AEROSPACE POWER FOR THE 21ST CENTURY

RESEARCH

Flying & Fighting in the Modern Age

Employing successful modern combat aerospace power today and in the future demands questioning long-standing assumptions and seeking smarter ways of achieving desired mission goals.

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A Growing Threat

With the threat environment growing far more dangerous, aerospace capabilities once considered survivable and resilient are now increasingly unable to execute their missions. Adversaries are defending their own territory with increasingly sophisticated surface-to-air missile systems, fighter aircraft, and electronic warfare systems. They are also projecting power far forward, leaving US operating bases at risk. This demands significant changes regarding aerospace force composition, strategies, operational concepts, and tactics.

A GROWING THREAT

Surviving and Succeeding in Today's Threat Environment

The United States faces an inflection point with respect to power projection in an increasingly dangerous, contested, and complex security environment.

Ever since the end of the Cold War, Americans have assumed their nation possessed military superiority, no matter the situation. However, the actions of multiple competing nations are steadily eroding this advantage. China and Russia are concurrently developing strategies and fielding advanced capabilities specially designed to counter US combat power. Emboldened, these countries are using their enhanced militaries to underwrite strategies that challenge US interests around the globe. Further down the threat spectrum, countries like North Korea and Iran—once isolated regional actors—have increasingly extended their power through robust defenses and offensive ballistic missiles. Non-state actors, often armed by aligned state sponsors, are also increasingly dangerous.

The June 2019 Iranian shoot down of a US Navy Broad Area Maritime Surveillance (BAMS) high altitude reconnaissance aircraft and Houthi rebels in Yemen successfully downing an MQ-9 Reaper emphasize the uniform lack of sanctuary across key regions around the world—from nation state adversaries to non-state actors. An overt confrontation against a peer state like Russia or China would yield exceedingly challenging scenarios that would press US combat forces to their limits.

Adversaries have had nearly three decades to study the way in which the US executes military operations. Resulting investments have focused both upon defensive measures like advanced surface-to-air missiles and fighter aircraft, combined with offensive capabilities that have the potential to hold US operating facilities, logistics lines, and command and control centers at risk. The combined set of defensive and offensive capacities speaks to a

stark evolution in the challenge facing US forces, especially when it comes to successfully harnessing aerospace power. Ever since the end of the Cold War, US air crews expected to face stiff opposition when crossing into hostile territory, but once they crossed into friendly territory, it was safe to assume operational sanctuary. That forward deployed safety is now under threat, with enemy defenses rapidly growing.

These opposing capabilities, highly integrated in design and employment, include advanced air defense systems; long range precision strike that can hold US installations and supply chains at risk; deployed, decentralized airborne command and control that can prudently direct enemy air operations for greatest desired effect both defensively and offensively; robust intelligence, surveillance, and reconnaissance (ISR) functions to understand the operating environment; and enhanced computing capacity to rapidly process and fuse

disparate data inputs into actionable information. Said another way, enemy commanders will likely be able to target American and allied forces in future conflicts with an incredibly lethal combination of range, precision, and mass. The US has never faced these types of threats and they promise to be incredibly lethal.

Strategies, operational practices, and military hardware built for the 20th century can no longer be assumed to be "good enough." Factors like wartime attrition and reserve forces must be considered again. Mass, concurrency, and survivable power projection becomes increasingly important given the scale and scope of these new challenges. Missions like air superiority and infrastructure defense are returning to the forefront as essential conditions for successful military aerospace operations.

This means that the Air Force must rapidly realign its capabilities and capacity with a requirements-driven force, not one shaped by arbitrary budget targets. Rather than just buying more of what the service already has, the United States needs the right balance of capabilities to ensure leaders are empowered by policy options that best serve the nation. To this point, just 18 percent of US Air Force fighter aircraft have the stealth attributes to survive in contested airspace. This ratio must adjust radically in the near term to ensure combat aircrews can execute their missions and get home safe. The picture is even worse in the bomber inventory, with a mere 20 B-2s standing as the nation's lone long-range stealthy strike aircraft. B-21s must enter the inventory in a rapid, high volume fashion to guarantee leaders the ability to strike key targets at range. The operational sanctuary enjoyed over Afghanistan and Iraq in post 9/11 operations created a false sense of complacency and it is time to rapidly reset the force.

A GROWING THREAT

Combat Air Force attributes required in the modern threat environment

Fifth Generation

The attributes below, while helpful on their own, gain tremendous effectiveness when fused within a single aircraft. That is the true power inherent within the F-22, F-35, and the future Next Generation Air Dominance (NGAD) system. Larger airplanes, like the B-21 may not focus on speed and maneuverability, but unique design attributes allow them to double down on other strengths like stealth, electronic warfare, and cyber functionality. Bottom line: fifth generation centers upon highly collaborative design attributes with the combined package dramatically complicating an adversary's defensive calculus.

Stealth

Carefully calculated airframe shaping, radar absorbent coatings, and operational tactics to avoid detection by enemy fire control radars. Stealth is not a binary capability either working or not—it is a combined set of attributes that complicate an enemy's ability to find, fix, target, track, and engage aircraft. Just because an enemy can "see" an aircraft does not mean it can guide a weapon to a successful intercept. Stealth complicates each and every step in the engagement process.

Electronic Warfare

The electromagnetic spectrum is a key domain that involves everything from radar to communication waveforms. After years of neglecting this important mission area, the Air Force needs to aggressively press forward in developing and acquiring leading edge electronic warfare capabilities, while also championing the operational experts in this realm.

Cyberspace

Almost every mission undertaken in the aerospace realm is facilitated by data moving through networks. Whether it is command and control information, technical data exchange between various mission systems, or offensive actions—cyberspace is an essential pillar facilitating today's missions. This requires cutting edge equipment, agile software updates, and well-trained operators. The bureaucracy that was used to acquire and sustain industrial age hardware in past decades is inadequate to maintain competent information age operations.

Speed, Maneuverability, and Agility

Since the opening days of combat aviation in World War One, the ability to outpace and outmaneuver an adversary has stood as an important attribute. This still holds true, with modern requirements driving performance to extremely advanced levels.

Range and Payload

The ability to transit vast distances is crucial in operating environments where regional bases may be unusable due to enemy attack or where bases simply do not exist due to geographic realities, like in the Pacific, stands as an increasingly important aerospace power attribute. Added to this, aircraft need to have deep magazine depth, whether discussing air-to-air or air-to-ground missions. Flying vast distances to reach a desired operating location, but running out of desired munitions is not an efficient or effective way to employ combat power.

Range and Payload

Numbers matter. Never in its history has the Air Force operated such a small, aged aircraft inventory. 186 F-22s, 200 F-35s, and 20 B-2s comprise the Air Force's entire stealth combat aircraft capacity. Modern operations demand far larger numbers of modern aircraft. Other aircraft types in service, many of which predate the Vietnam War, would prove wholly inadequate in modern threat environments.

Effective, Efficient Operations

Projecting aerospace power prudently also demands doing so in the most effective, efficient fashion possible. For too long leaders have focused upon how much aircraft and associated systems cost to buy. They place too little emphasis upon what it costs to achieve mission goals in a real world, enterprise fashion. Penny-wise, pound foolish is a strategy imbued with unsustainable costs and often leads to suboptimal decision making. Building the aerospace force required for success in the future will demand a smarter path forward.

EFFECTIVE, EFFICIENT OPERATIONS

Effects-Based Operations

Smart combat power is not just about projecting mass numbers of aircraft against a target. It demands harnessing key strengths and attributes to net desired goals in the most effective, efficient manner possible. For example, in the opening night of Desert Storm, twenty F-117 stealth fighters were able to strike 28 separate targets. Conversely, it took forty non-stealthy legacy aircraft to hit one target because of the need for electronic jamming aircraft, protective fighter cover, and surface-to-air missile suppression—all of which was facilitated through individual mission-specific aircraft. Not only does this drive individual mission cost, but the lifecycle expense of all the associated personnel, training, infrastructure, and support is tremendous. F-117s were often cited as "expensive" relative to the procurement figure of non-stealth legacy aircraft like the F-16, but those unit-costs are a wholly inadequate way of determining real-world fiscal drivers and pragmatic value.

Nor is this concept isolated to Desert Storm. Every military operation capability deemed "expensive" ended up affording best value and lowest total mission cost. During the opening months of Operation Enduring Freedom in Afghanistan, 24 bombers flew 11 percent of the sorties, but dropped 75 percent of munitions. These bombers are often derided as costly from an acquisition vantage, but they are incredibly cost-effective due to their long range and high payload carrying capacity. It would have taken dozens of smaller fighter aircraft, requiring significant aerial refueling support, and logistics infrastructure to net this same effect, but at many multiples of cost beyond the use of bombers.

More Recently

More recently, during air operations against Syrian forces as part of Operation Inherent Resolve, two B-1B sorties could deliver more ordnance than 40 carrier-based F/A-18 Super Hornets operating from the Persian Gulf—at a fraction of the total operating cost. During the initial days of the campaign, F/A-18s, seeking to maximize range to reach their targets,

carried just two GBU-38 500lb bombs per aircraft due to the need to maximize their fuel capacity. Bombers did not have to worry about these range and payload tradeoffs. That sort of power projection made them incredibly cost-effective and powerful tools. Compare the cost of a B-1B, to the cost involved with deploying and sustaining an entire aircraft carrier battle group; the personnel costs associated with all those ships and nearly a hundred aircraft to both protect the carrier and launch strikes; and the expense of that many aircraft to achieve a given effect. However, when individuals discuss bombers, they often describe them as “expensive.” Such an assessment fails to appreciate factors driving actual mission cost from a total enterprise vantage.

Seeking best mission value also involves investigating the cost and factors associated with alternate solutions. In Operation Allied Force, the 1999 Kosovo campaign, the Army sought

to employ its Apache attack helicopters even though Air Force, Navy, and Marine Corps aircraft were present in the theater achieving the same effects as part of their assigned missions. Deploying 24 AH-64 Apache attack helicopters to a base in Albania took 667,000 square meters of rock to build 58 landing pads; 26,000 tons of support equipment including 24 support vans, 12 M-1 tanks, 42 Bradley Fighting Vehicles; 24 rocket defense systems; 37 utility helicopters, and 6,200 troops. Some 2,200 airlift sorties were also required to get this massive infrastructure into theater. In the end, the helicopters were never used because the conflict was over by the time they became available for operational employment. These are extremely important elements to consider when deciding how to manage various aircraft inventories. It is not just about the direct cost of a given type. Leaders must also consider what does “plan b” cost if another capability is not available. It is a lot more complicated than simply looking at initial procurement expense.

Broadly speaking, seeking best value to ensure favorable cost-per-effect and effective mission execution suggests considering the following factors

Enterprise Cost

How much logistical support, enabling mission assets, personnel expenses, etc. do certain capabilities require to achieve a given mission effect versus another capability. One-for-one comparisons between individual aircraft are inaccurate measures of actual mission cost to achieve an equivalent effect. Broader enterprise assessments to achieve mission goals in a real-world fashion are far more realistic.

Survivability

Will an aircraft be able to successfully execute its mission and get home safe without undue support from other mission assets? A single stealthy F-35 or B-21 is far more cost-effective than the dozens of legacy, non-stealth aircraft required to achieve an equivalent effect. Added to the mission-cost advantage is also a personnel advantage, as the fewer aircraft required also means fewer personnel involved and less life at risk—the cost of aircrew attrition is enormous.

Range and Payload

The further an aircraft can fly and the more that it can carry reduces the need for aerial refueling; the multiple aircraft to carry an equivalent number of munitions; and the personnel cost and logistics support associated with larger strike packages.

Combat Cloud

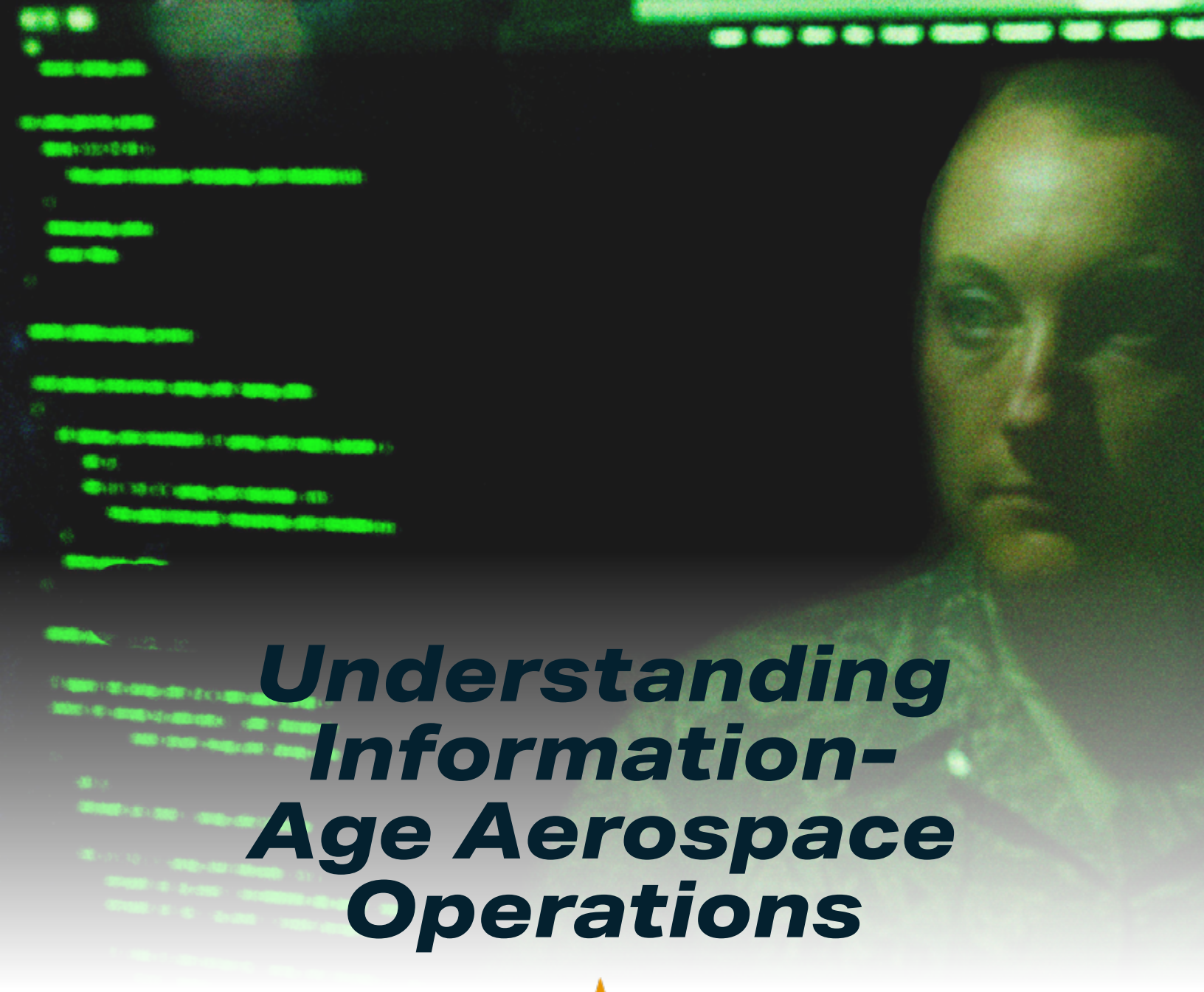
The ability for aircraft to gather data inflight, process it, collaborate with partner assets in the region, and engage in a highly dynamic fashion drives tremendous mission effectiveness and efficiency. While these technologies drive up-front investment, they also afford significant operational value. An F-35 and B-21 able to gather intelligence, surveillance, reconnaissance data through onboard sensors, process it into actionable information, and share relevant findings with mission partners drives significant mission efficiencies and boosts effectiveness versus segregated mission-specific airplanes operating in a stove-piped fashion.

Precision

It is a simple concept—one bomb or missile per target ensures mission goals are achieved rapidly, efficiently, and in a minimal risk fashion versus putting large numbers of mission aircraft at risk trying to net similar results through less precise means. While this concept is often taken for granted in the modern era, it is important to understand that adversaries also recognize this advantage and are seeking to disrupt it through various defensive and offensive means. Leaders must not assume results taken for granted in the permissive environments of Afghanistan or Iraq will work in contested environments against far more capable adversaries.

New Metrics

The Department of Defense must establish a new set of metrics to determine mission system value on a normalized "cost per effect" or mission-based affordability vantage basis. An undue focus on acquisition unit cost in the absence of mission effectiveness and operational enterprise cost is leading to dubious decisions that undercut combat effectiveness and fiscal common sense.



Understanding Information-Age Aerospace Operations

Aerospace power in the modern age also demands far more than the traditional tools of power—aircraft, satellites, and munitions. Just as civilian society has revolutionized the way in which it interacts with information through smart phones and ubiquitous connectivity, so too have military aerospace missions. The ability to gather data, process it into actionable information, and collaborate with other battlespace actors in a real-time fashion, a concept known as the combat cloud, stands as an increasingly important model.

Information-Age Combat Power

Throughout the history of aerospace power, success has demanded collaboration between highly trained personnel and advanced industrial machines. The information age is radically altering this paradigm through the ability to gather mass quantities of information, rapidly process this raw data into actionable information, and collaborate with a broad range of combat assets in a highly integrated fashion.

This trend is not unique to military applications. Wireless connectivity, powerful personal computing devices, and cloud-based applications are integral to daily life across the globe. The ability to access, process, and disseminate mass volumes of information anywhere, anytime has revolutionized the way in which society functions.

Accordingly, understanding aerospace power today and in the future requires an appreciation that highly advanced sensors, robust computing capabilities, and advanced networks are turning information into the dominant factor in modern warfare—one that is radically altering the way in which the United States military projects power. As one Air Force commander recently remarked— "We need to understand that platforms like the F-22 are information machines far above and beyond being killing assets." Operations over Syria validated this assertion, with F-22 Raptors employed as information nodes versus shooting down enemy fighters. The same holds true in countless exercises, with information age aircraft like the F-35 Lightning II holding a dominant edge as "sensor-shooters" of unparalleled power. The same will prove true for types in development, like the B-21 Raider.

Air Force Chief of Staff General David Goldfein said it best in a speech about this new operational reality: "If we are going to fight and win in wars of cognition, we've got to ask a different series of questions before starting an acquisition program on any platform, any sensor or any weapon," he said. "Does it connect? Good. Does it share? Better. Does it learn? Perfect."

Given this reality, it is critical to acknowledge the implications information and its management has upon the traditional tools of hard military power— airplanes, satellites on orbit, infantry, amphibious elements and warships at sea. It is the force evolving all these tools from isolated instruments of power into a highly integrated enterprise where enterprise knowledge and collaborative partnership will determine success or failure in 21st century warfare.

This has major implications throughout the military enterprise—shaping key focus areas like doctrine, organization, training, materiel acquisition and sustainment, along with command and control. Top leaders in the policy community also need to adjust to the new realities of information age combat operations. Paradigms dating back to World War Two and the Cold War will simply fall short when considering how to build, sustain and employ military power

in the modern era. Combat aircraft, space systems, and cyber tools will prove of little use and highly vulnerable without these new attributes.

This vision is best described as a combat cloud—an enterprise in which the US military and allied partners link information-age aerospace systems with cyber, sea, and land-based capabilities in ways that will enhance their combined effectiveness, while compensating for the vulnerabilities of each.

In the air-to-air realm, victory has demanded superior situational awareness, cutting edge aerodynamic performance, and greater weapons' range. Strike involved successfully penetrating an adversary's defenses and ensuring the weapons find their target. Command and control demanded high fidelity situational awareness, centralized leadership intent, and decentralized execution. Logistics are all about ensuring the right supplies meet their end user in the most effective, efficient fashion with on-time delivery making the difference between success and failure.