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Rebuilding America's Military: The United States Air Force

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CENTER FOR NATIONAL DEFENSE

About the Authors

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The Rebuilding America's Military Project

This *Special Report* is the fourth in a series from the *Rebuilding America's Military Project* of The Heritage Foundation's Center for National Defense, which addresses the U.S. military's efforts to prepare for future challenges and rebuild a military depleted after years of conflict in the Middle East and ill-advised reductions in both funding and end strength.

The first paper in this series (Dakota L. Wood, "Rebuilding America's Military: Thinking About the Future," Heritage Foundation *Special Report* No. 203, July 24, 2018, http://report.heritage.org/sr203) provides a framework for understanding how we should think about the future and principles for future planning.

The second (Dakota L. Wood, "Rebuilding America's Military: The United States Marine Corps," Heritage Foundation *Special Report* No. 211, March 21, 2019, http://report.heritage.org/sr211) discusses the current status of the U.S. Marine Corps and provides prescriptions for returning the Corps to its focus as a powerful and value-added element of U.S. naval power.

The third (Thomas W. Spoehr, "Rebuilding America's Military: The United States Army," Heritage Foundation *Special Report* No. 215, August 22, 2019, http://report.heritage.org/sr215) provides context and recommendations on how the U.S. Army should approach planning for future conflicts out to the year 2030.

This paper examines the impact of service concepts, doctrine, and plans to provide context for the state, status, and mindset of today's Air Force. It then evaluates critical aspects of the service and recommends specific policies and actions that the Air Force needs to pursue to prepare itself for future conflicts out to the year 2040. Because the Space Force is now an independent branch of the military, recommendations for that service are not included in this paper.

Contents

Rebuilding America's Military: The United States Air Force

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After 28 years of downsizing, combat deployments, and funding challenges, and despite billions of dollars spent on research and development, the Air Force lacks the capacity to meet the challenges laid out in the 2018 National Defense Strategy. Making do with a minimal, aging force structure while searching for the next revolutionary change puts the United States at risk not just for the present, but also during an almost 20-year acquisition cycle. The Air Force of 2040 will be comprised of current weapons systems and those that can be acquired from active production lines or those that are nearing production. The service needs to acquire as many leading-edge weapons systems as it can now, while the current surge in funding is available.

Executive Summary

The U.S. Air Force has many different missions, but as stated in Title 10 of the U.S. Code, its primary role is to prepare forces that can respond quickly to demands for sustained offensive and defensive air operations anywhere in the world. Unlike the other services that are optimized for a specific theater or domain (for example, the Marine Corps and the Indo–Pacific region), the Air Force must be able to conduct combat operations in Europe, the Pacific, the Middle East, or any other region as a peacekeeper, door kicker, force sustainer, and supporting arm for other services and allied nations.

Operating in its primary domain, the Air Force has the ability to see not only over the next hill, but also over a horizon of much greater depth than that viewed by the other domains. That vantage, coupled with extraordinary technology, gives the Air Force the ability to find, fix, and target an enemy

anywhere on or near the face of the Earth. The speed, radius of action, and advantages inherent to the air domain allow the air force to be the first to a region of conflict or instability, and those same traits often compel it to be the last of the services to depart.

How much airpower does the nation need? The 2018 National Defense Strategy (NDS) directed the services to prepare for a large-scale, high-intensity conventional war with China or Russia. That mission requires a force that, with little advanced warning, can rapidly deploy, fight, and defeat a regional threat or peer competitor anywhere in the world. Subsequently in 2018, the Air Force released a strategic vision for the capacity and capabilities it needs to execute the NDS called *The Air Force We Need* (TAFWN). Based on thousands of war-game simulations, the plan assessed that the service needed, among other things, one additional strategic airlift squadron, seven additional fighter squadrons, five additional bomber squadrons, and 14 additional tanker squadrons to execute that strategy and win such a war.

From its inception during World War I through today, the Air Force has been guided by more than 41 plans and strategic concepts like TAFWN. Each was designed to put the service on a better footing for the next conflict, but just three went on to infuse the service with the most advanced equipment available in numbers sufficient to execute the missions the nation expected of its Air Force. Their success was based on three principal elements: a plan to acquire the most advanced fieldable technology, commensurate funding to acquire weapons systems in numbers sufficient for the mission set, and exceptionally well-trained airmen to employ those systems.

With today's explosion in technology, some fear that a commitment to fielding relevant, leading-edge technologies like those mapped out by TAFWN will prevent the service from funding a game-changing technology when it emerges. Almost every technological innovation has been born with—and perhaps in spite of—that same fear; but if the history of land and naval warfare is any guide, the nature of air combat will be changed around the edges over the coming years, not fundamentally transformed by a new breakthrough.

The Air Force has the fewest combat squadrons in its history: less than half the number it possessed at the end of the Cold War, the last time the United States faced a peer competitor. Due to readiness and mobilization challenges, today's Air Force would likely be able to deploy just 30 of its 50 available total force fighter squadron equivalents to fight a peer competitor, although even those numbers would allow the Air Force to thwart an attack by either China or Russia if they were appropriately positioned forward in each region and rapidly reinforced.

Unfortunately, however, the lack of forward presence, coupled with low stateside readiness levels, would prevent a rapid response, much less timely reinforcement. Later in the campaign, 30 squadrons would fall well short of the number that would be required to force an aggressor nation to retreat back within its borders, and deployment of all 30 would leave no combat capability in the states either to defend the homeland against a cruise missile attack or to provide a strategic reserve.

The danger of the Air Force fleet's hitting obsolescence when faced with a peer competitor is now at hand. Until 2017, funding for recapitalization was minimal, but despite constant wear and tear on the jets, employment challenges have been few, munition hit rates high, and combat losses almost nonexistent. Remarkably, the service has managed to get by without seemingly suffering the effects of a debilitated weapons system, a series of major mishaps, or significant combat loss. Two decades of such accomplishments have given rise to external expectations that the service can maintain that record without significant reinvestment. After years of senior Air Force leaders fighting those expectations, it appears that this mindset has been embraced by an Air Force that is preparing to fight a different kind of enemy.

It is one thing for the Air Force to engage an adversary that has little ability to shoot back, as it has for the past 28 years; it is quite another to fight a nation-state that possesses capabilities that can challenge every perceived U.S. advantage in the air and space domains. Building and sustaining the capacity and capability required to fight and defeat a peer competitor requires a plan to increase readiness levels and to refresh and grow the service's fleet of aircraft with relevant capacity—systems with the most advanced, fieldable technology available in numbers sufficient to fulfill standing Operational Plans (OPLANs) in support of the 2018 NDS. That force is defined by *The Air Force We Need*, and the service needs to move immediately to acquire those systems and posture itself for the conflict on the horizon while the current surge in funding is available.

To meet these challenges, the Air Force should accelerate the acquisition of the F-35 and KC-46 weapons systems. Respective aircrew and maintenance pipelines and military contracting should be increased with the goal of standing up or increasing the number of squadrons to the levels within TAFWN before standing units transition from dated platforms to these new weapons systems. Sortie rates and flying hours within the current fighter force (particularly the F-35) should be increased significantly to enable more rapid development of experienced pilots to man additional squadrons.

Bringing the B-21 Raider up to operational standards and fielding that jet in the numbers required to support the 2018 NDS will not likely occur until well into the 2030s, which means the Air Force will be forced to rely on the B-1s, B-2s, and B-52s currently in its inventory through the mid-2030s. The current fleets of B-1s, B-2s, and KC-10s should be sustained until the service accepts the delivery of sufficient B-21 and KC-46 aircraft to fulfill the airframe requirements of TAFWN with those new systems.

The demands of the 2018 NDS require sufficient combat power positioned to thwart a move by either China or Russia with little to no warning. The Air Force should adjust the bed-down schedule for the F-35 to prioritize forward-based active-duty units in Pacific Air Forces (PACAF), U.S. Air Forces in Europe (USAFE), and Air Combat Command (ACC) over the Air National Guard (ANG).

Because of the readiness challenges associated with a part-time force, the Air Force should return the Air Reserve Component (ARC) to its critical role as a strategic reserve for the United States and allow the Guard and Reserve to reset the health of their respective force structures. As the ARC recovers manpower, ANG operational fighter squadrons should be increased from an average of 18 primary assigned aircraft to 24.

The Air Force should regain robust levels of readiness at the aircrew, squadron, and wing levels, with aircrews receiving a minimum of three sorties a week, and those events should be increasing in complexity to include adversaries and the most modern integrated air defense simulations available. Aircrews must remaster the ability to operate throughout the air domain to include moving in and out of the low-altitude structure at night. The service must also increase institutional readiness for a peer competitor fight. It should incrementally increase its annual flight school capacity to handle 1,700 pilot candidates and increase standards within and screening rates for flight school and the training pipeline beyond flight school that leads to their operational units.

To enhance deployability, the Air Force should return to the three-squadron operational wing model for all combat-coded wings that must deploy to fight. It should evaluate the readiness of those wings by reestablishing formal inspection teams that are organized and trained to evaluate the ability of units to mobilize rapidly and generate and fly combat sorties. Those teams should be formed immediately to assess wing combat readiness on a recurring two-year cycle.

The Air Force should continue its efforts to shorten developmental and procurement timelines, but it should not ignore historic challenges or the need for the rational checks and balances that were designed to

ensure that the services do not rush to buy a system that is not ready for combat. Nor should it delay the acquisition of fieldable systems based on a belief that revolutionary changes in the acquisition timeline can deliver game-changing technology in time to fight a peer competitor in the next 20 years. China and Russia have made their own advances with precision weapons development, stealth technology, and their own version of joint force employment. The cycles in the evolution of technology have grown arguably tighter during the digital age, as has the ability of hostile nations to pilfer or otherwise compromise those advances through the Internet. The combination makes any perceived technological leap or advantage less likely, not more likely, to be the pillar of a winning strategy. With that, the belief that fielding a game-changing technology, artificial intelligence (AI), or machine-to-machine learning can somehow carry us through the next conflict with "even less" capacity than the service currently possesses in such a fight is unrealistic.

The Air Force should prioritize procurement well ahead of research, development, test, and evaluation (RDT&E) and continue to fund Next Generation Air Dominance (NGAD), Penetrating Counter Air (PCA), and Air Battle Management System (ABMS) but at reduced levels. It should also continue to commit reasonable funding for directed energy and hypersonic experiments and developmental efforts for manned–unmanned teaming and employment concepts like the Low Cost "Attritable" Strike Demonstration program. Importantly, it should continue the Combined Operations Center–Nellis (CAOC–N) initiative to further integration and revitalize equipment, manning, and funding for the 53rd Test Wing and the 422nd Test and Evaluation Squadron.

The current Administration and Congress have provided the funding required for the Air Force to begin bringing its capability, capacity, and readiness up to meet the standards required of the 2018 NDS. The Department of the Air Force should reduce RDT&E funding from 22 percent of total (blue) obligation authority (TOA) to 18 percent and shift the saving to procurement, military construction (MILCON), and the ramp-up in training pipelines to implement the recommended changes. If more funding is required, the Air Force should divest part or all of its fleet of 27 E-3 AWACS and replace that capability with drone technology.

Perhaps the most important element required to fulfill the 2018 NDS is a change in the corporate-wide Air Force mindset. That change begins with acquiring the relevant capacity needed to fight through potential losses the U.S. has not witnessed in several generations of combat: to be able not just to respond around the edges of a limited conflict, but to win in an all-out war.

Introduction: "A Service of Technology"

"We're a service of technology as opposed to strategy."

—General Michael Dugan,
Chief of Staff,
United States Air Force.[1]

The primary role of the U.S. Air Force is established by U.S. law and Department of Defense (DOD) directive:

> The Air Force shall be organized, trained, and equipped primarily for prompt and sustained offensive and defensive air operations. It is responsible for the preparation of the air forces necessary for the effective prosecution of war except as otherwise assigned and, in accordance with integrated joint mobilization plans, for the expansion of the peacetime components of the Air Force to meet the needs of war.[2]

The Air Force has many different missions, but as stated in Title 10 of the U.S. Code, its primary role is to prepare forces that can respond quickly to demands for sustained offensive and defensive air operations anywhere in the world. Unlike the other services that are optimized for a specific theater or domain (for example, the Marine Corps and the Indo–Pacific region), the Air Force must be able to conduct combat operations in Europe, the Pacific, the Middle East, or any other region as a peacekeeper, door kicker, force sustainer, and supporting arm for other services and allied nations.

Operating in its primary domain, the Air Force has the ability to see not only over the next hill, but also over a horizon of much greater depth than that viewed by the other domains. That vantage, coupled with extraordinary technology, gives the Air Force the ability to find, fix, and target an enemy anywhere on or near the face of the Earth.[3] The speed, radius of action, and advantages inherent to the air domain allow the air force to be the first to a region of conflict or instability, and those same traits often compel it to be the last of the services to depart.

How much airpower does the nation need? The 2018 National Defense Strategy (NDS) directed the services to prepare for a large-scale, high-intensity conventional war with China or Russia.[4] That mission requires a force that, with little advanced warning, can rapidly deploy, fight, and defeat a regional threat or peer competitor anywhere in the world. Subsequently in

2018, the Air Force released a strategic vision for the capacity and capabilities it needs to execute the NDS. Called *The Air Force We Need* (TAFWN) and based on thousands of war-game simulations, the plan assessed that the service needed, among other things, one additional strategic airlift squadron, seven additional fighter squadrons, five additional bomber squadrons, and 14 additional tanker squadrons to execute that strategy and win such a war.

From its inception during World War I through 2019, our Air Force has been guided by more than 41 landmark acts, strategic concepts, road maps, and vision statements[5] through the tenures of 25 service secretaries, two Army Air Force commanders, and 21 different chiefs of staff.[6] Collectively, they paint a picture of a service that consistently embraces the promise of technology and its use.

Each of the critical ideas that have shaped the Air Force over the course of its history was well intended. Most, however, failed to deliver the desired results for two primary reasons: It was believed that a leap in technology would change the nature of air combat and stifle an adversary's ability to compete, and/or the plan or concept was not given enough funding to ensure that it was fielded in sufficient numbers. Understanding why each failed—or succeeded—in spite of flawed underpinnings enables one to understand the capability, capacity, readiness, and mindsets of today's Air Force and what will be required to ensure success in the future.

I. An Evolving Strategy of Concepts, Doctrine, and Plans: Defined by Technology and Saved by Enduring Truths

A military service's origin shapes how it thinks about itself, what it represents in national power, and how it approaches the future. The Air Force was born during a period of unrivaled technological growth in military affairs, delivering bigger gains in warfighting capabilities than during any other similar period of warfare, and this has given the service a culture that is different from the cultures of its more seasoned siblings.

Armies are the oldest components of the military, and the technology used to fight in that domain has evolved methodically over thousands of years.[7] Armies seize and hold ground and, once established, are hard to dislodge. They have never lost touch with the harsh realities of war and understand that combat involves both risk and losses. Navies seek maritime dominance and protect lines of communication and the free flow of commerce. They operate far from home and, once sent abroad, have historically been harder to contact and control. Because of this, ship captains and the service as a whole have developed a culture of independence and

view naval vessels as manifestations of national presence, empowered to act on behalf of their country with little requirement for coordination with authorities back home.

The Air Force is very different. While it cannot seize or hold territory, its assets have the ability to detect, track, and engage targets in the air, land, and sea domains and bring strategic, operational, and tactical effects to bear much faster than is possible for its sister services. Those capabilities, coupled with the rate at which technology has allowed it to sharpen its faculties, have given the Air Force a different mindset and conceptual path.

Throughout American history, U.S. ground combatants' weapons have evolved from muskets to missile systems with a range of more than 100 nautical miles (NMs),[8] and the Navy has evolved from a fleet of mere surface combatants to those that operate well above and below the wave tops. Technological growth in each domain has delivered increased speed, range, firepower, and maneuverability, but that growth has been methodical, and every increment has been countered by competent peers through novel tactics or other offsets until they could reach technological parity. While every increment in technology has elevated warfighting to a new level, nothing has changed the fundamental methods of war in either domain.[9]

Airmen are inherently enamored of technology and the prospect of emerging capabilities. As a result, they are easily convinced that the next big conceptual or technology leap will change the face of combat and dictate service strategy for the foreseeable future. Unfortunately, however, many of the biggest Air Force conceptual bets failed to deliver their promised lasting effects. The ideas that the bomber would always get through, that nuclear weapons would fundamentally change the way future wars are waged,[10] or that air-to-air missiles would render dogfighting irrelevant[11] all proved to be wrong. While no concept is invulnerable to the counters of competent adversaries or changing geopolitical landscapes, every success has been based on three principal elements: new, viable technology; enough funding to field it in sufficient numbers; and exceptionally well-trained airmen to employ those systems.

There are some who fear that fielding relevant, leading-edge technologies today could constrain the ability to fund a "no-kidding" game-changing technology when it emerges. Almost every technological innovation has been born with—and perhaps in spite of—that same fear, but if the history of land and naval warfare is any guide, the nature of air combat will change around the edges over the coming years, not undergo a fundamental transformation enabled by a new breakthrough. Moreover, making do with an aging force structure while searching for the next revolutionary

contribution puts the United States at severe risk not just for the present, but for the years associated with an acquisition cycle that is now more than 20 years long. Believing that this cycle will radically shorten or that commensurate funding will be available when the "real" breakthrough occurs ignores the reality of an ever-expanding political divide in Congress and unsustainable levels of national debt.

Fully processing the pattern of conceptual promise, actual results, and consequences is therefore important to any understanding of why the Air Force is where it is today and what it needs to do to prepare for future conflicts. That understanding begins with air combat in the Great War.

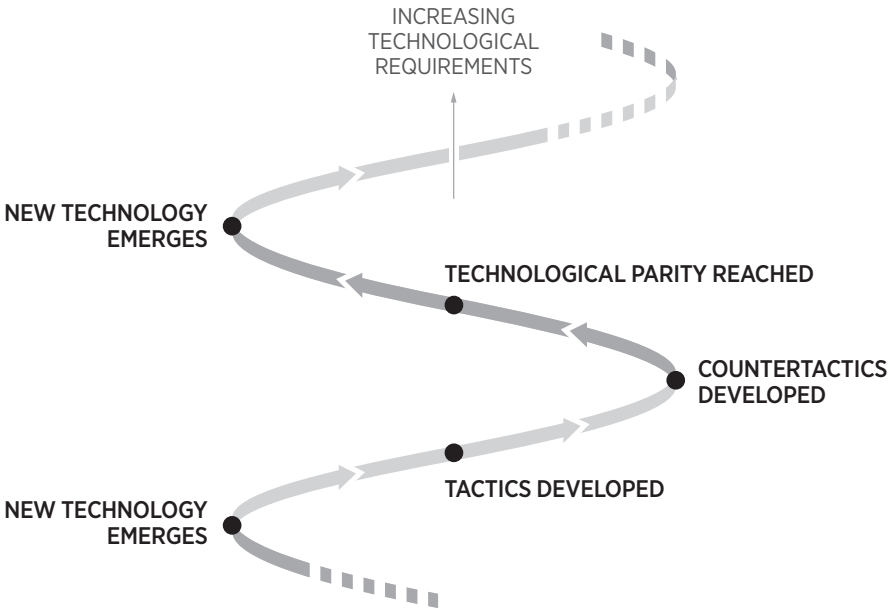
A. World War I and the Enduring Tenets of Airpower. Air combat was inaugurated in World War I, and while there was no real concept or doctrine that drove airpower during the war, the technical and tactical spirals of innovation throughout the domain delivered the tenets and missions that are pillars of today's Air Force. Some were slow to realize the game-changing nature of that access to the air domain. The majority of senior leaders began the war with the belief that winged aviation was just a more mobile balloon: an observation or intelligence-gathering platform that could see even deeper behind enemy lines.

The first combat sorties flown by winged aircraft were observation missions conducted at high altitude for the day where the only real threat was anti-aircraft artillery. Early in the war, cameras were integrated into observation aircraft,[12] and the intelligence gathered proved to be so valuable that aircrews began to throw bricks and grappling hooks, fire handguns, and finally arm observers with swivel-mounted machine guns in an effort to counter enemy airframes' collection capability.[13] Within months, "pursuit" aircraft were designed and fielded to deny those eyes to the enemy. The lighter-weight, single-seat design of these aircraft allowed them to climb and fly faster than two-seat observation aircraft and bombers. Machine guns were fixed to fire straight ahead, allowing pilots to aim more accurately. Those mounted above the arc of the propeller were hard to reload or clear when they jammed,[14] and those that fired through the propeller could damage the prop to a point where the aircraft was lost.[15]

One of the most significant technological inventions of the air war was a German mechanism that synchronized the machine gun with the motor, allowing it to fire in the gaps of a spinning propeller. The gear's advantage, coupled with evolving tactics,[16] gave the Germans a huge edge in combat. Counter tactics like the Lufbery Circle evolved to help offset the Germans' technological advantage,[17] but armed with the interruption gear in the spring of 1916, the Germans decimated the Allied fleet of two-seat

FIGURE 1

The Rising Spiral of Military Technological Advancements



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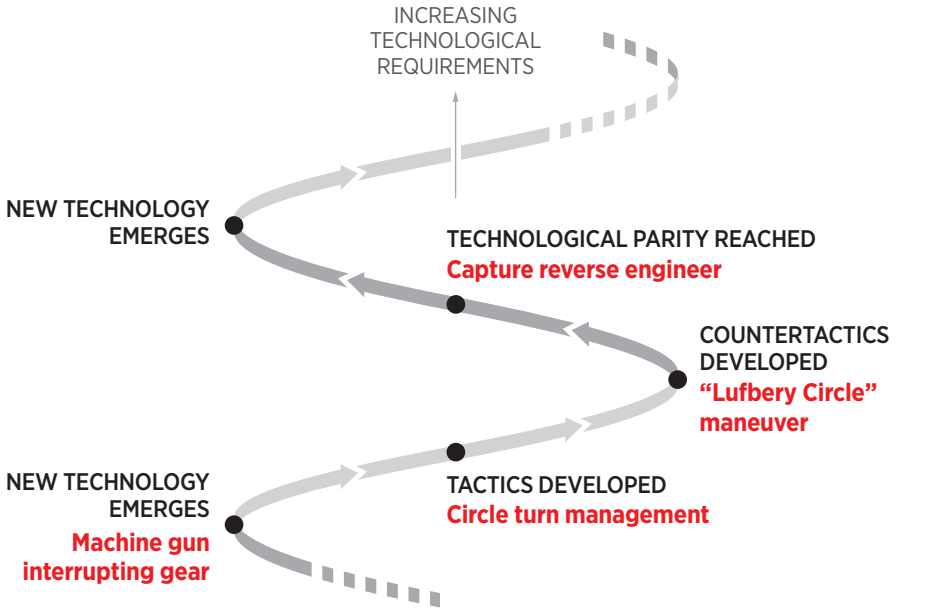
observation aircraft and forced France to abandon its daylight bombing campaign during a period known as the Fokker Scourge.[18]

This technological edge proved to be short-lived. The Germans lost a gear-equipped fighter behind Allied lines, allowing the Allies to reverse engineer and rapidly field their own version of the mechanism. The interruption gear was perceived as an absolute game changer, but once both sides had it, the gear merely elevated the requirements to compete in air-to-air combat. How an aircraft was employed by individual pilots and those working together in formation consistently proved to be just as important, if not more so, than the technology that went into it. Beyond the point of technological parity, training and mastery of tactics were the factors that made all the difference in outcomes.

The inherent mobility of individual observation, pursuit, and bomber aircraft allowed them to attack or defend large swaths of territory along the front. However, the relatively limited range and number of these aircraft constrained their ability to mass and concentrate airpower. The Germans answered this challenge by developing the capability to pack up pursuit units, move them rapidly from one location to another by train, and then operate from tents on improvised airfields in order to mass and concentrate the effects of airpower.[19]

FIGURE 2

Applying the Rising Spiral of Military Technological Advancements to WWI Air Battles with Germany



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Combat in the air domain during World War I proved to be the ultimate competitive environment. While aircraft speed, altitude, and range would grow significantly between the wars, however, the armament, fundamental tactics, and harsh truths of any facet of air combat have changed only around the edges. The fundamental tenets[20] and mission sets born in the Great War have endured through every war and every generation of aircraft since then,[21] and the ever-spiraling evolution of technology, tactics, and counter tactics within each tenet has continued uninterrupted.

B. The Interwar Years and Airpower's First Strategic Concept. The Army created the Air Service in 1920 and shortly thereafter established a graduate school for its air arm officers that became known as the Air Corps Tactical School (ACTS).[22] ACTS served as the highest educational establishment for the domain.[23]

Billy Mitchell's demonstration of the effects of precision air attack on capital ships in 1925, coupled with the writings of the Italian general Giulio Douhet,[24] fueled the debate within ACTS about what the next war would look like. Over time, the concept that the "bomber will always get through"

to strike strategic centers of gravity with such devastating effect that it could all but win the war alone began to dominate all others.

In 1935, a "revolutionary" four-engine bomber called the XB-17 was tested, and its demonstrated range, bomb-carrying capacity, armament, service ceiling, and rate of climb were significantly greater than those of its predecessors. It outperformed all known pursuit (fighter) aircraft, and the prevailing thought within ACTS was that a pursuit aircraft designed to keep pace with the XB-17 bomber "would have to sacrifice its fundamental pursuit characteristics to the point that it would be virtually useless for air fighting."[25]

Nevertheless, fighter technology also advanced considerably between the wars. Maneuverability was still of primary importance, and with the introduction of turbocharged engines, aircraft were able to attain and operate at heights and speeds well above those of the operational B-17 Flying Fortress. Exercises conducted during peacetime by Claire Chennault that disproved the theory were virtually ignored by thought leaders of the day, and with "unassailable intellectual ascendancy," strategic bombing theorists dismissed the idea that fighters could pose a meaningful threat to bombers.[26]

In spite of mounting evidence to the contrary,[27] by the end of 1935, ACTS made the direct assertion that airpower "could immediately reach the economic and political heart" of an enemy and defeat it,[28] effectively relegating land power to a supporting role. Once the Norden bombsight demonstrated bombing accuracy within 75 feet of the target,[29] the concept of daylight precision bombing became unstoppable.[30] The vastness of the air domain, coupled with the speed and interlacing defensive firepower of bombers flying in close formation, would supposedly preclude "any pitched air battle."[31]

As Germany began to move on Europe, champions of the ACTS concept convinced senior Army leaders that mass formations of heavily armed bombers could strike targets so effectively that they would pulverize German industry, cripple the enemy's will to fight, and bring a quick end to a war without the need to eliminate the opposing ground force.[32]

AWPD-1. In 1941, the U.S. Army's Air War Plans Division (AWPD) solidified the concept of daylight precision bombing by issuing the Army's concept for the air war. Titled AWPD-1, the plan detailed a concept for a six-month strategic bombing campaign that would defeat or significantly cripple the Axis powers before any land invasion of Europe took place. The plan called for a force of 2.1 million airmen, 251 groups, and 62,000 aircraft—numbers that would prove accurate to within 5 percent of the actual numbers the U.S. committed to the air war in Europe.[33]

The strategy itself would be thoroughly tested during the war. To the frustration of airpower advocates, bombing accuracy suffered significantly under the high threat conditions over Germany, and the results resembled nothing like the promises made during prewar peacetime demonstrations. Just 20 percent of daylight precision bombs fell within 1,000 feet of their targets,[34] well outside of the prewar estimates that 50 percent of the bombs would fall within 75 feet. The Air Corps was forced to overcome the odds through the sheer brute force of numbers, flying more than 1,440,000 bomber sorties and delivering more than 2,700,000 tons of munitions over Europe alone.[35]

The costs associated with those sorties were heavy. During a single mass raid in 1943, a force of 368 unescorted B-17s struck targets at Schweinfurt and Regensburg. Although the mission was partially successful, 147 B-17s either did not return or were damaged so badly that they were written off—losses that equated to 40 percent of the strike force.[36] Of the 250,000 Eighth Air Force aircrew members who flew missions during the war, there were 58,000 casualties: 18,000 killed, 6,500 wounded, and 33,500 missing.[37] An airman's chance of being killed while attempting to complete the required 30 missions in a heavy bomber during the spring of 1944 was 71 percent.[38] Ultimately, the number of U.S. airmen who died in combat during the air war over Europe was greater than the number of Marines who died in the Pacific.

While strategic bombing was important to the overall victory, its impact did not match the promises of the 1930s. Ironically, what saved the bomber offensive was the incorporation of long-range P-51 fighters that could escort the strikes through the target area;[39] in the spring of 1945, for example, escorted B-17s and B-24s suffered half as many losses as were suffered by those that flew with no fighter escort.[40] Over the course of the war, more than 2,680,000 such fighter sorties were flown, and the skill sets and lessons learned in World War I proved to be just as essential in World War II. The number of sorties and hours that pilots spent mastering dogfighting skills prior to combat proved essential to the outcome of individual engagements.

The quest for air superiority (as opposed to air supremacy)[41] was a long, hard-fought slog. Localized air superiority was not gained over the beaches of Normandy until weeks before the D-Day invasion, and to ensure local air superiority on D-day itself, the Allies dedicated virtually the whole of their available fighter force to the effort.[42] Air supremacy was not gained over France until that September,[43] and the Luftwaffe held the capability to defend the skies over Germany itself well into 1945, more than four years after the United States entered the war.[44]

TABLE 1

WWII: Number of Hours Flying Time Before Combat

	1940	1941	1942	1943	1944
German	240	240	205	170	110
British	200	200	240	335	340
U.S.	n/a	n/a	270	320	360

SOURCE: James F. Dunnigan and Albert A. Nofi, *Dirty Little Secrets of World War II* (New York: William Morrow, 1994), p. 200.

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The technical advances in radar and command and control that took place during the Second World War were enormous additions to the air war. Even during the earliest days of the Battle of Britain, the British network of radar sites (the Chain Home System) included an electronic Identification Friend or Foe (IFF) feature that allowed controllers instantly to distinguish Royal Air Force (RAF) aircraft from Luftwaffe aircraft.[45] Where there was technical parity between Allied and Axis air forces, counter tactics and technologies were developed to lessen an enemy's capability. The British, for example, packaged thin strips of aluminum foil and dumped them out of aircraft, creating massive radar returns that could mask formations of aircraft against detection by German radar sites or deceive controllers into launching fighters to intercept formations that were not actually there.[46]

The spiral in technology and the fundamental truths of warfare were present in World War II, just as they have been in every other conflict. Warring parties will always press the bounds of their own technology while learning to adapt to, neutralize, or overcome the technological and tactical advances of the enemy. By default, the move–countermove progression of that fight between relative peers made the numbers of technologically advanced combat aircraft and trained aircrews needed to meet war plan requirements the key elements that carried the day. By July of 1944, U.S. and RAF pilots were receiving three times as much training as their counterparts received,[47] and production of the latest allied fighter and bomber aircraft dwarfed that of the Germans.[48]

Despite its failure, ACTS dogma on the dominance of daylight precision bombing and the invincibility of the bomber was so politically entrenched among the senior leaders that emerged from the war that it would continue to guide the Air Force well into the 1950s. Many of the school's other doctrinal thoughts and concepts proved to be sound and are hallmarks of today's Air

TABLE 2

WWII: Ratio of Allied to German Combat Aircraft Available

Date	Ratio
1942 — June	3.1 to 1
1942 — December	4.8 to 1
1943 — June	5.1 to 1
1943 — December	6.0 to 1
1944 — June	8.6 to 1
1944 — December	5.0 to 1

SOURCE: James F. Dunnigan and Albert A. Nofi, *Dirty Little Secrets of World War II* (New York: William Morrow, 1994), p. 200.

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Force. ACTS promoted the importance of achieving air superiority at the expense of support to ground elements, and while there were times when elements of the Air Force would be diverted to support ground troops, airpower had to be centralized to be effective both in its primary role of destroying the enemy's air force and in providing support for ground elements.[49]

In spite of being based on a flawed employment concept, AWPD-1 planning for airframe and manpower requirements proved remarkably accurate. When coupled with commensurate funding, it delivered the most technologically advanced fighter, bomber, and airlift aircraft that could be fielded at that time in numbers required to defeat the Axis powers. By today's standards, the expansion of the Army Air Corps during the war was unimaginable. In July of 1939, the Air Corps had roughly 20,000 men and 2,400 total aircraft and was capable of training 1,200 pilots a year; by the time victory over Japan was declared, it had 2,253,000 military personnel and 75,000 aircraft and was training 82,700 pilots a year.[50] That residual capacity would serve the Air Corps and the Air Force well beyond the downsizing and peace dividend the United States enjoyed through the rest of that decade.

Birth of the U.S. Air Force and the Enduring Fight for Roles and Missions. Until the advent of combat airpower, the roles and missions associated with the services focused on the land and sea domains were clearly defined, but that all began to change during World War I, and aviation was the agent. The interwar period allowed the services to more fully develop and invest in their respective aviation arms and by the time World War II began, the clear lines of demarcation between Army operations in the land domain and Navy ops in and around the sea domain were gone.

The capabilities inherent in the seemingly boundless air domain held great promise, and by the end of the war, the most senior leaders within the Army felt the United States should establish the Air Force as a separate service.[51] The Navy certainly recognized the potential of airpower and, by war's end, the aircraft carrier had replaced the battleship as the fleet's principal capital ship. But unlike the Army, senior leaders in the Navy knew a new service focused on projecting airpower could result in the loss of naval aviation, just as it had in the United Kingdom. That fact, coupled with the desire to capture at least part of the new nuclear mission caused the Navy to fight the formation of a new service.

The National Security Act of 1947 that established the Air Force did its best to straddle the issue by sustaining the roles inherent in the other two services.[52] Under the new law, the Air Force was responsible for sustained offensive and defensive air combat operations, and the Army and Navy were charged with land combat and naval combat, respectively. In April 1948, the new service chiefs met in Key West, Florida, to draft the Key West Agreement to reaffirm the primary roles and establish collateral roles and missions for the services within all three domains. This quelled the turf battle among the services, but only temporarily.

The Air Force was organized according to components that were direct extensions of the bomber, fighter, air defense, and airlift missions that it had flown during the Second World War. Strategic Air Command, Tactical Air Command, and Air Defense Command were named as the primary functional organizations.[53]

Within a year, however, the first Secretary of Defense forced the merger of Air Transport Command with the Navy's Air Transport Service to create a new unified command under the Air Force called the Military Air Transport Service, thereby increasing the Navy's resentment of the new service.[54] The turf battle between the Air Force and Navy would grow into a natural but somewhat unhealthy competition for primacy among all of the services. Funding that went to one meant less for the others, and each would make efforts to prove that it was capable of operating effectively and at least to a degree independently of the other services. That would prove to be especially true for the Air Force as the United States embraced the nuclear age.

The Korean War. North Korea's invasion of South Korea in 1950 caught the world by surprise and the United States Air Force with low readiness levels and insufficient relevant capacity. Budget difficulties that prevented Air Force modernization also left the Far East Air Forces with only 26 World War II B-26 bombers, 22 B-29 bombers, and just under 400 F-80 and F-82

fighters. The F-82s proved challenging to sustain, and the F-80s were ill-suited for the unimproved Korean airfields.

Over time, many units were backfilled with the 1,500 available P-51s left over from World War II.[55] When the F-86, the most modern and maneuverable air-to-air jet fighter in the Air Force inventory, arrived in theater, U.S. pilots found that it was already outperformed by the Soviet-designed MiG-15.[56] Even with the technological advantage in the enemy's court, however, the superior training, skill sets, tactics, and combat lessons learned from World War II enabled U.S. fighter pilots to dominate the air fight during the Korean War. The Air Force needed competitive combat aircraft in sufficient numbers, but in the end, knowing how to employ those jets proved to be more important.

C. A Strategy for the Nuclear Age. The driving imperative for the United States following the Korean War was the need to contend with a numerically superior Soviet arsenal of long-range, high-altitude, nuclear weapon–laden bombers. When technological improvements made it possible to produce smaller nuclear weapons that could be carried by something other than massive bombers, the resulting debate among the services about which one was best suited to carrying out the nuclear mission led to an intense political rivalry to gain the funding and prestige associated with the mission.[57]

In April 1952, the Air Force Council[58] pushed for the development of nuclear weapons that could be delivered by the B-36, B-47, and B-52.[59] In 1953, the service issued Air Force Manual 1-2 (AFMN 1-2) on basic doctrine, reinforcing the concepts for strategic bombing in language that was very reminiscent of the ACTS writings from the 1930s.[60] In spite of the interdiction and strategic bombing failures of World War II and Korea, it went on to advocate for the capabilities of strategic bombers in the nuclear age.

As a counter to the Army's push to acquire ground-delivered nuclear weapons, the Air Force argued that tactical fighter bombers could achieve greater accuracy, cost less, and be more versatile and less vulnerable than nuclear artillery. While the disagreement over nuclear strategy within the Joint Chiefs of Staff was heated and anything but settled,[61] the Air Force began to design and field the Century Series fighters that were specifically designed for that mission. The F-101 and F-102 were armed with nuclear-tipped Genie missiles and air-to-air rockets that could destroy entire formations of Soviet bombers, effectively eliminating the need for air defense aircraft to maneuver in order to obtain a firing solution. On offense, the F-100 and F-105 were designed as fast jets that could penetrate enemy airspace to deliver offensive nuclear weapons to tactical targets.

TABLE 3

Cold War Defense Budget, by Military Branch

For 1951–1965, the Air Force received the lion's share of the Defense budget.

IN BILLIONS OF U.S. DOLLARS

Period	Army	USAF	Navy
1946–1950	147	57	99
1951–1961	131	184	126
1962–1965	120	193	143
1966–1972	170	179	159
1973–1980	110	129	145
1981–1986	156	202	207

NOTES: Figures are by fiscal year. Original figures from FY 1986 have been adjusted for inflation to 2019 dollars.
SOURCE: Kevin N. Lewis, "The U.S. Air Force Budget and Posture over Time," The Rand Corporation, February 1990, p. 11, https://www.rand.org/pubs/reports/R3807.html (accessed November 18, 2019).

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In the competition for funding, the Air Force used the fear of exorbitant peacetime military costs as the basis of its nuclear capability argument. The service argued that the United States should emphasize nuclear air and deemphasize ground and naval units to avoid the expense of a conventional arms race that could bring on political upheaval or economic collapse.[62]

Ultimately, President Eisenhower sided with the Air Force and ruled that nuclear weapons would be used from the outset of a general war.[63] This win resulted in huge gains for the service. From 1948 to 1952, the Air Force budget increased by 58 percent annually, dwarfing the 6.8 percent annual increase for both the Army and the Navy.[64] By holding the preponderance of the nuclear mission, the Air Force would capture the lion's share of the Defense Department budget through the mid-1960s.

Both the DOD's Joint Strategic Capabilities Plan (JSCP) and the Joint Chiefs' Joint Strategic Objectives Plan (JSOP) were revised to reflect this important decision, and the plans for a conventional war strategy were dropped in 1956.[65] Officially, the Air Force remained prepared for both, but by the summer of 1958, service pilots were close to losing their proficiency with conventional weapons.[66]

Conventional bombs had to be dropped within meters of their intended targets to be effective, but as nuclear weapons came to the forefront of employment options, training for employment of conventional weapons began to take less precedence. Even at the Air Force's Fighter Weapons School, the emphasis on delivering nuclear weapons dominated the curriculum of air-to-air and conventional weapons instruction because it (too) was enamored with the nuclear mission.[67] Nuclear weapons were the panacea for all things tactical, and the new training emphasis fit perfectly with the vision of senior Air Force officers and aviation pundits alike.

By the end of the 1950s, USAF strategic concepts still dominated U.S. military thinking. Priority for military funding was given to strategic nuclear weapons, and the advocates for increased conventional war forces had gained little ground within the defense budget.[68]

The doctrine surrounding nuclear employment shaped Air Force airframe acquisition, aircrew training, operations, and force disposition throughout the 1950s and early 1960s. Over time, AFM 1-2's concept that nuclear warfare would preclude other types of wars proved erroneous, but like AWPD-1, it received the funding needed to refit the Air Force with a fleet of technologically advanced fighter, bomber, and tanker aircraft that the service would need to see it through the first years of combat operations in Vietnam. The lack of conventional preparation in any operational area, however, would cost the United States dearly as it entered the war in Southeast Asia.

Vietnam. The onset of U.S. combat operations in Indochina was incremental, beginning with small, covert, detached counterinsurgency operations conducted by air and ground units. As the theater force structure increased, the command and control of air assets would also grow more robust, but the process fell well short of what would now be considered "joint." The Tactical Air Control System (TACS) focused largely on the allocation of sorties to support ground operations where ground commanders selected and prioritized targets for the majority of operations.[69] Movement to truly joint planning and joint effects would come at glacial speed over the next several decades.

The technology surrounding air warfare changed significantly during the war in Indochina as engineers improved the reliability and accuracy of radar-guided and infrared-guided air-to-air missiles. It was believed that the revolutionary advances in that technology would eliminate the need for all but the most basic maneuvering to defeat an enemy fighter and lead to, among other things, the removal of an internal gun from the design of the F-4 Phantom.[70]

Armed with new missile technology, the Air Force and Navy trained fighter pilots for benign intercepts, deemphasizing the classic dogfight training that their pilots had received prior to flying combat sorties in World War II or the Korean War.[71] Unfortunately, the air-to-air missiles did not measure up to their billing.[72]

The radar-guided AIM-7 was designed to be employed beyond the visual range of the pilot, giving it a great advantage against fighters that were not so equipped. However, because of the inherent difficulty of identifying a target as "hostile" until it was actually picked up visually[73]—a problem that nullified one of its key design characteristics—the missile was rarely employed at long range. The launch restrictions of the infrared-guided AIM-9B made it a poor match for a high-G turning dogfight,[74] and attempting to use either missile proved to be incredibly frustrating because the most basic hard turn by an adversary would defeat them.[75] Just 10 percent of the AIM-7 and AIM-9 firing attempts resulted in kills, compared to 50 percent of firing attempts with a gun.[76]

The consequence of a technology-driven vison that had compromised both aircraft design and air-to-air training was easy to predict: Even facing a poorly trained North Vietnamese fighter force, the Air Force lost almost one fighter for every enemy aircraft it downed during the early days of the war.[77] As in World War II and Korea, the Air Force entered the war without relevant capacity, but for the first time in its history, it also entered the war poorly trained. That kind of performance against a Third World fighter force made the thought of facing the more capable Soviets in air-to-air combat a painful one, but the Air Force took up the challenge.

In 1965, recognizing the gap in training, the service produced the Air Force Doctrine on Air Superiority, refocusing training on air-to-air combat. Wartime budgets allowed for the expansion in training, and over time, the air-to-air skills of U.S. fighter pilots came up to speed.[78] Missile improvements continued throughout the war, but they never proved to be game changers apart from the increased skills of the pilots employing them.

Over the course of the conflict in Vietnam, the Air Force achieved 137 air-to-air kills[79] compared to a loss of 67 aircraft to enemy fighters,[80] equating to a 2-to-1 kill ratio. While the ratio improved significantly before the end of the war, it was still ridiculously low in light of the dated aircraft and poor training that North Vietnamese pilots received.[81] By war's end, Air Force, Navy, and Marine Corps aviators were given credit for some 200 air-to-air kills. Roughly a quarter of those kills were made with guns or cannons that were carried by the fighters flown by those aviators—weapons that engineers, senior leaders, and aviation pundits thought would never be required in a modern air-to-air environment.[82]

Technology in the world of surface-to-air missiles (SAMs) grew significantly during the war. The first SAMs caught aircrews by surprise, and with no indication that they were actively being targeted, the first aircraft that were engaged took no evasive action from the time a missile was launched through its impact. The Air Force initially employed archaic radar warning receivers and counter tactics but eventually developed SAM hunter-killer teams, known as Wild Weasels.[83] From 1965 to 1972, the U.S. and its allies lost 205 aircraft to SAMs[84]—three times the number the Air Force lost in air-to-air combat. Countless others were damaged or forced to jettison their ordnance in order to lighten the aircraft to conduct evasive maneuvers.

As in previous wars, anti-aircraft artillery (AAA) proved to be the greatest killer of U.S. and allied aircraft. Unguided (dumb) bombs required fighters to drop below 10,000 feet—altitudes at which AAA gunners were much more accurate with their fire—to improve accuracy of delivery. By the end of the war, 875 U.S. Air Force aircraft were lost to small arms, automatic weapons, and AAA[85]—quadruple the losses from SAMs and 10 times more than the losses from enemy aircraft.

Overall, the U.S. Air Force lost almost 1,700 aircraft to enemy engagements and other mishaps during the war. Of those, 580 were Century Series fighters that were designed more for the limited maneuverability requirements envisioned in a nuclear scenario than for those needed for a conventional war.[86] While not designed for a conventional conflict, the abundance of those airframes, coupled with the luxury of time the U.S. had to modify fighter pilot training to cope with the air combat environment, allowed the Air Force to exercise a positive influence on U.S. military operations during that war.

The air war in Vietnam, coupled with Israeli air battles during the two Arab–Israeli conflicts,[87] reinforced lessons from previous wars on the need both for capable aircraft in sufficient numbers and for well-trained pilots. These lessons went on to affect the next series of U.S. fighter aircraft designs that could sustain high turn rates, engines that delivered markedly higher thrust, and training requirements and opportunities to give pilots the time they need in the air to master their employment.

Post-Vietnam and a Focus on the Cold War. In the early 1980s, the Air Staff crafted one of the service's most historically successful and enduring road maps. The USAF Strategy, Force and Capabilities Plan, which aimed to answer the question of what type of capabilities and structures the Air Force needed to meet national strategic priorities, would give birth to Air Force 2000, the Airlift Master Plan, and the Tactical Fighter Roadmap. Collectively, they spelled out how the Air Force would field the latest technology

TABLE 4

Reagan-Era Air Force Funding

FIGURES ARE IN BILLIONS OF U.S. DOLLARS		BUILD-UP						FUNDING REFOCUS		
	1981	**1982**	**1983**	**1984**	**1985**	**1986**	**1987**	**1988**	**1989**	**1990**
Personnel	40.5	41	41.9	42.2	53.9	54.6	55	53.9	52.8	51.7
O&M	45.4	46.9	49.6	51.2	54.2	53.6	53	54.7	56.7	56.3
Procurement	40.1	53.1	59	73.4	78.7	70.5	63	50.7	53.9	51.3
R&D	17.5	20.6	23.6	26.3	27.4	26.6	29	28	26.4	23.7
Military Construction	2.4	3.7	3.4	3.3	3.4	3.2	2.6	2.6	2.5	2.3
Family Housing	0.1	0.2	1.9	1.7	1.8	1.5	1.6	1.7	1.7	1.5
Management Funds	0.1	0.2	0.4	2.7	1.1	0.8	0.3	0.4	0.4	0.2
Total	**146.1**	**165.7**	**179.7**	**200.8**	**220.4**	**210.8**	**204.5**	**192**	**194.4**	**187**

NOTES: O&M—Operation and Maintenance. R&D—Research and development. Original figures from FY 1986 have been adjusted for inflation to 2019 dollars.
SOURCE: Office of the Assistant Secretary of Defense (Comptroller), "National Defense Budget Estimates for FY 1986," p. 127, https://www.esd.whs.mil/Portals/54/Documents/FOID/Reading%20Room/Selected_Acquisition_Reports/NationalDefenseBudgetEstimatesFY1986_March1985.pdf (accessed January 15, 2020).

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and grow capacity to reach the 40-wing fighter force enabled by the surge in Reagan-era defense spending.[88] They also explained the necessary research and development (R&D) priorities with respect to stealth and precision guidance technologies for Congress and defense pundits alike.

The plans were perfectly timed. As the Cold War escalated, manpower and acquisition strategies for NATO's defense of Europe became more focused on the increasingly capable Warsaw Pact, its highly mechanized ground forces, and the umbrella of overlapping SAM and radar-directed AAA systems that protected it. The layered defenses presented one of the most potent surface-to-air threat arrays ever assembled. When the Reagan-era funding arrived, senior Air Force leaders executed the associated strategies, ultimately buying the Air Force the capability and capacity required to thwart and then defeat an attack by the Warsaw Pact.

AirLand Battle Doctrine. The operational plan for the defense of Europe during the last years of the Cold War was based on the Army's AirLand Battle Doctrine. The doctrine stated that in order to thwart and then defeat a Warsaw Pact move on Western Europe, the U.S. would have to be

able to maintain the initiative through decisive maneuver and attack the assaulting force in depth, which included attacking logistic supply lines and command and control entities beyond the forward line of allied troops.[89]

In 1983, the Chiefs of Staff of the Air Force and U.S. Army co-signed an AirLand Battle memorandum of understanding titled "Joint USA/USAF Efforts for Enhancement of Joint Employment of the AirLand Battle Doctrine."[90] Although many believed it relegated the Air Force to a subordinate role similar to its role with relation to the Army in the 1940s, this memorandum was in fact an important step in the evolution of a joint warfighting approach as it forged a compromise between an Air Force with a 30-year focus on generating strategic effects and an Army that was pushing to obtain direct support from its sister service in a peer fight.[91]

Tactics were developed to counter Soviet integrated air defense systems (IADS) by flying at very low altitudes to deny acquisition and tracking radars time to detect and engage the jets. Through hundreds of hours of annual training, aircrews were able to master large force employment against a peer competitor. The concepts that were developed in the early 1980s were written in a way that won congressional support and, when coupled with the surge in Reagan-era defense spending, not only delivered to the Air Force the capability and capacity required to win the Cold War, but also would go on to serve as the backbone of the service for the next 40 years.

The Cold War ended without testing the premise of low-altitude employment, but the same tactics eventually were used to strike multiple protected compounds in Libya in 1986. During that operation, a force of 18 F-111Fs, accompanied by other supporting aircraft, struck multiple targets at night in Operation El Dorado Canyon. While the attack was successful, an F-111 was lost to SAM activity,[92] and that loss had repercussions. Coupled with the loss rates in the low-altitude structure in Vietnam and the results of several Red Flag exercises, it led the Air Force to consider the advantages of medium-altitude employment even in high-threat environments. Nevertheless, low-altitude attacks remained in vogue through the opening days of Desert Storm.

The Goldwater–Nichols Act, signed into law in 1986,[93] reorganized the Department of Defense to shift legal "command" authorities related to combat operations away from the service chiefs to the combatant commanders. The move accelerated efforts for joint interoperability and forced service chiefs to focus on organizing, training, and equipping their services for the needs of the warfighting combatant commanders. Removing the day-to-day focus on operations alleviated some of the backbiting and rivalries between the services, but it also had a subtle but insidious effect on the

balance between the immediate and near-term needs of the warfighter (now combatant commanders) and planning for the Air Force of the future.

Desert Storm. In August 1990, Saddam Hussein ordered the Iraqi military to invade Kuwait. Two years before the invasion, a book by Colonel John Warden on air campaigns had begun to earn favor with members of the Air Staff. Warden believed that there were situations in which airpower could theoretically win a war by striking an enemy's centers of gravity.[94] While he also pointed out that there were situations in which that was not possible, the scenarios in which it could be possible became the focus of the Air Staff, renewing the beliefs surrounding the ACTS doctrine from the 1930s suggesting that "airpower could do it all."[95]

In spite of giving new life to that erroneous notion, the effects-based operational plans born from those writings were employed during Desert Storm to great effect by the joint forces air component commander in support of the joint force commander's strategy.[96] While certainly air-centric during the first 45 days, it was perhaps the biggest step made in the modern era toward bringing the targeting needs of air, land, and naval component commanders together to prosecute a war.[97]

The timing of Hussein's invasion was fortuitous for U.S. forces, which were still near their peak in preparation for a possible war with the Soviet Union and its Warsaw Pact allies. During the opening day of the air campaign, the loss rate suffered by U.S. and coalition squadrons that chose to employ the same low-altitude attack tactics that were devised during the Cold War was much higher than the loss rate suffered by those that attacked from medium altitude. After assessing the results, the Air Force established a minimum altitude of 12,000 feet for the remainder of the war.[98]

Although this move certainly reduced aircraft losses,[99] higher-altitude weapons deliveries caused problems for target location and identification. Unguided munitions were not nearly as accurate at those altitudes, and the likelihood that clouds, haze, smoke, and high humidity would impede even guided munitions above 12,000 feet was much higher. Pound for pound, the "fully successful" hit rates for laser-guided bombs[100] were only marginally higher than those for unguided munitions.[101] Additionally, the majority of the pilots dropping guided munitions were not facing or reacting to air-to-air or surface-to-air threats, which would have further reduced their hit rates. Over the course of the 43-day air war, more than 224,000 munitions of all types would be expended, equating to more than 5,200 bombs a day, a rate that taxed U.S. bomb storage facilities worldwide.[102]

With few exceptions, air assets had free rein over Iraq, allowing them to strike centers of gravity, airfields, and fielded forces with devastating

effect for 39 days. The air campaign did not cause the Iraqi government to capitulate, but it did set the conditions for a ground offensive that would destroy the Iraqi ground force occupying Kuwait in just four days.[103]

Missile technology and training that had been refined during the Cold War paid huge dividends against a Third World air force. Paired against poorly trained and poorly motivated Iraqi pilots[104] flying generally dated equipment, the U.S. Air Force scored 32 aerial kills with improved versions of the radar-guided AIM-7 Sparrow and AIM-9 Sidewinder infrared-guided air-to-air missiles while suffering no air-to-air losses from the enemy.[105] The 14 USAF aircraft lost included 11 fighters, and 10 of the losses were to infrared-guided and radar-guided SAMs and three to AAA.[106]

The Iraqi IADS was considered formidable before the war, but in spite of the number of sites and components, its actual operating capabilities were limited. The system was designed to counter the capabilities and limited number of aircraft possessed by regional powers, but not the hundreds employed by the U.S. during the war.[107] The enhanced survivability of stealth platforms was proven in combat, as the F-117, used especially in the initial wave of attacks, was the only Air Force aircraft that sustained neither loss nor damage during the war.[108]

The mobilization, joint planning, execution, and sustainment of Desert Storm's air war was a resounding success, but it was a dividend of the concepts and road maps that delivered the most advanced aircraft and munitions that could be fielded, using funding provided by the Reagan Administration. Collectively, they delivered the kind of technology, exceptional training, and relevant capacity capable of defeating a peer, and when paired against a Third World adversary, the combination proved overwhelming. The lopsided victory and sheer dominance of airpower delivered a wave of expectations for quick, decisive "wars" with minimal loss rates that has shaped the tenures, expectations, and concepts that have emanated from the Air Force for the past 28 years.

D. Concepts and Doctrine 1994–2006. The Air Force generated more than nine concepts or vision statements from 1994–2006. The quick succession of documents came during a significant period of change caused first by post–Cold War downsizing and then by the change in mission sets from a high-end peer competitor fight with the Warsaw Pact to smaller-scale efforts in the Balkans and the global war on terrorism (GWOT). Each provided strategic guidance to cope with one or both of those challenges, but this paper addresses only those that had a lasting impact.

Blueprints for the Objective Air Force, published in 1990,[109] revisited the idea of basing several different types of squadrons such as transport, fighter,

and bomber together at a single location in "composite wings."[110] The idea proved (again) to be logistically unsustainable, and the composite wings that were created were dissolved over time. With the changing global order, it disbanded Strategic Air Command was disbanded and its assets shifted into Air Combat Command and Air Mobility Command.[111] While these major command (MAJCOM) moves have endured over the years, they did not reduce organizational overhead and did not increase the combat capability of the Air Force.

America's Air Force Vision 2020, published in 2000,[112] organized the Air Force into 10 Air Expeditionary Forces (AEFs), each with enough air superiority, strike, intelligence, and command and control assets to deal effectively with an area the size of Texas. One AEF would be on the hook for immediate deployment, leaving the others to enjoy a reset phase in a "tiered" system of readiness.[113] The service has since moved away from the idea of tiered readiness, but the effects of having just a third of the force ready to fight at any given time will take years to overcome.

The *U.S. Air Force Transformation Flight Plan*, published in 2004,[114] provided the R&D underpinning for capabilities and technologies that would lead to the Global Hawk, the F-35, and the B-21. While it was unable to stop the slide in the reduction of force structure (much less add to it), the plan facilitated the development of each of those systems, allowing follow-on administrations to fund and field those systems incrementally if funding became available.

Air Force Roadmap 2006–2025, published in 2006,[115] was an unsuccessful attempt to gain political backing to modernize and recapitalize an aging fleet during the drought in modernization funding caused by the GWOT. It was revised in 2008 to outline *where* future active-duty, Guard, and Reserve aircraft would likely be based. This congressional outreach strategy generated state-level political support for Air Force procurement based on the promise that the states (and their Guard units) would receive those aircraft.[116] Until the early 2000s, the Air National Guard and Reserve had been funded, regulated, and employed as a strategic reserve.[117] The Active Component fighter force structure was reduced in the mid-1990s, and partly out of necessity, the Reserve Component began to participate in the low-threat GWOT combat rotations. As the Active Component continued to downsize, that increased usage transformed the Reserve Component by necessity into an operational force and provided the justification and backing needed to buy the F-35A. The promissory notes are now being fulfilled, and ANG and Reserve units are receiving brand new F-35s simultaneously with the active-duty Air Force.[118]

E. Recent Concepts, Doctrine, and Planning Guidance. In 2015, seemingly on the cusp of new game-changing technologies, the service produced its *Air Force Future Operating Concept: A View of the Air Force in 2035*[119] and a companion *Strategic Master Plan*.[120] These concepts promoted a network of cyber, space, and air operations that would allow the service to move a generation ahead of competitor nations. It was envisioned that this network would deliver operational agility, flexibility, speed, coordination, balance, and strength across all domains.

Both plans were linked to a system-of-systems approach that includes the follow-on concepts of Next Generation Air Dominance (NGAD) and Penetrating Counter Air (PCA). NGAD *may* include a sixth-generation fighter like PCA, but it is conceived as a "network-connected family of systems" the components of which work together to ensure air superiority.[121] In the words of Major General David A. Krumm, Director of Air Force Global Power Programs, "It's not one thing; it's a multitude of things."[122] The problem is that plain language is a fundamental element of any successful concept, and such a formulation, while it may convey what those systems are intended to do, fails to spell out the composition of those systems. Even though the 2020 National Defense Authorization Act (NDAA) almost fully authorizes the continued development of NGAD,[123] the vagueness of the program and the assumption that lawmakers will just "get it" are two of the many reasons why concepts often fail.[124]

In 2018, the National Defense Strategy clearly stated the challenges of a strategic competition with China and Russia and provided direction to prepare for such challenges. This change means that the Air Force must now prepare for a large-scale, high-threat, high-intensity conventional war with peer-level competitors. It will be years before the implications of this change for Air Force structure, equipment, training, and organization become manifest.

Later that same year, the Air Force released *The Air Force We Need*, a bold strategic vision for the capacity and capabilities it would need to execute the NDS. TAFWN proposed to expand the size of the Air Force to meet the needs of Operational Plans within the new NDS and was based on thousands of iterations of war-game simulations that demonstrated the need for 74 additional operational squadrons comprised of, among other things, some 460 additional fighter, bomber, tanker, and airlift aircraft.[125] As with other concepts and plans like 1941's AWPD-1, 1953's AFM 1-2, and 1982's Air Force 2000, the timing of TAFWN's release was impeccable. It aligned perfectly with the 2018 NDS, published just six months earlier, and the

Trump Administration's surge in defense spending was still on the rise. The funding required to fulfill the plan and acquire seven additional fighter, five additional bomber, and 14 additional tanker squadrons and one additional strategic airlift squadron equates to more than $80 billion,[126] to be funded over several years.

Fortunately, recent budget increases make that entirely doable. If enacted, the President's budget for 2021 (PB 2021) will have increased Department of the Air Force (DOAF) total obligation authority (TOA) by close to $40.7 billion (32 percent) since fiscal year (FY) 2016. The DOAF could make a great deal of progress toward recapitalizing its fleet of aircraft and significantly increasing capacity if it chose to allocate a large portion of that money to procurement. Since the end of FY 2018 when TAFWN was announced, however, funding for procurement has remained relatively flat, going from $26.0 billion in FY 2019 to $25.4 billion with PB 2021, which means that the associated buying power has fallen with inflation. Research, development, test, and evaluation (RDT&E) funding, on the other hand, has increased by more than $11.3 billion, from $26.0 billion to $37.3, over those same years.[127] At no time in the history of the Air Force, from 1947 through FY 2017, did the budget for RDT&E exceed the budget for procurement, but it has done so every year since FY 2017.

In spite of the need to recapitalize and increase the capacity of the Air Force as spelled out in TAFWN, the Future Years Defense Program (FYDP) within the PB 2021 budget holds acquisition of the KC-46 steady at 15 aircraft a year and actually decreases procurement of the F-35 by 12 aircraft over the same five-year period. Funding priority remains with RDT&E, which in real terms will consume 22 percent of DOAF (blue) TOA. It is important to put those numbers in perspective and understand their potential repercussions.

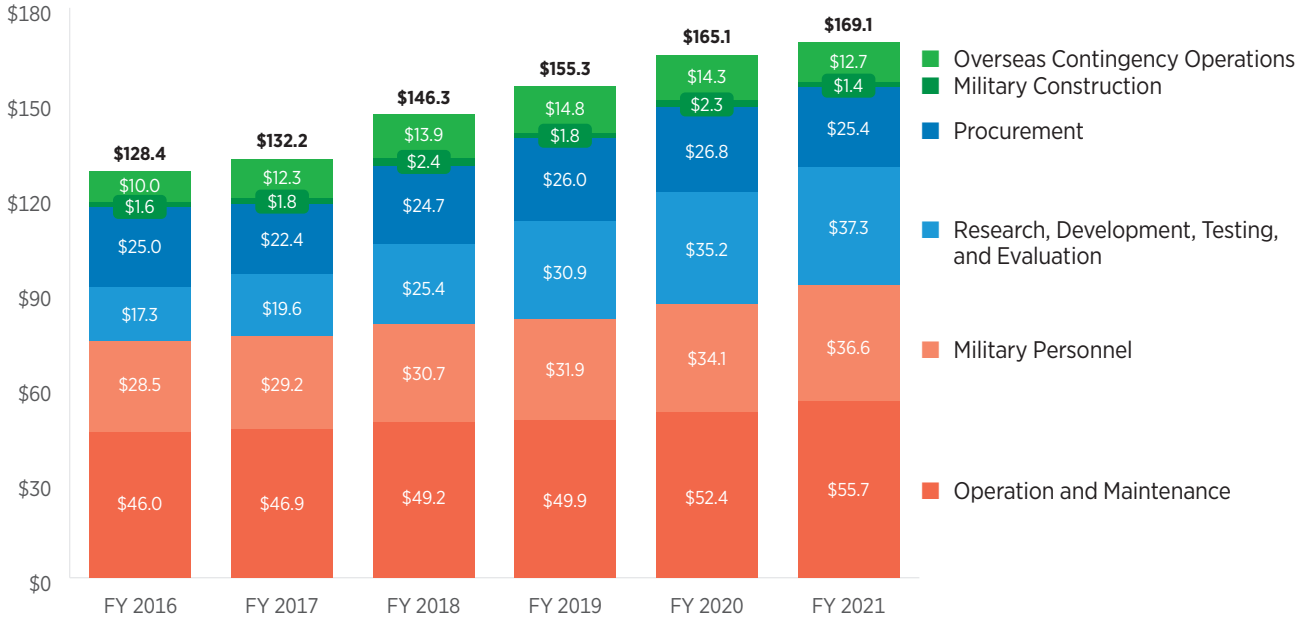
From 1962 through 2004, RDT&E averaged 13 percent of the annual Air Force budget. From 2005 through 2017, the highest RDT&E funding level within any budget as a percentage of DOAF (blue) TOA was 18 percent, but never did RDT&E exceed the department's expenditure for procurement.[128] From 2016 through PB 2021, the RDT&E budget has grown steadily from 15 percent to 22 percent.[129] Some will point to the B-21 as the culprit, but no other Air Force RDT&E budget—including during the peak developmental years for the F-15, F-16, A-10, F-35, F-22, and the B-2 bomber—has ever approached that level of investment.

It is perplexing to watch a service that since 2004 has stated and restated its need to recapitalize its fleet now turn from the opportunity when the funding is at hand. What appears to be driving the Air Force

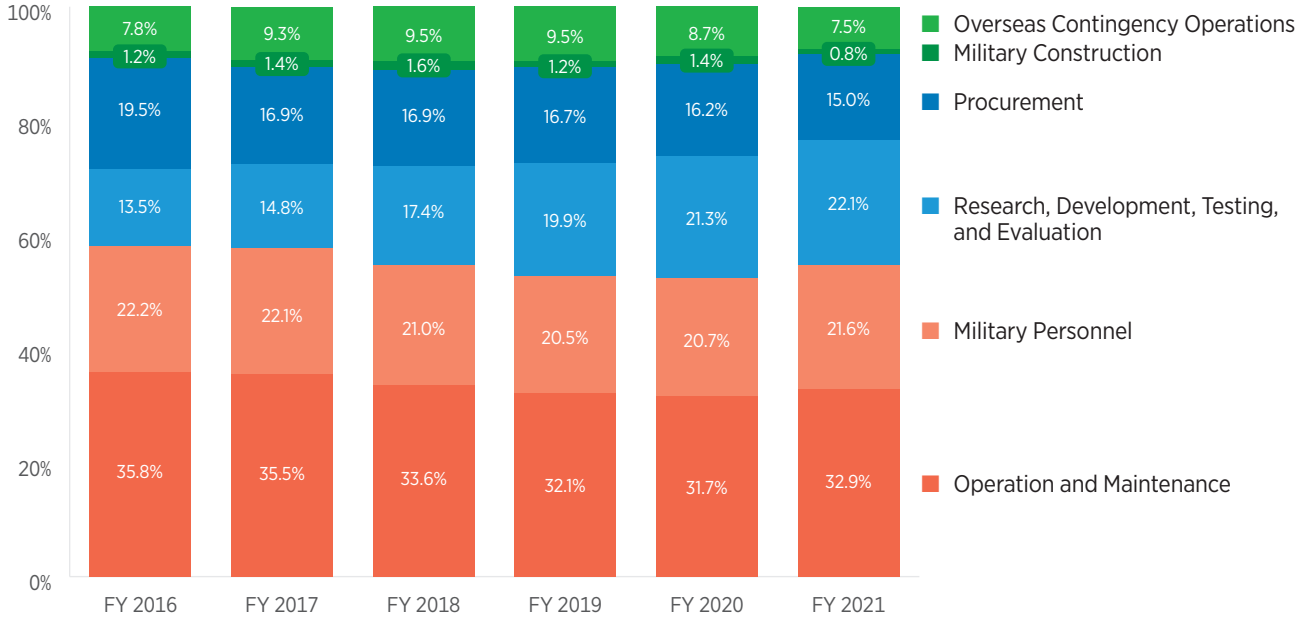
CHART 1

Department of the Air Force Total Obligation Authority

IN BILLIONS OF DOLLARS



AS A SHARE OF TOTAL



NOTES: Figures are by fiscal year and have been rounded. Figures for 2016–2019 are actual, and figures for 2020 are proposed.
SOURCE: Assistant Secretary for the Air Force for Financial Management and Budget, "Budget Overview," Fiscal Years 2016–2020, https://www.saffm.hq.af.mil/FM-Resources/Budget/ (accessed January 24, 2020).

to increase its RDT&E budgets is a belief that developmental programs like PCA, NGAD, and the Airborne Battle Management System (ABMS) will fundamentally revolutionize the way air combat is conducted. The history of warfare makes that unlikely, but assuming that those programs deliver capable and affordable endgame products and that commensurate funding for acquisition is made available, acquiring and fielding any of them in sufficient numbers will not likely be feasible until the late 2030s, if not well into the 2040s.[130] For this strategy to make sense, however, one would have to believe that the potential for conflict with a peer competitor is so low for that entire period that the Air Force can continue to wither and then somehow catch up when it needs to as long as it has the fruits of RDT&E in the wings. With a fighter fleet now averaging 29 years old, betting on a future Air Force that may (or may not) come to fruition 20 or more years from now is a huge wager.

The only concepts, doctrines, or long-range strategic plans that have successfully delivered significant capacity and capability were those paired with an Administration willing to fund them, and those funding periods were relatively short-lived. The Eisenhower surge in Air Force funding that began in the mid-1950s delivered an arsenal of nuclear weapons, a fleet of fighters that sustained the Air Force through the war in Vietnam, and a fleet of B-52s that are still in the arsenal today. The Reagan budget surge lasted six years before DOD funding gave way to other priorities, but from 1981 through 1987, the Air Force acquired or contracted for the vast majority of fighters that are still in its inventory today.

Funding cycles follow Administrations, and the two largest downturns were from 1987 to 2001 and from 2008 through 2016, equating to 20 of the past 32 years. The robust funding between those two periods was war-driven, not procurement-driven, and this effectively suppressed the fielding of extraordinary technologies now found in crushingly small fleets of the F-22A[131] and the B-2 bomber.[132] We are now entering the fourth year of the Trump Administration budget surge, and if history can be used as a guide and we assume a best case for DOD budgets, that funding surge could last another three years.

Betting that the Air Force can skip this cycle of technology and recapitalize and expand the fleet during the next funding cycle may prove to be too clever by half. The cycles in the evolution of technology have grown arguably tighter during the digital age, as has the ability of hostile nations to pilfer or otherwise compromise those advances through the Internet. The combination makes any perceived technological leap or advantage less, not more, likely to be the pillar of a winning strategy.

Deferring recapitalization is a high-risk proposition not only for the service, but also for the joint force and, ultimately, the nation. Without a significant change in budgetary priorities, *The Air Force We Need* will almost certainly wind up in the ever-growing bin of failed Air Force strategic plans and could very well put the United States in a situation in which it cannot come close to actualizing the 2018 NDS.

II. Today's Air Force: Choosing Future Capabilities over Current Readiness and Relevant Capacity

The challenges that lie ahead for the Air Force in 2040 will be significant. Nearly three decades of combat deployments, downsizing, and funding shortfalls have weakened the service's combat capability. A plan to refresh the service's fleet has been crafted, and Congress has provided commensurate funding, yet the Air Force is not moving to execution in spite of the fact that it is currently ill-prepared for a peer-level fight.

It is important to keep one overarching thought in mind: The Air Force of 2040 will be comprised of its current inventory of weapons systems as well as those that can be acquired from active production lines or that, like the B-21, are nearing production. The average age of the current fleet of aircraft is 31 years, and the service needs to acquire as many leading-edge weapons systems as it can while the funding is available.

The Air Force provides the nation with airpower that is globally vigilant, ready, and capable of responding to crisis situations quickly and effectively virtually anywhere in the world.[133] It maintains unrivaled strategic intelligence, surveillance and reconnaissance (ISR), airlift, and nuclear delivery capabilities, but its primary value to the nation is the ability to execute offensive and defensive air and space operations to defeat enemy command elements, fielded forces, and the infrastructure that supports them. That mission requires a force that, with little advanced warning, can rapidly deploy, fight, and defeat a regional threat or peer competitor anywhere in the world.

The costs and consequences of American engagement during the past three decades of low-threat operations are multifaceted. Air Force assets have been deployed constantly since Iraq invaded Kuwait in 1990 and have been engaged in continual combat operations since the onset of Operation Enduring Freedom in 2001. Throughout that time, the Air Force has been forced to effect gradual reductions in the size of its fleet of aircraft while flying its fighter, bomber, tanker, and ISR platforms at rates much higher than planned, using (and using up) those aircraft without the funding required for their appropriate recapitalization.

The danger of that inventory's becoming ineffective when paired against a peer competitor is now at hand. Funding for recapitalization through 2017 was minimal, but despite a technically dated and worn fleet of aircraft, the service has suffered few employment challenges, has enjoyed a low mishap rate, and has endured incredibly low combat losses. This has given rise to a misguided belief outside the service that it is still healthy and can go on without significant reinvestment. After years of fighting those expectations, it appears that this mindset has been embraced by the leadership within an Air Force that is now preparing to fight a different kind of enemy.

It is one thing for the Air Force to engage an adversary that has little ability to shoot back, as it has for the last 28 years; it is quite another to fight a nation-state that possesses capabilities that can challenge every perceived American advantage in the air and space domains. Building and sustaining the capacity and capability needed to fight and defeat a peer competitor requires a plan to increase readiness levels and to refresh and grow the service's fleet of aircraft with relevant capacity—systems with the most fieldable technology available in numbers that can fulfill standing Operational Plans (OPLANs) in support of the 2018 NDS. Understanding what is required in each of those areas begins with understanding how the Air Force has been winnowed down to its current state.

September 11, 2001. Shortly after the terrorist attacks on the World Trade Center and the Pentagon, the service moved to execute Operation Enduring Freedom and, later in 2003, Operation Iraqi Freedom, which rapidly morphed into the ongoing global war on terrorism. While shifting the priority to low-threat operations made absolute sense, the budgetary constraints imposed following the end of the Cold War, coupled with the reduction in the size of the service, made the shift a binary choice.

Unlike some of the other services, the Air Force did not benefit from an increase in capacity during the post-9/11 buildup. Instead, it got smaller as limited procurement of new aircraft was unable to offset the retirement of older weapons systems. In 2007, hoping to use the savings to acquire sufficient numbers of both the F-22A and the Joint Strike Fighter (JSF) to meet future warfighter requirements, the Air Force reduced manpower. The Pentagon's budget decision, known as Programmed Budget Decision (PBD) 720, cut a number of B-52s and several other dated systems from the Air Force inventory and reduced manpower by 40,000 personnel.[134] Unfortunately, the rate at which personnel deployed and then redeployed to the Gulf region (the operational tempo) only intensified while the money intended for the F-22A and JSF was consumed by other priorities.

In 2011, Congress passed the Budget Control Act,[135] significantly cutting the Defense Department budget without relieving the operational demand associated with combat operations in the war on terrorism. The cut in appropriations had an immediate effect on the funds available for flying operations. Deployed units commanded the priority for flying hours and the spare parts required to repair and maintain aircraft, and stateside units absorbed the brunt of the ensuing shortfall. The Air Force was forced to ground 50 percent (at the time, 18 of 36) of its active-duty, combat-coded squadrons temporarily in FY 2013 and reduced overall flying hours for the year by 18 percent.[136]

With fewer parts available for aircraft that were not involved in the fight, readiness levels across the service began to fall. To save money and preserve other resources, the Air Force moved to a three-phase cycle of readiness. Units and aircrews preparing to deploy to the fight flew at relatively healthy rates to prepare for the low-threat, low-intensity operations that they would be flying during deployment. Once deployed, those aircrews flew at much higher rates to meet the operational demand and tempo in Iraq, in Afghanistan, and later in Syria. On their return, they faced shortages of both spare parts and funding throughout the system that left them with pitifully few sorties and in very low states of readiness.

As draconian as they were, the cuts in readiness were not enough to balance the books, and the Air Force was compelled to reduce manpower even further. From 2012 to 2015, the active-duty Air Force cut another 14,000 airmen from its ranks, and the members most willing to separate from the service were the ones the Air Force needed the most: seasoned pilots, mechanics, specialists, and technicians. By 2016, the active-duty Air Force had a shortfall of 4,000 maintenance personnel and 873 fighter pilots.[137] The Guard and Reserve absorbed some of the reductions in force, but the vast majority of cuts were absorbed by the active-duty force because deeper cuts in the Reserve Component were deemed politically unfeasible.[138]

Shortfalls of spare parts and a shortage of aircraft maintenance personnel further reduced flying hours to the point where fighter pilots who once averaged more than 200 hours a year now struggled to get 120 hours in 2014,[139] and day-to-day training for a high-threat war with a near-peer competitor all but disappeared. At the same time, the demand from commercial airlines was growing. As the number of pilots choosing to leave the Air Force grew, the number of short-term temporary duty assignments levied on the non-deployed pilots snowballed; there simply were not enough pilots to handle everything that needed to be done. The result was a further erosion of retention.

Congress attempted to relieve the situation by supplementing DOD's budget through overseas contingency operations (OCO) funding, but it was not enough to offset the downward spiral in readiness and manning. That relief came with the 2016 presidential election, a National Defense Strategy that assigned top priority to preparation for a major conflict with China or Russia, and congressional support for the rebuilding of readiness to meet that challenge. From 2016 through 2020, the Air Force budget grew by 29 percent,[140] allowing the service to increase funding for operations and maintenance, manpower, and procurement. This infusion of funding helped to arrest the decline in readiness, but it will take years of sustained, properly allocated funding to rebuild Air Force capability and readiness to levels that can meet the demands of the 2018 NDS and dominate a high-end fight with a peer competitor.

New NDS. The National Defense Strategy issued by then-Secretary of Defense James Mattis in 2018 directed a major shift in focus for all of the services, but particularly for the Air Force. Both China and Russia are listed as great-power threats to U.S. interests, but the former is portrayed as the one of primary concern.[141] The strategy requires the services to be capable of penetrating dense anti-access and area denial (A2/AD) networks to strike key Chinese or Russian targets *from the beginning of hostilities*.[142]

Over the past 30 years, China and Russia have studied U.S. combat employment. During Operation Desert Storm, they watched the United States project a force of half a million people into the region over six months without hostile interference and then execute a strategy that delivered a rapid, low-casualty victory.[143] Assuming the U.S. could mobilize a force of similar size to fight a future conflict with either competitor, it would now likely have to deploy that force into a highly contested environment. Given the improving capabilities of China and Russia and the political-military objectives they would likely seize in such a scenario, the size of the force required would likely need to be much larger than the force employed by the U.S. in the Persian Gulf in 1991, and the associated costs would likely be far higher.

The NDS lays out the expectation that the U.S. and its allies will defeat or significantly stall such a move by either nation long enough to give the U.S. time to move other ready forces to the region and force the aggressor back into its own borders.[144] In light of the years of declining budgets and a singular focus on low-threat/low-intensity operations, the challenge that the NDS levies on the Air Force is huge, and the service, viewed in the context of great-power competition, is in a much deeper readiness hole than is immediately apparent.

A. Structural Readiness. Combat capability is a product of structural and operational readiness. Structural readiness concerns the amount (mass or capacity) of a nation's military power and how quickly that capacity can be made available. Operational readiness is the degree to which those units are capable of executing their mission, based on manning levels, equipment, and mission-essential training.[145]

At the end of FY 2019, the active-duty air force had a total of 329,100 active-duty airmen supporting 32 fighter, 10 bomber, 15 air refueling, and 12 strategic airlift squadrons.[146] The Guard and Reserve added 177,100 personnel and 23 fighter, one bomber, 22 air refueling, and six strategic airlift squadrons for a total force end strength of 506,200 airmen.[147] The Air Force is the only service that includes ARC capacity in its force structure numbers, and although the total capacity across the active-duty, Guard, and Reserve has been stated to be 55 fighter, 11 bomber, 32 air refueling, and 18 strategic airlift squadrons,[148] there are important caveats to those numbers with regard to size and individual levels of readiness.

Currently, there are 30 fighter, 10 bomber, 15 tanker, and 15 heavy airlift aircraft[149] in the average active-duty squadron of each type.[150] The 32 Air Force active-duty and four Reserve fighter squadrons are comparable in size, but the 19 Air National Guard fighter squadrons accounted for in current Air Force literature[151] are generally much smaller, averaging just 19 fighter aircraft per squadron. Leveling the size of an ANG fighter squadron with the size of a squadron in the active-duty force reduces the number from 19 to 14 squadrons for a total force capacity across all components of 50 fighter squadrons—five below the number stated in recent Air Force literature.[152]

B. Operational Readiness. The age of the average Air Force aircraft is now 31 years,[153] 12 years older than it was during Desert Storm.[154] Despite software and some hardware updates, the systems are now dated, and maintenance is very challenging. The vast majority of Air Force aircraft in the inventory today were purchased in the 1980s and early 1990s. Those aircraft have endured years of overuse and underfunding, as have the personnel required to keep them flying. The service estimates that it needs 350,000 active-duty airmen to execute its mission set.[155] It will add 4,400 more to its ranks by the end of FY 2020 for a total of approximately 333,000 personnel.[156] The maintenance shortfall of 4,000 personnel in 2016 has been resolved, but the service is still 2,000 pilots below its current manning requirements.[157]

The service has taken steps to increase pilot production by increasing the size of the pilot pipeline and lowering historic standards for graduation.[158] During the Cold War, flight school graduation rates hovered around

80 percent, but in recent years, the numbers have been consistently above 95 percent without additional pre–flight school screening.[159] That rate has been achieved by giving students the ability to fly graded sorties again and again if required until they demonstrate the skills required to pass them.[160] Unfortunately, high-threat combat environments are less forgiving and, because of the deadly nature of such engagements, do not allow marginal performers to repeat poorly executed tactics. Merely surviving in combat requires that pilots adapt to rapidly changing combat environments that are characterized by rapidly evolving enemy technology and tactics. Demonstrating the traits needed to thrive in such environments has historically involved flight training standards that are much higher than those currently in place.

While the service does not publicly release data on critical elements and capabilities related to readiness and pilot competency, the data surrounding the health of the fighter community are more readily available and are indicative of the health of the service's other weapons system components. Current details on fighter training, manning, availability of maintenance personnel, and the total number of aircraft indicate that the service is falling short in key areas. Coming to terms with its well-being will help to convey an understanding of just how ready today's Air Force is to meet the demands described by the NDS.

The tactics and types of weapons deliveries required while flying low-threat combat sorties over Iraq, Afghanistan, and Syria in a fighter are quite tame when compared to operations in a high-threat environment. By the standards within the fighter community, pilots often fly entire missions without a single hard turn or pulling more than 4 Gs.[161] The high-intensity training conducted during the Cold War involved tactics that required high levels of maneuvering throughout the flight envelope and flying in packages with other aircraft at or below 500 feet above ground level (AGL) where the potential for everything from bird strikes to collision with the ground goes up, reaction times are shorter, and the rate at which accidents occur (known as training sortie mishap rates) is higher. Preparation for flying in that demanding environment began with intense curricula and high screening rates in flight school and continued with every subsequent phase of training.[162]

The Air Force began to move away from low-altitude tactics to maneuvering and employment at or above 10,000 feet AGL following Desert Storm. Nearly simultaneously, the service reduced screening (failure) rates at Weapons School and fighter Replacement Training Units to almost zero. Flight school graduation rates varied from year to year during the 1980s,

TABLE 5

Air Force Major Command, Wings and Squadrons

Major Command	Wings	Flying/ ICBM Squadrons
Global Strike	8	24
Air Combat Command (ACC)	12	46
U.S. Air Forces in Europe—Air Forces Africa (USAFE-AFAFRICA)	5	11
Pacific Air Forces (PACAF)	8	20
Air Mobility Command (AMC)	12	35
Air Education and Training Command (AETC)	10	38
Air National Guard (ANG)	n/a	89
Air Force Reserve (AFR)	n/a	31

NOTE: International Institute for Strategic Studies, *The Military Balance 2019* (London: Routledge, 2019), pp. 55–57.

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but on average, less than 80 percent of those entering undergraduate pilot training earned their wings. By 1995, annual graduation rates for flight school were above 90 percent, and performance-related washout rates for schooling beyond that level were all but nonexistent.[163]

Over the past three years, graduation rates for basic flight school have averaged above 96 percent. Even with declining standards, training sortie mishap rates within the service have remained significantly lower than those of the 1980s because of the light employment demands involved in and padded (longer) reaction times associated with flying at medium altitude. In short, the current mishap rates are not a reliable indicator of either the quality or the capability of today's fighter force.

As the Air Force prepares for combat with a peer competitor, it must remaster the ability to operate throughout the air domain, to include moving in and out of the low-altitude structure at night.[164] More low-altitude training will likely increase the mishap rate, but attacking targets in a high-threat area will require novel and unpredictable tactics that at times will include low-altitude ingress. Stepping into that environment and accepting higher mishap rates incrementally during peacetime is clearly better than forcing pilots to adapt to that much more demanding environment in the throes of combat. Senior leaders should begin to make Congress aware of these training demands and their associated rationale,

based on the 2018 NDS, so that Members can be prepared for a potential increase in mishap rates.

Learning the ins and outs of high-threat fighter tactics requires the hands-on knowledge and detailed instruction handed down by ever-cascading generations of fighter pilots. Fighter pilots' faculties peak after seven years of fighter employment, and as those pilots cycle out, they pass their experience and mindsets on to follow-on generations. Two full generations of fighter pilots have come and gone since the last time Air Force fighter pilots faced air-to-air engagements in the relatively high-threat environment of Desert Storm.[165] Regaining that institutional knowledge and those individual faculties will take more years than one can accurately assess, but training to that end must begin immediately. Standards within and screening rates for flight school and every institution beyond that level must be viewed and elevated with that goal in mind.

To accommodate the need for higher performance standards, the Air Force should incrementally increase the capacity of flight school to handle 1,700 pilot candidates annually. This would allow the service to reestablish limits on curriculum "re-fly" or "X" sorties in each phase of training. Capacity within post–flight school training should also be increased to handle higher standards and rates of production. It will take several years of increases in pilot production across the system to end the active-duty pilot shortfall. When this shortfall is filled, the Air Force should use blended Active Duty and Reserve Component pilot commitments[166] to regulate total force pilot manning and ensure that the Reserve Component/Strategic Reserve shortfall is also filled.

Readiness Levels. Active-duty fighter squadrons are required to maintain readiness levels that allow them to deploy rapidly within days if not hours of notification, and they must be capable of employing in high-threat environments immediately upon arrival. In 2015, just four of 32 active-duty fighter squadrons were assessed as "fully mission capable" (FMC)[167] or ready for full-spectrum (high-threat) combat operations.[168] Those assessments were made not by external teams, but by the squadron commanders of the units themselves based on the additive metrics of aircraft mission-capable rates, aircrew and maintenance personnel qualifications, spare parts, and other readiness factors.[169]

Those metrics certainly add up to what units possess, but they in no way convey how ready those squadrons are to fight,[170] and few commanders are willing to step beyond those metrics to declare that they are not ready for a peer-level conflict. Assessments from within the service should be made by independent teams the members of which are trained for that specific

purpose. Attempting to score genuine readiness from outside the Air Force admittedly presents an enormous challenge,[171] but there are several solid indicators that can be assessed.

The service places a distinct value on the numbers and types of sorties that individual pilots need to accomplish in order to be considered "mission ready." Over its history, the service has determined that recent flight school graduates require 500 hours in a specific fighter to gain enough confidence to be considered "experienced."[172] Inexperienced pilots require a minimum of nine sorties a month, or slightly more than two a week, to be considered mission ready. Experienced fighter pilots require a minimum of eight sorties a month, or about two a week, to retain their status.[173]

Other unwritten guidelines that have been around for decades are even more important than sortie rates. When a pilot flies two sorties or fewer a week, his competence and confidence continually wane. Pilots flying three times a week can generally maintain the skills they had when they began the week, but those that fly four times or more a week seem to get better at everything.[174] Competencies at any level are perishable, and if those same pilots fall back to flying two sorties or fewer a week for several weeks in a row, most will lose that subconscious processing capacity and the employment confidence that comes with it.[175] Unfortunately, regaining those competencies and their associated employment confidence takes time.

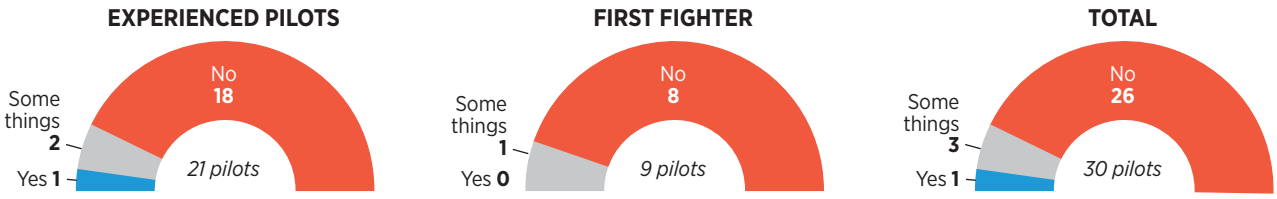
With funding increases, flying time and sortie counts for active-duty pilots edged up to an average of 16 hours per month and 2.4 sorties a week in 2018.[176] Fighter pilots need a minimum of three sorties a week[177] to be ready to meet the challenges detailed in the 2018 NDS. Some believe that high-fidelity simulators operating in a "live, virtual construct" in which multiple high-fidelity simulators are linked together (at times) with actual flying aircraft can offset or decrease that number, but when interviewed, just one of 30 pilots flying the most modern F-35 simulators in the Air Force believed that they offered a viable replacement for flying time.[178] Active-duty fighter pilots are still not getting what they need to be ready for full-spectrum combat against a near-peer competitor, even though their flying time already exceeds that of their peers in the Guard and Reserve.

Some might argue that combat-coded Guard and Reserve units maintain the same level of readiness and capability to deploy in response to a contingency operation[179] as their active-duty counterparts maintain. Historically, however, because of the part-time nature of their service, the number of sorties expected of Guard and Reserve fighter pilots has been lower than the number required of active-duty pilots. As a current example, inexperienced Air National Guard F-16 pilots are required to fly a minimum of eight

CHART 2

Can F–35 Simulation Replace Time in the Jet?

Q: "Do you believe flight time in the simulator is a viable replacement for time in the jet?"



SOURCE: John Venable, "The F-35A Fighter Is the Most Dominant and Lethal Multi-Role Weapons System in the World: Now Is the Time to Ramp Up Production," The Heritage Foundation *Backgrounder* No. 3406, May 14, 2019, p. 13, https://www.heritage.org/defense/report/the-f-35a-fighter-the-most-dominant-and-lethal-multi-role-weapons-system-the-world.

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sorties a month, 12 percent less than the nine required of those on active duty.[180] Experienced ANG F-16 pilots are required to fly a minimum of six sorties a month to remain mission ready, 33 percent less than the eight required of active-duty pilots. The ANG F-16 simulator requirements are also significantly smaller than those for the active-duty force: eight a year for both inexperienced and experienced Guard pilots versus three a month or 36 a year for active-duty pilots.[181]

While some pilots in Guard and Reserve units fly more than the minimum number of sorties required for mission-ready status, most, because of commitments in their full-time civilian jobs, are only able to make the minimum. Unfortunately, the Air National Guard faces other real-world limitations as well. Training to ready those units for the formidable air-to-air and surface-to-air-missile (SAM) threats from China and Russia requires flights over training ranges and/or sorties in robust flight simulators offering those types of threat replications,[182] but the Air Force did not fund or acquire enough high-fidelity simulators to outfit the ARC, and only a handful of Guard and Reserve units have regular access to training ranges or active-duty simulator facilities.

Recent training documents have not changed standing requirements for Air Force Reserve pilots, but as fielding decisions were being made for the F-35, the minimum number of sorties required for ANG pilots was adjusted to be in line with those of their active-duty counterparts. Both now require nine sorties a month for inexperienced pilots, eight sorties for experienced pilots, and three simulators a month for both categories of pilots. With the

average month having four weekends, the requirement for an experienced, part-time ANG fighter pilot will be 11 flying or simulator sorties (training events) in eight available training days—a demand that full-time active-duty pilots often find challenging to meet in 20 training days.[183]

Notably, due to the challenges that part-time fighter pilots face in trying to meet more demanding requirements, Air Force Reserve sortie requirements for the F-35 have remained constant at eight a month for inexperienced pilots and six a month for experienced pilots.[184] F-35As are now being delivered to Burlington, Vermont, the first ANG base to be so equipped, and while they may well prove capable of sustaining that operational tempo, if history and common sense are any guides, those rates will prove unsustainable for that squadron.[185] If these scarce fifth-generation fighter units fail to sustain the required training and readiness tempo, the Air Force will find them unavailable for the amount of time it takes to spin those units up to the readiness levels required to deploy and compete in a full-spectrum fight with a peer competitor.

The Air National Guard and Air Force Reserve are filled with airmen who are dedicated to their critical role as strategic reserves for the United States, and the Air Force has leaned heavily on them in recent years. However, because of the training limitations they face, weeks if not months of additional training would be needed before they could be employed responsibly during the first month(s) of a response to a Chinese or Russian military incursion into, for example, Taiwan or the Baltics. The associated high-threat environments that surround those regions are exactly what the F-35 was designed to take on, and placing those jets in the Guard or Reserve inventory would make them essentially unemployable during a conflict when they were most needed. Although delivery of the F-35 is already taking place at Burlington, the Air Force should adjust the subsequent bed-down schedule to prioritize forward-based active-duty units in the Pacific (Pacific Air Forces or PACAF) and Europe (U.S. Air Forces in Europe or USAFE).

The Air Force should initiate and Congress should engage in a national-level discussion on the purpose and future of the Reserve Component. Through its support of ongoing contingencies, the ARC has been stressed to the point where it is also facing retention challenges. Of the 2,000-pilot shortfall reported by the Air Force at the end of 2018, more than 1,100 were unfilled billets in the ARC.[186] When the United States genuinely needs a strategic reserve, it must be there to answer the call. Regaining stability in that force is therefore critical and will require both an active component large enough to meet ongoing demands within the 2018 NDS and returning the ARC to the operational tempo it enjoyed prior to 2001.

C. Force Disposition. Another significant aspect of readiness is geographic force disposition: how much of our combat power is positioned to respond immediately to a hostile move by a peer competitor from their home station and how rapidly the Air Force can increase regional force levels through rapid deployment. Today, the U.S. has just six Air Force fighter squadrons based in Europe[187] and a total of eight based in Japan and Korea.[188] During the Cold War with the Soviet Union, the U.S. had 29 fighter squadrons based in Europe and 14 more based in and around South Korea to keep North Korea in check. When combined, USAFE and PACAF alone had 43 combat-coded fighter squadrons—11 more than the total of 32 active-duty squadrons the Air Force has on its books today and just seven short of today's total force.

Today, the threat to the United States from Russia is not as great as the threat posed by the Soviet Union during the Cold War, but the threat posed by China is much greater and more capable than the one presented by North Korea during the same period. America's significantly smaller forward footprint puts a premium on the speed at which reinforcing units can deploy and be ready to fight in either region. Unfortunately, that capability has also withered with the years.

D. Deployability. At the height of the Cold War, fighter squadrons based in the Continental United States were tasked, trained, and graded on their ability to deploy rapidly, establish operations, and fight effectively in a survive-to-operate[189] environment. It is hard to fathom the full depth of that requirement, but there are basic elements that shed light on the associated challenges, beginning with packing and shipping the things those units will need in order to fight.

The process of packing up all of the required bags, tools, and equipment[190] is mastered only through repetition, which is its own challenge because units have to use much of the equipment they need to practice packing during their normal training regimens. Taking time to practice such an event therefore completely interrupts any normal training regimen. The planning, scheduling whitespace, and funding required to rehearse that process were overcome by execution of the GWOT mission more than 15 years ago, and the corporate memory of how to do this rapidly is now gone. Relearning it well enough to meet an emergency deployment order will likely take iterations of exercise over several years, and that process should begin immediately. One of the many big-picture things to be relearned is that, historically, it takes three active-duty squadrons to deploy two squadrons forward effectively.

Until the end of the Cold War, the Air Force organizational structure was based on a three-squadron wing. On any given day, units had several aircraft that were not flyable because of long-term inspections, deep maintenance, or the

need for spare parts. By using aircraft from one of the three squadrons to "plus up" the others, the wing could immediately deploy two full-strength units into combat. The handful of fully flyable jets and pilots left at the home station were then used to train new and inbound pilots up to mission-ready status so that, among other things, they could replace pilots that were lost during combat.[191]

Normal fighter squadron manning levels are based on a ratio of 1.25 aircrew members for every aircraft,[192] which means that a unit with 24 assigned aircraft should have 30 fully qualified pilots.[193] Flight times, sortie rates, mission planning teams, and flight supervision requirements are significantly higher in combat, and to cover those requirements, the manning ratio normally increases to 1.50 pilots per aircraft, or 36 pilots per squadron. In other words, every squadron deployed to fight requires six more pilots than it has on its roster.[194] Pilots from the "donor" squadron can fill those slots for the deploying units.

With the downsizing that has taken place since the end of the Cold War and the reduction in the number of fighter squadrons, the Air Force has reduced the number of fighter squadrons to two or even one in many wings, significantly complicating the math behind the number of deployable active-duty fighter squadrons. At best, the capacity associated with two out of every three squadrons can be considered deployable.

Those same challenges are levied on Guard and Reserve units, except that the vast majority of those wings have just one fighter squadron per wing, further straining their ability to muster the airframes and manning to meet an emergency deployment.[195] Planning for low-threat, low-intensity deployments to Operation Iraqi Freedom and Operation Enduring Freedom took this into consideration by mapping deployments out months (often years) in advance of the required movement. That allowed pilots to deconflict their civilian work schedules not just for the deployment, but also to get the training and time in the air that they needed to employ successfully in those low-threat combat operations.[196] Nevertheless, it was common for Guard units to pull pilots from other units in order to fulfill manning requirements to build "rainbow" fighter squadrons.[197]

Calculating the number of deployable Guard and Reserve squadrons that could be made available to meet an order for emergency deployment to a high-threat environment is at best an exercise in guesswork, but given the readiness and manning issues that have been addressed, two ANG squadrons would likely enable one to deploy forward.[198] However, it is hard to fathom how well those pilots would fare and what kind of attrition those units would suffer in an emergency deployment into a high-threat environment where there was no time to give them the training that they would need to thrive.

The fighter assets within the ANG and Air Force Reserve provide the United States with incredibly important reserves for a major confrontation with a near-peer adversary, but for the reasons stated, they should remain emergency reserves and be considered unavailable for the first weeks if not months of high-threat, high-intensity war with a peer competitor.

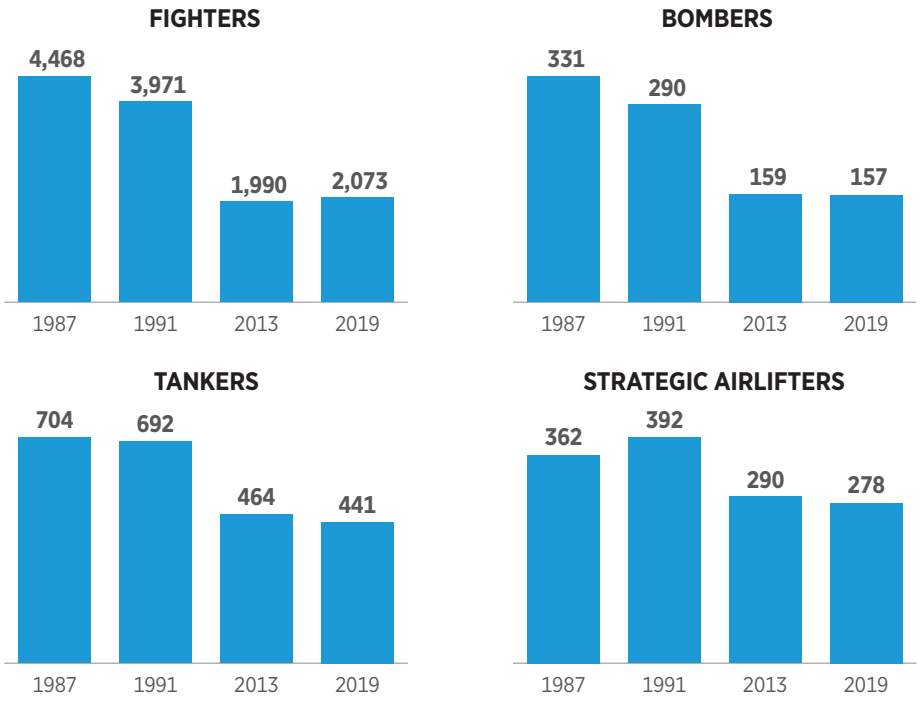
Advantages of the Second Offset. When the Air Force downsized following the Vietnam War, it followed an overarching Defense Department strategy called the Second Offset that "focused on conventional munitions with near-zero miss, precision-guided weapons and the joint battle networks that employed them." The "key drivers" of this strategy "were information technologies and the digital microprocessor that changed the game in terms of sensors and the weapons carried by our platforms."[199] The Second Offset was framed by the technological advantage that came with the Reagan buildup, which ultimately created a total Air Force fleet that was almost exactly twice the size of today's total force.[200]

When sequestration compounded the challenges levied by PBD 720 in 2012, the Air Force consciously chose to cut size (again) to sustain quality.[201] believing that money saved through reduced manpower costs could be reapplied to the acquisition of new planes, better maintenance, and enhanced training and readiness. None of this worked as intended, as those cost savings were absorbed by other demands. In the end, the Air Force certainly became smaller—well below the framework the Second Offset was meant to cover in a great-power competition—and lost significant ground in every area that it was hoping to sustain by taking those cuts.

Meanwhile, China and Russia have made their own advances in precision weapons development, stealth technology, and their own versions of joint force employment. Realizing that the advantages of the Second Offset had faded, senior leaders in the Obama Administration adopted the concept of a Third Offset, believing that perceived Western advantages in artificial intelligence and machine-to-machine learning[202] would somehow carry us through the next conflict with "even less" capacity: New technologies would make an even smaller military more capable than its larger predecessor. While the U.S. has been making advances in those areas, a competitive technological advantage has yet to materialize. China and Russia are pressing forward on similar paths, and their efforts, coupled with intellectual espionage to steal advanced technology being developed by the U.S. and other countries, will likely conspire to make whatever advantage we gain in this technological spiral short-lived. Without a marked technological advantage, relevant capacity and readiness will need to carry the day.

CHART 3

Changes to Air Force Capacity



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Whether taken individually or as a whole, today's Air Force does not have the capacity, capability, readiness, or deployability to execute the NDS successfully.[203] Recovering from that trough to blunt an attack on Taiwan or the Baltics and then drive the assaulting force back to the confines of its own borders will take a mindset that is focused on an all-out conventional war, along with supporting strategies focused on organization, capacity, funding, and acquisition.

E. Mindset. The realities of facing a conventional war with a peer possessing a numerical advantage and technology only slightly behind those of the United States are harsh, particularly in light of Air Force employment successes since the end of the Cold War. For more than 28 years, the Air Force has operated above the threat, flying higher than any enemy could threaten most Air Force aircraft, allowing the unfettered employment of munitions with exceedingly high hit rates, and all the while enjoying near-zero loss rates. Success of that kind cultivates a mindset similar to one the United States had when it entered its last war with a peer competitor.

Before World War II, airmen believed that the B-17 was nearly invincible and would enable the U.S. to win a war with Germany with high-altitude bombing, but the realities of fighting against a peer that was equally intent on winning shattered this illusion. Flying into a resilient, high-threat environment generated bombing miss rates that were 44 times prewar estimates[204] and aircraft and aircrew losses that are unthinkable by today's standards.

The U.S. Air Force has been flying above broken factions in Iraq, Syria, and Afghanistan with impunity while dropping precision weapons "on a dime" since 2001. In the process, many airmen have forgotten just how vicious the fight with a peer competitor can be. When great-power competition results in open warfare, it is unlike any other endeavor: Winning is everything, and hostile nations that choose to wage such a war will move to deny the U.S. every advantage they can, the first of which is timing.

The history of war shows that the advantage enjoyed by the country that acts first is hard to overcome. As was seen in the opening days of World War II or the start of the 1967 Arab–Israeli War,[205] initial losses to a surprise attack can be devastating. Should China or Russia initiate an attack, the U.S. military must have the ability to take the hit and respond quickly with overwhelming combat power, likely projected across vast distances. There will not be time for aircrews to gain proficiency, broken planes to be made ready, spare parts and munitions to be acquired, and all of the support assets necessary for offensive operations to be generated. The equipment and training required to thwart and then dominate the aggressor, as spelled out in the NDS, must be readily available. The Air Force would need to have a sufficient number of leading-edge platforms in place with crews already trained for the throes of all-out war—but that is not now the case in either Europe or the Pacific.

For example, a Russian move on the Baltics would be supported by fighter and bomber assets that could strike U.S.-allied facilities and combat

aircraft throughout Europe. The threat rings of Kaliningrad-based S-400s, the world's most advanced, most capable, and longest-range SAM system, envelop the Baltics, and penetration of that threat by fourth-generation fighters would be problematic at best.[206] Fifth-generation fighters would give NATO the ability to challenge a Russian assault on day one, but there are no U.S. F-35 or F-22s based in Europe, and USAFE is not scheduled to begin receiving the F-35 until 2021 (although Burlington is getting the platform now).[207]

Chinese IADS and the lack of forward-based fifth-generation assets in the Pacific would make a U.S. response to a Chinese move on Taiwan equally problematic.[208] John Warden has framed these situations in *The Air Campaign*, but it is hard to believe that he envisioned the U.S. and its allies being vulnerable to attack while also being unable to reach the enemy.[209] Remedying that imbalance begins with reorganizing the assets currently in the Air Force portfolio.

F. Organization. The Air Force is organized in five fundamental command levels that span all three Air Force components: Active, Air National Guard, and Air Force Reserve. There are approximately 3,300 squadrons,[210] organized under approximately 700 groups, 147 wings, 15 numbered air forces, and 11 Major Commands (MAJCOMs).[211] Span of control for any level, based on the mission set and the need to push decision authority down to the lowest level, is critical. Three levels that deserve scrutiny in this regard are MAJCOMs, wings, and groups.

Through years of downsizing, the service has reduced forward basing in PACAF and USAFE to the point where the number of operational squadrons that each theater controls is markedly lower than the number that other MAJCOMs have under their command. (See Table 5.) Consolidating these two MAJCOMs and most others into six or fewer "super" MAJCOMs[212] would make sense because MAJCOMs are not the warfighting commands. Reducing their number along with their supporting staffs might also reduce service overhead. In times of war, specified numbered Air Forces lead air and space assets as a warfighting Air Force component under the control of Combatant Commands (COCOMs). During Desert Storm, 9th Air Force, which is under Air Combat Command during peacetime, became the Air Component Command for U.S. Central Command (CENTCOM).

As it is, Areas of Responsibility (AOR) covered by PACAF and USAFE will still require more assets to adequately counter the threats in their regions. The small number of fighter squadrons based in both regions means that most of the airpower required to thwart a hostile move in either AOR is currently based in the United States. The distances that stateside-based

assets would need to fly to get to a fight in the Pacific are particularly daunting,[213] and as already noted, getting those squadrons mobilized during the opening moments of hostilities would be its own challenge. With likely mobility response times from the states measured in days or weeks rather than hours, both AORs require the basing of additional fighter assets to act as a deterrent during peace and to reduce response times during war. Permanently basing fighters at Main Operating Bases (MOBs) in the region would certainly elevate risk to those assets, as they would likely be within range of enemy weapons systems. To that end, those MOBs will require coverage of Patriot-like defensive systems before open conflict occurs.

PACAF should be assigned six additional fighter squadrons (for a total of 14) and should likewise be assigned priority to receive the majority of new F-35s coming off the production line until it has those fighter squadrons in place. Basing options should place those squadrons in Korea, Southern Japan, or another location within 1,000 miles (or one air refueling) of likely points of conflict such as Taiwan. Air refueling numbers will also need to be strengthened with the addition of two full squadrons of either KC-135s or KC-46s. USAFE should be assigned a minimum of six additional squadrons (for a total of 12), and all new units should be equipped with the F-35A.

The Air Force has long held the vast majority of space assets within the Defense Department, but the recently approved NDAA will remove those assets along with Air Force Space Command from the service to establish the Space Force. On the whole, this move will be a healthy one for the MAJCOMs that remain within the Air Force as well as for the service as a whole as it will allow them to focus on the mission that this service was formed to master—airpower—but the transition of the space mission and related assets, activities, and personnel will have to be carefully managed.

Wing Structure. The average operational fighter wing has fewer than three squadrons, and this both increases logistical support challenges during peacetime and reduces the ability to deploy sufficient combat power rapidly to the fight. For reasons previously noted, the Air Force should return to the three-squadron operational wing model for all combat-coded wings that must deploy forward to fight.

Group Structure. Between the wing and squadron columns depicted in Table 5 is an embedded group layer of command. Using total service numbers of 3,300 squadrons and 700 groups, there are five squadrons for every group commander across the Active/Guard/Reserve, fewer than three flying squadrons per group commander on active duty, and a ratio of just over 1-to-1 in the Guard and Reserve.[214] That level of supervision is inconsistent with pushing decision authority down to the lowest level and

TABLE 6

What the Air Force Says They Need

The Air Force has indicated they require 27 additional squadrons of operational aircraft, which is the equivalent of adding 482 aircraft.

Aircraft	Current Number of Squadrons	Additional Squadrons Needed	Resulting Additional Aircraft Needed
Airlift	53	1	15
Bombers	9	5	75
Fighters	55	7	182
Tankers	40	14	210
			Total: 482

SOURCE: U.S. Air Force, "The Air Force We Need: 386 Operational Squadrons," September 17, 2018, https://www.af.mil/News/Article-Display/Article/1635070/the-air-force-we-need-386-operational-squadrons/ (accessed March 9, 2020).

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giving more authority to squadron commanders.[215] The Air Force should cut the group command level from the standard wing structure[216] as it rebuilds capacity throughout the service.

Capacity. Operations in defense of any well-defended area in either Europe or the Pacific will require forward-based stealth fighters capable of executing missions on the first day of hostilities, stealth bombers capable of penetrating enemy IADS in number, and other bombers with the ability to launch stealthy stand-off munitions. But just how big a force does the Air Force need?

The size and composition of the Air Force were pitted against current Operation Plans (OPLANs) in a study commissioned by the Secretary of the Air Force, and the results were revealed in September 2018 when senior service leaders presented a force-sizing construct called *The Air Force We Need* (TAFWN). In comparing the current Air Force with the demands of OPLANs, analysts determined that the service is short 74 squadrons and needs to acquire one additional strategic airlift squadron, five additional stealth bomber squadrons, seven additional fighter squadrons, and 14 additional tanker squadrons. Given the average number of planes in each type of squadron, the Air Force needs approximately 15 more C-17s, 75 more B-21s, 182 more F-35s, and 210 more KC-46s than the current totals in each category.

Those requirements are sound, but they also appear to be based on a mindset that is more reminiscent of conflicts with high sortie success rates and low combat losses against an enemy with limited objectives. Betting that Chinese or Russian objectives would be limited in any scenario may prove to be as shortsighted as mid-1930s European estimates proved to be against Germany. While it would be challenging for the United States to build a force structure large enough to handle open warfare as it did during the Cold War, the Air Force does not get to decide how far either China or Russia might press an offensive move. If an all-out war were to break out in either the Pacific or Europe, the Air Force would need the mindset, capabilities, and capacity required not just to respond around the edges of a conflict, but to employ to win, fighting through potential losses that the U.S. has not witnessed in several generations of combat.

U.S. stealth technology currently gives the United States a competitive advantage against Russian and Chinese air defense systems, but that does not mean that stealth aircraft are invulnerable to attack. Enemy detection and targeting ranges are certainly reduced, but those jets are still vulnerable to a modern air defense network that includes fighter aircraft. During a night exercise in 1999, F-16s flying combat air patrols over a Nevada range complex were unable to detect stealth B-2 bombers with radar, but the pilots *were* able to detect them using night vision goggles and subsequently engaged and killed the bombers during the exercise.

For the near term, F-35s and F-22s will likely still dominate any fight that they have the range to reach, but unescorted B-2s and B-21s will be at risk from the time they enter an enemy's air defense system until they leave it. Future systems like air-to-air lasers may be in the works to give those bombers a level of self-protection, but over time, enemies will develop countermeasures, tactics, and technology to nullify those defensive systems just as the Germans did against the B-17 in World War II. In order to protect stealth bombers as they fly through critical threat regions, the Air Force should develop an escort capability that will require extending the range of stealth fighters. Along with its adaptive engine program to extend the range of fifth-generation fighters, the service should develop stealthy long-range, expendable, drop tanks that enable F-22s and F-35s to retain their full stealth signatures post-jettison.

During the next peer-level war, the United States will rely on its competitive technological advantage, but with surges in technology coming out of both Russia and China, it may find itself fighting a genuine peer working toward objectives that are not as limited as current war plans have presumed. If and when that happens, the United States Air Force will have

to fall back on the same fundamental elements of relevant capacity and exceptional training that saw the U.S. through World War II.

Appropriately prepositioned and rapidly reinforced, the Air Force's current capacity and capability would allow it to thwart an attack in either the Pacific or Europe. However, the Chinese are expanding every aspect of their military capability and capacity. China already has 2,786 fighter and attack aircraft[217] (92 active USAF fighter squadron equivalents) that would fight a home game with internal lines of communication and logistical support, while the U.S. would have to deploy its force several thousand miles from home, and only part of the total force would be able to deploy.

Assuming that the average active-duty wing is fully mission ready and that the "three fighter squadrons get you two" model remains valid, 32 fighter squadrons would allow some 21 to respond to a Russian or Chinese move. This is seven squadrons less than the "in place" force in USAFE during the Cold War, a force that required reinforcing to defeat the Warsaw Pact. Assuming that it will take two ANG and Reserve fighter squadrons to get one squadron forward deployed, the Active Reserve Component (ARC) would add another nine fighter squadrons to the fight some time later with nothing left in reserve. This equates to a total of 30 combat fighter squadrons that could respond to a fight with a peer and defend the homeland. That total is nowhere near the number required to dominate a fight with a peer competitor. In addition, there would be nothing left as a deployable reserve, the supporting structures would be markedly smaller, and the logistical supply lines would not go unchallenged. The United States needs to increase the size of that responsive fleet.

Given the ranges associated with Pacific region operations, the PACOM commander would rely heavily on an inventory of 157 total force B-2, B-1, and B-52 bombers,[218] which, according to *The Air Force We Need*, is already 75 bombers short of the number required to execute the 2018 NDS. The Air Force has already stated its intent to acquire 100 B-21s to fill that gap. Because of that system's "high level of technical readiness," the Air Force had expected the B-21 Raider to be IOC by October 2025, just 10 years after the contract was awarded to Northrup Grumman,[219] but the new bomber has yet to make its first flight. That event was to take place in 2020, but the date has slipped to what looks like 2022 at the earliest.[220]

The Air Force recently stated that the B-21 IOC will still occur in the late 2020s,[221] but if the developmental and funding history of the B-1 and B-2[222] can be used as a guide, the dates for the B-21 will likely slip several more times before the jet is fielded. The B-1 first flew in December 1974, and the Air Force accepted delivery of its first operational B-1 in 1985. It did not have

all 100 aircraft in the inventory until 1988—14 years after its first flight. The B-2 first flew in July 1989, and the last of those 21 bombers was delivered to the Air Force and the weapons system became IOC in 1997—eight years after its first flight. Because of the B-21 program's rapid acquisition construct, it may take even less time to bring the Raider up to IOC standards than it took for the B-2, but it will not likely occur until the late 2020s. Assuming that funding is made available, fielding that jet in the numbers required to support an OPLAN will likely not occur until well into the 2030s, and the Air Force will have to rely on B-1s, B-2s, and B-52s currently in its inventory to support any war plan through the mid-2030s.

The service will be tempted to retire the B-1 in the near term to make budgetary room for other assets like long-range strategic weapons,[223] but barring some fatal sustainability flaw in those aircraft, it would be foolish to do so. When the Lancer was designed, initial plans called for the acquisition of 244 bombers. The Carter Administration canceled the acquisition program after the jet's first flight, and when the program was revived under the Reagan Administration, just 100 B-1s were acquired.[224] Initial plans for the B-2 in the 1990s called for the purchase of 132 aircraft. The Secretary of Defense reduced the purchase to a total of 21 B-2s because of a perceived change in global environments and the need to fund other priorities.[225]

If the Air Force retires the B-1 fleet of 62 jets and/or the B-2 fleet of 20 jets in this decade, and if, sometime before fielding, the B-21 suffers the same cuts that the B-2 fleet endured, there will be no magical offset that can fill the gap in the bomber force we need. There are other assets in the inventory that, like JSTARS, will not survive a high-threat scenario at a range where they could be usefully employed and that should therefore be considered for retirement before any combat power, like the B-1, is retired. Retiring part or all of the fleet of 27 E-3 AWACS should be considered if capital becomes that tight. Those capabilities could easily be filled with current drone technology.

However, with the few exceptions noted in the first part of this paper, the timing for plans and concepts involving major acquisition strategies is rarely accompanied by commensurate funding as TAFWN is today. Congress has made funding available to execute TAFWN, at least in part, but the temptation to forgo execution of that plan based on the belief that future concepts will deliver even bigger gains appears to have taken hold. As noted, the Air Force has made big bets on technology-driven concepts like high-altitude precision bombing in World War II and nuclear weapons in the 1950s, and very few have delivered their promised affects. Concepts like NGAD, PCA, and the nearly complete situational awareness promised

with the ABMS may deliver huge gains in the future, and to a reasonable degree, their R&D should continue. But based on the Air Force's history of fielding new concepts and designs, none of them will likely become part of the inventory until the late 2030s, if they are fielded at all, and by the time they are fielded, any competitive advantage they offer will likely be short-lived.

Many of the fighters in the inventory today were acquired during the last years of the Reagan buildup. At best, assuming that the current surge in DOD funding also runs for six years, the Air Force has at most three years to refresh its technology and grow capacity because, by most estimates, funding in the years beyond that time will likely go down or level off. Funding cycles follow Administrations, and from 1987 to 2001 and 2008 to 2016, minimal non-contingency DOD funding suppressed the fielding of extraordinary technologies now found in the crushingly small fleets of the F-22A fighter and B-2 bomber. Because of the high levels of maintenance required on both aircraft, just 12 of the 20 B-2s and 72 of 138 combat-coded F-22s can fly combat missions at any given time.[226]

After more than 30 years of being unable to execute a concept or plan for significant recapitalization of its fleet of aircraft because of funding shortfalls, forgoing the opportunity to do so now while the money is available would be a mistake that both the Air Force and the nation would likely regret. The Air Force needs to execute the acquisition of the force structure detailed in *The Air Force We Need* now.

G. Funding. Defense Department budgets have increased significantly over the past four years. Now that Congress has passed the budget for FY 2020, it will equate to a topline Air Force funding increase of 29 percent over the past five years. When supplemental funding is excluded, the president's budget for FY2021 will increase the DOAF budget by 31 percent.[227]

The money to support significant recapitalization of the Air Force is in hand, as is the plan to spend it, but the service is not using this money for that purpose. As previously noted, the DOAF's budget for research, development, test, and evaluation increased from $35.2 billion to $37.3 billion in FY 2021. Up until 2018, the Department's largest budget for RDT&E was 17 percent of TOA, including Space. Excluding Overseas Contingency Operations, $37.3 billion equates to 24 percent of the department's TOA, marking an all-time-high for RDT&E, which now exceeds the budget for procurement by $11.9 billion. When Space is factored out, the Air Force budget for RDT&E in FY 2021 is $26.9 billion, equating to 19 percent of total Air Force TOA. As a point of comparison, both Microsoft and Apple spent $16.8 billion on R&D, equating to 13 percent and 6 percent of revenue,

respectively, in 2019. Despite having a fleet of aircraft that it acknowledges, through TAFWN, is not up to challenges articulated in the 2018 NDS, the service is electing to place its bets on a hope for future systems, commensurate future funding, and the time it will need to acquire those systems before any peer competitor makes a move requiring a U.S. response. The efforts being made to shorten developmental and procurement timelines should continue, but those goals should not be a reason either to ignore historic challenges and acquisition timelines or to forgo common sense regarding the need to build available, relevant capacity.

H. Acquisition. The technological and political machinations surrounding the acquisition of major weapons systems have become even more painfully slow than they used to be. The F-16, for example, was conceived in 1965 as an Advanced Day Fighter (ADF) that later morphed into the Lightweight Fighter concept. It took less than 10 years to move the F-16 through its acquisition process from the initial request for design proposals through flyoff and selection of the YF-16 over the YF-17.[228] The first operational F-16 arrived at Hill Air Force Base in 1978, a mere three years after final selection was made and only 13 years after the whole process was initiated.

By contrast, fielding for the last two major fighter aircraft acquisition programs did not begin until more than 20 years after they were conceptualized—twice the time it took for the F-16. It took more than 23 years for the F-22 to reach IOC[229] and more than 21 years for the F-35 to reach the same milestone.[230] The acquisition process rightly includes several checks that cause delays, but many of them are needed to ensure that the service does not rush to buy a system that is not ready for combat. Unfortunately, the bureaucratic maze has become so cumbersome over the past two decades that it is proving to be a hazard to itself in the sense that a weapons system takes so long to work through the system and become operational that it may no longer be viable.

Senior leaders currently pushing to reduce acquisition timelines are using commercial products like the iPhone as a model to be emulated. There, the vertical spiral in technology is so tight that companies must drive innovation and product turnover every year.[231] One major difference is that those annual updates are generally not revolutionary, but rather move on preferential systems that are appealing to the consumer.

The cell phone, for example, was revolutionary and became available in the late 1980s.[232] Subsequent iterations involved reducing the size and attractiveness of those handheld, mobile phones, but each upgrade fell short of the kind of "generational" change that would give cause for a new wave of acquisitions in the fighter or bomber world. The next major change came

some 20 years later with the iPhone and follow-on offerings that delivered a handheld mobile connection to phone, text, email, photo, web access, and personal organization.[233] Iterations since then have been beautifully marketed improvements in the same capabilities, but every upgrade has done little more than work around the edges of the same basic capabilities.

Nevertheless, with the technological spiral of an iPhone as a guiding premise and R&D expenditures at an all-time high, the Air Force appears to be convinced that it can drive acquisition timelines from concept to fielding new, groundbreaking major acquisition programs down to something approaching five years.[234] This might enable the Air Force to recapitalize its fleet with even newer technology before older weapons systems like the A-10, F-16, and F-15C begin to fail in the field or a move by a peer competitor requires a significant military response. However, given the current political situation with a deeply divided Congress, bringing the acquisition timelines down to those enjoyed by the F-16 would require a herculean effort. Even then, production would have to coincide with commensurate funding. With perhaps three years left in the current surge of DOD funding, the developmental efforts of NGAD, PCA, and ABMS would have to deliver their game-changing, fieldable technology before the end of FY 2022 to enable even partial recapitalization of the fleet.

If, on the other hand, the DOAF held Space RDT&E funding steady at $10.3 billion and reduced Air Force RDT&E to $21.1 billion (a still-robust 15 percent), it could increase Air Force procurement funding by $5.79 billion in PB 2021 alone. Holding those levels relatively constant over the FYDP would allow the service to increase acquisition of the F-35 easily from 60 jets in FY 2020 to 80 in FY 2021, 100 in FY 2022, and 110 in FY 2023, as well as to cover the military contracting required for bed-down and ramp up training pipelines to meet production demands.[235] It would also allow the service to fund and implement expedited fixes to the KC-46 refueling and cargo systems and begin to accelerate procurement of that critical enabler.

In the decades since passage of the Goldwater-Nichols Act in 1986, every Chief of Staff has tried to balance the immediate and near-term needs of the warfighter against the desire to shape the Air Force of the future into a truly revolutionary force. The service has not had the opportunity to sustain both efforts fully since the early 1990s, but under the current Administration, a genuine choice is at hand. While the temptation to bring on revolutionary change will always be present, the NDS makes it clear that the service can no longer wait to fix the capability, capacity, and readiness challenges that exist in today's Air Force. The Combatant Commanders need a ready, capable force, and the Air Force must move to field it now.

Reducing R&D expenditures and moving those funds to procurement would allow the Air Force to field 12 additional F-35 fighter squadrons over the next three years—enough to meet increased basing requirements in PACAF and USAFE, and then begin to add to ACC's inventory to get closer to the capacity Air Force the nation needs.

In the fall of 2018, the Secretary of the Air Force made a compelling case for the force structure the service needs to execute the 2018 NDS. Given the real-world restrictions associated with funding cycles and timelines associated with everything from concept design to acquisition to fielding, the Air Force that will be in place in 2040 will be made up largely of what is in its current inventory and whatever else it can afford to purchase from production lines that are either active or, like the B-21, already moving to that end. With that as underlying premise, the Air Force needs to acquire as many leading-edge weapons systems as it can now while the funding is available.

III. Integration and Experimentation

Integration. Historically, the effects that fielded forces can bring to bear have been enhanced through Air Force experimentation and Operational Test and Evaluation (OT&E) efforts. Those efforts were significantly curtailed during the years of decreasing budgets. Recently, however, the Air Force has worked with the other services to establish the Combined Operations Center–Nellis (CAOC–N).[236] This facility, located at Nellis Air Force Base in Nevada, is completely disconnected from the worldwide web or any other external network and is therefore able to conduct exercises and experiments with joint warfighting forces, weapons systems, and networks that otherwise would be rendered impossible by restrictions or security requirements.

By integrating the other services into CAOC–N, the Air Force can drive innovation and further integration for multi-domain operations (MDO) and joint all-domain command and control (JADC2). Here, small increases in situational awareness can pay big dividends in C2, streamlining execution across the board. The same is true with respect to coalition partners. It is imperative that they be included in these efforts, because if we leave them behind, we will lose their critical force capabilities and needed capacity in times of war.

The Air Force should continue to refine the operations and capabilities of current and future weapons systems as they move from concept to reality. One of the key players in that endeavor is the 422nd Test and Evaluation

Squadron, which is also located at Nellis. The 422nd has small numbers of the most advanced weapons systems in the Air Force that it flies to explore, evaluate, and refine operational concepts that span the depth and breadth of combat employment. Historically small in size and composition, this organization suffered deep cuts over the past three decades, even though OT&E requirements have skyrocketed.[237] This squadron and its parent organization (the 53rd Test Wing) need to be appropriately equipped, manned, and funded to maximize the potential within the weapons systems that will be fielded throughout the coming decades.

Experimentation. After years of individual and joint service R&D on directed energy and hypersonic technology, the Army is taking an operational approach to experimentation with both weapons systems. It will field a platoon-size "unit of action" of striker combat vehicles fixed with 50 kilowatt lasers, pushing a potential combat capability directly into realistic experimentation.

Hypersonic glide bodies have been co-developed by all three services. The first viable hypersonic "battery" is set to be delivered in FY 2023 and will include a command and control center along with four transporter-erector-launcher vehicles, each of which will carry two live rounds. The opportunity to experiment with those live systems will undoubtedly shape not just those individual systems, but also how they integrate with other joint direct and indirect fires as the capabilities of each system spiral in mobility, power, and range.[238]

The Air Force should observe those directed energy and hypersonic experiments closely to see how ground employment of those systems may complicate joint operational employment and how they might influence its own experimentation and fielding efforts.

The Air Force has taken a somewhat similar approach with major acquisition lots of the F-22 and F-35 to refine those individual weapons systems, but it should adopt an approach similar to the Army's unit of action and deliver early lots of combat aircraft and new weapons capabilities for those jets in unit of action "flights" of four aircraft to the 422nd Test and Evaluation Squadron. That squadron contains other combat platforms, and combining them during the early experimentation stage could offer significant benefits before those new systems are fielded operationally and then influence subsequent spirals. There is little doubt that hypersonic and directed energy weapons systems will elevate the requirements to compete in the air domain, but as has been the case with most other technological leaps, they are unlikely to be genuine game changers.

The Air Force should continue its development and experimentation efforts for manned and unmanned teaming, employing platforms like the XQ-58A Valkyrie. The Valkyrie is part of the service's Low Cost "Attritable" Strike Demonstration (LCASD) program[239] and is designed to operate in high-threat areas under the control of nearby manned aircraft. Rapidly prototyping such systems[240] in lots that permit genuine experimentation would allow the service to field systems faster and more capably than they would otherwise. Also, while the potential offered by Valkyrie and other developmental efforts is huge, they must remain affordable.[241]

IV. Summary of Recommendations

Capacity. The Air Force has an inventory of 50 total force, combat-coded fighter squadron equivalents. It would likely be able to mobilize a total of just 30 to fight a peer competitor, leaving nothing for homeland defense and no strategic reserve. The Air Force of 2040 will be comprised of the current inventory of weapons systems as well as those than can be acquired from active production lines or that, like the B-21, are nearing production. The Air Force therefore should:

- Move immediately to execute the plan detailed in *The Air Force We Need* (TAFWN) with emphasis on acquiring seven additional fighter squadrons, five additional bomber squadrons, and 14 additional tanker squadrons.

- Accelerate acquisition of the most modern and fieldable weapons systems currently available, to include 80 F-35s in FY 2021, 100 F-35s in FY 2022, and 110 F-35s in FY 2023 and 18 KC-46 tankers in FY 2021, 20 KC-46 tankers in FY 2022, and 22 KC-46 tankers in FY 2023.

- Increase respective aircrew and maintenance pipelines and military contracting with the goal of standing up or increasing the number of squadrons to the levels within TAFWN before standing units transition from dated platforms to new weapons systems.

- Bringing the B-21 Raider up to IOC standards and fielding that jet in the numbers required to support an OPLAN will not likely occur until well into the 2030s. This means that the Air Force will rely on the B-1s, B-2s, and B-52s currently in its inventory to support any war plan through the mid-2030s. The current fleets of B-1s, B-2s, and the KC-10s should be sustained until the service accepts the delivery of

sufficient B-21 and KC-46 aircraft and can fulfill the airframe requirements of TAFWN with those new systems.

Capability. The demands of the 2018 NDS require sufficient combat power positioned to thwart a move by either China or Russia with little to no warning. To meet these demands, the Air Force should:

- Adjust the bed-down schedule for the F-35 to prioritize forward-based active-duty units in PACAF, USAFE, and ACC over the Air National Guard.

- Assign PACAF six additional fighter squadrons and two additional air refueling squadrons (for a total of 14 and three, respectively). PACAF should receive priority for F-35s coming off the production line until it has those fighter squadrons in place.

- Assign USAFE six additional squadrons (for a total of 12). All new fighter units should be equipped with the F-35A, and USAFE should receive second priority for those fifth-generation fighters.

Readiness. The Air Force should regain robust levels of readiness at the aircrew, squadron, and wing levels. To this end, the Air Force should:

- Ensure that aircrews receive a minimum of three sorties a week, with those events increasing in complexity to include adversaries and robust IADS simulations.

- Significantly increase sortie rates and flying hours within the current fighter force (particularly the F-35) to enable more rapid development of experienced pilots to man additional squadrons.

- Form inspection teams, organized and trained to evaluate the ability of units to mobilize, generate, and fly combat sorties more rapidly, to assess wing combat readiness on a recurring two-year cycle.

- Enhance deployability by returning to the three-squadron operational wing model for all combat-coded wings that must deploy to fight.

- Increase the number of primary assigned aircraft in Air National Guard operational fighter squadrons from an average of 18 to 24.

- Return the ARC to its critical role as a strategic reserve for the United States and allow the Guard and Reserve to reset the health of their respective force structures.

Training. Air Force training must be revitalized to ensure that the force is prepared to fight a peer competitor in a high-threat environment. To that end, the service must:

- Incrementally increase the annual flight school capacity to handle 1,700 pilot candidates.

- Increase standards within and screening rates for flight school and the training pipelines beyond flight school that deliver ready aircrews to combat units.

- Ensure that aircrews remaster the ability to operate throughout the air domain, to include moving in and out of the low-altitude structure at night.[242]

Organization. The Air Force should:

- Consider consolidating its 11 Major Commands into six or fewer super MAJCOMs to reduce overhead and recoup manpower.

- Remove group command from its wing structure.

Acquisition. The Air Force should continue its efforts to shorten developmental and procurement timelines. However, it should also:

- Not ignore historic challenges or the need for rational checks and balances within that system to ensure that the service does not rush to buy a system that is not ready for combat.

- Not delay acquisition of fieldable systems in the belief that revolutionary changes in the acquisition timeline can deliver game-changing technology in time to fight a peer competitor in the next 20 years.

- Not buy into a Third Offset strategy and bet that perceived Western advantages in situational awareness, artificial intelligence, machine-to-machine learning,[243] or a game-changing technology can somehow

carry us through the next conflict with even less capacity than it currently possesses.

RDT&E. The Air Force should:

- Reduce but continue funding for Next Generation Air Dominance (NGAD), Penetrating Counter Air (PCA), and Air Battle Management System (ABMS).
- Continue reasonable funding for directed energy and hypersonic experiments.
- Continue developmental efforts for manned-unmanned teaming and employment concepts like the Low Cost "Attritable" Strike Demonstration program.
- Continue the Combined Operations Center–Nellis (CAOC–N)[244] initiative to further integration.
- Revitalize equipment, manning, and funding for the 53rd Test Wing and the 422nd Test and Evaluation Squadron.

Mindset. During the next peer-level war, the Air Force should:

- Be exceptionally well trained to dominate the technological spiral associated with fighting a peer competitor.
- Have the relevant capacity required to fight through potential losses that the U.S. has not witnessed in several generations of combat.
- Have the mindset required not just to respond around the edges of a limited conflict, but to employ to win in an all-out war.

Funding. The current Administration, in concert with Congress, has provided the funding required for the Air Force to begin enhancing its capability, capacity, and readiness to meet the standards in the 2018 NDS. To this end, the service should immediately:

- Reduce RDT&E funding from 22 percent of DOAF (blue) TOA to 18 percent.

- Shift the savings from that reduction to procurement, MILCON, and the ramp-up in training pipelines.

- Retire part or all of the fleet of 27 E-3 AWACS and replace that capability with drone technology.

Conclusion

The Air Force has the smallest number of combat squadrons in its history—less than half the number it possessed the last time the United States faced a peer competitor at the end of the Cold War. Because of readiness and mobilization challenges, today's Air Force would likely be able to deploy just 30 of 50 available total force fighter squadron equivalents to fight a peer competitor.

Although it would be challenging for the United States to build a force structure large enough to handle open warfare as it did during the Cold War, it is important to understand that the Air Force does not get to decide just how far either China or Russia might press an offensive move. If an all-out war were to break out in either the Pacific or Europe, the Air Force must have the mindset, capabilities, and capacity required not just to respond around the edges of a conflict, but also to employ to win, fighting through potential losses that the U.S. has not witnessed in several generations of combat.

The plan to build and sustain the capacity, capability, and readiness levels needed to fight and defeat a peer competitor resides in TAFWN, and the current Administration, in concert with Congress, has provided the funding required to bring it to life. The service needs to move immediately to acquire those systems and posture itself for the conflict on the horizon while that funding is available.

Endnotes

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5. Adapted from Cohen, *Air Force Strategic Planning: Past, Present, and Future*.
6. These numbers include Secretary Barbara M. Barrett; two Army Air Force Commanders (Generals Henry "Hap" Arnold and Carl Spaatz); and 21 Chiefs of Staff of the Air Force.
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9. See, for example, Michael Riggs, *Edicts of Ares: 13 Absolute Rules of Warfare* (Xlibris Corp., 2006).
10. Air Force Manual 1-2 was oriented toward nuclear deterrence and general war, suited to the strategy of massive retaliation. Warren A. Trest, *Air Force Roles and Missions: A History* (Washington: Air Force History and Museums Program, 1998), p. 175, https://media.defense.gov/2010/Sep/22/2001330059/-1/-1/0/AFD-100922-020.pdf (accessed January 16, 2020).
11. "But the Air Force had assumed that wouldn't be a problem—that its then-brand-new twin-seat F-4s would never even get into a close-range dogfight. Instead, the F-4s—and other Air Force and Navy fighters—would always destroy their enemies from long range, using the Sparrow and other air-to-air missiles." David Axe, "The U.S. Air Force Promised the F-4 Would Never Dogfight," War is Boring, July 6, 2015, https://medium.com/war-is-boring/the-u-s-air-force-promised-the-f-4-would-never-dogfight-3e1a66da4e73 (accessed January 16, 2020).
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14. In 1915, for example, Curtis Strange was flying a scout plane when he spotted, engaged, and fired on a German observation aircraft. After he emptied the ammunition from his machine gun's drum, Strange tried to exchange it for another, but the drum was frozen, so he stood up in the cockpit to get better leverage. Inherently unstable, the aircraft ended up flipping upside down, and Strange fell out of his seat and was lucky to find himself dangling from the machine gun's drum at altitude. He somehow managed to hook an ankle inside the padding surrounding the cockpit and then use the other foot to right the craft and return safely to his home field. Logan Nye, "This Famous Pilot Once Dangled from His Plane by the Machine Gun," We Are the Mighty, April 24, 2019, https://www.wearethemighty.com/history/ww1-pilot-dangled-machine-gun (accessed January 16, 2020).
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17. Robert L. Shaw, *Fighter Combat: Tactics and Maneuvering* (Annapolis, MD: Naval Institute Press, 1987), p. 277, http://falcon.blu3wolf.com/Docs/Fighter%20Combat-Tactics%20and%20Maneuvering.pdf (accessed January 16, 2020).
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20. The war gave birth to the tenets of Intelligence, Surveillance, and Reconnaissance (ISR); Offensive and Defensive Counter Air; Air Superiority; Close Air Support (CAS); and Command and Control (C2) that are integral parts of today's Air Force. Real-time operational C2 began with pursuit (fighter) control. Forward observation posts, enabled through a network of telegraph and phone lines, began to pass the location, altitude, and heading of enemy aircraft to pursuit squadrons positioned well behind the lines. The combination allowed pursuit aircraft to scramble, launch, and climb to advantageous positions to intercept adversaries before they could lay eyes on troop movements or reach their respective targets. Captain Eddie V. Rickenbacker, *Fighting the Flying Circus* (Garden City, NY: Doubleday, 1965), p. 44.
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25. Finney, *History of the Air Corps Tactical School, 1920–1940*, p. 68.
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80. Richard D. Gabbert and Gary B. Streets, *A Comparative Analysis of USAF Fixed-Wing Aircraft Losses in Southeast Asia Combat*, Air Force Flight Dynamics Laboratory *Technical Report* No. AFFDL-TR-77-115, Final Report for Period June 1974–March 1975, December 1977; declassified December 31, 1988; approved for public release June 14, 2002, p. 78, https://apps.dtic.mil/dtic/tr/fulltext/u2/c016682.pdf (accessed January 29, 2020).
81. The U.S. kill ratio for Korea was 10:1. The Israeli kill ratios for the 1967 Six-Day War, 1973 Yom Kippur War, and 2006 war in Lebanon, respectively, were 6:1, 20:1, and 87:0. Cooling, ed., *Case Studies in the Achievement of Air Superiority*, pp. 581, 597, and 601.
82. Estimate based on compilation of resources: Appendix B, "F-8 MiG-Killers," in Peter Mersky, *F-8 Crusader Units of the Vietnam War* (London: Osprey Publishing Limited, 1998), p. 101, https://epdf.pub/queue/f-8-crusader-units-of-the-vietnam-war.html (accessed March 11, 2020); Gabbert and Streets, *A Comparative Analysis of USAF Fixed-Wing Aircraft Losses in Southeast Asia Combat*, p. 78; and R. Frank Futrell, William H. Greenhalgh, Carl Grubb, Gerard E. Hasselwander, Robert F. Jakob, and Charles A. Ravenstein, *The United States Air Force in Southeast Asia: Aces and Aerial Victories, 1965–1973*, Albert F. Simpson Historical Research Center, Air University, and Office of Air Force History, Headquarters USAF, 1976, p. 157, https://www.afhistoryandmuseums.af.mil/Portals/56/Documents/Vietnam/aces_aerial_victories%20redu.pdf?ver=2016-12-30-095441-900 (accessed March 11, 2020).
83. These teams were made up of fighter aircraft that could detect the presence of a SAM system and bait it with aircraft that would get the system to use its target-tracking radar while other aircraft in the formation attacked it with anti-radiation missiles or unguided weapons.
84. Chris Hobson, *Vietnam Air Losses: United States Air Force, Navy and Marine Corps Fixed-Wing Aircraft Losses in Southeast Asia 1961–1973* (Hinckley, England: Midland Publishing; North Branch, MN: Specialty Press, 2001), pp. 270–271.
85. Gabbert and Streets, *A Comparative Analysis of USAF Fixed-Wing Aircraft Losses in Southeast Asia Combat*, pp. 78–83.
86. This was an effective loss of 9 percent of total production of the Century Series fighters. Ibid., pp. 81–82.
87. U.S. Central Intelligence Agency, *The 1973 Arab-Israeli War: Overview and Analysis of the Conflict*, Intelligence Report No. 75-16, September 1975, approved for release September 4, 2012, pp. 50 (training) and p. 32 (aircraft), https://www.cia.gov/library/readingroom/docs/1975-09-01A.pdf (accessed January 29, 2020).
88. Cohen, *Air Force Strategic Planning: Past, Present, and Future*, pp. 20–21.
89. Army Field Manual No. 100-5, *Operations*, Headquarters, Department of the Army, August 20, 1982, p. 1-1, http://cgsc.cdmhost.com/cdm/ref/collection/p4013coll9/id/48 (accessed January 29, 2020).
90. For the text of this memorandum, see Appendix 1 in Richard G. Davis, *The 31 Initiatives: A Study in Air Force–Army Cooperation* (Washington: Office of Air Force History, 1987), pp. 91–92, https://history.army.mil/html/books/106/106-1/CMH_Pub_106-1.pdf (accessed January 29, 2020).
91. See, for example, General Robert D. Russ, Commander, Tactical Air Command, USAF, "An Open Letter on Tacair Support," *Armor*, Vol. 97, Issue 3 (May–June 1988), p. 45: "Tactical aviators have two primary jobs—to provide air defense for the North American continent and support the Army in achieving its battlefield objectives." The same quote is also cited in Harold T. Gonzales, Lt. Col., USAF, *Tactical Air Support of Ground Forces in the Future* (Maxwell Air Force Base, AL: Air University Press, 1990), p. xiii, https://apps.dtic.mil/dtic/tr/fulltext/u2/a223270.pdf (accessed January 29, 2020), and sourced as Gen Robert D. Russ. USAF, "Open Letter to the Field," *AirLand Bulletin* 81-1, TAC-TRADOC ALFA (31 March 1988): 7, in ibid., p. xiv.
92. History.com, "U.S. Bombs Terrorist and Military Targets in Libya," This Day in History, last updated July 27, 2019, https://www.history.com/this-day-in-history/u-s-bombs-libya (accessed January 29, 2020).
93. H.R. 3622, Goldwater–Nichols Department of Defense Reorganization Act of 1986, Public Law 99-333, 99th Cong., October, 1, 1996, https://www.govinfo.gov/content/pkg/STATUTE-100/pdf/STATUTE-100-Pg992.pdf (accessed January 29, 2020).

94. John A. Warden III, *The Air Campaign: Planning for Combat* (Washington: National Defense University Press, 1988), p. 39, https://apps.dtic.mil/dtic/tr/fulltext/u2/a259303.pdf (accessed January 29, 2020).
95. Matt McKeon, "Joint Targeting: What's Still Broke?" Thesis presented to the faculty of the School of Advanced Airpower Studies, Air University, Maxwell Air Force Base, Alabama, for completion of graduation requirements, June 1999, p. 23, https://apps.dtic.mil/dtic/tr/fulltext/u2/a391813.pdf (accessed January 29, 2020).
96. Despite 39 days of bombing, the coalition still needed to launch a ground war to expel Iraqi forces from Kuwait. Deptula, "Effects-Based Operations," p. 13.
97. Ibid., p. 24.
98. Rob Sexton, "Gulf War 20th: The 20th Fighter Wing in Operation Desert Storm," Defense Media Network, February 6, 2011, http://www.defensemedianetwork.com/stories/gulf-war-20th-the-20th-fighter-wing-in-operation-desert-storm/ (accessed January 30, 2020).
99. U.S. General Accounting Office, *Operation Desert Storm: Evaluation of the Air Campaign*, GAO/NSAID-97-134, June 1997, p. 181, https://www.gao.gov/assets/230/224366.pdf (accessed January 30, 2020).
100. GPS-guided munitions had yet to be fielded.
101. Attacks deemed totally successful were 54 percent for laser-guided bombs and 45 percent for dumb bombs. Those percentages were calculated based on the tonnage of precision and non-precision expenditures rated "fully successful," divided by the total precision and non-precision tonnages dropped during the war. A total of 209,716 unguided and 14,659 guided bombs and missiles were expended during the 44-day war for a total of 224,556 munitions. The average "daily" expenditure was 5,219 weapons. U.S. General Accounting Office, *Operation Desert Storm: Evaluation of the Air Campaign*, p. 20.
102. The author was based at Kunsan Air Base, Republic of Korea, during Desert Storm and watched munitions from the base's stockpile load up and depart on C-5 after C-5.
103. R. T. Johnson, "Operation Desert Storm—The Ground War," The History Rat, February 3, 2011, https://historyrat.wordpress.com/2011/02/03/operation-desert-storm-the-ground-war/ (accessed January 30, 2020).
104. Paul J. Springer, "Iraq, Air Force," in *The Encyclopedia of Middle East Wars: The United States in the Persian Gulf, Afghanistan, and Iraq Conflicts, Vol. II: E–L* (Santa Barbara, CA: ABC-CLIO, 2010), p. 583, https://www.researchgate.net/profile/Priscilla_Roberts/publication/301764087_The_Encyclopedia_of_Middle_East_Wars_The_United_States_in_the_Persian_Gulf_Afghanistan_and_Iraq_Conflicts_5_vols_2_Awards_Choice_Outstanding_Academic_Title_for_2011_Booklist_Editors%27_Choice_2011/links/58eda44aaca2724f0a26df58/The-Encyclopedia-of-Middle-East-Wars-The-United-States-in-the-Persian-Gulf-Afghanistan-and-Iraq-Conflicts-5-vols-2-Awards-Choice-Outstanding-Academic-Title-for-2011-Booklist-Editors-Choice-2011.pdf?origin=publication_detail (accessed January 30, 2020).
105. One F-15C pilot downed an Iraqi MiG-29 by maneuvering his adversary into the ground, and two A-10s brought down two Iraqi helicopters with the jet's GAU-8 30mm cannon. Robert F. Dorr, "Gulf War 20th: F-15 Eagles Were the Deadliest Birds of Desert Storm," Defense Media Network, January 7, 2011, http://www.defensemedianetwork.com/stories/f-15-eagles-were-the-deadliest-birds-of-desert-storm/ (accessed January 30, 2020).
106. One loss was attributed to "Direct Enemy Action–Other." Table 203, "Desert Storm Total Coalition Combat Losses by Cause," in Gulf War Air Power Survey, *Gulf War Air Power Survey, Volume V: A Statistical Compendium and Chronology*, "Part I: A Statistical Compendium," 1993, p. 641, https://media.defense.gov/2010/Sep/27/2001329816/-1/-1/0/AFD-100927-065.pdf (accessed January 30, 2020). "The Gulf War Air Power Survey was commissioned on 22 August 1991 to review all aspects of air warfare in the Persian Gulf for use by the United States Air Force, but it was not to confine itself to discussion of that institution. The Survey has produced reports on planning, the conduct of operations, the effects of the air campaign, command and control, logistics, air base support, space, weapons and tactics, as well as a chronology and a compendium of statistics on the war. It has prepared as well a summary report and some shorter papers and assembled an archive composed of paper, microfilm, and electronic records, all of which have been deposited at the Air Force Historical Research Agency at Maxwell Air Force Base, Alabama." Ibid., p. v.
107. U.S. General Accounting Office, *Operation Desert Storm: Evaluation of the Air Campaign*, pp. 205–206.
108. Ibid., p. 20.
109. See Cohen, *Air Force Strategic Planning: Past, Present, and Future*, pp. 38–32.
110. Composite wings are comprised of several different types of aircraft, formed by mission sets and collocated so that those assets can train together. The logistical challenges associated with having just one or two squadrons of each type of aircraft at these wings made the concept too hard and expensive to sustain. Tyler Rogoway, "Remembering When the 366th Wing Was an Experimental Rapid Response 'Air Force in a Box,'" The War Zone, July 27, 2018, https://www.thedrive.com/the-war-zone/22447/remembering-when-the-366th-wing-was-an-experimental-rapid-response-air-force-in-a-box (accessed January 31, 2020).
111. Previously known as Tactical Air Command and Military Airlift Command, respectively. The *Blueprint* also folded Air Systems Command and Air Logistics Command into the new Air Force Material Command.
112. Cohen, *Air Force Strategic Planning: Past, Present, and Future*, pp. 38–41.
113. One AEF would be ready to deploy within 48 hours, and another four could be ready within 15 days. Cohen, *Air Force Strategic Planning: Past, Present, and Future*, pp. 40–41.

114. Cohen, *Air Force Strategic Planning: Past, Present, and Future*, pp. 43–46.

115. Ibid., pp. 47–49.

116. Ibid., p. 48.

117. Except during the Vietnam conflict, which saw no mobilization, a fact that some claim was a key component of the lack of popular support.

118. Hill Air Force Base was the first active-duty Air Force location to receive F-35As. The second bed-down location is the Air National Guard's 15th Fighter Wing at Burlington, Vermont.

119. Cohen, *Air Force Strategic Planning: Past, Present, and Future*, pp. 56–57.

120. Ibid. and U.S. Air Force, *USAF Strategic Master Plan*, May 2015, https://www.af.mil/Portals/1/documents/Force%20Management/Strategic_Master_Plan.pdf (accessed January 31, 2020.

121. John A. Tirpak, "Holmes Fights for NGAD as USAF Mulls Tough Budget Choices," *Air Force Magazine*, August 20, 2019, http://www.airforcemag.com/Features/Pages/2019/August%202019/Holmes-Fights-for-NGAD-as-USAF-Mulls-Tough-Budget-Choices.aspx (accessed January 31, 2020).

122. Dylan Malyasov, "U.S. Air Force Unveils Additional Details About Next-Gen Air Dominance Program," Defence Blog, August 8, 2019, https://defence-blog.com/news/u-s-air-force-unveils-additional-details-about-next-gen-air-dominance-program.html (accessed February 1, 2020).

123. Rachel S. Cohen, "Air Force Winners and Losers in the Draft 2020 NDAA," *Air Force Magazine*, December 11, 2019, https://www.airforcemag.com/air-force-winners-and-losers-in-the-draft-2020-ndaa/ (last accessed January 17, 2020December 18, 2019).

124. Theresa Hitchens, "Roper Unveils PEO for Next Gen Digital Planes; Critics Grumble," *Breaking Defense*, October 3, 2019, https://breakingdefense.com/2019/10/roper-unveils-peo-for-next-gen-digital-planes-critics-grumble/ (accessed February 3, 2020).

125. *The Air Force We Need* calls for one additional airlift squadron and five additional bomber, seven additional fighter, and 14 additional tanker squadrons. While the number of aircraft in any one of those categories varies from unit to unit, there are approximately 30 fighters, 10 bombers, 15 tankers, and 15 strategic airlift aircraft in each squadron. Mathematically, *The Air Force We Need* calls for 182 more fighters, 50 more bombers, 210 more refuelers, and 15 more airlift aircraft than the Air Force currently has in its inventory. U.S. Air Force, "The Air Force We Need: 386 Operational Squadrons," September 17, 2018, https://www.af.mil/News/Article-Display/Article/1635070/the-air-force-we-need-386-operational-squadrons/ (accessed March 5, 2020).

126. $80 billion is a rough estimate based on the need for 182 more F-35s (seven squadrons, 26 fighters per squadron, $80 million each); 50 more B-21 bombers (five squadrons, 10 bombers per squadron, $511 million each); 210 more KC-46s (14 squadrons, 15 tankers per squadron, $166 million each); and 15 additional C-17s (one squadron, 15 aircraft per squadron, $312 million each). The C-17 is no longer in production, but the numbers are provided as a reference. See Valarie Insinna, "In Newly Inked Deal, F-35 Price Falls to $78 Million a Copy," *Defense News*, October 29, 2019, https://www.defensenews.com/air/2019/10/29/in-newly-inked-deal-f-35-prices-fall-to-78-million-a-copy/ (accessed March 11, 2020); Colin Clark, "B-21 Bomber Estimate by CAPE: $511M a Copy," *Breaking Defense*, September 19, 2016, https://breakingdefense.com/2016/09/b-21-bomber-estimate-by-cape-511m-a-copy/ (accessed March 11, 2020); Exhibit P-40, "Budget Line Item Justification: PB 2021 Air Force," in U.S. Department of Defense, *Department of Defense Fiscal Year (FY) 2021 Budget Estimates, Air Force, Justification Book Volume 1 of 2: Aircraft Procurement, Air Force, Vol–1*, February 2020, pp. Volume 1-31–Volume 1-42, esp. p. Volume 1-32, https://www.saffm.hq.af.mil/Portals/84/documents/FY21/PROCUREMENT_/FY21%20Air%20Force%20Aircraft%20Procurement%20Vol%201_1.pdf?ver=2020-02-10-145310-973 (accessed March 13, 2020); and Colin Ritsick, "C-17 Facts: Everything You Need to Know," Military Machine, January 15, 2020, https://militarymachine.com/c-17-facts/ (accessed March 11, 2020).

127. These numbers are estimates based on the requirements presented by the Air Force within the President's budget for FY 2021. The funding levels approved in the 2020 NDAA and proposed in PB 2021 include Air Force and other agency (non-blue) dollar values.

128. Due to the inclusion of non-blue funding with Air Force TOA over numerous years, these data were extracted, compared, and analyzed from three different sources: Table 6-18, "Air Force TOA by Public Law," in U.S. Department of Defense, Office of the Under Secretary of Defense (Comptroller), *National Defense Budget Estimates for FY 2020*, May 2019, pp. 193–199, esp. pp. 196–198, https://comptroller.defense.gov/Portals/45/Documents/defbudget/fy2020/FY20_Green_Book.pdf (accessed February 4, 2020); *Budget Overview* pages for the respective years at U.S. Air Force, Financial Management and Comptroller, "Budget: Previous Years," https://www.saffm.hq.af.mil/FM-Resources/Budget/ (accessed February 4, 2020); and Lewis, *The U.S. Air Force Budget and Posture over Time*, p. 18.

129. Extracted from *Budget Overview* pages for the respective years at U.S. Air Force, Financial Management and Comptroller, "Budget: Previous Years." As an example, the data for FY 2020 were extracted from Table 1, "Air Force Budget Highlights Summary," in U.S. Air Force, Assistant Secretary for Financial Management and Budget, *United States Air Force Fiscal Year 2020 Budget Overview*, March 2019, p. 5, https://www.saffm.hq.af.mil/Portals/84/documents/FY20/FY2020%20Air%20Force%20Budget%20Overview%20Book%20Final%20v3.pdf?ver=2019-03-13-082653-843 (accessed February 4, 2020).

130. It took more than 23 years for the F-22 to move from concept to initial operational capability (IOC) and more than 21 years for the F-35 to reach the same milestone. Jeremiah Gertler, "F-35 Joint Strike Fighter (JSF) Program," Congressional Research Service *Report for Members and Committees of Congress*, April 23, 2018, pp. 1 and 11, https://fas.org/sgp/crs/weapons/RL30563.pdf (accessed February 1, 2020). Moving from first flight of the YF-22 to fielding the first fully equipped, IOC operational squadron took 15 years. Lockheed Martin, "First Flights: YF-22 First Flight," *Code One Magazine*, July 15, 2010, https://www.codeonemagazine.com/f22_gallery_video.html?item_id=142 (accessed February 5, 2020). The first production model of the F-35A "rolled out of the assembly" in 2006, and the first fully equipped fighter squadron reached IOC 10 years later in 2016. Lockheed Martin, "F-35 Lightning II: F-35 Program Timeline," https://www.f35.com/about/history (accessed February 4, 2020).

131. "The Air Force originally envisaged a production run of 750 F-22s. The figure was reduced to 648 in 1991. DOD's 1993 Bottom-Up Review reduced the planned number of production F-22s to 438 (plus 4 pre-production versions, later reduced to 2), which was enough to support 4 F-22 fighter wings in a total Air Force force structure of 20 wings (13 active; 7 Reserve/National Guard). The 1997 Quadrennial Defense Review (QDR) reduced the planned number of production F-22s to 339, which was enough to support three F-22 fighter wings in a 20-wing force structure (12 active; 8 Reserve/National Guard)." Although "[s]ome DOD documents show slightly different planned procurement totals," the "most commonly cited figure is 183." Jeremiah Gertler, "Air Force F-22 Fighter Program," Congressional Research Service *Report for Members and Committees of Congress*, July 11, 2013, p. 7, https://fas.org/sgp/crs/weapons/RL31673.pdf (accessed March 12, 2020).
132. The Air Force originally planned to procure 132 B-2 aircraft. That number was later reduced to 75. A total of 21 B-2s were actually fielded. Steve Pace, *B-2 Spirit: The Most Capable War Machine on the Planet* (New York: McGraw-Hill, 1999), pp 75–76.
133. Derived from vision statement in U.S. Air Force, "Air Force Mission," https://www.af.mil/About-Us/ (accessed February 5, 2020): "The United States Air Force will be a trusted and reliable joint partner with our sister services known for integrity in all of our activities, including supporting the joint mission first and foremost. We will provide compelling air, space, and cyber capabilities for use by the combatant commanders. We will excel as stewards of all Air Force resources in service to the American people, while providing precise and reliable Global Vigilance, Reach and Power for the nation."
134. Doug Troyer, "Program Budget Decision 720, Force Shaping: Why Now?" August 28, 2007, https://www.vance.af.mil/News/Commentaries/Display/Article/372321/program-budget-decision-720-force-shaping-why-now/ (accessed February 5, 2020).
135. S. 365, Budget Control Act of 2011, Public Law 112-25, 112th Cong., August 2, 2011, https://www.congress.gov/bill/112th-congress/senate-bill/365/text (accessed February 6, 2020).
136. John Venable, "Independent Capability Assessment of U.S. Air Force Reveals Readiness Level Below Carter Administration Hollow Force," Heritage Foundation *Backgrounder* No. 3208, April 17, 2017, p. 4, https://www.heritage.org/sites/default/files/2017-04/BG3208.pdf.
137. Will Skowronski, "Maintainer Misery," *Air Force Magazine*, Vol. 99, No. 11 (November–December 2016), https://www.airforcemag.com/article/maintainer-misery/ (accessed February 5, 2020), and Venable, "Independent Capability Assessment of U.S. Air Force Reveals Readiness Level Below Carter Administration Hollow Force," p. 8.
138. Interview with senior Air National Guard leader, November 20, 2019.
139. A level comparable to that of Soviet fighter pilots in the 1980s. When the numbers for units in all three phases were combined, the average fighter pilot flew fewer than two times a week. John Venable, "Fighter Pilots Aren't Flying Enough to Hone the Skills of Full-Spectrum War," *Defense One*, November 21, 2016, http://www.defenseone.com/ideas/2016/11/fighter-pilots-arent-flying-enough-hone-skills-full-spectrum-war/133328/ (accessed February 5, 2020).
140. See note 129, *supra*.
141. Ashley Townshend, Brendan Thomas-Noone, and Matilda Steward, *Averting Crisis: American Strategy, Military Spending and Collective Defence in the Indo-Pacific*, United States Study Centre at the University of Sydney, Australia, August 2019, p. 15, https://www.ussc.edu.au/analysis/averting-crisis-american-strategy-military-spending-and-collective-defence-in-the-indo-pacific (accessed February 7, 2020).
142. Elbridge A Colby, Director of the Defense Program, Center for a New American Security, "Testimony Before the Senate Armed Services Committee Hearing on the Implementation of the National Defense Strategy," January 29, 2019, p. 6, https://www.armed-services.senate.gov/imo/media/doc/Colby_01-29-19.pdf (accessed February 6, 2020).
143. Richard K. Betts, *Military Readiness: Concepts, Choices, Consequences* (Washington: Brookings Institution Press, 1995), p. 22.
144. Colby, "Testimony Before the Senate Armed Services Committee Hearing on the Implementation of the National Defense Strategy," p. 5.
145. Betts, *Military Readiness: Concepts, Choices, Consequences*, p. 39.
146. U.S. Air Force, Assistant Secretary for Financial Management and Budget, *United States Air Force Fiscal Year 2020 Budget Overview*, pp. 14 (number of active-duty airmen) and 5 (numbers of squadrons).
147. Ibid., pp. 13 (number of Guard and Reserve personnel); 38 (numbers of squadrons); and 5 (total force end strength). As noted, the endless string of deployments to the Middle East following 9/11 took a toll on the active-duty Air Force. To provide relief, the Air National Guard and Air Force Reserve stepped up and began to assume a portion of that rotational schedule. The move changed the paradigm for the Guard and Reserve (taken together, known as the Active Reserve Component or ARC) from a classic strategic reserve to a hybrid force that is now part of the force structure/planning construct for every aspect of leading-edge combat employment.
148. U.S. Air Force, "The Air Force We Need: 386 Operational Squadrons."
149. Classic active-duty squadron aircraft numbers generally include only primary aircraft assigned (PAA), which nominally includes 24 fighter, eight bomber, 14 tanker, and 14 airlift aircraft. Backup aircraft are those that are intended to be in a maintenance pipeline. Attrition reserve aircraft are procured specifically to replace the anticipated losses due to peacetime or wartime attrition. Michael Boito, Edward G. Keating, John Wallace, Bradley DeBlois, and Ilana Blum, *Metrics to Compare Aircraft Operating and Support Costs in the Department of Defense*, RAND Corporation, 2015, p. 27, https://www.rand.org/content/dam/rand/pubs/research_reports/RR1100/RR1178/RAND_RR1178.pdf (accessed January 30, 2020).

150. In order to make the comparisons relative, the numbers for all assessed years had to be standardized based on the average number of aircraft that each unit in the active-duty Air Force had in 2019 (30 fighter, 10 bomber, 15 tanker, 15 heavy airlift). Those numbers were calculated based on dividing the total number of aircraft for each category (fighter, bomber, etc.) by the total number of squadrons (training and operational) within the Active force and then multiplying that average number of aircraft by the number of active-duty combat-coded squadrons.
151. Open-source research reveals that there are 21 combat-coded squadrons in the Air National Guard—an unresolved conflict between that research and the numbers stated in *The Air Force We Need*. Those units include the following unit designators and locations: 112th FS (Toledo); 104th (Warfield); 107th (Selfridge); 112th (Toledo); 119th (Atlantic City); 120th (Buckley); 121st (Andrews); 122nd (New Orleans); 123rd (Portland); 125th (Tulsa); 131st (Barnes); 157th (McEntire); 159th (Jacksonville); 163rd (Fort Wayne); 175th (Sioux Falls). 179th (Duluth); 190th (Boise); 194th (Fresno); 199th (Hickam); 377th (Montgomery); and 378th (Truax Field). The 315th at Burlington is in transition to the F-35A and is not included in the total number.
152. There are approximately 414 combat-coded fighters across the ANG. Leveling those numbers with an active-duty squadron that averages 30 jets equates to 13.8 fighter squadron equivalents. *The Air Force We Need* states that the Air Force has 55 "total force" fighter squadrons. U.S. Air Force, "The Air Force We Need: 386 Operational Squadrons."
153. Table, "Total Force Average Aircraft Age (as of Sept. 30, 2018)," in "USAF Almanac 2019," *Air Force Magazine*, Vol. 102, No. 6 (June 2019), p. 59, https://www.airforcemag.com/PDF/MagazineArchive/Magazine%20Documents/2019/June%202019/0619_Equipment.pdf (accessed March 12, 2020). Eighteen months have been added because of the difference between the aircraft data capture dates for the 2019 USAF Almanac and publication of this paper.
154. Table E-15, "AF Average Age Trends (Regular Air Force, Air Force Reserve, & Air National Guard," in Assistant Secretary of the Air Force (Financial Management and Comptroller of the Air Force), Deputy Assistant Secretary (Cost and Economics), *United States Air Force Statistical Digest, Fiscal Year 2003*, p. 108, https://www.afhistory.af.mil/Portals/64/Statistics/2003%20USAF%20STATISTICAL%20DIGEST.pdf?ver=2017-04-28-100502-240 (accessed March 12, 2020).
155. Stephen Losey, "Air Force: 29,000 More Airmen Needed to Fill Critical Manning Gaps," *Air Force Times*, December 23, 2016, https://www.airforcetimes.com/news/your-air-force/2016/12/23/air-force-29000-more-airmen-needed-to-fill-critical-manning-gaps/ (accessed February 7, 2020).
156. U.S. Air Force, Assistant Secretary for Financial Management and Budget, *United States Air Force Fiscal Year 2020 Budget Overview*, p. 5.
157. Stephen Losey, "The Air Force Still Has a Serious Maintainer Staffing Problem, GAO Says—but No Strategy to Fix It," *Air Force Times*, February 8, 2019, https://www.airforcetimes.com/news/your-air-force/2019/02/08/the-air-force-still-has-a-serious-maintainer-staffing-problem-gao-says-but-no-strategy-to-fix-it/ (accessed February 7, 2020), and Headquarters U.S. Air Force, Deputy Chief of Staff for Operations, written response to Heritage Foundation request for information on Air Force manning levels, June 10, 2018.
158. The Air Force is projecting 1,300 flight school graduates in FY 2019 and 1,480 in FY 2020.
159. The graduation rates for 2016, 2017, and 2018, respectively, were 93 percent, 98 percent, and 97 percent. See *2020 Index of U.S. Military Strength*, ed. Dakota L. Wood (Washington: The Heritage Foundation, 2020), p. 421, https://www.heritage.org/sites/default/files/2019-11/2020_IndexOfUSMilitaryStrength_WEB.pdf, and John Venable, "A Plan for Keeping the U.S. Air Force's Best Pilots in Service," Heritage Foundation *Commentary*, November 14, 2017, https://www.heritage.org/defense/commentary/plan-keeping-the-us-air-forces-best-pilots-service.
160. Interviews with more than 20 recent flight school graduates now flying the F-16C and F-35A, conducted at Spangdahlem Air Base in Germany and Hill Air Force Base in Utah from 2016 through 2018.
161. One "G" is the natural force of the Earth's gravity. When a fighter makes a hard turn, the force a pilot experiences is measured in multiples of that force. Collectively, a pilot's head and helmet weigh approximately 20 pounds under 1 G. Under 4 Gs, a pilot's neck experiences the weight of 80 pounds. Under 9Gs, that weight rises to 180 pounds.
162. Venable, "Independent Capability Assessment of U.S. Air Force Reveals Readiness Level Below Carter Administration Hollow Force," p. 7.
163. Ibid.
164. Written correspondence with senior U.S. Air Force leader, December 8, 2019.
165. Venable, "Independent Capability Assessment of U.S. Air Force Reveals Readiness Level Below Carter Administration Hollow Force," pp. 5–6.
166. As an example, pilot candidates would sign up for an eight-year commitment to active duty and a two-year commitment to fly with the ARC, or even six years active duty and four years with the ARC.
167. The term "full(y) mission capable" (FMC), or C-1, means that a unit is capable of executing all of its wartime missions.
168. Venable, "Independent Capability Assessment of U.S. Air Force Reveals Readiness Level Below Carter Administration Hollow Force," p. 2.
169. Ibid.
170. A Formula One racing group may possess the personnel, cars, parts, and pieces required to be a team, but that in no way means that it could compete effectively against a team that has repeatedly executed the building-block subtasks and then tested them all together on a track for time.

171. One of the metrics that squadron commanders use to evaluate unit readiness is participation in a Red Flag (or equivalent) exercise every two years. Although some may argue that they are the equivalent of a full-up wartime capability test, those war games exercise only a fraction of what it takes to prepare a unit for war. Among many other things, because deployments to those exercises are planned months or years in advance, the equipment can be assembled for deployment over weeks if not months. The pace of play throughout a Red Flag and every sortie therein is methodical; mission durations are much shorter than those that would be experienced fighting Russia or China, which means short crew duty days and lower (qualified) manning requirements; there are no combat turns, no battle damage repair requirements, no combat losses, no unit survival to operate exercises, no losses of power, and no mission planning cells; wartime command and control requirements at the wing and squadron levels are not exercised; and there are no evaluations associated with any facet of those exercises. Red Flags are important for aircrew training, but they cannot be taken as a reliable indicator of a unit's ability to deploy and employ successfully under combat conditions.
172. Albert A. Robbert, Anthony D. Rosello, Clarence R. Anderegg, John A. Ausink, James H. Bigelow, William W. Taylor, and James Pita, *Reducing Air Force Fighter Pilot Shortages*, RAND Corporation, 2015, p. 8, https://www.rand.org/pubs/research_reports/RR1113.html (accessed January 30, 2020).
173. The numbers have fallen from 9.6 sorties a month for inexperienced active-duty pilots and eight a month for experienced active-duty pilots in 1998 to nine a month for inexperienced and eight a month for experienced active-duty pilots in 2019. U.S. Air Force, Air Force Instruction 11-2F-16, Volume 1, "Flying Operations: F-16—Aircrew Training," May 1, 1998, p. 11, https://f22oma.pagesperso-orange.fr/Download/Pratique/11-2f-16v1.pdf (accessed February 10, 2020); HQ ACC/A3T, F-16 Blk 25-42 Ready Aircrew Program (RAP) Tasking Memorandum, October 1, 2019 (not available online); and HQ ACC/A3T, F-35A Ready Aircrew Program (RAP) Tasking Memorandum, October 1, 2019 (not available online).
174. When a pilot flies four times or more a week, flipping switches, calling up displays, and complex tasks like air-to-air refueling are so well practiced that they can be executed almost without thinking, allowing the pilot to remain focused on dominating the fight. John Venable, "The F-35A Fighter Is the Most Dominant and Lethal Multi-Role Weapons System in the World: Time to Ramp up Production," Heritage Foundation *Backgrounder* No. 3406, May 14, 2019, p. 16, https://www.heritage.org/defense/report/the-f-35a-fighter-the-most-dominant-and-lethal-multi-role-weapons-system-the-world.
175. Venable, "Independent Capability Assessment of U.S. Air Force Reveals Readiness Level Below Carter Administration Hollow Force."
176. *2020 Index of U.S. Military Strength*, p. 423.
177. Chart 12 in ibid., p. 423, and Venable, "A Plan for Keeping the U.S. Air Force's Best Pilots in Service."
178. Venable, "The F-35A Fighter Is the Most Dominant and Lethal Multi-Role Weapons System in the World," p. 13.
179. Senior leader engagement on training, Headquarters U.S. Air Force, Pentagon, June 27, 2019.
180. Inexperienced Air Force Reserve pilots must fly a minimum of 10 sorties a month to be considered mission ready. That requirement used to be the same for active-duty pilots, but over the years of funding cuts, it was reduced to a minimum of nine sorties a month for inexperienced pilots. The Air Force should return the active-duty requirement to a minimum of 10 sorties a month for inexperienced pilots.
181. The simulator requirements for active duty are three sorties a month for both experienced and inexperienced F-16 pilots. The Guard and Reserve requirement is two sorties a month (50 percent lower) for both categories of pilots. HQ ACC/A3T, F-16 Blk 25-42 Ready Aircrew Program (RAP) Tasking Memorandum, October 1, 2019.
182. Venable, "The F-35A Fighter Is the Most Dominant and Lethal Multi-Role Weapons System in the World," pp. 10–12.
183. Weather, aircraft/range/simulator availability, and individual health are factors that often cause the cancellation of sorties. The 11 training events do not include other, ground training requirements that pilots must meet in order to remain qualified.
184. HQ ACC/A3T, F-16 Blk 25-42 Ready Aircrew Program (RAP) Tasking Memorandum, October 1, 2019, and HQ ACC/A3T, F-35A Ready Aircrew Program (RAP) Tasking Memorandum, October 1, 2019.
185. Inclement weather, aircraft/simulator nonavailability for maintenance, the need to fill ground training requirements, flying stand-downs for safety, and/or mishaps are common to all locations. Assuming that a training event will take place on every available training day is unrealistic.
186. Scott Maucione, "New Study Shows Grim Outlook for Future of Air Force Pilot Shortage," Federal News Network, April 15, 2019, https://federalnewsnetwork.com/dod-personnel-notebook/2019/04/new-study-shows-grim-outlook-for-future-of-air-force-pilot-shortage/ (accessed February 10, 2020).
187. Three squadrons at RAF Lakenheath in the United Kingdom, one at Spangdahlem Air Base in Germany, and two at Aviano Air Base in Italy. The total number of Main Operating Bases (MOBs) has dropped to 11.
188. Two squadrons at Osan Air Base in the Republic of Korea, two at Kunsan Air Base kin the ROK, two at Kandena Air Base in Japan, and two at Misawa Air Base in Japan.
189. Under threat of imminent attack.
190. When maintenance and operations are combined, an average fighter squadron includes roughly 500 airmen. Each person requires four large mobility bags that contain everything from underwear to chemical warfare ensembles, but those bags are just the leading edge of the packing and shipping requirement. Mission planning/laptop computers and life-support equipment also need to be packed and shipped. The maintenance package required to support deployed fighter operations physically dwarfs all others. Tool boxes, jacks, spare parts and engines, and other items in wartime readiness kits all must be packaged and positioned on pallets for shipment to their wartime operating locations.

191. Author's experience through 26 years of Air Force operations, coupled with senior leader engagements from 2018–2019.
192. Robbert et al, *Reducing Air Force Fighter Pilot Shortages*, p. 33.
193. Even though active-duty fighter squadrons have an average of 30 aircraft per squadron, that number includes maintenance spare and attrition reserve platforms. Manning is based on Primary Assigned Aircraft (PAA), which is 24 aircraft for active-duty fighter squadrons.
194. Based on a squadron with 24 Primary Assigned Aircraft. For units with 18 PAA, four additional pilots are required.
195. The very premise of these units is that they are manned with citizen soldiers whose main source of income is full-time civilian jobs and who are committed to travel and temporary duty locations that make them unavailable for days or weeks at a time. Those units would likely require several days to assemble the manpower required to deploy, and once an assessment of their real mission currency was made, they would need some period of intense training before a responsible senior leader could employ them in a fight with a peer competitor.
196. "Deployments most suited to the ARC are those in which there is long lead time (six months or more), and in which the operation is of short duration (six days or less), requiring a small force package (12 aircraft or less), and in which the scheduling is flexible." John T. Correll, "Future Total Force," *Air Force Magazine*, Vol. 82, No. 7 (July 1999), p. 32, https://www.airforcemag.com/PDF/MagazineArchive/Documents/1999/July%201999/0799total.pdf (accessed January 30, 2020).
197. The author commanded the 349th Expeditionary Combat Group at Al Udeid, Qatar, from 2004–2005. During that time, he flew with seven different Air National Guard F-16 squadrons. Every one of those units had some level of rainbow manning, and each performed admirably.
198. Interview with senior Air National Guard leader, November 20, 2019.
199. Katie Lange, "3rd Offset Strategy 101: What It Is, What the Tech Focuses Are," DoDLive, March 30, 2016, http://www.dodlive.mil/2016/03/30/3rd-offset-strategy-101-what-it-is-what-the-tech-focuses-are/ (accessed February 12, 2020).
200. In 1987, the total was 5,865 aircraft: 4,468 fighters, 331 bombers, 704 tankers, and 362 strategic airlift. Table D-4, "Total Active Aircraft Inventory by Mission/Designation, Regular Air Force as of Feb[ruary] 1988," in U.S. Air Force, Comptroller of the Air Force, Deputy Comptroller, Cost & Economics, *The United States Air Force Summary FY 1988/1989 (Amended)*, May 15, 1988, pp. D-4–D-6, https://media.defense.gov/2011/Apr/12/2001330036/-1/-1/0/AFD-110412-036.pdf (accessed February 12, 2020), and Table D-5, "Total Active Aircraft Inventory by Mission/Designation, Air Force Reserves, as of Feb[ruary] 1988," in ibid., pp. D-7–D-8. Today, there are 2,949 aircraft: 2,073 fighters, 157 bombers, 441 tankers, and 278 strategic airlift. Appendix, "Air Force Total Aircraft Inventory (TAI)," in U.S. Air Force, Assistant Secretary for Financial Management and Budget, *United States Air Force Fiscal Year 2020 Budget Overview*, p. 38.
201. The Honorable Michael B. Donley, Secretary of the Air Force, and General Mark A. Welsh III, Chief of Staff, United States Air Force, "Fiscal Year 2014 Air Force Posture Statement" before the Committee on Armed Services, U.S. House of Representatives, April 12, 2013, p. 2, https://www.af.mil/Portals/1/documents/budget/2014-budget-posture-statement.pdf (accessed February 12, 2020).
202. Robert Martinage, *Toward a New Offset Strategy: Exploiting U.S. Long-Term Advantages to Restore U.S. Global Power Projection Capability*, Center for Strategic and Budgetary Assessments, 2014, pp. 16–18, https://csbaonline.org/uploads/documents/Offset-Strategy-Web.pdf (accessed January 30, 2020).
203. Colby, "Testimony Before the Senate Armed Services Committee Hearing on the Implementation of the National Defense Strategy," p. 6. The NDS model has four layers: Contact, Blunt, Surge, and Homeland. The Contact layer is oriented to "gray zone" activities. The Blunt layer is designed to stop or effectively slow the offensive moves of an aggressor long enough for the U.S. to deploy the reinforcements required for the surge. The Surge layer provides the decisive force to defeat an invasion. The Homeland layer deters and/or defeats attacks on the U.S. homeland.
204. The B-17's demonstrated Circular Error Probable (CEP) was 75 feet. Postwar estimates put the real CEP at 3,300 feet. Kathleen T. Rhem, "Technology, Doctrine Changes Allow for Better Bombing Runs," U.S. Department of Defense, March 19, 2003, https://archive.defense.gov/news/newsarticle.aspx?id=29272 (accessed February 12, 2020).
205. Cooling, ed., *Case Studies in the Achievement of Air Superiority*, p. 578.
206. Every U.S. F-16CJ pilot interviewed at Spangdahlem Air Base in Germany stated that the threat was too high for fourth-generation operations: that stealth fighters were needed to take down those threats before the F-16 could operate over the Baltics. Venable, "Independent Capability Assessment of U.S. Air Force Reveals Readiness Level Below Carter Administration Hollow Force," p. 6.
207. The bed-down schedule for F-35s has placed two Air National Guard squadrons ahead of USAFE.
208. There are F-22s in Hawaii and Alaska, but getting them into a position to defend Taiwan would take at least 48 hours, and those jets would likely recover to an airfield that had already been attacked. Attacking mainland China from U.S. bases in the Pacific is possible, but the required tanker bridge would be significant, and the out-and-back ranges would make for inordinately long sortie durations, limiting the number of sorties that the available fleet of fighters could muster.
209. "Case III…is a dangerous situation, Here, one side is vulnerable to attack but is unable to reach the enemy. It is the situation in which Britain found herself during the Battle of Britain. She did not feel she had the capability to strike the *Luftwaffe* fields in France; thus, for practical purposes, German bases were safe during the two months of the battle." Warden, *The Air Campaign: Planning for Combat*, p. 20.
210. A squadron is the most basic level of command in the Air Force, and all career fields and professional areas within the service, both flying and non-flying, are organized by squadrons.

211. "USAF Almanac 2019," pp. 40–44.
212. Futures/Systems Command; Force Command (ACC an; AMC), Support Command (all Logistics); Training and Education Command; and a single Active Reserve Command that combines the Guard and Reserve assets makes sense. Global Strike Command's nuclear deterrent mission set has proven worthy of elevated levels of supervision with a low subordinate command-to-MAJCOM ratio.
213. The approximate distances and flight times at 480 knots true air speed to Taipei are 4,067 NMs and 8.5 hours from Anchorage, Alaska; 5,876 NMs and 12.5 hours from Hill Air Force Base, Utah; 6,569 NMs and 13.7 hours from Burlington, Vermont; and 8,000 NMs and 16.7 hours from Montgomery, Alabama. Distances are rough estimates based on figures captured through the Air Miles Calculator, https://www.airmilescalculator.com/distance/bhm-to-tpe/ (accessed February 13, 2020).
214. Air National Guard flying wings are generally organized with one flying squadron, one operations group commander, and one wing commander.
215. In March 2017, Chief of Staff General David Goldfein stated that streamlining (cutting) Air Force Instructions (AFIs) would empower squadron commanders and that he intended to overhaul them. Stephen Losey, "Goldfein: Cut out Pointless AFIs to Empower Squadron Commanders," *Air force Times*, March 10, 2017, https://www.airforcetimes.com/news/your-air-force/2017/03/10/goldfein-cut-out-pointless-afis-to-empower-squadron-commanders/ (accessed February 7, 2020). That fall, he went on to say that the Air Force would push decision authority back to the lowest practical level, Megan Friedl, "Goldfein Delivers Air Force update," U.S. Air Force, September 19, 2017, https://www.af.mil/News/Article-Display/Article/1316603/goldfein-delivers-air-force-update/ (accessed February 14, 2020).
216. Air Mobility Command has one group-level command outside of a wing structure, which is appropriate.
217. GlobalFirepower.com, "China Military Strength (2020)," https://www.globalfirepower.com/country-military-strength-detail.asp?country_id=china (accessed February 14, 2020).
218. Appendix, "Air Force Total Aircraft Inventory (TAI)," in U.S. Air Force, Assistant Secretary for Financial Management and Budget, *United States Air Force Fiscal Year 2020 Budget Overview*, p. 38.
219. Jeremiah Gertler, "Air Force B-21 Raider Long-Range Strike Bomber," Congressional Research Service *Report for Members and Committees of Congress*, updated November 13, 2019, pp. 1 and 5, https://fas.org/sgp/crs/weapons/R44463.pdf (accessed February 6, 2020).
220. Theresa Hitchens, "B-21 First Flight in 2021 Not Likely," *Breaking Defense*, October 24, 2019, https://breakingdefense.com/2019/10/b-21-first-flight-in-2021-unlikely/ (accessed February 6, 2020).
221. Gertler, "Air Force B-21 Raider Long-Range Strike Bomber," p. 10.
222. Fact Sheet, "B-1B Lancer," U.S. Air Force, December 16, 2015, https://www.af.mil/About-Us/Fact-Sheets/Display/Article/104500/b-1b-lancer/ (accessed February 14, 2020); Fact Sheet, "B-2 Spirit," U.S. Air Force, December 16, 2015, https://www.af.mil/About-Us/Fact-Sheets/Display/Article/104482/b-2-spirit/ (accessed February 14, 2020); and GlobalSecurity.org, "Weapons of Mass Destruction (WMD): B-2 Production," SecurityGlobal.org, https://www.globalsecurity.org/wmd/systems/b-2-production.htm (accessed February 14, 2020).
223. Garrett Reim, "USAF May Retire B-1s to Free Funds for B-21 Raider," FlightGlobal, September 17, 2019, https://www.flightglobal.com/news/articles/usaf-may-retire-b-1s-to-free-funds-for-b-21-raider-460915/ (accessed February 14, 2020).
224. Roger H. Bezdek, "B-1: A History," *Bulletin of the Atomic Scientists*, Vol. 40, No. 9 (November 1984), p. 13, https://books.google.com/books?id=1AUAAAAAMBAJ&pg=PA10&lpg=PA10&dq=Bezdek,+B-1:+A+History,+Bulletin+of+the+Atomic+Scientists,+November+1984&source=bl&ots=CPX1uQprg2&sig=ACfU3U21R5JU7lLEwozD7GBKv_OJoK97iw&hl=en&sa=X&ved=2ahUKEwi046qOnITOAhV4lHIEHUzsD4UQ6AEwAHoECAkQAQ#v=onepage&q=Bezdek%2C%20B-1%3A%20A%20History%2C%20Bulletin%20of%20the%20Atomic%20Scientists%2C%20November%201984&f=false (accessed March 5, 2020).
225. Gertler, "Air Force B-21 Raider Long-Range Strike Bomber," p. 9.
226. Table 5, "Total Air Force Inventory," in *2020 Index of U. S. Military Strength*, pp. 415–417, and Table 10, "Mission-Capable Combat-Coded Fighters in Active Duty Air Force," in ibid., p. 425.
227. According to Air Force budget documents, the non-OCO budget increased from $119.09 billion to $156.31 billion over that same period for an overall TOA increase of 31 percent. Extracted from *Budget Overview* pages for the respective years at U.S. Air Force, Financial Management and Comptroller, "Budget: Previous Years."
228. Jay Miller, "F-16 Design Origins," *Code One Magazine*, February 4, 2014, http://www.codeonemagazine.com/f16_article.html?item_id=131 (accessed February 14, 2020).
229. The Air Force identified the requirement for an Advanced Tactical Fighter to replace the F-15 and F-16 in 1981. The first operational F-22 squadron became IOC in 2005. Air Force Print News, "F-22A Raptor Goes Operational," U.S. Air Force, December 15, 2005, https://www.af.mil/News/Article-Display/Article/132463/f-22a-raptor-goes-operational/ (accessed February 14, 2020).
230. Planning for the JSF began in 1994 when Congress mandated that a next-generation Marine fighter design be merged with the Air Force/Navy program. The first Air Force F-35A squadron declared IOC in 2016. The service had less than 100 combat-coded F-35s in its inventory at the end of 2019, 25 years after the JSF program came together. Gertler, "F-35 Joint Strike Fighter (JSF) Program," pp. 1 and 11.
231. Statement by Will Roeper, Assistant Secretary of the Air Force for Acquisition, during Think Tank engagement, October 10, 2019.

232. BeBusinessed, "History of Mobile Cell Phones | The First Cell Phone to Present Time," https://bebusinessed.com/history/history-cell-phones/ (accessed February 14, 2020).
233. Matthew Jones, "iPhone History: Every Generation in Timeline Order," History Cooperative, September 14, 2014, https://historycooperative.org/the-history-of-the-iphone/ (accessed February 14, 2020).
234. Roeper statement, October 10, 2019.
235. The President's budget proposal for FY 2021 included 48 F-35s and 12 F-15EXs. With the F-15EX foregone, each of these suggested changes would be based on 60 F-35As, increasing the total number acquired in each of the following fiscal years and reaching 110 in FY 2023. Using a nominal $85 million per jet for the F-35A ($77.5 million per jet plus supporting equipment, facilities, etc.) would increase the procurement budget by $4.25 billion in FY 2023.
236. Conversation with Brigadier General Clinton Hinote, Air Force Warfighting Integration Capability (AFWIC), July 22, 2019.
237. Ibid.
238. Neil Thurgood, Lieutenant General, U.S. Army, Presentation on Army Rapid Capabilities and Critical Technologies Office (RCCTO) efforts, Space and Missile Defense Symposium, August 7, 2019.
239. Tyler Rogoway, "Air Force's Secretive XQ-58A Valkyrie Experimental Combat Drone Emerges After First Flight," The War Zone, March 6, 2019, https://www.thedrive.com/the-war-zone/26825/air-forces-secretive-xq-58a-valkyrie-experimental-combat-drone-emerges-after-first-flight (accessed January 30, 2020).
240. Statement by the Honorable Matt Donovan, Acting Secretary of the Air Force, during Think Tank engagement, September 16, 2019.
241. Conversation with Brigadier General Clinton Hinote, July 22, 2019.
242. Written correspondence with senior U.S. Air Force leader, December 8, 2019.
243. Martinage, *Toward a New Offset Strategy*, pp. 16–18.
244. Conversation with Brigadier General Clinton Hinote, July 22, 2019.

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