes from the Air Force's significant conflicts to augment abstract ideas with practical examples. Space constraints, along with the large volume of data and analyses stemming from any major dispute, necessitate that these case studies be treated at the surface level. This quick review is still sufficient to highlight the impact of history on the theoretical and doctrinal understanding of airpower. Section three consists of a historical review of airpower theory. The author concludes by examining the degree to which history, theory, and doctrine prepare the Air Force to gain air supremacy against a peer adversary in the immediate future. For the earlier sections on doctrine and theory, the author uses primary sources supplemented with secondary expert analyses. The final section on contemporary airpower relies on contemporary works addressing future warfare, that, by their nature, contain more conjecture and less certainty. The author incorporates his own beliefs and premonitions into the last section but is careful not to present conjecture as truth. Risk is inherent when discussing the future, and time may prove this monograph's conclusions inaccurate. Accepting that risk, the author concludes that the unfolding and interaction of airpower history, theory, and doctrine led the Air Force down a primrose path with severe consequences.

Air Supremacy in Airpower Doctrine

Wars now happen so quickly that what is not ready at the outset will not be made ready in time . . . and a ready army is twice as powerful as a half-ready one.

—Austrian Field Marshal Heinrich Hess, *The Franco-Prussian War*

The integration of aircraft into militaries worldwide outpaced airpower's doctrinal incorporation. Before World War I, doctrinal publications that concentrated on the use of air forces and airpower's treatment in doctrine were sparse and restrictive. The US War Department's 1914 *Field Service Regulations* mentions "aero squadrons" and "aeroplanes" only in terms of their use as reconnaissance and observation assets. Reference to aircraft does not exist in the discussion on combined arms or fire superiority. It explicitly states, "During combat, the aero squadron will operate . . . for the purpose of reporting [the enemy's] dispositions, the approach of reinforcements, or the beginning of his withdrawal."[13] The war of attrition taking place in the trenches of France led to innovative leaps in the use of aviation. In August 1914, the Germans used a Zeppelin for the aerial bombardment of Liege, leaving nine civilians dead.[14] The French retaliated by bombing German Zeppelin hangars eight days later.[15] A single week in August 1914 provided practical applications that would shape and dominate airpower theories and doctrine, even to the present. The United States learned a lot about aircraft employment from both Allies and enemies during World War I. Lacking a real guiding principle, "the Air Service took over and applied the training methods and tactics which the Allies had developed in the course of the air battle with the Germans."[16] Out of this war, the first US Army Air Corps doctrine would develop.

Aircraft of the time engaged in air-to-air combat, referred to epochally as pursuit aviation and aerial bombardment. Both approaches demonstrated monumental advances in modern warfare, but only one would lead the way forward following the Great War. Some indications existed that control of this new domain would be the driving force of early doctrine. Airmen drawing lessons from their experiences over Europe "agreed that the first and foremost principle emerging from the war was that air supremacy was the primary aim of an air force."[17] Gen John Pershing noticed the initial tendency of the air services to attach too much importance to deep attacks against enemy forces leaving friendly forces vulnerable. As a result, it became essential "to concentrate our attention on the enemy's aviation and to make every effort to obtain superiority over it . . . Once in command of the air, the enemy's artillery and

ground troops became the object of their attacks."[18] Though some suggest that the overall results of American airpower in World War I "were somewhat less than impressive," the preponderance of US productivity came from their pursuit aircraft. This aircraft shot down 781 enemy aircraft and 73 enemy balloons while losing only 289 airplanes and 48 balloons. The defeat of enemy air forces and command of the air was a more significant contribution than the 150 bombing raids and 275,000 pounds of ordnance dropped.[19] Indeed, *Training Regulation (TR) 440-15* issued by the War Department in January 1926 recognized the vital role of airpower in the early stages of any future war. It claimed that the "offensive power of the Air Service should be ready for instant use . . . primarily to secure the control of the air."[20] Many of those who fought in World War I recognized the primacy of air supremacy. The idea made its way into doctrine, including an extensive, yet general outline of how pursuit aviation should be employed to command the air completely. Nevertheless, competing priorities existed both during and after the war, and the focus of doctrine soon shifted away from the command of the air.

Aviation was a secondary feature of the US military before World War I, but its proponents envisioned a more significant role for airpower in combat. The early twentieth-century fascination with the impact of "will" and moral factors in the outcomes of war was driven in large part by French theoreticians, such as Ardant du Picq and Ferdinand Foch. This shaped how the US planned to use airpower.[21] In August 1917, the Bolling Commission, established by Secretary of War Newton Baker recommended that an ideal air force would be composed of 62.5 percent bombers and 37.5 percent fighters.[22] That same year, Lt Col Edgar Gorrell produced a strategic plan that "was a truly striking forerunner of the doctrine which matured years later."[23] Gorrell made a passionate argument for the use of strategic bombing against the Germans using a drill as his metaphor of choice. A drill can only bore so long as its shaft remains intact. Gorrell argued that an Army, like the drill, is defeated if the supporting national effort, its "shank," is broken.[24] Aerial bombardment of the strategic deep area was the key to success in war. These ideas were taking root as the United States entered World War I. The realities of war did not correlate to expectations. Still, the limited US involvement allowed the ideas to remain relevant and flourish. Despite the minimal impact of US strategic bombing, in October 1918, Mitchell believed that all that remained was "to attack the interior of Germany" and that "if the war lasted, air power would decide it."[25]

Post-World War I

The years following the war were a time of reflection and growth for US aviation. However, with only the short-lived events of World War I to draw from, the thinking was as much abstract as it was concrete. In 1935, *TR 440-15* explained, "The power of air forces has not as yet been fully tested . . . The effect . . . and the extent to which they will influence warfare is still undetermined."[26] The necessity of pursuit aviation, "regarded as the basic arm of the air force," conflicted with the vision of an air force that would win wars by striking strategic enemy centers in the deep area.[27] It mirrored the struggle between an Air Corps that sought independence and an Army that still controlled its funding and mission. Doctrine reflected competing interests.

The 1935 edition of *TR 440-15* was shorter than in 1926 but with an essential new section, "Doctrines of Employment," that detailed the utility of air forces against both air and land-based targets. It did not give clear precedence to either but hinted at a hierarchy by claiming air-to-air engagements would be constant while strategic attacks were of "varying importance" and should primarily be focused against enemy air forces.[28] As in 1926, doctrine mentioned control of the air as a critical capability of the air forces, but this time it included an important caveat. Earlier, air forces were expected to gain total control of the air. By 1935, Army doctrine dictated, "complete control of the air . . . is unlikely ever to be accomplished."[29] In the buildup to World War II, the Army replaced *TR 440-15* with *Field Manual (FM) 1-5*. First published in 1940, *FM 1-5* used different wording than *TR 440-15* but conveyed the same message of constant air-to-air operations since complete control of the air was "seldom practicable."[30] The effects of World War II on aviation doctrine were remarkable. January 1943 brought a new *FM 1-5* that added "local air superiority" to an otherwise verbatim recitation of the paragraph downplaying complete control of the air.[31] By July, the Army released *FM 100-20* to supersede *FM 1-5*, which began by stating, "THE GAINING OF AIR SUPERIORITY IS THE FIRST REQUIREMENT FOR THE SUCCESS OF ANY MAJOR LAND OPERATION . . . AIR FORCES MUST BE EMPLOYED PRIMARILY AGAINST THE ENEMY'S AIR FORCES UNTIL AIR SUPERIORITY IS OBTAINED."[32] Doctrine underwent significant changes, but the pendulum had already started to swing away from the traditional Army approach.

World War II

As the doctrine leading up to World War II remained consistent, the members of the ACTS advocated for an independent Air Force and new use of airpower. Their mission was, in part, "to coordinate individual notions into a

unified and consistent body of doctrine."[33] World War II offered the chance to move from the theoretical to the tangible. Starting in August 1941, the Air War Plans Division (AWPD) wrote and refined a series of war plans outlining the US air strategy in World War II. While not official doctrine, these documents, beginning with *AWPD-1*, fulfilled the doctrinal role of defining how the United States would fight the air war in Europe. After 1947, they became foundational documents in the development of Air Force doctrine and thinking.[34] *AWPD-1* is an evident expression of contemporaneous airpower theory that favored strategic bombing over aerial supremacy. It reinforced the standard Army belief that "air superiority within a theater may be highly variable and . . . never absolute" but contradicted itself by saying land operations were not expected until "an overwhelming air superiority has been achieved."[35] The statements held limited import to the authors for whom the singular focus was strategic bombing, a departure from FM 1-5. The document began by identifying the long-range bomber as being "of vital importance." It encouraged reducing the number of pursuit aircraft, which "could only be attained at the expense of our bomber aviation . . . our real striking force."[36] In a not-so-subtle stake to their claim, the writers emphasized, "If the air offensive is successful, a land offensive may not be necessary."[37] As in 1917, the war provided the opportunity to create an unofficial doctrine that extolled airpower and attempted to remove it from the shadow of Army influence.

As the war unfolded, the air planning team refined their ideas multiple times, culminating in *AWPD-42*, a final effort produced to meet Pres. Franklin Roosevelt's request "to get complete control and domination of the air."[38] The plan, entitled *Requirements for Air Ascendancy*, began by defining air ascendancy as, "the conditions of air strength . . . under which it will be possible for our several armed forces to complete the defeat of our enemies."[39] Such a fluid definition gave the planners freedom in setting force ratios and timeframes for gaining air ascendancy. On the other hand, it failed to provide a solid foundation from which leaders could ascertain when President Roosevelt's requirements were achieved. Contrasting *AWPD-1*, which downplayed numerical superiority, *AWPD-42* stressed that "our numerically superior air forces must deplete the air forces of the enemy."[40] However, in the same mold as *AWPD-1*, the planners pursued a strict strategic bombing regimen with aircraft factories as their primary target set. Details of the air offensives in both Germany and Japan concentrate on the bombing campaigns and downplay any air-to-air attrition. A section entitled "Factors Involved in Conducting these Air Operations" lists four issues related solely to the bombing campaign.[41] *AWPD-42* reduced air campaigns to strategic bombing missions; everything else was considered support. In his comments, Gen Dwight

Eisenhower supported *AWPD-42* as proposed and emphatically noted, "This is an air war until the ground forces gain a lodgment in Europe . . . Build *air power first*."[42] At the same time *FM 100-20* preached the necessity of air superiority, *AWPD-42* clarified how it would be obtained—not in the air but via strategic bombing.

Korea and Vietnam

Two years after World War II concluded, the US Air Force was statutorily recognized as the branch of the armed forces responsible for its doctrine. The arduous process took five years and resulted in the controversial *Air Force Manual (AFM) 1-2* in 1953. The manual divided air operations into "heartland" actions, strategic bombing against a country's center, and "peripheral" activities as everything else including air-to-air combat.[43] It included a section on control of the air, defined as the ability to "effect planned degrees of destruction while denying this opportunity to the enemy" but downplayed its value.[44] The doctrine now expressed the paradigm shift of nuclear warfare. Nuclear weapons did not make air supremacy essential, and the manual stated, "lack of control of the air must not . . . deter commitment of the entire striking force."[45] A lack of consensus led to further revisions and a complete *AFM 1-2* in 1955. It stated in plain terms, "Air forces are employed to gain and exploit a dominant position . . . The desired dominant position is control of the air."[46] The updated version differed in two primary ways. First, it claimed that control of the air was a requirement during both peacetime and war. Second, it emphasized an effects-based approach to air supremacy, indicating that passive or geographically dislocated measures could achieve a dominant position if they influenced enemy behavior.[47]

In the Cold War era, where deterrence reigned, peace was as important as war. Thus, control of the air was as much about humanitarian endeavors like the Berlin Airlift or flood relief in Pakistan as it was about delivering nuclear weapons to strategic targets. Command of the air still mattered, but it took on a whole new meaning.

The Korean War preceded the publication of *AFM 1-2*, but it never contributed to Air Force doctrine. The US government focused on a land-based campaign in Korea, and the Joint Chiefs of Staff opposed any attacks against North Korea's cities in an attempt to mitigate civilian enmity and the financial burden of rebuilding.[48] Serving as a premonition of the future, US airpower "easily destroyed the small North Korean air force, thus establishing local air superiority over Korea in the opening weeks of the war."[49] With enemy air forces defeated and unable to commit more than minor bombing

runs against limited North Korean industrial targets, the Air Force spent most of the Korean War conducting close air support. It strengthened the conception that air superiority was critical for successful ground operations. Army Gen Albert Wedemeyer testified before Congress, "In future warfare the essential weapon is air. We must have undisputed control of the air . . . I can't emphasize that too strongly."[50] However, for the Air Force, many valuable lessons were lost. The United States F-86 Sabres destroyed 810 enemy aircraft while losing only 78. Gen George Stratemeyer worried that such shocking numbers "might lead to an erroneous conclusion that such a feat could be duplicated at will in a future conflict."[51] In other words, Korea should have sounded alarms about the dangers of a myopic focus on strategic bombardment. Instead, the looming Soviet nuclear threat took precedence over everything else, and the Air Force prepared for only one type of war.[52] The Soviet menace and the lack of strategic bombing north of the Yalu River allowed the Air Force to ignore the lessons of Korea and continue pursuing its vision of the uncontested bomber winning wars from the air. *AFM 1-2* was the doctrinal reflection of this failure to evolve.

This remained the dominant mindset as the United States entered into another limited war in Vietnam in the mid-1960s. The 1964 *AFM 1-1* was built around strategic superiority via deterrence and nuclear attack. For the first time, "control of the air" was not used in Air Force doctrine. Local air superiority is mentioned in passing. Consistent with the previous doctrine, this was "best accomplished by multiple attacks against enemy airbases," though air-to-air combat was necessary to a lesser degree.[53] This approach guided the United States into Vietnam. Gen William Westmoreland based his 1965 "Commander's Estimate" around his belief that "the basic strategy of retaliatory and punitive air strikes against North Vietnam . . . will bring about the desired results."[54] His premise proved faulty. Only 6 percent of the bombs employed by B-52s were dropped on North Vietnam during the war, and bombarding "cities in support of a minor policing and support operation in 1965" was unrealistic.[55] Another significant factor in Vietnam was the large-scale introduction of surface-to-air missiles (SAM) into combat for the first time, bringing an end to the days when the pursuit fighter was the bomber's biggest threat. During the war, Americans lost 2,561 airplanes and 3,587 helicopters to enemy action, many a result of SAM attacks.[56] After Vietnam, "air superiority lessons, as well as air-to-air and tactical lessons, had to be learned all over again."[57]

Post-Vietnam and the Modern Era

As early as 1971, "Air Force leaders recognized they had just come through a reckoning and lost."[58] That same year, the new *AFM 1-1* was not substantively different from 1964. The biggest transition surrounded targeting practices during nuclear conflicts, an indication that Vietnam had not shifted the strategic and doctrinal focus.[59] Regarding control of the air, little changed beyond addressing the importance of early attack against the enemy's "air order of battle," which now included SAM along with aircraft.[60] Outside of doctrine, the Air Force altered its concept of tactical aviation, which had been designed for a tactical nuclear war. This approach "proved costly to the ongoing war in Vietnam."[61] Vietnam retaught the lessons of World War II. Fighter aviation is indispensable to control of the air; the bomber is not invincible. Those ideas were slow to be incorporated into doctrine.

Within a decade, the Air Force had started to adapt. The F-15C air superiority fighter gained initial operational capability in 1979. Three years later, Gen Charles Gabriel became the first fighter pilot to be named chief of staff of the Air Force.[62] The doctrine was changing, as well. The 1984 *AFM 1-1* contained three times more pages than its 1971 counterpart, and the results were evident. It delineated air superiority from the larger air supremacy, which it defined as "when a commander is free to employ his aerospace assets at a time and place of his choosing, and enemy forces are incapable of effective interference."[63] As before, it emphasized the prioritization of air superiority above all else but pointed out that "the ultimate goal of counterair is air supremacy."[64] Perhaps the most glaring evidence of a culture shift was the lack of discussion on nuclear war. In 1971, *AFM 1-1* devoted two chapters to tactical and strategic nuclear conflict. Thirteen years later, the doctrine did not even mention nuclear war.

Events since then only furthered the Air Force's approach to air supremacy. The United States gained air supremacy in a matter of weeks during Desert Storm. Operation Deny Flight established such overwhelming air supremacy that allied aircraft did not fire a single air-to-air missile during Operation Deliberate Force over Bosnia.[65] The United States did not face aerial opposition in either Operation Enduring Freedom or Operation Iraqi Freedom. By 1992, an official joint definition of air supremacy existed, but *AFM 1-1* pithily summarized it as "absolute control of the air."[66] Of interest, this contradicted a 1990 Air Force white paper that defined control of the air as air superiority instead of air supremacy.[67] Despite the definitional differences, both publications agreed that dominance of the air domain was a primary function of the Air Force.[68] In the intervening years and up to the present, the Air Force has

clarified further the difference in air superiority versus air supremacy. It has done so by stating that superiority allows operations "at a given time and place without prohibitive interference by the opposing force," while supremacy is a higher degree of superiority in which enemy forces "are incapable of effective interference anywhere in a given theater of operations."[69] Concurrently, the Air Force softened its traditional stance regarding air supremacy claiming, "While air . . . supremacy is most desirable, it may exact too high a price. Superiority . . . may provide sufficient freedom of action to accomplish assigned objectives."[70] As the global war on terrorism gained priority, that qualification disappeared from subsequent doctrine. By 2011, the Air Force emphasized that US forces possessed and benefited from air supremacy in current ongoing operations.[71]

One can trace the thread of air supremacy as it winds its way through the evolution of Air Force doctrine. Even in its earliest manifestation, doctrine recognized the value of air supremacy. It has remained a central pillar of Air Force thinking to the present. Initially, strategic bombing was the chosen method for obtaining air supremacy. The lessons of Vietnam and the advent of SAM changed that approach. Today, the Air Force stresses that the platform and the mission are irrelevant; instead, "the outcome of the mission, the effect achieved, is what's important."[72] Doctrine is one piece of the puzzle. It is shaped by history and informed by theory. Next, this paper examines the impact of airpower theory on control of the air as a concept.

Air Supremacy in Airpower Theory

> *Anyone writing airpower theory today has a great deal of rewriting to do, because some large conceptual weeds have been allowed to prosper in airpower's intellectual garden.*
>
> —Colin S. Gray, *Airpower Reborn*

The importance and definition of control of the air ebbed and flowed as doctrine evolved but were unaccompanied by concomitant theoretical changes. Strategic bombing dominated airpower theory "ever since Mitchell's later years at least down to the Vietnam War—even down to the end of the Cold War."[73] Several authors, among them Robert Pape and Barry Watts, argue that airpower theory remained stagnant from the halcyon days of Douhet and Mitchell despite the immense technological advancements and operational changes encountered by the Air Force.[74] This created an environment in which there was "a tendency to over-emphasize long-range bombardment,

and to ignore the versatile application of Air Power."[75] A brief review of airpower theory shows the consequences of such an environment.

Early Theorists

Discussions of airpower theory often begin with Douhet and Mitchell, while another leading thinker, Sir Hugh Trenchard, is marginalized. Trenchard never wrote a book espousing his theories, but his experiences in World War I shaped other early innovators.[76] His belief in the importance of courage and élan guided his advocacy for relentless offensive airpower. As commander of the British Royal Flying Corps, his views dominated British air forces, which operated "a continual air offensive over the western front" from 1917–1918.[77] The airplane's role in the unremitting offensive, first practiced in World War I, shaped early airpower theorists.

Most famous among these theorists were Douhet and Mitchell, both of whom specified the importance of air supremacy to their theories of airpower.[78] For them and their contemporaries, air supremacy was that level of control that allowed bombers to hit their strategic targets with acceptable attrition rates. It was assumed that the only competition for control of the air came from an enemy air force. Radar did not exist to provide early warning to ground forces, and surface-to-air fires were almost nonexistent. The 1914 *Field Service Regulations* claimed, "Aeroplanes are safe from hostile fire at altitudes of 4,000 feet or more."[79] The only threat was other airplanes, and those were best destroyed on the ground or by removing industrial capacity to replace those lost through combat or crashes. Later, the advent of radar and high-speed interceptors undercut the assumptions on which Douhet based his theory.[80] Until then, the only real debate was whether to follow Douhet's approach that rested "on the belief that infliction of high costs can shatter civilian morale, unraveling the social basis of resistance" or a Mitchell model that saw aircraft as "an entirely new method of subduing industrial centers."[81] Either way, strategic bombardment subordinated pursuit aviation. Douhet claimed that pursuit aircraft only offered "a temporary superiority" and were incapable of providing the command of the air.[82] For him, command of the air depended on bombers and belonged to he who prevented air offensives against his territory while conducting air offensives against the enemy.[83] There was not a discussion of how this applied to geographically isolated parties like the United States. Mitchell saw more value in pursuit aircraft than Douhet. Still, he believed more deeply in the bomber, writing, "To afford Bombardment close pursuit protection is unnecessary and a waste of pursuit aviation."[84] The lessons of World War I, as reflected in doctrine, favored pursuit aircraft to

gain air superiority and air supremacy. Douhet and Mitchell argued for bombers, and they wielded more considerable influence.

The interwar period saw the rise of the first airpower theorists as well as increased attention on aviation and increased politicization. The desire among many within the Army Air Corps to gain recognition as a separate branch influenced their approach to theory development. The best case for aviation independence could be made by promoting the ability to achieve an objective more cheaply and efficiently than the Army or Navy.[85] The Great War's expense in lives and money was still fresh, and cheap bloodless wars were what the aviation community promised. In the United States, the theorists of ACTS led this charge. These men built upon the early theorists' ideas to create their airpower theory. The ACTS theorists' composition and contributions were such that they "cannot be attributed to any one person or even any one group of persons." Still, perhaps their most lasting legacy is the industrial web theory.[86] Understanding that Mitchell's "hundreds of [airplanes] in one formation" and Douhet's "offensive capacity the like of which has never before been imagined" were unrealistic, ACTS theorists focused their attention on scientifically identifying targets.[87] They proposed that a country's industry was like a web with critical nodes whose destruction would have amplified effects. By striking these targets, "a relatively small force [could] bring an enemy's war production to a halt with almost surgical precision."[88] As before, the industrial web theory downplayed control of the air. This reflected the dominant concept of the time that "a well-organized, well planned, and well flown air force attack will constitute an offensive that cannot be stopped," stated axiomatically as, "The bomber always gets through."[89] The industrial web theory and the plans derived from it guided the United States through World War II. It traded mass for precision but otherwise was a derivation of earlier theories. Like those, it proclaimed the bomber as the proper vehicle for command of the air by destroying factories and airdromes while downplaying the role of pursuit aircraft.[90]

World War II

World War II supplied the proving ground for the airpower theories that blossomed post-World War I. For the first time, the US Army Air Forces would battle an equivalent adversary for air supremacy. It was a conflict in which, unlike World War I, airpower played a prominent role. The initial implementation of airpower theory was a disaster. Many of its assumptions, including the irrelevance of fighter-escort, the quality of bombing accuracy, and the ability to accurately select and identify targets proved false.[91] After two years at war, by early 1944, "the Allies had not just lost air superiority over Germany but were

also losing the air war."[92] The United States adapted its escort tactics and allowed its new P-51 and P-47 aircraft to engage the Luftwaffe offensively instead of defensively escorting bombers. The Americans realized that attacking factories limited industrial production "but [it] would mean nothing unless the *Luftwaffe* force in being also underwent wastage."[93] The results were tremendous. From January to March 1944, the Germans suffered 3,450 claimed losses and a resultant loss of experience aircrew.[94] It was only after these air-to-air victories that bombing campaigns, such as those on the German oil industry started to be more effective. In December 1945, the German industry still produced 3,155 aircraft which was easily capable of covering air-to-air materiel losses. Concurrently, the decimation of their oil industry that began in May 1944 began to have an effect.[95] The aircraft being built could not be manned or fueled. As Conrad Crane notes, the US Army Air Forces "quickly made up its losses in men and materiel" and "[German] pilot replacements could not keep up with their losses while the American buildup continued."[96]

A similar story unfolded in Japan. The Japanese gained a greater appreciation for airpower during the war, but it paled in comparison to US industrial and combat capability. The Japanese produced 65,300 aircraft throughout the war but lost 50,000, the majority in noncombat incidents.[97] The United States lost only 27,000 aircraft, and by 1943, had gained numerical superiority in the Pacific.[98] Even when numerically inferior, the United States inflicted a higher number of Japanese losses, and an ever-increasing shift in experience exacerbated the difference. The Japanese had 35,000 pilots at war's end, but the average experience of Japanese pilots was only 100 hours. In contrast, the average US pilot had 600 flight hours by 1945.[99] Japan's strategy failed to consider control of the air as a critical component, which compounded these resource disadvantages. Materiel deficiencies would have been difficult for Japan to overcome in the best case. Because air supremacy was not included in their strategy, it guaranteed that "there was no way in which they could . . . reverse the growing predominance in the air of a basically stronger opponent."[100] The strategic incendiary bombing of Japan followed but long after air supremacy had been achieved.[101] At its essence, the World War II air campaigns in Europe and the Pacific demonstrated the industrial and demographic power of the United States in a war of attrition far more than they supported the underlying airpower theories of the time.

The Nuclear Age

On the surface, World War II was a glorious validation for airpower. It proved "decisive in the war" and "its victory was complete."[102] Field Marshal Montgomery

declared, "In global war today . . . airpower is the dominant factor. Therefore, the first object in our strategy . . . must be to win command of the air."[103] Airpower theories, though, were found wanting. William Head explained, "In the aftermath of World War II, Airmen had to reevaluate the old theories . . . The lessons of the war seemed to indicate . . . that bombing technology and the quantity of bombers had not been sufficient . . . to allow air power to be as decisive as possible."[104] In reality, airpower theorists never inculcated those lessons. Deficiencies were never challenged, and its underlying premises continued to guide airpower theory.[105] The advent of nuclear weapons and the corresponding growth of deterrence theory were the most prominent shifts following the war. David MacIsaac writes, "The atomic bombs had the effect of turning the [postwar] reports into instant ancient history in the minds of most people."[106] The advent of Intercontinental Ballistic Missiles and limited war reduced the importance of air supremacy in the realm of military theory.[107] Within airpower theory, nuclear weapons solidified the importance of strategic bombing assets. Changes in airpower theory, exemplified by Thomas Schelling, among others, were new arrangements of the same old songs.[108]

After the dawn of the nuclear age, the most significant advances were in technology and tactics instead of theory. Vietnam introduced the SAM and the birth of precision-guided munitions (PGM). As technology improved, the accuracy and effectiveness of PGMs increased. Coupled with the Air Force's emphasis on precision delivery—tactical maneuvering to maximize the likelihood of a non-precision weapon hitting its target—PGMs and other technological advances, such as stealth aircraft eventually played a central role in the advancement of airpower theory. However, that change would not occur for another 20 years.

The most prominent airpower theorist in the interval was John Boyd, but his Observe-Orient-Decide-Act (OODA) Loop theory was inconsequential and ignored by Air Force leaders in its own time. It was derived from air-to-air tactics, and as Boyd expounded upon his theory later in life, it became more a theory of war than of airpower in an operational or strategic sense.[109] During this period, the Air Force "lost the theoretical foundation that had given the profession its meaning."[110] Strategic bombing and nuclear deterrence dictated airpower theory until Warden's ideas appeared in the 1980s and 1990s.

John Warden and Desert Storm

Warden's proposals delivered the first major shift in airpower theory since World War II. In many ways, his ideas contained direct links to earlier warfare theorists.[111] Like them, he believed that command of the skies should be the

preeminent military objective (Warden preferred the term "air superiority"). Warden also agreed with his predecessors that air-to-air combat was the least efficient means of achieving this end.[112] In the ACTS theorists' footsteps, Warden posited that enemies were "closed systems that can be disrupted or paralyzed by destroying key targets."[113] Aligned with Boyd, Warden envisioned strategic paralysis through airpower as the most effective means of victory.[114] Warden's theory brought these ideas together in a coherent form that incorporated the significant post-Vietnam technological advances. Stealth aircraft, PGMs, and advanced data links promoted "simultaneous and devastating air attacks . . . [that] could disorganize and confuse an enemy to the point of mental paralysis."[115] The new capabilities were central to Warden's ideas. In the 1990s, one F-117 could accomplish an attack that required a thousand B-17 sorties during World War II.[116] Warden viewed all systems as composed of five concentric rings of increasing importance from outside to inside. Leadership, exemplified by the government, was the central and most vital ring, whereas fighting forces, the military and law enforcement, constituted the outermost ring.[117] Warden theorized that if a military destroyed centers of gravity on the inner rings, the enemy would be paralyzed and victory obtained. This could be done via a single strike against the innermost ring or through simultaneous parallel attacks at multiple levels.

For Warden, air supremacy was essential before attacks occurred. He believed that since 1939, offensive attack only succeeded by first gaining air supremacy.[118] He differentiated between local air superiority and air supremacy, with the former only being acceptable in circumstances involving short-duration missions.[119] Warden's theory was the first to incorporate the systemic changes following the "revolution in military affairs." He made essential contributions, among them the ideas that ground and naval forces can play important roles in achieving air supremacy and that the air campaign may be either the supporting or the supported effort.[120] These factors disguise the reality that Warden's theory is largely an updated version of previous airpower theories incorporating new weaponry and capabilities—strategic bombardment 2.0.

Warden was able to apply his theory soon after its publication in his role as one of the creators of Instant Thunder, the air campaign of Operation Desert Storm. On the surface, Desert Storm appeared to be a good proving ground for his ideas. More than 700 aircraft, along with a modern and formidable air defense system, composed the Iraqi Air Force.[121] The anticipated challenge never manifested. The coalition began the war with 1,800 aircraft dwarfing Iraq's 700 by almost three-to-one.[122] The tremendous US technological superiority in both aircraft and munitions accentuated Iraq's numerical shortcomings. Throughout the war, the Iraqi Air Force rarely engaged coalition forces

in the air, and the air campaign devolved into avoiding ground-based air defenses while destroying Iraqi aircraft on the ground. As a result, the United States benefited from "low-risk attack options that required neither traditional air superiority as a prerequisite nor electronic warfare and fighter-escort support."[123] The United States established air superiority in two days, and in fewer than two weeks, Gen Norman Schwarzkopf declared air supremacy.[124] Warden believed his theory validated, but debates about its validity began in Desert Storm and continue today.[125] The events of Desert Storm cannot be considered a near-peer air war, but its conclusions validated the paradigm of effects-based bombing after establishing air supremacy.

Subsequent Air Force campaigns merit little attention here. Operation Deliberate Force was previously discussed. Air supremacy during Operation Allied Force in 1999 was never threatened, and the greatest threat to US pilots came from enemy SAM systems. The United States had three aircraft downed by Serbian SAM systems during the two conflicts but did not lose a plane to enemy air-to-air action. The United States maintained a 48-0 advantage in air-to-air victories.[126] Enemy aircraft were less likely to fight than to be used as decoys to lure US aircraft into SAM range.[127] Victory from the air in Allied Force was so complete that John Keegan considered it a turning point in history, proving "that a war can be won by air power alone."[128] In operations Enduring Freedom, Iraqi Freedom, Odyssey Dawn, and Inherent Resolve, enemy air opposition did not exist other than the occasional man-portable air defense system useful primarily against helicopters and easily overflown by fixed-wing aircraft. Advancements in training, aircraft and weapons technology, tactics, and geopolitical factors created a world which has not contested US airpower for nearly 30 years.

An initial burst of theorizing accompanied the birth of aviation and its rapid application to warfare, but a dramatic decline followed World War II. Airpower theory always centered around what made it most unique—the ability to strike strategic targets in the enemy's deep area. A corollary to that focus has always been the necessity of air supremacy. The need for long-range fighters in World War II, the introduction of nuclear weapons and SAMs afterward, and the explosion of PGMs and stealth technology in the Gulf War all shaped airpower theory. In general, theoretical updates did not follow historical experience. Lessons learned sometimes resulted in changed tactics or upgraded technologies but rarely in challenges to theoretical assumptions. In reality, the last serious threat to US air supremacy was in 1944. It is not a surprise that airpower theory stagnated during this period as well. This lethargy will shape the United States' ability to gain air supremacy in a large-scale conflict.

Air Supremacy Today and Tomorrow

If feedback on the consequences of our actions comes rarely and is of a kind that can be easily ignored, immunizing marginal conditionalizing is a marvelous method for dispelling all doubts about our competence.

—Dietrich Dörner, The Logic of Failure

Looking to the future is necessary but perilous. Ideas that seem logical one day might seem ludicrous the next. For example, the economic growth of Japan in the 1980s led George Friedman and Meredith Lebard to predict the United States would war with Japan. They dismissed China because of its inability to produce a blue-water navy.[129] The purpose here is not to forecast what the future Air Force will look like nor to suggest its optimal use. Others have addressed those topics. John Arquilla suggests the modern Air Force is a relic of the past. He argues that strategic bombing failed as a paradigm, and, as a result, the Air Force should disassociate from the concept. Instead, it should serve in close air support and intelligence gathering roles supporting ground forces. In other words, the Air Force should dismiss the past century and return to its World War I infancy as a form of airborne artillery for the Army.[130] Others argue that today's "gray zone" wars are the model for future conflicts that will not require large-scale aerial combat. Tactical lift, surveillance and reconnaissance, and on-call strike or interdiction will be the coin of the future realm.[131] One could point to the skies over Syria as foreshadowing a new reality in which no one controls the air. Freedom of action is guaranteed by military and diplomatic agreements that have little to do with combat capabilities. These ideas rest on the implicit assumption that the air is controlled either by force or by agreement and supported by the threat of force. Given the Army's recent transition from counterinsurgency to large-scale combat operations, it is crucial to examine the Air Force's ability to provide the expected air supremacy. Space and cyber domains will factor in any future calculation but are beyond the scope of this research. Whatever shape future wars take, command of the air domain will remain a *necessity for* US military operations in the present and near future.

Industry

History, insofar as it contributes to future expectations, gives cause for concern. The last considerable challenge to US air supremacy was in World War II. There has not been a threat from enemy aircraft since 1991. Since 2003, even surface-to-air threats have been nonfactors.[132] This does not imply that

the Air Force is tactically ill-prepared for large-scale conflict. Large force exercises that arose post-Vietnam, most famously Red Flag, are designed to ensure that Airmen are ready for such an eventuality. However, tactics are only one piece of the puzzle. The Air Force's greatest advantage in World War II, the one that led it to victory, was not tactics or strategy but industry. The United States cannot expect a similar advantage in the future.

The much-touted industrial shift that powered the United States' victory began well before US entry into the war. Aircraft production increased by 1,471 percent between 1940 and 1942.[133] Almost two years before Pearl Harbor, the United States was already transforming its aviation industry. It is foolhardy to think the United States would have an unmolested, two-year preparation period before its next large-scale conflict. Still, the drastic increase that began in 1940 was insufficient. The explosion of production continued during the war. From 1942 until the war's end, the United States alone manufactured 190,600 combat aircraft, 150 percent of the 121,200 produced by Germany and Japan combined.[134] In comparison, Lockheed Martin delivered 91 F-35 aircraft in 2018 and hopes to increase its production to 160 per year by 2023.[135] The F-35 consists of over 300,000 individual parts produced by more than 1,400 domestic and international companies.[136] Significant logistical and production advancements make such processes possible today, unlike in the 1940s; however, there is a limit to the maximum output of this system. The notion of consolidating or centralizing the products and accompanying intellectual property of 1,400 companies in a manner that increases production to anything near World War II levels is unrealistic. Perhaps the losses incurred in gaining air supremacy will be less in a future war than in World War II, but they will be significant.

In a similar vein, the introduction of the P-51 Mustang with its extended range is considered a turning point in World War II's aerial conflict.[137] The P-51 began as a concept in 1940, and by 1944 it changed the war in Europe, "a feat that would have been quite beyond the capacity of the German aero-industry."[138] Another rapid development came 20 years later, with the addition of a 20mm cannon to the F-4 during the Vietnam War. Initial development occurred in June 1964, and the first production F-4E was flown in June 1967.[139] Despite the timeline's rapidity, some argued that Secretary of Defense Robert McNamara's new requirements made it longer than necessary.[140] Producing an aircraft from scratch takes longer than modifying a current one, and the pressures of war drive increased flexibility, spending, and production timelines unavailable in peacetime. In a future war, the United States will continue to modify and upgrade its existing fleet of aircraft. Nevertheless, the F-22 and F-35 took 20 years from prototype to production.[141] The idea for a

new long-range strike-bomber first surfaced in 2004. Congressional funding began in 2011, a contract for the B-21 was awarded in 2015, and the Air Force expects initial operational capability around 2025 barring unforeseen setbacks.[142] The B-21 is following the same 20 year timeline seen earlier. Current industrial practices preclude the speed of production that proved critical to US victory in World War II. Further, the scale of the industrial output in World War II would take several years to achieve, if it is even possible today. World War II was the United States' only competition for air supremacy against a peer adversary. Airpower history, theory, and doctrine in the 1940s did not prepare the United States for air supremacy in World War II. Unlike that war, the Air Force cannot expect industrial production to provide the defining advantage in the future.

Technology

Airpower pioneers and theorists are forward-looking. Mitchell wrote, "In the development of air power, one has to look ahead and not backward to figure out what is going to happen, not too much what has happened."[143] This proclivity often manifests as an obsession with technology. "The Air Force could be said to worship at the altar of technology," according to Carl Builder.[144] The emphasis on technology as the Air Force's savior exists today. Its *Air Superiority 2030 Flight Plan* prioritized cutting-edge technologies and modernizing acquisition processes to more quickly incorporate technological advancements. It demands that "failure to adopt agile acquisition approaches is not an option," and these changes allow the Air Force "to more rapidly infuse advanced technologies into the force."[145] The report does not limit itself to technological solutions, but they compose the dominant theme. The section addressing doctrine, organization, training, materiel, logistics, personnel, facilities, and policy (DOTMLPF-P) does not include doctrinal or training recommendations. Instead, topics include new acquisition paradigms, investment in "game-changing" technologies and the infrastructure to assess them, and the pursuit of low-cost technologies to allow for "rapid fielding of larger quantities of capability."[146] Technological pursuit is so ingrained in Air Force thinking that its "non-materiel" plans devolve into proposals surrounding improved pursuit and acquisition of technological materiel.

Inarguably, technology will be an essential element of a future air war. Space and cyber assets will become increasingly important in gaining and maintaining air supremacy. However, their precise value will depend on the specific cultural, physical, and geopolitical factors of the war. Additionally, the unique capabilities of space and cyber assets are offset to a degree by their

unique vulnerabilities. Advances in robotics and drone technology make concepts like swarming more plausible and tactically relevant in a future war, both for the United States and its potential adversaries.[147] The United States will not continue to enjoy its customary extreme technological advantage. China, in particular, has devoted significant resources to closing the technology gap in recent decades.[148] It hopes to use technological equivalency, or near equivalency, to deter US actions in the Indo-Pacific Region. Should deterrence fail, China desires not just to compete with the United States but to defeat them. It is pursuing technological, doctrinal, and organizational modifications to convert this plan to reality.[149] The Air Force cannot lose sight of other factors in a myopic pursuit of technology as its single savior without detrimental effects to its potential for air supremacy in war with a peer adversary.

Attrition and Air-to-Air Combat

Other factors abound that will determine the Air Force's ability to maintain higher degrees of control of the air against a peer. Strategic bombardment was the foundational paradigm of the Air Force. History has not confirmed strategic bombardment's promises to win wars through airpower alone, but airpower still provides unique deep strike capabilities unavailable via other means. Some historical truths remain consistent, however. The Air Force has long relied on its deep strike ability to establish air supremacy because of the increased efficiency deep strike provides. Warden spelled it out in *The Air Campaign* writing, "The most difficult and costly place to attack the aircraft chain is in the air."[150] He and others are correct if the problem is one of materiel. History suggests otherwise. The decisive factor is not the materiel; it is the Airmen who employ it. Defeat in the air is more than the loss of an aircraft. It typically results in the loss of the pilot, whether killed or taken prisoner. It is easier to replace materiel than the knowledge and skill of a pilot gained through experience. Enemies, such as China and Russia, have demographic advantages against the United States. They also have industrial advantages to the degree that their centralized governments can dictate top-down production processes. As in World War II, their ability to continue producing materiel will be impossible to eradicate. In contrast, their ability to deliver experienced and capable pilots will be exponentially more difficult as the war progresses. The US Air Force's strategic bombardment capability will be valuable in gaining air supremacy, especially concerning enemy integrated air defense systems. Yet their expertise in the air-to-air environment might play a more significant role in achieving and maintaining air supremacy in a future war just as it did in the past.

This does not imply a Jominian-Mahanian decisive battle in the air, a practical impossibility even if it were desirable. Even so, one must contend with inherent risks of aerial combat that exist on a smaller scale than a singular decisive engagement. During World War II, air planners estimated a 20 percent per month average rate of attrition, including higher initial losses.[151] In Korea, Gen Hoyt Vandenberg stressed bombing north of the Yalu River would reduce the Air Force to the point that it could not operate at full strength in any other theater.[152] Neither the Air Force nor the US public are accustomed to this level of attrition. Public polling indicates that civilians are more inclined to support air strikes than ground invasions while simultaneously recognizing that the odds of victory are lower if an "air only" strategy is pursued.[153] These findings illuminate a public conception that air campaigns result in fewer casualties than ground invasions, and the public accepts a more challenging strategic situation in exchange for fewer casualties. At the same time, Americans see the Air Force as the most critical military service both in general and specifically in a war against Russia or China by more than a two-to-one margin.[154] The public values the Air Force's contributions to national defense but perceives airpower as resulting in relatively fewer casualties. The increase in attrition rates associated with peer-to-peer air war would create problems replacing personnel and materiel. Worse, it risks the loss of public support if the public responds negatively to unexpectedly high rates of loss.

Attacking the enemy in the air is a high-risk endeavor but exploits the United States' significant advantage in technology and airmanship. This presents a dilemma for the United States. The Air Force's doctrine and theory rely on strategic bombardment as the primary means of establishing air superiority and air supremacy. History shows the limitations and pitfalls of this approach. It points instead to rapid industrial production and innovation in winning a war of attrition as the means of gaining air supremacy against a peer adversary. Current production rates in both personnel and equipment do not support high attrition rates. Wartime production increases could supplement these losses, but it is doubtful they would occur quickly or in large quantities. History also validates the United States' long-held technological advantage as a key to air supremacy. The technology gap is decreasing, but the Air Force still maintains its technological obsession. The Air Force's ability to gain and maintain air supremacy against a peer adversary cannot be assumed. This is vital for today's ground forces that are reliant on maneuver warfare. Gen Shelford Bidwell claimed, "A sustained armored offensive was almost impossible in the face of attack by an air force with command of the sky."[155] The Department of Defense must account for the impact of this paradigm shift as it transitions to multi-domain and large-scale combat operations.

Conclusion

Winning air superiority is difficult and one of the surest ways to fail is to think you can take the parsimonious approach and just go for local superiority.

—John Warden, *The Air Campaign*

Aviation changed the conduct of warfare. General Pershing admitted in his memoirs, "the usefulness of our Air Service . . . could hardly be overestimated."[156] From its inception, airpower and the protection it provides became an essential aspect of military thinking. On the whole, however, it is poorly understood. This is in part because of the US dominance of the air domain. The United States has not lost a member of its ground forces to aerial attack since the Korean War.[157] Air supremacy will be more difficult to gain and exploit in the future, but it is likely to maintain its preeminent position in the conduct of military operations. Little can happen without first establishing long-term air superiority at a minimum.

Thus, air supremacy in the future requires detailed investigation. Jasjit Singh writes, "The struggle of air superiority is a campaign and not a battle: it is a highly complex operation, becoming even more so as the conflict environments get more sophisticated."[158] The dominance of the air domain is more difficult to visualize than in other areas because it cannot always be easily depicted on a map and because of the vast spaces it encompasses.[159] It is challenging to see air supremacy the same way as a ground campaign. This approach is helpful, however, because airpower must gain control of enemy airspace to have decisive effects. Local air superiority in friendly territory provides minimal benefit to long-term objectives.[160] One reason for the US struggle in Vietnam was the inability to gain air supremacy over enemy territory, despite its dominance in South Vietnam.[161] The concept of an air campaign is not new, but its conduct may need to be reconsidered in light of future conflicts.

In 2007, Colin Gray warned that America was too comfortable with benign aerial environments and that "one should not assume . . . air domination . . . by divine right."[162] Today, airpower theory and doctrine disregard Gray's admonition. They fail to incorporate the realities of historical experience. New ideas are warranted. Gray further argued that airpower theory could only exist as one part of a general theory of war.[163] Shifting gears, he proposed his airpower theory in 2015, but its 27 dicta read more like a laundry list of airpower capabilities rather than a general theory of airpower.[164] Future airpower

theory may follow or diverge from the trails blazed by Gray and others. Regardless, it must continue to develop and evolve.

Current Air Force publications hedge on the ability to provide complete air supremacy and argue that localized and temporary air superiority might be all that is needed or available in the future.[165] The Air Force may recognize this flaw. In September 2018, Dr. Heather Wilson, Secretary of the Air Force, stated, "We know now from analysis . . . the Air Force is too small for what the nation expects of us."[166] Cynics may see this as a political move to garner financial resources, but it is a positive first step. To be complete, evolution in airpower theory and doctrine must parallel policy proposals to meet national strategies. As in World War II, theory and doctrine are misguided and not sufficient enough to guarantee air supremacy against an equal opponent.

It is unclear to what degree other military branches understand this and what impact it would have on their doctrinal approaches to warfare. Airpower theory and doctrine are at odds with precedence. This creates an environment in which the United States cannot assume air supremacy against a peer adversary. This fact has been overlooked during the past 18 years of counterinsurgency warfare. It is time to address it. Dolman reminds us, "Organisms that dominate their niche will be successful only so long as the environment remains stable, and the longer an environment is perceived as stable . . . the more catastrophic the collapse . . . when change inevitably occurs."[167] The Air Force has maintained air supremacy in a stable environment for decades. Its proficiency at the tactical level is unparalleled. Failure to revisit the theory and doctrine that underlie its approach to war could lead to the Air Force's failure to control the air. Should that foundational pillar of US military operations be lost, the collapse might well be catastrophic.

Notes

(All notes appear in shortened form. For full details, see the appropriate entry in the bibliography.)

1. See Wikipedia, "Corvus (Boarding Device)"—"The Corvus (meaning "crow" or "raven" in Latin) was a Roman naval boarding device used in sea battles against Carthage during the First Punic War." Also see "Paixhans Gun,"—"The Paixhans gun was the first naval gun designed to fire explosive shells. It was developed by the French general Henri-Joseph Paixhans in 1822–23. The design furthered the evolution of naval artillery into the modern age. Its use presaged the end of wood as the preferred material in naval warships, and the rise of the ironclad."

2. Greer, *The Development of Air Doctrine in the Army Air Arm*, 149.

3. The goal of this act is to promote national security by providing for a Secretary of Defense; for a National Military Establishment; for a Department of the Army, a Department of the Navy, and a Department of the Air Force; and for the coordination of the activities of the National Military Establishment with other departments and agencies of the Government concerned with national security

4. Douhet, *The Command of the Air*, 20.

5. Mitchell, *Winged Defense*, 126–27.

6. MacIsaac, *Strategic Bombing in World War Two*, 7.

7. Douhet, *The Command of the Air*, 57.

8. Mitchell, *Winged Defense*, 127.

9. Winton, *Strategy*, 51.

10. Winton, *Strategy,* 40.

11. Dolman, *Pure Strategy,* 44.

12. USAF, *Air Force Doctrine (AFD) 1, Basic Doctrine*.

13. US Department of War, *Field Service Regulations*, 17.

14. Herwig, *The Marne, 1914*, 110.

15. Herwig, *The Marne, 1914*, 57.

16. Greer, *The Development of Air Doctrine in the Army Air Arm*, 7.

17. Greer, *The Development of Air Doctrine in the Army Air Arm*, 7–8.

18. Pershing, *My Experiences in the World War*, 337.

19. Futrell, *Ideas, Concepts, Doctrine*, 27.

20. US Department of War, *Training Regulation (TR) 440-15, Air Service*, 7.

21. Biddle, *Rhetoric and Reality in Air Warfare*, 14.

22. Futrell, *Ideas, Concepts, Doctrine*, 20.

23. Greer, *The Development of Air Doctrine in the Army Air Arm*, 11.

24. Greer, *The Development of Air Doctrine in the Army Air Arm*, 11.

25. Mitchell, *Memoirs of World War I*, 277.

26. US Department of War, *TR 440-15, Air Corps*, 5.

27. Greer, *The Development of Air Doctrine in the Army Air Arm*, 55.

28. US War Department, *TR 440-15*, 5–6.

29. US War Department, *TR 440-15*, 4.

30. US Department of War, *Field Manual (FM) 1-5, Air Corps Field Manual*, 9.

31. US Department of War, *FM 1-5, Army Air Forces Field Manual*, 10.

32. US Department of War, *Field Manual (FM) 100-20, Field Service Regulations*, 1. Capitalization is consistent with publication.

33. Greer, *The Development of Air Doctrine in the Army Air Arm*, 47.

34. Watts, *The Foundations of US Air Doctrine*, 23.

35. US Department of War, *AWPD-1, Munitions Requirements of the Army Air Forces*, 81, 32.

36. US Department of War, *AWPD-1,* 2, 67.

37. US Department of War, *AWPD-1,* 15.

38. Roosevelt to Marshall, memorandum, August 24, 1942.

39. US Department of War, *AWPD-42: Requirements for Air Ascendancy*, 1. From the personal collection of Dr. Scott Gorman.

40. US Department of War, *AWPD-42*, 1.

41. US Department of War, *AWPD-42*, 5.

42. Gen Dwight D. Eisenhower, supreme Allied commander, memorandum, subject: Comments on AWPD-42, 29 September 1942, 2 (emphasis in original). From the personal collection of Dr. Scott Gorman.

43. USAF, *Air Force Manual (AFM) 1-2*, *Basic Doctrine*, 11.

44. AFM 1-2, 13.

45. US Air Force, *AFM 1-2*, 13.

46. Futrell, *Ideas, Concepts, Doctrine*, 399.

47. Futrell, *Ideas, Concepts, Doctrine*, 399.

48. Futrell, *Ideas, Concepts, Doctrine*, 295.

49. Futrell, *Ideas, Concepts, Doctrine*, 296.

50. Senate, *Military Situation in the Far East.*

51. Futrell, *Ideas, Concepts, Doctrine*, 350.

52. Head, "Conclusion," in *Plotting a True Course,* edited by David R. Mets and William P. Head, 292.

53. USAF, *Air Force Manual (AFM) 1-1*, *Basic Doctrine*, 5-1–5-2.

54. Westmoreland, "Commander's Estimate of the Military Situation in South Vietnam," 4.

55. Buckley, *Air Power in the Age of Total War*, 215.

56. Buckley, *Air Power in the Age of Total War*, 215.

57. Head, "Conclusion," in Mets and Head, *Plotting a True Course*, 295.

58. Laslie, *The Air Force Way of War*, 34.

59. USAF, *Air Force Manual (AFM) 1-1, Basic Doctrine*, 5-1–5-2.

60. AFM 1-1, 3-1–3-2.

61. Laslie, *The Air Force Way of War*, 25.

62. Laslie, *The Air Force Way of War*, 100.

63. USAF, *Air Force Manual (AFM) 1-1, Basic Doctrine*, 2-12.

64. AFM 1-1, 3-3.

65. Sargent, "Aircraft Used in Deliberate Force," 270.

66. USAF, *Air Force Manual (AFM) 1-1, Basic Aerospace Doctrine,* 1:10.

67. USAF, *The Air Force and US National Security,* 7.

68. USAF, *Air Force Manual (AFM) 1-1,* 2:259; US Air Force, *The Air Force and US National Security*, 7.

69. USAF, *Air Force Doctrine Document (AFDD) 1*, *Basic Doctrine*, 29. The wording of definitions has changed since 1997, but the key concepts of prohibitive vice effective and localized vice global remain in effect.

70. USAF, *AFDD 1, Basic Doctrine*, 29.

71. USAF, *Air Force Doctrine Document (AFDD) 3-01, Counterair Operations*, 2.

72. USAF, *AFD 1* (2018), 11.

73. Mets, *Plotting a True Course*, 17.

74. Watts, *The Foundations of US Air Doctrine*, 1; Pape, *Bombing to Win*, 326–29.

75. Mets, *Plotting a True Course*, 10.

76. Greer, *The Development of Air Doctrine in the Army Air Arm*, 9–10.

77. Biddle, *Rhetoric and Reality in Air Warfare*, 29.

78. Reference this monograph's introduction for direct quotes supporting this conclusion.

79. US Department of War, *Field Service Regulations*, 21.

80. Buckley, *Air Power in the Age of Total War*, 77.

81. Pape, *Bombing to Win*, 60; Watts, *The Foundation of US Air Doctrine*, 9; Pape includes the quote referencing Douhet's approach while Watts cites the line corresponding to Mitchell's opinion.

82. Douhet, *The Command of the Air*, 43.

83. Douhet, *The Command of the Air*, 96.

84. Mitchell quoted in Watts, *The Foundations of US Air Doctrine*, 7.

85. Pape, *Bombing to Win*, 65.

86. MacIsaac, *Strategic Bombing in World War Two*, 8. See also, *Warden and the Air Corps Tactical School 5-15.* Wikipedia also has a definition of "Industrial Web Theory:"

> Industrial web theory is the military concept that an enemy's industrial power can be attacked at nodes of vulnerability, and thus the enemy's ability to wage a lengthy war can be severely limited, as well as his morale—his will to resist. The theory was formulated by American airmen at the Air Corps Tactical School (ACTS) in the 1930s. The term "industrial web theory" cannot be found in any official United States Army Air Corps (USAAC) doctrine. Instead, the term was coined in the 1930s by Donald Wilson, an instructor at ACTS, to cover the concept then under development.

87. Mitchell, *Winged Defense*, 8; Douhet, *The Command of the Air*, 200.

88. MacIsaac, *Strategic Bombing in World War Two*, 8.

89. Futrell, *Ideas, Concepts, Doctrine*, 64; De Bruhl, *Firestorm*, 12. The quote, "The bomber always gets through" is credited to British Prime Minister Stanley Baldwin in 1931 before becoming a rallying cry of airpower advocates.

90. Futrell, *Ideas, Concepts, Doctrine*, 65.

91. Crane, *American Airpower Strategy in World War II*, 35; MacIsaac, *Strategic Bombing in World War Two*, 17.

92. Crane, *American Airpower Strategy in World War II*, 39.

93. McFarland and Newton, *To Command the Sky*, 170.

94. *US Strategic Bombing Survey (USBSS)*, *Summary Report (European War)*, 7.

95. *USBSS*, *Summary Report (European War)*, 8.

96. Crane, *American Airpower Strategy in World War II*, 41–3.

97. *USBSS Summary Report (Pacific War)*, 67–8.

98. *USBSS, Summary Report (Pacific War)*, 68.

99. *USBSS*, *Summary Report (Pacific War)*, 68.

100. *USBSS, Summary Report (Pacific War)*, 69–70.

101. Warden III, *The Air Campaign,* 53.

102. *USBSS, Summary Report (European War)*, 15–16.

103. Montgomery, "Tradition Versus Progress."
104. Head, in Mets and Head, *Plotting a True Course*, 47.
105. Mets, *Plotting a True Course*, 19, 30; Crane, *American Airpower Strategy in World War II*, 191.
106. MacIsaac, *Strategic Bombing in World War Two*, 165.
107. Singh, *Air Power in Modern Warfare*, 5.
108. Pape, *Bombing to Win*, 66–9.
109. Hammond, "Introduction," in Boyd, *A Discourse on Winning and Losing*, 3–10.
110. Olsen, *John Warden and the Renaissance of American Air Power*, 251.
111. Mets, *The Air Campaign,* 79; Olsen, *John Warden and the Renaissance of American Air Power*, 75.
112. Mets, *The Air Campaign*, 60; Warden III, *The Air Campaign*, 35.
113. Belote, "Warden and the Air Corps Tactical School," 42.
114. Fadok, *John Boyd and John Warden:* 47–8.
115. Olsen, *John Warden and the Renaissance of American Air Power*, 28.
116. Warden III, *The Air Campaign*, 147–8.
117. Warden III, "The Enemy as a System," 44.
118. Warden III, *The Air Campaign*, 10.
119. Warden III, *The Air Campaign*, 130–1.
120. Warden III, *The Air Campaign*, 14, 128–32.
121. Keaney and Cohen, *Gulf War Air Power Survey: Summary Report*, 8.
122. Keaney and Cohen, *Gulf War Air Power Survey*, 7.
123. Keaney and Cohen, *Gulf War Air Power Survey*, 245.
124. Keaney and Cohen, *Gulf War Air Power Survey*, 56–7.
125. Mets, *The Air Campaign*, 78; Warden III, *The Air Campaign*, 158–61.
126. Haulman, *No Contest: Aerial Combat in the 1990s.*
127. Haulman, *No Contest,* 8.
128. Olsen, *Airpower Reborn*, 2.
129. Freedman, *The Future of War*, 266.
130. Arquilla, *Worst Enemy*, 82–91.
131. Grynkewich, "The Future of Air Superiority, Part I."
132. Barno and Bensahel, "The Catastrophic Success of the US Air Force."
133. Biggers, "Getting into Quantity Production," 261.
134. Harrison, *The Economics of World War II*, 15–16.
135. "Lockheed Martin Meets 2018 F-35 Production Target with 91 Aircraft Deliveries."
136. "Combining Teamwork and Technology."
137. Buckley, *Air Power in the Age of Total War*, 149–50.
138. Buckley, *Air Power in the Age of Total War*, 162.
139. Knaack, *Encyclopedia of US Air Force Aircraft and Missile Systems*, 277–9.
140. Sponsler et al., *The F-4 and the F-14*, 26–7.
141. Gertler, *Air Force B-21 Raider Long-Range Strike Bomber*, 2–4.
142. Gertler, *Air Force B-21 Raider Long-Range Strike Bomber*, 4.

143. Mitchell, *Winged Defense*, 20–1.

144. Builder, *The Masks of War*, 19.

145. Enterprise Capability Collaboration Team, *Air Force 2030 Air Superiority Flight Plan*, 2–3.

146. Enterprise Capability Collaboration Team, *Air Force 2030 Air Superiority Flight Plan*, 8.

147. Freedman, *The Future of War*, 247–8.

148. Heginbotham et al., *The US-China Military Scorecard.*

149. Harold, *Defeat, Not Merely Compete,* 17–20.

150. Warden III, *The Air Campaign*, 35.

151. US Department of War, *AWPD-42*, 7.

152. Futrell, *Ideas, Concepts, Doctrine*, 301.

153. Vick, *Proclaiming Airpower,* 132.

154. Vick, *Proclaiming Airpower,* 126.

155. Bidwell, *Modern Warfare*, 73.

156. Pershing, *My Experiences in the World War*, 2, 125.

157. Randy Roughton, "Air Superiority: Advantage Over Enemy Skies for 60 Years."

158. Singh, *Air Power in Modern Warfare*, 15.

159. Warden III, *Air Campaign*, 42–3.

160. Singh, *Air Power in Modern Warfare*, 15.

161. Laslie, *The Air Force Way of War*, 25.

162. Gray, *The Airpower Advantage in Future Warfare*, 16.

163. Gray, *The Airpower Advantage in Future Warfare*, 14.

164. Olsen, *Airpower Reborn*, 156–78.

165. USAF, *Air Force Doctrine Annex (AFDA) 3-01, Counterair Operations*, 4; Enterprise Capability Collaboration Team, *Air Superiority 2030*, 2.

166. Heather Wilson, "The Air Force We Need."

167. Dolman, *Pure Strategy*, 32.

Abbreviations

ACTS	Air Corps Tactical School
AFD	Air Force Doctrine
AFDD	Air Force Doctrine Document
AFM	Air Force Manual
AWPD	Air War Plans Division
DOTMLPF-P	Doctrine, Organization, Training, Materiel, Logistics, Personnel, Facilities, and Policy
FM	Field Manual
MDO	Multi-Domain Operations
OODA	Observe-Orient-Decide-Act
PGM	Precison-guided Munitions
SAM	Surface-to-Air Missile
TR	Training Regulation
USSBS	United States Strategic Bombing Survey

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