Department of the Air Force

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Air & Space Operations Review

Ace Gets Light and Lean
Macro-Management in the Air Component
Agile Autonomy in Airpower
Evolution of Air Force Targeting
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Air & Space Operations Review

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FROM THE EDITOR

Dear Reader,

The operational level of war serves as the crucial link between strategic objectives and tactical actions. Joint Publication (JP) 3-0, *Joint Campaigns and Operations*, defines operational art as "the cognitive approach by commanders and staffs—supported by their skill, knowledge, experience, creativity, and judgment—to develop strategies, campaigns, and operations to organize and employ military forces by integrating ends, ways, means, and risks."[1] This definition forms the core of this journal and its predecessor titles. Our goal for each issue is to examine and debate the ends, ways, and means to best organize, train, and employ today's air and space forces.

This issue begins with the Elements of Airpower Forum. Stephen Blackstone leads the four-ship formation with his article, "ACE Gets Light and Lean: Joint Concepts to Make ACE Effective in the Western Pacific." Blackstone argues for integrating agile combat employment (ACE) with Marine and Army concepts, leveraging joint capabilities for greater effectiveness in contested environments. "Macro-Management in the Air Component: Learning to Love the Mission Type Order" by Robin Kimmelman and Tom Cantrell, presents a fresh perspective on integrating mission type orders (MTO) into sustained operations. The authors propose that MTOs can complement the air tasking order (ATO) rather than serve merely as a contingency for lost communications, arguing that this requires procedural, experiential, and cultural changes to enhance large-scale air warfare.

In the forum's third article, "An Argument for Agile Autonomy in Airpower," David Heinitz critically examines the Air Force's traditional technology development process and advocates for agile solutions for hardware, autonomy, and machine learning in aircraft design and training to accelerate fielding, enhance adaptability, and meet evolving defense needs. Chance Smith completes this forum with "The Continued Evolution of Air Force Targeting," in which he highlights the challenges of Air Force targeting readiness by analyzing six air campaigns since Desert Storm. Smith proposes proactive strategies, sustained expertise, and investments vital to improving targeting proficiency and ensuring success in future conflicts.

Benjamin Johnis, Robert Bettinger, and James W. Dean launch the Space Operations Forum with their article, "The Space Rescue Professional: Operationalizing Guardians for the Future." They propose a dedicated space rescue professional career field within the Space Force, leveraging Air Force rescue expertise and a partnership with the National Aeronautics and Space Administration to safeguard astronauts and strengthen American leadership in space. John Cserep follows with "Electrifying delta-v for the Space Force," in which he envisions a future where propellantless space propulsion transforms Space Force capabilities, enhancing resilience and countering threats in space operations.

In the Education Forum, Mark Clodfelter offers a compelling argument for a balanced curriculum at the US Air Force Academy. In "Critiquing the US Air Force Academy's

1. Joint Publication 3-0, *Joint Campaigns and Operations* (Chairman of the Joint Chiefs of Staff, 18 June 2022), xiii.

Core: Does It Satisfy the Need?," he proposes a core curriculum that blends military skills with humanities education, which he believes will best prepare officers to understand the nature of war and become effective warrior-leaders in future conflicts.

Rounding out the issue, we introduce the Heritage Forum, where authors examine the rich history of the US Air Force to draw timeless wisdom applicable to today's operational challenges. In this vein, Shane Reilly's "Diplomats in Fortresses: The 1938 'Good Will Flight' to Argentina" recounts how one mission showcased American soft power, validated bomber capabilities, and advanced training. This historical flight of YB-17 bombers reveals lessons for developing Airmen leadership, necessary to ensure the future effectiveness of the Department of the Air Force.

I sincerely hope you enjoy this issue of *Air & Space Operations Review*.

~ The Editor

ACE Gets Light and Lean

Joint Concepts to Make ACE Effective in the Western Pacific

Stephen Blackstone

As currently designed, agile combat employment (ACE) is a flawed concept for peer adversary conflict in the anti-access/area denial area of the Western Pacific; however, merging ACE with other joint force concepts, such as the Marine Corps expeditionary advanced base operations and the US Army's multi-domain operations, will increase its effectiveness in a contested environment. ACE should evolve to incorporate joint effects more suitable to light and lean operations than the generation of fighter aircraft. Moving beyond existing research, this article offers a meta-analysis of service concepts that identifies ways to optimize ACE, leveraging both Air Force and joint capabilities.

Over the last quarter century, the US military advantage over the People's Republic of China (PRC) has eroded as the United States was occupied with multiple low intensity conflicts around the world. Across all its military services, the Chinese People's Liberation Army (PLA) has closed the capability gap with the United States with a force design intended to control the battlespace in the event of war at increasing distance from mainland China, with ambitions beyond the second island chain—which stretches from Japan to the Mariana Islands, where Guam is located, to western New Guinea. Key to this force design is the PLA Rocket Force (PLARF), created in 2015, which underpins the PLA's anti-access and area denial (A2/AD) strategy to create an area of air base and sea denial past the second island chain.[1]

The PLARF has built thousands of theater ballistic, hypersonic, and cruise missiles to target US bases and fleets critical to long-range precision strike from the air, which has characterized the American way of war.[2] To counter this strategy, each service has developed an operational concept to fight through the A2/AD challenge. The US Air Force's concept is called agile combat employment (ACE), defined by doctrine as "a proactive and reactive operational scheme of maneuver executed within threat timelines to increase resiliency and

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1. *Annual Report to Congress: Military and Security Developments Involving the People's Republic of China 2024* (US Department of Defense [DOD], 2024).
2. *Annual Report: 2024.*

survivability while generating combat power."[3] Conceptually, ACE appears to be a reasonable approach to mitigate the significant problems posed by the PLA's A2/AD strategy.

Yet as currently designed, ACE is unable to overcome A2/AD challenges in the Western Pacific. In particular, ACE faces three challenges: the PLARF arsenal of theater ballistic, hypersonic, and cruise missiles, which is capable of saturating the handful of ACE air bases and overwhelming their active and passive defenses; its inability to operate with the necessary agility required to be effective; and the theater geometry of the Western Pacific paired with the PLA Air Force's (PLAAF) long-range counterair capabilities. By merging ACE with other joint force concepts, however, the US Air Force can operate despite sustained missile attack and provide survivable long-range strike to prevent and even deter China's aggression in the region. To overcome these challenges ACE should adapt by incorporating the US Marines' expeditionary advanced base operations (EABO) concepts to mitigate China's missile threat and theater geometry problems while using the US Army's multi-domain operations to make long-range strike agile, light, and lean.

Unpacking Agile Combat Employment

ACE is an operational concept designed for fighter aircraft operations that evolved over time from competing adaptive basing concepts—which centered on identifying air base options that enable air operations while under attack—to deal with China's theater ballistic, hypersonic, and cruise missiles. Three "umbrella" adaptive basing possibilities focus on this threat: hardening to survive a missile attack, standoff to withdraw from missile attacks, and alternate force employment concepts to operate despite missile attacks.[4] ACE is an "operate despite missile attack" type of adaptive basing. Air Force Doctrine Note 1-21 outlines ACE operating within a hub-and-spoke model, distributing support cargo from a main hub to forward contingency location spokes to enable fighter sorties from those locations.[5] Fighters and support equipment then cycle between hub and contingency location spokes while the missile threat persists. As one PRC-based military expert states, dispersal is critical in the Western Pacific because air bases are one of the primary targets for PLARF missiles.[6]

China's Long-Range Precision Strike

Although the ACE base cluster model seeks to distribute risk across multiple main operating base hubs and semi-permanent contingency location spokes—provisional locations with the infrastructure and support services needed for sustained operations—the

3. Air Force Doctrine Note (AFDN) 1-21, *Agile Combat Employment* (Curtis E. Lemay Center for Doctrine Development and Education, 2023), 2.

4. David T. Orletsky et al., *How Can the Mobility Air Forces Better Support Adaptive Basing? Appendixes A–C, Supporting Analyses of Adaptive Basing, Soft Power, and Historical Case Studies* (RAND Corporation, 2023), 1–2.

5. AFDN 1-21, 2-6.

6. *Annual Report: 2024*, 65.

plan is inadequate to mitigate the threat of thousands of theater ballistic, hypersonic, and cruise missiles, and PLA missile volume would overcome this small number of distributed bases.[7] In 2024, the PLARF had 900 short-range ballistic missiles (SRBM) and 300 launchers with a range of 300 to 1,000 kilometers (km); 1,300 medium-range ballistic missiles (MRBM) and 300 launchers with a range of 1,000 to 3,000 km; 400 ground-launched cruise missiles (GLCM) and 150 launchers with a range greater than 1,500 km; and 500 intermediate-range ballistic missiles (IRBM) and 250 launchers with a range of 3,000 to 5,500 km.[8]

Figure 1 illustrates the reach of these missiles overlaid with US airbases—including allied airbases that allow US operations—and enhanced defense cooperation agreement locations. One of the missiles the PLARF has deployed, the DF-17, is an MRBM equipped with a hypersonic glide vehicle, designed to evade radar and ballistic missile defenses. According to a PRC-based military expert, the DF-17 is intended to target foreign military bases and warships in the Western Pacific region.[9] The *2022 Annual Report to Congress* on China's military and security developments notes, "PLA writings frame logistics and power projection assets as potential vulnerabilities in modern warfare, which aligns with the PLA's expanding ability to conduct strikes against regional air bases." It further points out that American bases in Guam "are in range of a growing number of the PLA's ballistic and cruise missiles."[10] The PLA not only has the magazine depth to bring power projection from ACE clusters to a halt, but it also has the intelligence, surveillance, and reconnaissance (ISR) and targeting capabilities that enable these strikes.

China has developed a sophisticated find-fix-track-target-engage-assess (F2T2EA) capability using space-based ISR. This enables precision strikes during adverse-weather with 24-hour coverage, thanks to a constellation of electro-optical, synthetic aperture radar imaging, and electronic/signals intelligence satellites.[11] The PRC has integrated these ISR advances with improved command, control, and communications systems.[12] This provides high-fidelity over-the-horizon targeting information from strategic to tactical levels, allowing rapid tracking and targeting of US aircraft carriers and deployed air wings.[13]

7. Sean M. Zeigler et al., *Assessing Progress on Air Base Defense: Past Investments and Future Options* (RAND Corporation, 2025), 21, https://www.rand.org/; and AFDN 1-21, 13.

8. *Annual Report: 2024*, 66.

9. *Annual Report: 2024*, 65.

10. *Annual Report to Congress: Military and Security Developments Involving the People's Republic of China 2022* (DOD, 2022), 81–82.

11. Zeigler et al., *Assessing Progress*, 34.

12. *Annual Report: 2022*, 90.

13. *Annual Report: 2022*, 90.

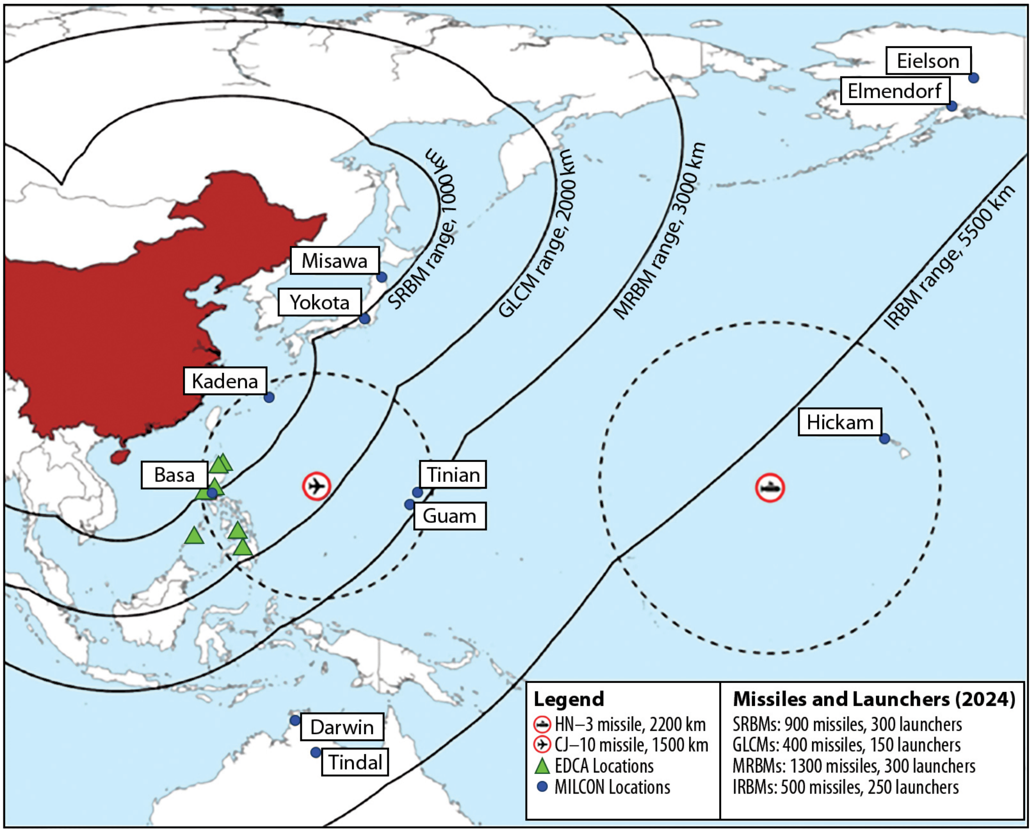

Figure 1. China's missile capabilities as of 2024[14]

Consequently, operating continuously from either semi-permanent contingency location spokes or main operating base hubs within a cluster will likely only be possible for a single targeting cycle, potentially less than a day, until the PLARF exhausts its missiles. Even if US Air Force rapid runway repair teams can restore runways quickly, the PLA is likely to target aircraft parking areas, fuel, and munitions storage. This would leave undamaged aircraft without essential supplies, requiring re-supply flights that could take days or weeks. In a conflict involving thousands of missiles targeting tens of bases, getting inside the PRC's targeting cycle is increasingly challenging due to its growing ISR capabilities. This requires a light and lean force capable of relocating daily or sooner.

Light and Lean Gains Weight

As commander of Pacific Air Forces Command, General Charles Q. Brown Jr. sought to "generate combat power from a number of locations to create dilemmas for an adversary."

14. Zeigler et al., *Assessing Progress*, 34, https://www.rand.org/; and *Annual Report: 2024*, 66.

He stated, "I just need a runway, a ramp, a weapons trailer, a fuel bladder, and a pallet of MRE [Meals, Ready-to-Eat]. That's maybe a little bit bold, but the point is, we've got to be light, lean, and agile."[15] Adapting to planning realities, the ACE base cluster model has strayed from this light and lean concept, making logistics vulnerable and unsustainable.

Once planners considered the logistical requirements to fuel and arm aircraft, provide secure facilities, communication equipment, planning tools, and provisions for aircrew to receive taskings, intelligence, inspect equipment, and plan missions, the requirements quickly accumulate. Meeting these basic operational support needs alone can tie a fighter formation to a location for days. When multi-day sortie generation is required, logistical demands escalate dramatically. These demands involve everything from munitions and fuel to maintenance, aircraft generation, material handling, and crash fire rescue personnel and equipment, just to generate the sorties. When adding the base support functions of power generation, water, rations, lodging, command and control, communications equipment, air traffic control, and short-range air defense, the logistics tail truly becomes unmanageable.[16] While efforts to reduce these requirements have been made, the sheer volume of supplies and equipment needed to generate fighter sorties for even a few days makes these contingency locations far from light and lean.

Pre-positioning equipment and supplies is one way the Air Force is trying to meet the logistical challenges of ACE.[17] Yet, pre-positioning is cost-prohibitive from a procurement and sustainment aspect, particularly when munitions are in short supply and the defense industrial base is challenged to provide the parts and equipment for current operations, much less contingencies. Additionally, pre-positioning works against the agility of ACE since the build-up of equipment and supplies is difficult to conceal from persistent Chinese ISR, making targeting likely. If agility is prioritized over pre-positioning to reduce observable signatures, the airlift requirement would be prohibitively high. With 222 C-17s in the US inventory, assigning tens of C-17s per cluster is not practical when strategic airlift will be in high-demand to deploy the joint force.[18] If these airlift assets were allocated to ACE operations, it would require multiple days to move, download, set up, and reload fighter generation cargo from hub-to-spoke and back again. Multi-day operations would fail to get inside the PLA's targeting cycle, making the spoke vulnerable to long-range precision fires.

Tyranny of Distance

Air refueling is crucial to the success of agile combat employment, which relies on dispersed base clusters. Yet, China has developed missiles that threaten American tanker

15. General Charles Q. Brown Jr., Pacific Air Force commander, remarks at the Air Force Association's Air, Space, and Cyberspace Conference, National Harbor, MD, September 2019.

16. Air Force Doctrine Publication (AFDP) 4-0, *Combat Support* (LeMay Center, 2020), 29.

17. AFDN 1-21, 7.

18. "C-17 Globemaster III," US Air Force [USAF, website], accessed 7 October 2023, https://www.af.mil/.

aircraft, and the number of tankers needed to support operations at these distances outstrips supply. Land-based fifth-generation fighters have a combat radius of approximately 600 nautical miles (NM), requiring air refueling if based beyond the first island chain, which stretches southward from Japan through Taiwan to the Philippines.[19] With thousands of short- and medium-range ballistic missiles, basing fighters at unrefueled range from the objective is untenable. Generating sorties beyond the reach of these missiles mitigates some of the challenge but creates a large air refueling demand.

China has observed the United States overcome problematic theater geometry in Afghanistan using tanker aircraft to extend the range and time-on-station of its aircraft. Compared to tactical aircraft, tanker aircraft are slow, unmaneuverable, and unable to defend themselves against radar-guided missiles. China has developed the PL-17 (CH-AA-12) "tanker killer" very long-range air-to-air missile that has a 186 NM range, which is greater than any air-to-air missile in the US inventory with exquisite guidance capabilities specifically designed to target tankers and other high-value aircraft.[20] If fighter sorties can be generated despite missile attacks, China's tanker killer missiles make it exceedingly difficult to get fighters within a relevant range of the Taiwan Strait or other conflict point in the first island chain. Even if tankers could survive the PL-17 missiles, the required volume of tankers is still daunting. If fighter formations were generated from a 2,000 NM standoff range, outside of SRBM and MRBM striking distance, the tanker fleet available could only support about nine 24-hour two-ship combat air-patrols.[21] The challenges posed by China in the Western Pacific are daunting for operationalizing ACE, but combining strengths of each service's emerging warfighting concept can help address these challenges.

Ace and Multi-Domain Fires

Perhaps the Air Force can resolve the logistical challenges of the current ACE construct while building up enough passive defense and convincing the joint force to provide enough active defense for Air Force fighter aircraft to make a difference in the Western Pacific. If conflict occurs in the region, however, this operational approach to apply airpower should not be the only arrow in the Air Force's quiver. A different approach would be to expand ACE to dramatically increase the movement and maneuver of land-based tactical missiles as part of a broader distributed operational fires concept, or missile-ACE (M-ACE). By leveraging Marine Corps expeditionary advance base operations and Army multi-domain operation capabilities, the Air Force could reduce the fighter demand for air interdiction, maritime interdiction, and offensive counterair missions for areas covered by these forces during the initial days of conflict when the theater ballistic and cruise missile threat is greatest.

19. "F-35A Lightning II," USAF, accessed 7 October 2023, https://www.af.mil/.

20. Tyler Rogoway, "Massive PL-17 Air-To-Air Missile Seen on Chinese J-16 Fighters," *TWZ* [*The War Zone*], 2 December 2023, https://www.twz.com/.

21. Orletsky et al., *Mobility Air Forces*, 9.

The limitation of land forces throughout history is that movement and maneuver are limited to hundreds of miles per day if good overland lines of communication are available. When the operational terrain is limited to an island a few miles wide or less, movement and maneuver for force protection or operational and strategic impact is not organically possible. Applying a M-ACE concept to these forces would enable their movement and maneuver with operational and strategic impacts. Air Force mobility and special operations aircraft can airlift these systems and move them hundreds of miles in minutes, including between remote islands, as demonstrated in the HIRAIN (High Mobility Artillery Rocket System Rapid Insertion) exercises that have been occurring for years.[22] Air Force C-130s and C-17s can land on short, semi-prepared or unimproved surfaces, opening most airfields in the region to these aircraft. More importantly, improvised landing zones like fields, roads, and even beaches vastly increase the available ACE locations while reducing the logistical tail required to bring joint fires to bear, since fighter-capable runways and support would not be required.[23]

The Marine Corps is already practicing these types of landing zone operations by creating expeditionary airfields to support air operations in austere locations unlikely to be targeted by the PLARF's ballistic missiles. These airfields are defined in Marine Corps Warfighting Publication 3-20 as "portable airfields that can be constructed, used, dismantled, and moved to another site for reuse . . . [that] are constructed on-site . . . [and that] permits Marine aviation to operate from captured or damaged runways, parking lots, or roads and to establish bases where none previously existed."[24] Although some landing zones are created when needed, the Marines' expeditionary advanced base operations concept prepares the operational environment during competition to help ensure access and placement during conflict.

While campaigning, EABO looks "to support allies and partners with local infrastructure improvements, which can mask construction of dual-use infrastructure that will enable [the] conduct of future distributed operations."[25] By understanding the local environment and building relationships with allies, the Air Force could determine the best locations for landing zones and the local equipment available for improvements, and could understand the sentiment of local populations to a conflict.

The HIMARS battery in the MDTF is being retooled with the PrSM, the follow-on to Army tactical missile systems, which are being produced in several increments in rapid succession. The currently fielded Increment 1 is equipped with two missiles per vehicle,

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22. Brenden Beezley, "U.S. and Belgian Forces Conduct HIRAIN Training," Ramstein Air Base, 31 July 2024, https://www.ramstein.af.mil/.

23. Joseph Trevithick, "Special Ops C-130s Using Beaches as Runways Eyed for Pacific Fight," *TWZ*, 19 September 2023, https://www.twz.com/.

24. Marine Corps Warfighting Publication (MCWP) 3-20, *Aviation Operations* (Department of the Navy, Headquarters US Marine Corps [HQMC], 2008, Change 1, 2018), 6-2.

25. *Tentative Manual For Expeditionary Advanced Base Operations, 2nd ed.* (HQMC, 2023), 6-6.

uses attack on coordinate guidance, and has a range of greater than 499 km.[26] Increment 2, which will be fielded by 2027, has a similar range with a dual-mode radio-frequency/infrared (RF/IR) seeker, allowing it to target moving land and naval targets.[27] Increment 4 will increase the range to 1,000 km, Increment 5 beyond that, and Increment 3, which will now come after Increment 4, will provide enhanced lethality in the warhead.[28] The Typhon battery consists of four tractor-trailer mounted launchers that hold four launch cells each and a command post that employ either Tomahawk missiles against land-based targets or anti-ship variants of the Tomahawk and SM-6s that provide air defense with demonstrated capability in anti-ship and counter-hypersonic weapon roles.[29]

The Marine Corps EABO concept employs mobile, low-signature capabilities like the Navy Marine Expeditionary Ship Interdiction System (NMESIS) launching Naval Strike Missiles (NSM) from shore in a contested environment for sea denial operations.[30] The NMESIS is smaller and more mobile than Army tactical missiles since the NSM cells are mounted on the joint light tactical vehicle chassis but their range is shorter at 115 NM (212 km).[31] Yet, the mobility tradeoff is amplified when airlift is concerned, as two NMESIS can be airlifted per C-130, versus one HIMARS. Up to four NMESIS could theoretically be airdropped from a C-17, providing runway independent insertion, a capability not available to HIMARS.[32]

Figure 2 demonstrates the potential operational and strategic impacts of rapidly inserting a mixture of these capabilities when moving from crisis to conflict in the Western Pacific. Just seven C-130s would be required to insert PrSM-equipped HIMARS covering the area represented in figure 2, providing sea denial around the entirety of Taiwan and western approaches to the Philippines, leaving only the Straits of Malacca and Karimata as permissive exit points for the PLA Navy (PLAN). Just four C-17s could deliver enough Typhon launchers for 16 SM-6s to surround Taiwan and Kadena Air Base. This could be expanded to a denial area from the north part of Borneo to the Japanese home islands with only modest airlift cost. Establishing a sector of air superiority over this large an area of allied territory would have a knock-on effect of enabling the freedom of movement for mobility aircraft to relocate all the missiles outlined in the M-ACE concept inside of PLARF targeting timelines without need of fighter escort. When the Tomahawk-equipped Typhon launchers are added, one can begin to range all PLAN

26. Feickert, *Typhon*.

27. Joseph Trevithick, "PrSM Ballistic Missiles Loaded with Coyote Drones, Hatchet Mini Smart Bombs Eyed by Army," *TWZ*, 30 April 2025, https://www.twz.com/.

28. Trevithick, "PrSM."

29. Joseph Trevithick, "Army Fires Tomahawk Missile from Its New Typhon Battery in Major Milestone," *The Drive*, 3 July 2023, https://www.thedrive.com/; and Feickert, *Typhon*.

30. *Tentative Manual*, 1-2.

31. Jeff Schogol, "The Marines Have a New Ship-Killing Weapons System to Counter China," *Task & Purpose*, 16 January 2023, https://taskandpurpose.com/.

32. Kenneth B. Rice, "U.S. Army Tests Gravity Airdrop, High-Altitude Parachutes and Powered Paragliders," Aerospace America, 1 December 2023, https://aerospaceamerica.aiaa.org/.

vessels to the docks of China and a large portion of PLARF theater ballistic, hypersonic, and cruise missiles that create the A2/AD challenge.

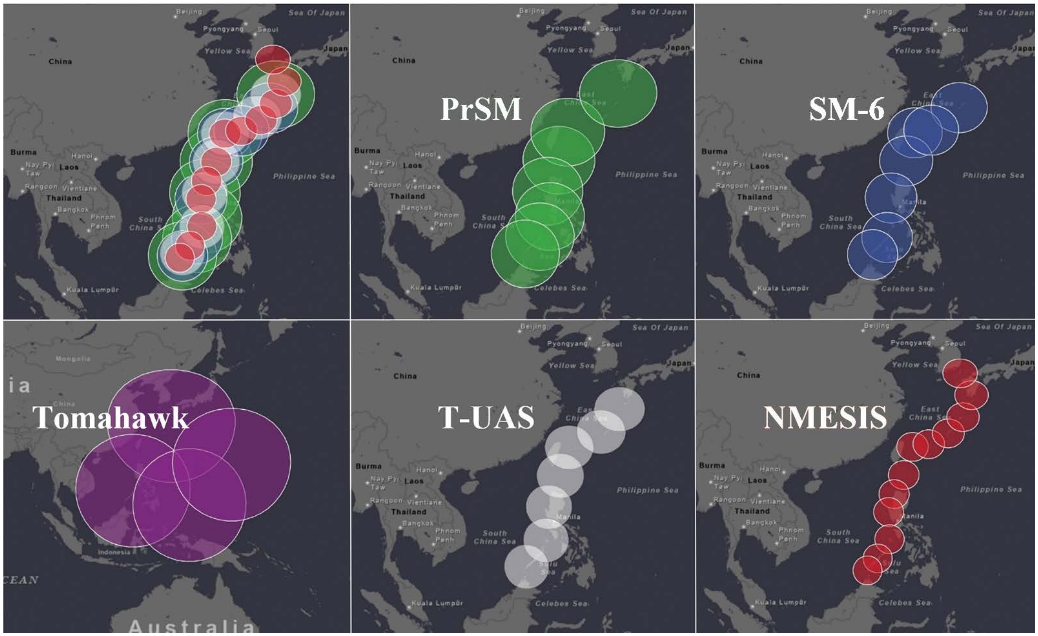

Figure 2. Range of M-ACE deployed missile and T-UAS systems

China is no doubt aware of the Air Force's efforts to operationalize the ACE concept, given the military construction outlays at various locations across the Western Pacific.[33] Exponentially multiplying the number of airfields on the PLARF target list would force it to spend more of its missile magazine depth degrading these additional airfields. This would limit the duration it could suppress American airpower. Even if the PLARF targeted runways of all lengths, targeting every conceivable landing surface within the first island chain is not practical, given a finite number of missiles.

To operationalize a M-ACE concept, the Army's MDTF—and to a lesser degree the Marines' NMESIS forces—would need to rethink the self-sustaining heavy force package the current force design requires. As with any ground force, the Army prefers to mass its long-range fires in batteries including the support personnel and equipment to provide on-sight intel analysis, target cueing, and the prime movers, trailers, generators, and support vehicles an Army battalion requires to move overland.[34] Reconceptualizing the MDO concept to allow a true "shoot-and-scoot" capability would allow this support to be accomplished disaggregated from the missile launch points using the aircraft's tactical datalinks to relay cueing information.

33. Zeigler et al., *Assessing Progress*.
34. Feickert, *Typhon*.

The HIMARS and Typhon systems within the MDTF are currently unable to operate effectively in disaggregated scenarios where command and control or target cueing are not organically located with the battalion. The HIMARS/PrSM battalion and the MRC/Typhon battalion rely on a collocated multi-domain effects battalion, which uses space-based or space enabled sensors to provide target acquisition, identification, and custody to cue the missiles.[35] While space-based cueing would certainly be used in an M-ACE concept, this target acquisition, tracking and dissemination could be disseminated from the air operations center or the Naval Integrated Fires Element via tactical datalinks since they would have the highest situational awareness of the orders of battle and priority for deep strike.

In a peer-conflict, space-based sensors will be operating in a contested domain and may be denied and unavailable. The development of tactical unmanned aerial systems (T-UAS) and the shrinking of RF and IR sensors make this an important addition to any F2T2EA PACE plan, especially one wholly reliant on space support for operations. T-UAS, also known as Group 3 UAS, are usually some form of small fixed-wing aircraft like a Jump-20 that has a range of 115 NM on line-of-sight datalink control.[36] When paired with a small (24 pound) multimode radar like the NSP-7, the T-UAS can detect and geolocate maritime targets out to 174 NMs, for a total detection range of 289 NM (535 km) from the launch point.[37] This is in addition to the electro-optical/IR and passive collect payloads these UAS can carry that can determine what vessels were detected and characterize the electromagnetic environment.[38]

To get a sense of the mobility of these T-UAS, the AeroVironment Jump-20 is a VTOL fixed-wing aircraft that is man-portable (215 pound maximum gross takeoff weight), can carry a usable load of 30 pounds, has an endurance of 13-plus hours, can be launched in 60 minutes with no launch equipment or runway, and can fit onto a single pallet position and loaded onto a mobility aircraft's ramp—a place an Army wheeled vehicle like the HIMARS would not occupy.[39] Figure 2 depicts the range a T-UAS can detect maritime targets.

When paired with a PrSM equipped HIMARS, this would provide a light and lean F2T2EA system for counter-maritime and land-based targets like PLA landing craft, disembarked vehicles, and escorting PLAN destroyers and cruisers. If additional T-UAS were added to the equation in the form of one-way attack aircraft, M-ACE enabled temporary long-range strike positions could provide a high-low strike mix with enough mass to overwhelm PLAN and PLA defenses during an invasion or blockade. As the technology matures, the range and sensing of T-UAS will increase, and T-UAS mesh

35. Joe Mroszczyk, "Multi-Domain Effects Battalion: Space Integration and Effects in Multidomain Operations," *Military Review*, Space and Missile Defense (2024): 96, https://www.armyupress.army.mil/.

36. "Jump 20 VTOL Fixed-Wing," AV [AeroVironment], accessed 27 August 2025, https://www.avinc.com/.

37. "Jump 20"; and "NSP-7: Multi-Mode, Multi-Domain SAR/MTI Radar," IMSAR, accessed 27 August 2025, https://www.imsar.com/.

38. "Jump 20."

39. "Jump 20."

networks—a capability on the near horizon—will pair well with future PrSM increments.[40] Yet, the range of the current systems, especially when paired with the Air Force special tactics' distributed C2 architecture and other passive sensors, has the mobility and capabilities required to provide targeting information in a contested environment when space-based capabilities are denied.

Army of One Multi-Domain Task Force

Given the range and multi-domain strike capabilities of the Army's and Marine Corps' long-range missile systems, they clearly will have a role in a conflict with China. If the Army and Marine Corps plan to deploy these capabilities as a stand-in force in the first island chain prior to conflict, why would a joint employment concept be necessary for mission success? While the small size of the Marine Corps NMESIS lends itself to camouflage and concealment in the expeditionary advanced base operations concept, the Army's battery-based structure with command vehicles and prime movers, generators, and other support vehicles have the same large signature problems as Air Force fighter airfields. While these systems are road-mobile, the large battalion support package footprint makes these ground forces unlikely to go undetected and get inside of the PLARF's theater ballistic, hypersonic, and cruise missile targeting cycle. The M-ACE concept eliminates much of the Army's forward-deployed support tail that enables the multi-domain task force. The HIMARS battery has proven this concept in multiple HIRAIN exercises, and similar aircraft mobile packages could be developed for Typhon.

The Army is organizing its forces to satisfy multiple geographic combatant commands, and would face access, placement, and mobility challenges to ensure missiles are at the point of need in relevant timelines. The regionally aligned concept of the Army's five MDTFs make it clear that only 20 percent of the US Typhon and PrSM assets may be a stand-in force in the first island chain at the outset of the conflict.[41] Organic movement and maneuver of MDTF battalions in the first island chain is limited to aging allied road networks, where the speed of movement is limited and the range is limited to the island's geography. In a war with China, it is likely these systems will not be at the point of need in a rapidly changing conflict. Even if the Army dedicated 100 percent of its MDTFs to the Western Pacific, it is not guaranteed to have access and placement to desired locations for political reasons during competition. If it gains this access, the Army may be unable to employ long-range fires from the host nation's territory if that nation is not a party to the conflict. As currently planned, the deployment of MDTF battalions in the Western Pacific would face limited mobility with the same A2/AD challenges as the Air Force,

40. Ryan Schradin, "Unlocking Drone Potential: How Mobile Mesh Networking Enhances Tactical Operations for Public Safety and Military Operators," *The Last Mile*, 2 November 2023, https://thelastmile.gotennapro.com/.

41. Feickert, *Typhon*.

without an ACE capability, and may be out of position and unable to provide long-range strike should conflict come.

The Army is adapting to meet the PLA's force design by developing weapon systems that operate beyond the land domain. The air domain is the most advantageous, given the widely dispersed island geography of the Western Pacific, and the ability to strike maritime targets is essential in a theater of islands and vast oceans. The Army is pouring resources into theater ballistic and cruise missiles, Groups 1 to 4 UAS, high-altitude balloons, a diversified air and missile defense portfolio, and likely anything else that flies.

The Air Force is ceding the high ground—the air domain—to the Army. The Air Force has been the branch with long-range strike expertise since the Air Corps created the concept in World War II. Theater ballistic, hypersonic, and cruise missiles are just unmanned aircraft systems by another name. Since the demise of the Intermediate-Range Nuclear Force Treaty in 2019—which restricted the United States and Russia from possessing and producing intermediate-range (500 to 5,500 km) conventional and nuclear missiles—the Army has moved to develop weapons in that domain.[42]

Yet the Air Force should be the service conducting long-range strike from the air, be it with bombers, fighters, one-way attack UAS, or ballistic and cruise missiles. Across the military, the Air Force is the service that has target analysts with expertise in long-range strike operations and the ability to rapidly process the find-fix-track-target portion of the targeting cycle, enabling dynamic, long-range strike. Similarly, the Air Force should continue to lead in the UAS field—at a minimum Groups 3 to 5 UAS, including ISR, strike, C2 nodes, collaborative combat aircraft, and one-way attack UAS. Now is the time for the Department of Defense to reassess the roles and missions of the services, especially mission creep of the services, and reallocate resources accordingly. The Air Force should be the one to lead the way in all aspects of airpower.

The Future of Ace and Airpower

China has studied the American way of war and understands its strengths and vulnerabilities, building its force design around countering such strengths, including American airpower. So far, agile combat employment is the Air Force's answer to the People Liberation Army's anti-access/area denial force design; however, it is a one-dimensional approach that has devolved from a light and lean concept to a logistically heavy and vulnerable operational concept. Should China choose to invade or blockade Taiwan, or violate the territorial integrity of the Philippines, a missile-ACE concept that combines joint concepts in the air domain would give the joint force additional options for long-range strike, taking the best aspects of ACE and pairing them with long-range strike capabilities against land and maritime targets in what is sure to be a contested environment.

42. C. Todd Lopez, "U.S. Withdraws from Intermediate-Range Nuclear Forces Treaty," DOD, 2 August 2019, https://www.defense.gov/.

Utilizing a M-ACE concept to build out a missile force organized, trained, and equipped for rapid mobility—even one based as far away as Australia or in Hawaii or Alaska—would provide a missile force "in being" in the first island chain, with an alert force that can be in place in hours. This would be a powerful deterrent to decisionmakers in Beijing as an opposing A2/AD network would be ready to overlap its own, centered on Taiwan. Finally, the Air Force should reassert its role as the lead service for all aspects of the air domain, taking the best parts of emerging joint concepts and designing an Air Force that meets the challenges of the twenty-first century.

Macro-Management in the Air Component

Learning to Love the Mission Type Order

Robin P. Kimmelman
Thomas L. Cantrell

Air components conventionally view mission type orders (MTO)—the writing of orders focusing on what the mission is rather than how to execute it—as a contingency-only tool used when communications are degraded. Yet because of the sheer scale and speed of major war, MTO is needed even when communications are robust. Air components should therefore use them fluidly alongside air tasking orders (ATO). Their use within the air tasking cycle requires procedural, experiential, and cultural approaches. A review of doctrine, existing research, and Operational Command Training Program engagement with air components worldwide reveals solutions to the challenges of distributed control in multiple theaters, offering tailored prescriptions for creating procedures, gaining experience, and building the culture necessary for mission command.

The Air Force considers its leadership approach of *mission command* as the main counter to adversary anti-access/area denial (A2/AD) capabilities designed to erode US and allied command-and-control (C2) architecture. The Air Force's newly published doctrine on mission command defines it as a "philosophy of leadership that empowers Airmen to operate in uncertain, complex, and rapidly changing environments through trust, shared awareness, and understanding of the commander's intent" and decentralized execution.[1]

Agile combat employment, lead wing/expeditionary air base, joint all-domain C2, and sensor-to-shooter kill webs are all reflections of mission command as a decentralizing philosophy designed to thwart advantages in adversary hardware with the software of the US Airman, Sailor, Marine, and Soldier, who demonstrate a historic bias for action, creativity, and initiative. Future conflict will occur in a contested, degraded, and operationally limited (CDO) environment, where the superb C2 advantages of the United States will be

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1. Air Force Doctrine Publication (AFDP) 1-1, *Mission Command* (Curtis LeMay Center for Doctrine Development and Education, 14 August 2023), https://www.doctrine.af.mil/.

diminished, exquisite long-range and high-speed A2/AD capability will hold US basing and logistics networks at risk, and the air component's operational C2 construct will need to evolve to win.

The Air Force laid the intellectual framework for evolving its C2 construct by examining mission command as a cultural concept and *distributed control*—the delegation of authorities to diverse locations that enables them to coordinate, execute, and assess air operations—as a C2 mechanism. Mission command is a cultural philosophy that breeds a preference for action and innovative problem solving.[2] The term refers not only to the approach's execution but also to the "philosophical, organizational, and cultural elements that must be in place" to effect decentralized operations.[3]

This decentralized execution and innovative problem solving is based on the mission type order (MTO)—a technique for writing orders that tells a unit what mission to perform without specifying how it is to be accomplished. *Commander's intent* is the guiding principle for those working under such orders and free to determine how a mission will be achieved. MTOs and distributed control are concepts that challenge the traditional C2 construct of the centralized air operations center (AOC) and prescriptive air tasking order (ATO) that tells a unit both what to do and how to do it.

Analyses examining how to implement greater decentralization in Air Force C2 often criticize AOC and ATO. One Marine Corps officer assessed the ATO's prescriptive and detailed nature as antithetical to mission command, calling for its revamp with greater emphasis on commander's intent.[4] One senior leader noted that a side effect of the successful ATO is the gradual removal of "every opportunity for combat decision making," leading to a need to "put all echelons of command back in C2."[5] Another commentary characterizes the AOC as "centralized, rigid, and vulnerable" with an ATO that does not provide sufficient guidance when the situation changes.[6] These authors and several others cite the ATO's emphasis on what to do and how to do it will hamstring subordinates in a CDO environment and call for greater reliance on MTOs that feature commander's intent and decentralized decision-making.[7]

The most notable dissent to this argument characterizes a case study of MTO use in Afghanistan as unscalable and impractical. While embracing mission command as a culture,

2. Brian Blaine, "USAF Mission Command: Cultural, Organizational and Operational Change to Meet Future Demands," *Wild Blue Yonder*, 10 June 2024, https://www.airuniversity.af.edu/.

3. AFDP 1-1, 1.

4. Blaine, "USAF Mission Command."

5. Alex Grynkewich and Antonio J. Goldstrum, "The AETF Today: Enabling Mission Command of Airpower," *Air & Space Power Journal* 34, no. 20 (Summer 2020): 12, https://www.airuniversity.af.edu/.

6. George Kamena, "Before Mission Command," *Wild Blue Yonder*, 20 April 2023, https://www.airuniversity.af.edu/.

7. Matthew Quintero, "Master and Commander in Joint Air Operations: Winning the Air War Through Mission Command," *Joint Force Quarterly* 92, no. 1 (2019); and Trent R. Carpenter, "Command and Control of Joint Operations Through Mission Command," *Air & Space Power Journal* 30, no. 2 (2017), https://www.airuniversity.af.edu/.

it rejects MTO as a C2 mechanism, noting its usefulness "is inversely correlated to the subordinate headquarters' requirement for external support and coordination."[8] MTOs falter on airpower's need for force packaging—the combination of assets such as strike, refueling, and electromagnetic warfare—to achieve range, protection, and precision. The case study concluded that MTOs should not be part of the air tasking cycle because centralized C2 is necessary to schedule myriad units to appear at the same place and time to achieve effects.[9]

The 505th Command and Control Wing Operational Command Training Program (OCTP) notes many Airmen and air components share this perspective and are loathe to abandon the ATO and centralized C2 construct that has served them so well. OCTP comprises operational C2 subject matter experts who mentor and advise every air component around the globe via major exercises and real-world contingencies.[10] During dozens of events from 2023 to 2025, OCTP observed that discussion of mission command and MTOs, if it ever occurred, was in the context of what to do in the event of a temporary communications outage. Multi-day ATOs, guidance packages, and contingency-only MTOs appear in exercises as band-aids to communications outages. Continuity-of-operations plans are discussed as ways to keep the centralized C2 node moving and surviving.

All of this rests on the premise that resilient communications will eventually allow normal operations to resume—that the ATO will always get through and centralized airpower will continue. It also assumes that communications outages are the only reason to entertain the thought of mission command. With this mindset, the MTO and distributed control are rare at the air component, even during exercises, and infrequently practiced.

Yet air components will need mission command, MTOs, and distributed control, even if communications are robust. The sheer scale and speed of the operational environment in a peer conflict will require decentralized decision-making. Even if the AOC is fully manned and completely protected with flawless communications, it cannot contend with the entirety of the complexity such a war will present. The air component will need to macro-manage and establish a broader view of the air war.

This article calls for the greater use of commander's intent and MTOs that emphasize what to do over how to do it and seeks to give practical advice on how to make that a reality within the C2 structure. Airpower has unique challenges for MTO usage, and fluidity in ATO versus MTO will help bridge the false dichotomy between them. Air components must set conditions by working out the delegation of authorities in advance and test those authorities by seeking peacetime distributed control experience using MTOs.

Air components should attack mission command through three lenses: procedural, experiential, and cultural. Establishing delegated authorities and pre-arranged approvals, deliberately

8. Frederick Coleman, "The Limited Utility of Mission Type Orders for ACE … and a Better Way to Execute Mission Command," *The Mitchell Forum* 49, January 2023, 4, https://www.mitchellaerospacepower.org/.

9. Coleman, "Limited Utility."

10. Deb Henley and William Murphey, "Air Force Provides C2 Advisors to Operational-Level Commanders," US Air Force [website], 29 April 2021, https://www.af.mil/.

assigning tasks to specific distributed C2 nodes, and identifying when to use the ATO and the MTO are important procedures. This will allow air components to understand how mission command works at the operational level. But understanding alone is not enough. It must also be experienced to be made real.[11] Finding ways to use mission command in peacetime operations and exercises will be crucial in turning procedures into muscle memory.

Perhaps the most egregious weakness of a contingency-MTO is relying on subordinates to act in a mission command manner for the first time during war. Experience with using MTOs, leading with a distributed mindset, and perhaps most importantly, failing and learning from the experience when the stakes are low are essential to set conditions for success when the stakes are high. Culture underlies both procedure and experience and is more important than either. Building a mission command culture means rewarding initiative-based failure, championing learning through mistakes, and establishing trust.

The Legacy of Mission Command in the Air Force

The Operation Command Training Program seeks to challenge the general sense among Airmen that mission command is ill-suited to the Air Force and unlikely to take root, a doubt based in an Air Force culture that emphasizes safety over risk-taking. It also stems from an ATO process that has proven successful for over a generation but is highly prescriptive with how to execute missions.

Mission command has shaped the Air Force since its early days. During World War II, General George C. Kenney and the Fifth Air Force set the template by adopting mission command to manage the Southwest Pacific's complexity and widely dispersed geography.[12] Kenney established composite units known as air task forces (ATF), which had the assets and authority to fulfill broad mission sets. He issued brief MTOs that emphasized commander's intent, identified the main effort, and described the why of a mission over the how, relying on ATF or wing or group commanders to work out the details. He empowered these commanders to coordinate actions laterally and self-synchronize. Geographic separation and clearly established supported/supporting relationships helped deconflict decentralized operations.

The construct was fluid, with composite units coming together or disbanding as the operational environment dictated.[13] The Fifth Air Force relied on centralized command, but that command was focused on *macro-management*: putting forces together, assigning them broad missions, and keeping an eye on the campaign's progress.

During the Vietnam War, a unit called Commando Sabre flew what were known as *Misty* missions along the Ho Chi Minh Trail to identify targets, serve as forward air

11. Kamena, "Before Mission Command."
12. AFDP 1-1, 2.
13. Michael E. Fischer, *Mission-Type Orders in Joint Air Operations: The Empowerment of Air Leadership* (Air University Press, 1995), 80.

controllers, and conduct assessment.[14] Commando Sabre was given MTOs to troll over this enemy terrain in North Vietnam and Laos, freely focusing on areas as the operational environment dictated. It looked for choice targets such as anti-aircraft sites and concentrated supplies and submitted them to airborne C2, which would vector in fighters loaded with bombs.[15] The Mistys would act as forward air controllers and mission commanders of downed aircrew rescue attempts. They operated under MTOs in their own deconflicted space with the freedom to adjust to the changing operational environment and also served as an element of distributed control, helping guide strike and rescue sorties.

The 7440th Composite Wing, a Türkiye-based unit assigned to a separate Northern Iraq geographic space, used MTOs to good effect during Desert Storm. It had a robust planning and intel staff and organic capabilities that enabled force packaging—that is, strike, electromagnetic warfare, and airlift, among others—all under a single wing commander. While other units were directed and force-packaged by the daily ATO, the 7440th was given air component commander's intent and three broad tasks to execute: attack air bases in the north, tie down Iraqi forces on the Turkish border, and strike weapons-of-mass-destruction facilities.[16] The air component commander could, and did, pull the 7440th into the ATO for specific missions as needed but generally allowed the unit to conduct its own planning and execution based on a broad-based MTO.

During the Iraq and Afghanistan wars, Air Force intelligence, surveillance, and reconnaissance (ISR) stood out as a positive example of mission command. ISR was frequently identified as the core combat capability needed to fight insurgent networks, and its use was a special operations best practice that later migrated to conventional forces.[17] The AOC evolved ISR tasking from a highly prescriptive method with emphasis on specific collection tasking to a mission command method where ISR was force-packaged with supported ground units. ISR was allocated for extended periods of time in a supported/supporting relationship and given the freedom to maneuver within a broad mission and commander's intent. This enabled greater speed and responsiveness because ground commanders and ISR could coordinate laterally and develop habitual relationships in a joint force package that emphasized qualitative results.[18]

Air Forces Central experimented with MTOs in 2019 by delegating operational C2 to the Air Expeditionary Task Force-Afghanistan. The task force had its own geographical operational area, robust planning staff, and force packaging capabilities. The planning staff

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14. "The Misty Experiment: The Secret Battle for the Ho Chi Minh Trail," posted 4 July 2024, by History & Warfare Now, YouTube, https://www.youtube.com/.

15. William R. Phillips, *Bury Us Upside Down: The Misty Pilots and the Secret Battle for the Sky* (St. Martin's Press, 1996).

16. AFDP 1-1, 12.

17. Michael T. Flynn et al., "Employing ISR SOF Best Practices," *Joint Force Quarterly* 50, no. 3 (2008).

18. Jaylan Michael Haley, "An Evolution in Intelligence Doctrine: The Intelligence, Surveillance, and Reconnaissance Mission Type Order," *Air & Space Power Journal* 26, no. 5 (September–October 2012), https://www.airuniversity.af.edu/.

was well integrated into Combined Forces Command-Afghanistan and had a deep understanding of commander's intent and priorities. MTOs allowed the task force to plan its own sorties and strikes and to inform the AOC in Al Udeid Air Base merely for administrative inclusion in the ATO.

The Challenge of MTOs for the Air Force

Despite this history, the general sense in the Air Force is that MTOs are ill-suited to airpower. The air tasking cycle has proven efficient and effective in providing airpower in every air campaign since Desert Storm. Although the 72-hour span is sometimes maligned for its length and rigidity, such criticism often ignores the cycle's inherent flexibility through dynamic targeting and ad hoc tasking, which enable it to respond to events as they occur. MTO usage has legitimate challenges that must be acknowledged, yet all are surmountable.

Force Packaging

Airpower requires force packaging to be effective. For example, strike assets require tankers, ISR, defensive counterair, electromagnetic warfare support, airborne early warning, and other capabilities to conduct its mission. Unless a wing or ATF commander has the requisite platforms to be independent, they must rely upon operational level C2 to orchestrate timing, tempo, and location for a force package.

Lack of Master Air Attack Plan Capability

Wings or ATFs must have planning and intelligence staff to take an MTO and turn it into a force-packaged tasking. Ensuring they have the necessary experience and manning to work out packaging and deliberate targeting in a timely manner is a challenge. Wing staffs will undoubtedly be small but can be augmented by AOCs dispersing and thus creating distributed control nodes at strategic points. While there may be creative manning solutions, having small numbers does not necessarily equate to less capability if the leadership and training are there. Manning challenges aside, the existence of a wing A-staff should not imply an ability by AEW commanders to endlessly carry on an air campaign by themselves. They should be designed to execute MTOs in a discrete geographic area akin to many mission command examples in Air Force history.

Airpower is Strategic

As Air Force doctrine makes clear, mission command is not applicable in all situations, noting that "certain missions and operations are not suited to a decentralized approach." This is especially true for missions requiring "consistency and uniformity," such as nuclear operations. Doctrine further adds that "commanders may elect to retain authorities or impose restraints to reduce strategic risk; preserve resources; or when subordinates lack the ability, knowledge, information, or awareness needed to make decisions."[19]

Highly orchestrated events that consume inordinate resources with a high strategic cost of failure do not make good candidates for MTO. Some in the air component could argue against MTO by saying that airpower is strategic—it travels too fast and too far, is highly destructive, and represents great potential for unintended military escalation and political blowback. Airpower by its very nature may be in that category of military capabilities that require more top-down management versus decentralized decision-making, yet this is not true in all cases.

Communications Will Persevere

The CDO assumption is the air component will be cut off due to non-kinetic or kinetic strike on a C2 node like the AOC. The ATO will then have difficulty getting published, hence the use of MTO, where daily and detailed guidance may not be necessary. Yet, one school of thought is that adversaries will never be able to jam 100 percent of blue force communications or destroy an AOC adopting distributed control. Hence, the ATO will always get through. The US Space Force initiative to deploy the proliferated warfighter space architecture with a network of 1,000+ satellites in low Earth orbit for the purpose of providing resilient communications to terrestrial actors reinforces confidence that no adversary could completely deny air component comms.[20] If air component leadership has high confidence in this architecture and other forms of comms resiliency, then the imperative for MTOs becomes less urgent.

While these challenges are significant they do not necessarily mean that MTOs are a bad fit for the Air Force. Like much else in warfare, C2 is rarely dilemma free. There will be trade-offs and sacrifices, and the above challenges illuminate these as well as indicate that there is a role for both the ATO and MTO simultaneously within Air Force C2.

One former Ninth Air Force commander encouraged Airmen to think about how they could "retool the current air component C2 system and processes to improve war fighting," stating that "mission-type orders need not be seen as only useful when they 'can' be used, such as in Afghanistan, or when they 'must' be used, such as when communications are degraded." He challenged Airmen to integrate MTOs when they should be used as a norm in the daily air tasking cycle and not just at the extremes of an overly permissive air environment, where choices hold little consequence, or in an extremely non-permissive air environment, where no choice exists.[21] This calls for a sliding scale of ATO-MTO usage where both coexist and are used in circumstances most beneficial to specific operational environments.

19. AFDP 1-1, 13–14.

20. Ramin Skibba, "The Space Force Is Launching Its Own Swarm of Tiny Satellites," Space Development Agency, 14 August 2023, https://www.sda.mil/.

21. Grynkewich and Goldstrum, "AETF Today," 13.

Whether an air component uses MTOs when it can, must, or should, Airmen must gain MTO experience and training during peacetime. If MTOs are employed only when communications and the AOC are down, then Airmen do not want their first real MTO experience to be in a conflict. Air components must exercise their mission command muscles by developing procedures, experience, and culture during peacetime to be proficient in it during wartime.

Three Lenses for Air Component MTOs

These three interrelated elements create genuine capacity. Procedure is intentionally and typically written. It covers the gamut from plans to techniques but is theoretical if never used. Experience, however, is theory in use and bridges intentions and behaviors.[22] Experience determines whether a unit is hypocritical or not—whether they do what they say and say what they do. Culture simultaneously underlies and is reinforced by both procedures and experience but is more elusive than them. A unit's culture is its behavior at rest, when it is not trying to be anything other than it is. All three need addressing by air components to create an environment conducive to mission command, MTO, and distributed control.

The Procedural Lens

The overall gist of MTO and distributed control procedures is to focus the air component on macro-management—setting conditions in which subordinate units can exercise their initiative and make decisions in a decentralized way. Macro-management involves the following elements.

Habitual Use of Commander's Intent

Commander's intent represents the core of a MTO and the heart of mission command. Airmen should seek ways to emphasize commander's intent, focusing on the why versus the how of a task. Even a highly prescriptive order like the ATO could better enable mission command by explaining the reasons behind the tasking lines.[23] All taskings, briefings, and orders should have a section for commander's intent so all air component members become accustomed to hearing why something is being done or tasked.

Delegated Authorities

Delegation of authorities is a critical element for mission command, MTO, and distributed control. Delegations can be standing or based on conditions. An apt example of

22. Eitan Shamir, *Transforming Command: The Pursuit of Mission Command in the US, British, and Israeli Armies*, Stanford Security Studies (Stanford University Press, 2011), 23.
23. Blaine, "USAF Mission Command."

standing delegation of authorities could be air defense, specifically the regional air defense command or sector air defense command. Both Pacific Air Forces and Air Forces North make effective use of these commands, which are in essence self-contained entities with the awareness and capability to execute the air defense mission for the area air defense commander.

Conditions based authorities (CBA) are crucial to time-sensitive AOC tasks and should be increasingly important to air expeditionary wings employing the agile combat employment concept. CBAs are typically approved through iterative discussions with the joint force commander in peacetime and through execution during exercises. Exercises are a good time to discuss authorities that may be best delegated to the air component commander and, ideally, much lower. Procedurally, having pre-approved CBAs during peacetime will serve to put the combatant command, air component, and subordinate AEWs on the same wavelength regarding expectations to take initiative and manage risk.

MTO Tips from History

Air components should write orders using the best practices from Air Force mission command history. From World War II to Afghanistan, Air Force history offers techniques repeatedly used that allowed air components to macro-manage and subordinates to micro-execute. Some examples of this are as follows:

- Aim for short orders that define what to do, not how to do it. MTOs are brief, being historically three to five pages in length. Air components should strive for MTO brevity because it forces a commander to focus on what and why versus how. Left and right limits are fine, but the entirety of the order should be concise.
- Identifying a unit as the main effort and establishing supported/supporting relationships among units provides additional intent that subordinates will use to make decisions when circumstances change. Identifying a main effort enables *Zusammenwirken*—the German military concept meaning lateral self-coordination at the lowest level.[24] Subordinate units will lend each other support and minimize secondary efforts without higher headquarters involvement if the main effort is clearly understood.
- Assigning geographical areas and distinct tasks will help deconflict subordinate units. Using zone C2 where a distributed control node like tactical C2 is assigned a specific geographic area may be an organizing principle for this. The role of tactical C2 that is in the air, on a boat, or on the ground may become increasingly important to force package disparate elements.
- Finally, writing orders that create composite units will enable force packaging under a subordinate leader. These composite units may be permanently established, but more likely the air component will set up temporary and mission-focused composite units that will disband once the task is complete. These were used to great effect

24. William S. Lind, *The New Maneuver Warfare Handbook* (Special Tactics LLC, 2023), 62.

by the Fifth Air Force in World War II, the 7440th in Desert Storm, and the Air Expeditionary Task Force-Afghanistan in 2019, which were assigned those forces based in Afghanistan. The revival of ATFs as an Air Force unit may augur a revival of the composite wing concept at least as a series of deployed force modules coming together under a single commander.

Fluid Tasking Orders

Using an ATO or a MTO does not have to be presented as a dichotomy or all-or-nothing proposition. There is a need for proper balance between prescriptive or permissive orders based on the situation and operation's nature.[25] The general belief is that it must be ATO until there is an outage; then MTO takes over until communications are restored and the ATO can make its return. But the two can and should be blended with some missions requiring a high degree of orchestration with others needing general guidance with intent and end-state.

The concept of a fluid ATO emerged during one OCTP seminar with an air reserve unit that emphasized the importance of the ATO's prescriptive guidance during the early phase of an air campaign, when concentration and tempo are a must. But the ATO could transition to the more permissive MTO once air superiority is achieved.[26] Broad mission MTOs may succeed where swift reaction to opportunities and dilemmas is at a premium, for example when close air support for the ground component is important. MTOs could also prosper where persistent and patient effort over time is required for the desired effect, such as an air interdiction campaign designed to isolate part of the battlespace.

In other words, the air component must be able to flow between the ATO and the MTO as the operational environment dictates. The two will likely coexist like they did during Desert Storm with southern units directed by ATO while northern units were given an MTO under the 7440th wing commander. The key to these air component procedures is to give a mission to a commander and let them work out the rest. Simultaneously, that same air component needs to execute some missions with a high degree of direction and coordination.

The Experiential Lens

Determining MTO procedures is only the first step. Building these plans and procedures will not matter much unless the air component staff and subordinate units gain practical experience to build the necessary muscle memory to execute these missions during war. The following prescriptions are concrete suggestions to gain experience in MTO use.

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25. Carpenter, "Command and Control."

26. Robin Kimmelman and Thomas Cantrell, Operational Command Training Program, "Mission Command Seminar," March Air Reserve Base, California, 20 July 2024.

Wing Tabletop Discussions

During an OCTP seminar in Europe, Airmen recommended the use of wing commander tabletop discussions with the air component commander as an easy means for them to experience mission command, MTOs, and distributed control. This recommendation would start with the air component publishing an MTO with commander's intent, output-based missions, clear risk discussion, and constraints/restraints with a wing identified as the main effort and others as supporting. Provided the what and why, all the wings would be given several days to work out the how and be invited to the air component to tabletop discuss their actions.

This discussion would likely identify gaps in authorities, understanding of risk, mutual trust, and left and right limits. The air component commander would thereby have a means to assess subordinate's mission command capabilities, and the wings would benefit from better understanding the commander's mind and risk tolerance. This simple exercise would require little preparation and no simulation but would result in the trust-building needed among commanders to make mission command a reality.

ISR MTOs

The air component should seek real-world events for which MTOs are appropriate. ISR is a natural place for this to occur with execution of the daily collection plan changing as circumstances dictate, under the delegated authority of the AOC's senior intelligence duty officer, the distributed ground station, or the ISR aircrew. Appointing a package commander, identifying a broad collection mission, determining an allocation of sorties, and giving several days to develop results will unleash the initiative of such a team, perhaps packaged with tactical C2 or other distributed control nodes. This will force ISR to think like a maneuver element and empower it to solve problems posed by the operational environment versus delivering a specific sortie at a specific time like an ISR help desk. Some air components are employing the ISR MTO today in real-world scenarios and in exercises, usually against discrete target sets like ballistic missiles or a hostile network, where time and flexibility are needed to achieve impactful effect.

Find, Fix, Track, Target

Real-world find, fix, track, target (F2T2) events are ideal for MTOs. F2T2 is the Air Force kill chain minus the engage and assess steps, since no fires occur. These are self-generated drills that practice an actual kill chain conducted with, for example, maritime and ground surface fires and all-domain capabilities like space and cyber against a real adversary in the area. Once the adversary is found and fixed, ground, maritime, and cyber participants run their respective kill chains to obtain a targeting solution, which helps measure speed and breed interoperability. The F2T2 initiative is ingenious because it combines real-world requirements with actual joint targeting processes and can occur many times a year.

These events could easily exercise C2 procedures for mission command. MTOs could create an ad hoc composite unit in-being that appoints a mission commander and supported/supporting relationships between space, cyber, maritime, and air. The MTO-enabled mission commander would determine maneuver within left and right limits, generate sorties as the operational environment requires, and exercise conditions-based authorities in deciding to strike or not strike a target. Multiple F2T2 mission commanders could operate in geographically assigned areas and work laterally (*Zusammenwirken*) to deconflict use of shared resources.

Competition Event MTO

In a variation of the F2T2, one air component is experimenting with MTO usage during real-world competition events with an adversary. Day-to-day airpower is tasked using ATO. Yet, during a discrete event an air package commander will be given broad guidance, an output-based mission, and control of sufficient resources to achieve real-world objectives. These MTO competition events may be flexible deterrent options or a partner nation capacity-building activity. They are meant to exercise both the AOC and wings in mission command principles with an after-action review that will help further develop air component procedures.

Exercises

Some air components have experimented with an MTO paragraph in the daily air operations directive and stand-alone MTOs that execute in the event of a contingency—namely the inability of the AOC to function or communicate due to kinetic or non-kinetic fires. In that contingency, the MTO is temporary until the continuity of operations site or communications backup plan kicks in, and another node picks up responsibility for ATO publication.

In addition to using MTOs when one must, air components should exercise using them when one should. Exercises should test how MTOs could be used for airpower in the context of major theater war when communications are robust. Real-world MTOs in the Air Force might be limited in size and scope, but exercises offer a time to show how it might work on a grander scale. Examples include assigning package commanders responsibility for a pulse strike when air superiority is contested; tasking regional air defense command with air defense of geographic areas; or tasking an air expeditionary wing as supporting airpower to a supported surface force for a short time or an entire phase of the campaign. Both command post exercises and field training exercises are good venues to flex how an air component should employ mission command and MTOs on a scale that real-world events cannot provide.

Battle Drills

While tabletop discussions educate leaders, real-world events add friction, and exercises test procedures, battle drills instill muscle memory in the air component through increased frequency. Sound MTO procedures worthy of repeating and scaling will become obvious from the experience gained in tabletop discussions, exercises, and real-world events. Battle drills that practice distributed control, dynamic targeting, partner nation teaming, or simply orders writing are ways to knit together the disparate elements of an AOC, staff, tactical C2, distributed ground station, and joint partners, helping to solidify processes and build expectations. Commander's intent should precede every battle drill event to inculcate these disparate elements on mission command expectations.

Battle drills should be accompanied by habitual MTO use. MTO writing is an art that requires practice. Such orders should "include only a mission statement, a statement of intent, disposition of enemy and friendly forces, and special instructions" and should be "clear and concise," leaving "the details of execution to subordinates."[27] Finding the sweet spot between too much and too little detail in MTO requires experience that battle drills can deliver.

The experiential recommendations will build the sets and reps necessary for the air component to make the wartime transition to mission command, MTO, and distributed control. Tabletop discussions build commander-to-commander experience; real-world activities such as ISR MTOs, F2T2s, and competition event MTOs will add practical field experience; and exercises and battle drills will allow air components to practice the worst-case or most complicated scenarios from warfare. All this will not only test and refine the procedural lens but also give the air component the necessary practice in the art of macro-management for success in high-speed warfare.

The Cultural Lens

Establishing MTO and distributed control procedures and seeking experience in using them are essential for wartime expertise. Yet, building a mission command culture is foundational. The discussion on building mission command culture in the Air Force has centered on revamping education and taking a generational view to cultural transformation.[28] This is a valid approach, but one that lets the air component off the hook. Airmen who only serve a few years at the operational level of war may feel that this cultural transformation is best left to Air Education and Training Command. OCTP would encourage air component leaders to seize responsibility in consciously developing a mission command culture in tandem with crafting procedures and gaining experience. The three efforts should unfold more or less simultaneously to create a self-reinforcing virtuous cycle. Developing a culture is amorphous, but three concrete recommendations will help.

27. Shamir, *Transforming Command*, 40.
28. Kamena, "Before Mission Command."

Discussion-Based Trust

Mission command relies on trust. Trust flows from the higher commander to the lower commander—the former believes that the latter will operate with intent through a shared understanding of risk tolerance, mission output, and constraints/restraints. Trust also flows in the opposite direction. The lower commander trusts that the higher commander will encourage and reward initiative and risk-taking. Thus, mission command is based on a relationship between commanders and a common understanding of what risk, initiative, and recklessness mean.

One participant in an OCTP seminar, a graduate from an advanced Army school, observed that this type of trust is built in the ground forces through a heavy investment in discussion.[29] Discussing the mission, intent, and common frames of references consistently is the foundation for building trust. While every single MTO does not require a discussion, fundamentally, a commander's trust in subordinates is built through consistent communication that ensures everyone approaches problems from a basis of shared values.

Mistake Tolerance

The tolerance for mistakes in the Air Force may be lower than other services due to the potential for greater consequences. Anecdotally, one often hears Airmen describe a "one-mistake Air Force" with fixation on safety and a general tendency of risk aversion. While every unit is different, this attitude may be one of the greatest obstacles to instilling mission command, which requires a great deal of trust not only from the commander down but also from the subordinate up. Subordinates must believe that decision-making and "prudent risk" are encouraged and that mistakes that inevitably follow from taking initiative will be forgiven. Notably, Army doctrine has adjusted the phrase "prudent risk taking" to simply "risk taking," seeking to eliminate a modifier that may slow subordinate initiative.[30] The commander assumes risk for mistakes on behalf of subordinates by encouraging them to seize the initiative—but subordinates must believe in the initiative to make it real.

Train to Failure

This means taking risk to test out new ideas, undertake a bold initiative, and learn from mistakes. Commanders who encourage initiative must also be tolerant of initiative-driven failure, because one cannot exist without the other. Initiative-driven and action-prone mistakes during training and exercises are wonderful opportunities for commanders to demonstrate this tolerance, which in turn generates the trust needed for mission command.

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29. Robin Kimmelman and Thomas Cantrell, Operational Command Training Program, "Mission Command Seminar," Ramstein Air Base, Germany, 6 September 2024.

30. James D. Corless, *Mission Command in the USAF: Challenges and an Analytical Framework, School of Advanced Military Studies* (US Army Command and General Staff College, 2024), 17.

At a 2025 exercise, a three-star general air component commander emphasized, "I am okay with failure we can learn from," in an effort to encourage his staff to make the bold decisions in a low-risk exercise that will pay dividends in a higher-stakes war.[31] A crucial component to building a culture of mistake tolerance is vulnerability based trust. According to this concept, the fastest way for a leader to build trust is to allow subordinates to see their shortfalls and mistakes and own them.[32] By not punishing vulnerability, leaders create an environment that encourages risk-taking, initiative, and taking responsibility.

Conclusion

Mission command should be incorporated in the daily operations of the air component and not relegated to contingency. The first time the air component staff and its wings employ these concepts in a substantial way should not be during war or real-world crisis. The sheer quantity and complexity of problems facing the air component—or any theater C2 node—during near-peer war necessitates the need for macro-management and delegating decision-making and authority.

Air components can best prepare themselves and their units for macro-management by viewing the concepts of mission command, distributed control, and MTOs through procedural, experiential, and cultural lenses. Building procedures to publish MTOs and empower distributed control nodes and wings with delegated authorities are a critical first step. Both ATO and MTO will have their place in near-peer war. Viewing these procedures through the experiential lens of exercises, battle drills, and small-scale, real-world operations will make those procedures stronger and result in more mission command-capable staff and units. Lastly, viewing both procedures and experience through a cultural lens will emphasize the trust and mistake tolerance needed to invoke bias to action. The criticality of the air component in future war necessitates its embrace of mission command to unlock the initiative of its Airmen, a historical legacy that is the surest path to victory.

31. Personal observation by authors, March 2025.
32. Blaine, "USAF Mission Command."

An Argument for Agile Autonomy in Airpower

David A. Heinitz

The US Air Force's existing processes for developing and fielding aircraft technologies and training pilots on new systems place warfighters at a disadvantage against rapidly advancing adversaries. In order to keep pace with technological advances and changes in global competition, the Air Force should employ Agile hardware development frameworks to its aircraft development. An analysis of the commercial use of Agile systems and of the Air Force's current fielding approach demonstrates how Agile hardware fielding, autonomy, and machine learning can be applied to Air Force aircraft development to meet current national defense needs.

Major Anichka Singh looks out the cockpit of her F-35 to where her augmented reality visor displays eight "wingmen"—an archaic term since these jets have a total crew of zero. Three new aircraft join her menagerie: five different airframe types, three manufacturers. But all run the same version of the Tactical Autonomy and Logistics Operating System (TALOS), updated just two days ago. The new aircraft are a type that she was briefed on only when she arrived in theater. She doesn't recall much about the missile they're armed with other than its name.

Just then two hostiles appear, out of her range but apparently not out of the hostiles' as launch indications quickly follow. TALOS presents defensive maneuver options for the wingmen most likely targeted, and with a few clicks Singh accepts the autonomy-generated options. One wingman automatically dispenses countermeasures, but the other doesn't have any. As the two missiles disappear so does one of her wingmen.

Two more launch icons appear from the hostiles. TALOS automatically repositions her now seven-ship of robots into an optional formation, but they are already within no escape range. Just then TALOS provides launch options from two of the new aircraft, one on the incoming missiles and one on what she thought were the out-of-range hostiles. Singh empties the aircraft's bays. Four of the missiles she had barely recognized take out the incoming missiles while the other four streak toward the distant hostiles who make last ditch maneuvers before disappearing from the sky.

While this story is science fiction today, the continuing acceleration of military technology amid a rapidly shifting global security environment will make it not only possible but potentially necessary for a pilot to go to war with weapons and capabilities they had never trained with before. A way to enable such rapidly fielded capabilities to be used effectively in combat is to move human hands further back from the stick and throttle work.

Recent advances in hardware, software, and product management frameworks have provided a way for complex systems to be updated daily—if not faster—but military systems

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still take months or even years to be upgraded, and military pilots spend months training to fly their specific aircraft. This temporal disparity means US pilots currently cannot have the latest technology at any moment. But could a pilot even maximize a jet's performance in a life-or-death situation when its systems are updated every day?

User productivity can be slowed when a simple update to Microsoft Office moves buttons on an application. Although pilots today are fully briefed on software updates before they fly with them and safety procedures are in place to ensure aircrew receive adequate training on new systems, the current security environment is demanding changes at an increasingly faster rate, and this may pose a challenge for pilots in combat. But if the pilot were instead focused on the nature of air combat and able to easily handle shifts in its character by working like the fictional Major Singh in the above vignette—moved back from basic fighter maneuvers and instead guiding the flow of the fight and letting autonomy provide options—could that pilot maximize every daily system update?

This article argues that Agile software development methodologies applied to military aircraft could enable the US Air Force to make faster, incremental improvements to more effectively meet national defense needs. An analysis of current Air Force structures reveals that they cannot absorb such rapid changes as they are built around lengthy fielding timelines. This article thus recommends that such human-integration challenges may be alleviated by the increased use of automation.

Using Agile Software Development for Hardware

Agile software development represents one approach to faster, incremental improvement. In 2001, when the original members of the Agile Alliance, a team of software developers, codified the *Manifesto for Agile Software Development* and the principles behind it, they provided clarity to a process that had been evolving for nearly 70 years.[1] The subsequent rise in familiarity and popularity of Agile frameworks for project management methodologies such as Scrum, Kanban, and Extreme Programming in companies, including Amazon, has driven a wide shift in how software is delivered to customers.[2] From design

1. "A Short History of Agile," Agile Alliance, accessed 9 March 2025, https://www.agilealliance.org/; Kent Beck et al., "Manifesto for Agile Software Development," agilemanifesto.org, accessed 8 March 2025, https://agilemanifesto.org/; and Craig Larman and Victor Basili, "Iterative and Incremental Development: A Brief History," *IEEE* [*Institute of Electrical and Electronic Engineers*] *Computer* 36, no. 6 (2003), https://doi.org/.

2. "What Is Scrum?," Scrum.org, accessed 8 March 2025, https://www.scrum.org/; Dan Radigan, "Kanban: How the Kanban Method Applies to Software Development," Atlassian, accessed 8 March 2025, https://www.atlassian.com/; "Agile Glossary: Extreme Programming," Agile Alliance, accessed 8 March 2025, https://www.agilealliance.org/; and Beth Galetti et al., "Inside Day 1: How Amazon Uses Agile Team Structures, Adaptive Practices to Innovate on Behalf of Customers," SHRM [Society for Human Resource Management] Executive Network, accessed 8 March 2025, https://www.shrm.org/.

programs to video gaming, users no longer purchase finalized software projects and wait years for updates.[3] Instead, they receive enhancements and new features sometimes weekly.

With these examples of success, companies have been looking to apply Agile software development methodologies and frameworks to physical products as well. For example, Trek Bicycle, Dainese, and SpaceX use Agile methodologies to rapidly prototype and iterate physical items, providing improved versions of products at a much faster rate than before.[4] Yet, there are challenges in applying such methodologies to physical product development. A company cannot as easily or quickly push an update that changes physical components of already fielded systems as they could with software. The more complex and integrated a physical system is, the harder it is to update fielded systems. This is the case with military aircraft, which represent some of the most complicated physical systems available today.

Aircraft Versus Space Hardware

A review of conventional US military aircraft development shows how it differs from recent spacecraft development using Agile methodologies, even when such methodologies have already been applied to some military support areas. For example, Air Mobility Command's Negative Pressurized Conex, an air-transportable isolation and medical room, took only 85 days to develop from issuance of the Joint Urgent Operational Need to the first system being flown on a mission using Agile development processes.[5] While impressive, the progress SpaceX has made with its Falcon series of rockets using Agile methodologies is even more directly applicable to aircraft development. SpaceX, founded in 2002, tested its first rocket, the Falcon 1, in 2006.[6] By 2009, the Falcon 1 was flying operational missions, and by 2010, it had been replaced by the larger, improved Falcon 9, itself only five years in development.[7]

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3. Peter Green, "Measuring the Impact of Scrum on Product Development at Adobe Systems," *Proceedings, 44th Hawaii International Conference on System Sciences* (2011), https://doi.org/; and Edward Lowe, "Riot Games: Using Agile to Build the World's Largest E-Sport," *Medium*, 23 February 2022, https://edwardlowe13.medium.com/.

4. PTC, "Why Agile is the Next Big Thing in Product Development," *Wired*, accessed 8 March 2025, https://www.wired.com/; Vasco Duarte, host, *Scrum Master Toolbox*, podcast, "Agile in Hardware: Agile for Physical Products—Insights from Dainese's Helmet Project with Massimo Terzo," Oikosofy, 7 November 2024, https://scrum-master-toolbox.org/; and Ryan de Freitas Bart, "Is Hardware Agile Worth It? - Analyzing the SpaceX Development Process," *Proceedings of AIAA* [*American Institute of Aeronautics & Astronautics*] *SCITECH 2024 Forum* (2 January 2024), https://doi.org/.

5. Joseph Novick, "Agile Acquisition for... Hardware?," *Army AL & T Magazine*, Spring 2024, https://www.lineofdeparture.army.mil/; and "Negatively Pressurized Conex (NPC) and NPC Lite (NPCL)," Air Mobility Command, accessed 24 May 2025, https://www.amc.af.mil/.

6. Tariq Malik, "SpaceX's Inaugural Falcon 1 Rocket Lost After Launch," Space.com, last updated 23 March 2021, https://www.space.com/.

7. Paul Spudis, "The Tale of Falcon 1," *Smithsonian Air & Space Magazine*, 22 July 2012, https://www.smithsonianmag.com/; and Office of Safety and Mission Assurance, "SpaceX Falcon 9 Data Sheet," National Aeronautics and Space Administration (NASA), updated 1 May 2017, https://sma.nasa.gov/.

Conversely, F-35 development had its origins in the 1993 Common Affordable Lightweight Fighter program and produced a flying prototype seven years later.[8] Yet it would be another 15 years before the first F-35 version was declared operational.[9] Similarly, the Air Force's Common Configuration Implementation Program took a decade, from 2000 to 2010, to upgrade 650 F-16s to a common standard.[10] The next set of 22 modifications to the F-16—begun in 2022 and called the Post Block Integration Team (PoBIT) project—is being completed in phases, with the first phase taking seven weeks per jet and the total time expected to be up to nine months per jet.[11] This disparity of fighter jets taking three times longer to be developed and twice as long to be upgraded as space launch vehicles potentially highlights the benefits of Agile development methodologies.

At first glance, in terms of safety and operations, a comparison between the development of an unmanned space launch vehicle and a manned fighter jet might appear tenuous. Dramatic SpaceX failures, such as the 16 January 2025 explosion of a Starship rocket, may raise questions regarding the safety of applying rapid fielding Agile principles to systems with humans onboard. But a look at the data shows that such risks have at times been accepted and may become even more so with increases in automation.[12]

SpaceX has suffered 12 failures in rocket takeoff or landing from 2006 to May 2025: three with its Falcon 1 rockets, three with Falcon 9, and six with Starship.[13] Those 12 failures over 19 years yield just over a 0.6 failure rate per year. From the start of its Mercury program through the end of the Apollo program (1958 to 1972), the National Aeronautics and Space Administration lost nine people in aircraft or spacecraft flight and test operations: four in T-38s, one in an F-105, one in an X-15, and three in the Apollo 1 fire.[14] Those nine

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8. "DARPA/Navy Common Affordable Lightweight Fighter (CALF), 1993–1994," GlobalSecurity.org, last modified 7 July 2011, https://www.globalsecurity.org/; and "Lockheed-Martin X-35A First Flight," photograph, US Air Force [USAF, website], accessed 8 March 2025, https://www.af.mil/.

9. "U.S. Marine Corps Declares the F-35B Operational," US Marines [website], 31 July 2015, https://www.marines.mil/.

10. Chris McGee, "Largest-Ever Modernization Program Enhances F-16s," Air Force Materiel Command, 16 March 2006, https://www.afmc.af.mil/.

11. Kaylin P. Hankerson, "8FW Flies First 7AF POBIT-Upgraded F-16," Kunsan Air Base, 7 April 2023, https://www.kunsan.af.mil/; and Christian Baghai, "How the U.S. Air Force Will Keep Its F-16s Flying into the 2040s," *Medium*, 31 January 2024, https://christianbaghai.medium.com/.

12. "FAA Orders SpaceX to Investigate Starship Explosion," *World News Tonight* with David Muir, posted 17 January 2025, by ABC News, YouTube, 1:11, https://www.youtube.com/.

13. Tom Junod, "Elon Musk: Triumph of His Will," *Esquire*, 14 November 2012, https://www.esquire.com/; "Starlink Mission," SpaceX [website], 11 July 2024, https://www.spacex.com/; Will Robinson-Smith, "SpaceX Falcon 9 Booster Collapses in a Fireball on the Droneship, Ending a Streak of 267 Successful Landings," *Spaceflight Now*, 28 August 2024, https://spaceflightnow.com/; and Jeff Foust, "Fuel Leak Blamed for Falcon 9 Booster Loss After Landing," *SpaceNews*, 8 March 2025, https://spacenews.com/.

14. "Astronaut Killed in Plane Crash," *The Spokesman-Review*, 1 November 1964, https://news.google.com/; "2 Astronauts Die in Plane Crash," *The Tuscaloosa News*, 28 February 1966, https://news.google.com/; "Board Pinpoints Astronaut's Death," *Sarasota Herald-Tribune*, 7 June 1968, https://news.google.com/; and "Air Crash Kills Astro," *Nashua Telegraph*, 9 December 1967, https://news.google.com/.

fatalities over 14 years yielded just over a 0.6 fatality rate per year.[15] While no program desires a failure rate this high—or any fatality rate for that matter—circumstances have previously driven the industry to accept them for the rapid development of critical systems.

Moreover, with an increased use of automation, it may be possible, even in manned aircraft development, to remove humans from the most dangerous, rapid tests. The Air Force Test Pilot School's X-62A VISTA (Variable In-Flight Stability Test Aircraft) is one such example of this path. The VISTA, a manned aircraft designed to test autonomy software and fly without pilot input, could lead the way to autonomy software that enables aircraft tests without pilots onboard.[16]

While there are mitigation strategies for Agile safety concerns, it could be argued that a fighter jet piloted by one person and reused nearly every day for hours of dynamic missions is significantly different than a semi-reusable launch vehicle whose single, 30-minute function is carefully managed by dozens of people. Perhaps that is exactly the point. In other words, to keep up with advancing technology, perhaps fighter jets should be both developed and used differently.

Multiple factors have driven the Air Force to keep its aging aircraft for longer and longer. The most extreme example is the B-52 bombers built in 1960 and scheduled to fly until 2060.[17] Additionally, military aircraft are mostly crewed systems. Even the MQ-9 remotely piloted aircraft has a crew complement larger than many planes with humans in them.[18] This structure of decades-old aircraft designed to have humans monitoring individual gauges and adjusting specific switches leads to the need for slow upgrades to entire fleets of physical objects as major long-term projects—something that is the antithesis of Agile development.

But what would happen if Agile methodologies were applied to this process? Evidence from other fields suggests that such methodologies could incrementally yet significantly speed up development; however, the operational implications of such rapid fielding warrant further exploration.

Agile Systems and the Air Force's Current Combat Employment

Analysis of the Air Force's current aircraft employment structures reveals potential compatibility issues with Agile development methodologies. Yet it also begs the question

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15. See also "Pilot Killed as X-15 Falls from Altitude of 50 Miles," *Toledo Blade*, 16 November 1967, https://news.google.com/; and "One Astronaut Cried 'Fire' Before All Died," *Daytona Beach Sundy News-Journal*, 29 January 1967, https://news.google.com/.

16. Giancarlo Casem, "Modified X-62 Helps Accelerate Tactical Autonomy Development," Edwards Air Force Base, 22 August 2022, https://www.edwards.af.mil/.

17. Justin Hayward, "The Oldest Active B-52: A Guide," *Simple Flying*, 7 March 2024, https://simpleflying.com/; and Stephen Losey, "The New B-52: How the Air Force Is Prepping to Fly Century-Old Bombers," *Defense News*, 12 February 2024, https://www.defensenews.com/.

18. "Reaper (MQ-9A)," Royal Air Force [website], accessed 4 May 2025, https://www.raf.mod.uk/.

of whether such issues could be overcome with changes to the ways in which these structures are managed.

A typical Air Force fighter squadron has 18 to 24 jets. If an engine manufacturer created rapid, small, and iterative changes to the jets' engines that improved thrust and fuel efficiency, these changes could be immediately implemented one jet at a time. But following Agile methodologies, that vendor would keep developing new improvements before the squadron's entire fleet had been updated with the first changes. If the second set of improvements was ready before all the jets had been upgraded with the first set, the next jets to be upgraded should receive both the first and second set of improvements simultaneously, resulting in three different engines operating in one squadron at the same time.

If this logic were applied to aircraft sensors, computer hardware, communication systems, electronic warfare systems, weapon carriage modifications, and cockpit instrumentation, trying to keep the squadron up to date with the latest capabilities using an Agile methodology could result in every jet in the squadron being different, indefinitely. This may be a problem for systems requiring complex direct human interaction.

A typical fighter squadron has 30 to 100 crew members and is supported by a maintenance squadron with 100 to 300 personnel. Ensuring the maintenance personnel are familiar with ever-changing technical specifications on multiple versions of each system of that squadron's jets would be a daunting challenge, as would ensuring the right jets were available for specific mission needs, especially with daily maintenance fallouts and tail swaps. Similarly, different power, fuel consumption, and weight values across the fleet would require different takeoff and landing data and in-flight fuel planning assumptions for the crew members. Operationally, different jets would bring different capabilities, adding complexity to training plans and transferability from one tail to another.

Operational units regularly deal with daily fallouts and tail swaps because the current rate of system fielding does not overly strain the structures in place. A pilot who has spent hundreds or thousands of hours training to expect a jet and its systems to behave in a certain way in combat depends upon that muscle and process memory to be able to maximize that jet's potential. What if this jet is different from the jet they flew yesterday?

This line of thinking indicates that current combat aircraft employment structures may not be compatible with Agile development of physical systems. Yet the structure can be changed to execute within Agile methodologies. Starting with basic mission planning, when a pilot steps to a spare with different power and weight than the jet they were planning to fly, algorithms could be written for that jet to automatically calculate its own takeoff and landing data and determine if that jet is compatible to perform a formation takeoff with another jet. It could even go so far as to let the jet perform the takeoff without any human interaction. For fuel planning, additional algorithms could consider the performance of all aircraft in a four-ship formation, determine which jet is the limiting factor from a fuel standpoint, and recommend a mission profile that still allows objectives to be met. It might even be better to have the jets fly themselves during administrative portions of the flight to optimize each jet's profile. This approach was highlighted in the introduction when the fictional TALOS software automatically repositioned the uncrewed wingmen when one was shot down.

Regarding tactical operations, a hypothetical scenario illustrates how this might play out. Assume Blue 1 has been modified with a new, longer-range missile carriage and employment capability that the other jets in the formation do not have, but Blue 2 has engine modifications that permit a higher operating altitude. It is possible in certain situations that Blue 2 might have a longer range shot than Blue 1 due to the improved kinematics of the older missile when fired from higher altitude. If these system capabilities and mixes were put into computer simulations during development and machine learning approaches applied to the variations of these simulations, a set of algorithms could be developed and loaded into the jets that provide optimal and alternate solutions to tactical problems as they arise, like the launch options TALOS provided in the introductory story.

If each of the 24 jets in a squadron had different capabilities and a pilot could not know for sure which jets their flight would be flying tomorrow, it is unlikely they could optimize their formation's capabilities in real time. Instead, if a pre-trained algorithm were presented with the problem and provided the pilot with choices to select from, they could pick the option that made the most sense as easily as Singh did with a click of the button in the introductory vignette. But would having different jets in the same squadron really be a problem, or is this just speculation?

Although the Air Force has not yet realized the type of rapid system fielding being described above, small movements in this direction provide an indication of what challenges such fielding may entail. Current Air Force combat aircraft spent decades in development, and partially for that reason, many—such as the F-15, B-1, and B-2—have already spent over 30 years in service, with the aforementioned B-52 scheduled for a century in service.[19] If this is combined with a structure that has crew members monitoring and setting individual switches, it leads to the desire for entire fleets to be up to the same standard, the goal the Common Configuration Information Program achieved with the F-16 fleet in 2010.

But going forward the Air Force is approaching upgrades in a more piecemeal manner. The Post Block Integration Team program has broken the next nine months of F-16 upgrades into steps as small as seven weeks. While this is not true Agile development, since the 22 upgrades scheduled in the PoBIT program have already been fully developed, the F-35's development path is closer. Each year the new lot of F-35 aircraft delivered from Lockheed-Martin includes the newest modifications. This has resulted in something similar to the hypothetical squadron problems described above.

There are nominally three versions of the F-35: the F-35A employed by the Air Force, the F-35B with vertical takeoff capability employed by the Marine Corps, and the F-35C with aircraft carrier landing capability employed by the Navy. Yet, according to a 2023

19. John Tirpak, "Average Age of USAF Aircraft Drops Slightly, but Eight Fleets Now Exceed 50 Years Old," *Air & Space Forces Magazine*, 23 November 2021, https://www.airandspaceforces.com/.

Government Accountability Office (GAO) report, there are "at least 14 different versions."[20] This is due to the continual improvements with each lot delivered. The GAO report highlights the complication this is creating for maintenance and sustainability, which contributes to poor fleet-wide readiness. While there are currently no reports that state the continual improvement of F-35s from lot to lot creates the same tactical mission issues for pilots outlined in the hypothetical squadron above, this might be because those mission updates are long delayed.

A separate GAO report from 2023 states that "the [F-35] program hasn't fully installed the hardware and software needed for future aircraft upgrades because of delays developing the needed technologies."[21] Given these realities it does not appear that there is any future where there are only three versions of the F-35, but this can be an opportunity as opposed to a problem. The military has already seen the issues such incremental fielding can create for maintenance and sustainment, and if operational capability upgrades reach the same speed of delivery, it is possible similar challenges could arise for pilots. A way to potentially overcome these challenges and marry this rapid capability fielding with effective operations is to automate the wrench-turning and G-pulling.

If humans can simply direct the intent of what is desired instead of flipping each switch or installing each piece of hardware, the speed of Agile development can be joined with consistently effective operations. An example of this in practice can be seen at Amazon. The sale and distribution juggernaut is currently also one of the world leaders in hardware automation. Since 2012, it has expanded its fleet of semi-autonomous and autonomous robots to over 750,000 across its distribution centers. Some of these robots can locate individual products in acres of warehouse space or select them from bins of mixed products. Additionally, "machine-learning techniques allow robots to teach themselves what to pick and how to pick."[22] Amazon continually collects data from these operations and uses it to improve its robot fleet across all centers. This increase in the use of automation fueled Amazon's ten-fold growth in sales from 2010 to 2020.[23]

For Amazon, merging autonomy with data has thus proved successful for evolving its operations. The potential for the Air Force to do the same warrants serious consideration if it is to meet the demands of an increasingly competitive security environment.

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20. Audrey Decker, "How Many F-35 Versions Are There? Hint: More Than 3," *Defense One*, 3 October 2023, https://www.defenseone.com/.

21. Jon Ludwigson, *F-35 Joint Strike Fighter: More Actions Needed to Explain Cost Growth and Support Engine Modernization Decision*, GAO-24-107177 (US Government Accountability Office, 12 December 2023), https://www.gao.gov/.

22. Will Knight, "Amazon's New Robots and the Automation Revolution," *Wired*, 26 June 2023, https://www.wired.com/.

23. Knight.

Agile Application and Concerns

If similar automation were applied to Air Force maintenance and sustainment, could the service keep up with the year-by-year F-35 lot improvements, or better yet, continual system improvements? What would automated parts distribution and computer optimized maintenance scheduling look like? Perhaps an aircraft technician could check their computer-generated schedule to find which plane they were working on that day, arrive at the jet with all necessary equipment already brought there by automated robots, and then supervise a robotic installation of the part to be replaced using augmented reality goggles that show them what steps should be followed for any part they have never seen before.

Similar logic applied to flight operations may manifest as automated takeoff or automated administrative flying. Automated tactics options based on the real-time situation and pre-trained algorithms might be updated daily with new data across the fleet. Perhaps the pilot becomes more of a passenger, focused on military command of the operation, instead of a stick actuator flying the jet. In this case, there may not need to be a pilot in every jet.

Key players in the international community including technology leaders, Human Rights Watch, and the UN secretary general have raised concerns that automated weapons or "killer robots" are an unwise direction for military development. While there may be legitimate issues with certain levels of autonomy, what is proposed here is a small step down a path that has been progressing for centuries.[24] Employment of the first projectile weapons required several key points of human involvement. The intent of the commander had to be passed to the shooter; the shooter had to then determine the right target and right time to fire, use their skill to aim the shot, have the physical strength to fire the weapon, and then shoot.

When gunpowder changed how projectile weapons were employed, the commander's intent, right target, right time, and aiming skill were still required, but the physical strength of firing was eliminated. When guided missiles augmented simple firearms, the commander's intent, right target, and right time were still required, but aiming skill was eliminated with the push of a button. Now the military is looking at autonomy handling the right time and right target components, with only the commander's intent required for execution. This could manifest as a pilot giving their uncrewed wingman a target and launch criteria and letting the wingman decide how to get there and when to fire, or autonomy providing options for a commander to choose from, like Singh's TALOS software did. While more of the tasks would be handled by autonomy, this is only a small step away from how military operations are already executed.

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24. See, for example, "Killer Robots," Human Rights Watch, accessed 8 March 2025, https://www.hrw.org/; Samuel Gibbs, "Elon Musk Leads 116 Experts Calling for Outright Ban of Killer Robots," *The Guardian*, 20 August 2017, https://www.theguardian.com/; and " 'Politically Unacceptable, Morally Repugnant': UN Chief Calls for Global Ban on 'Killer Robots,' " *UN News*, 14 May 2025, https://news.un.org/.

Conclusion

The idea that autonomy is the key to Agile fielding of state-of-the-art airpower technology does not require belief in science fiction or acquiescence to killer robots. Instead, a structural change that removes many of the manual tasks from human hands, unlocking the higher order thinking of the supercomputer that is the human brain, may allow daily changes to warfighting systems to be utilized by fast-thinking warfighters. Companies like SpaceX have shown how Agile development methodologies can be applied to physical products, and Amazon has shown how merging autonomy and data can make continually changing operations effective.

While fighter aircraft development has historically taken a much slower approach, there are ways to shift development to more incremental releases and optimize operations with mixed fleets. In a war tomorrow many fighter pilots would be flying with technology that is more than 20 years old. Changing that paradigm is an immediate necessity so the Major Singhs of the future can keep the United States safe.

The Continued Evolution of Air Force Targeting

Chance Smith

An examination of the evolution of US Air Force targeting readiness over six air campaigns since Desert Storm illustrates the complexities and challenges of Air Force targeting operations in diverse operational environments. Proactive targeting strategies, comprehensive analysis, and continuous investment in expertise and infrastructure are needed to ensure readiness and effectiveness in air campaigns. Ultimately, targeting proficiency is indispensable in shaping the outcome of modern conflicts, and ongoing adaptation and improvement in Air Force targeting capabilities are imperative to prepare Airmen for the future of air warfare.

How has US Air Force targeting readiness evolved since Operation Desert Storm? The 1991 air campaign over Iraq marked a turning point: stealth technology and precision-guided munitions (PGM) finally brought early airpower theorists' nodal targeting concepts to life, showcasing airpower's ability to contribute to a quick, decisive military victory in large-scale combat operations. Due to the political flexibility and room to maneuver it provides, airpower has become a favored coercive tool among American policymakers in the years since.[1] Yet, Desert Storm also revealed enduring flaws in targeting readiness, including organizational confusion, inadequate targeting materials, and suboptimal assessments.

John Glock's 1994 seminal *Airpower Journal* article, "The Evolution of Air Force Targeting," traced the service's successes and struggles with targeting from the dawn of airpower through the Gulf War. Glock attributed many of the aforementioned flaws to a lack of specialization, insufficient personnel, and the absence of a robust targeting database or analytical organization.[2] Despite its Gulf War successes, the Air Force removed the targeting officer career field and reduced training in the war's aftermath, mirroring the broader neglect of targeting intelligence at the national level.[3] Many of the same structural and institutional challenges persist three decades later—despite repeated lessons drawn from combat.

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1. Dag Henriksen, *NATO's Gamble: Combining Diplomacy and Airpower in the Kosovo Crisis* (Naval Institute Press, Annapolis, 2007), 190.
2. John Glock, "The Evolution of Air Force Targeting," *Airpower Journal* 8, no. 3 (1994), reprinted in *Air and Space Power Journal* 26, no. 6 (December 2012): 156, https://www.airuniversity.af.edu/.
3. Sarah Gee, "Through Rose Colored Glasses: Targeting in Its Heyday" (master's thesis, School of Advanced Air and Space Studies, June 2018), 8–9.

This article serves two purposes. First, it synthesizes secondary sources to trace the continued evolution of Air Force targeting from 1995 through today, providing a contemporary addendum to Glock's work. Second, it distills the findings related to the Air Force's readiness to perform its joint targeting functions from six air campaigns into nine lessons learned for policymakers, commanders, and strategists. These operations and time periods were chosen for their doctrinal significance, variation in scale and scope, and applicability to the evolution of Air Force targeting practices—together offering a representative cross section of successes and challenges in both deliberate and dynamic targeting—or, respectively, processes involving planned targets and targets of opportunity.

The Air Force's experience in conflicts from 1995 through today shows that holistic targeting readiness depends on extensive preparation before the initiation of hostilities, technical mastery of deliberate and dynamic targeting skills during conflict, organizational specialization, and seamless joint and combined target development and approval. These findings must inform the development of future Air Force targeting doctrine, training programs, and organizational structures to maintain readiness and strategic effectiveness in limited war and large-scale combat operations.

A Targeting Primer

> *Our product in war is dead targets, and our product in peace is all that goes into generating the warrior proficiency that kills those targets in wartime.*
>
> - General John P. Jumper, commander, Air Warfare Command[4]

Joint doctrine defines targeting as selecting, prioritizing, and matching appropriate responses to physical or virtual adversary entities.[5] Deliberate targets are identified, developed, and selected ahead of operations, while dynamic targets emerge during operations. A targeteer is an expert in the full spectrum of targeting tasks, aiding in operations planning, target analysis, and target material development. A weaponeer specializes in matching weapons and fuses to targets.

The targeting process integrates intelligence, planning, and operations to degrade adversaries and synchronize lethal or nonlethal effects.[6] While the complete, six-step joint targeting cycle occurs during wartime, steps like target development and capabilities analysis should begin in peacetime (fig. 1). Target system analysis identifies vulnerabilities in adversary systems. Analysts can develop these vulnerabilities into targets that align with commander objectives; once complete, targets are vetted, validated, and added to a joint target list. For this article, insufficient target quantity refers to a lack of validated targets, while insufficient target quality alludes to inadequacies in information such as current

4. John P. Jumper, remarks at the Air Force Association Air Warfare Symposium, 24 February 2000, Orlando, FL, https://secure.afa.org/.

5. Joint Publication (JP) 3-60, *Joint Targeting* (Chairman of the Joint Chiefs of Staff, 28 September 2018), I-1.

6. JP 3-60, I-6.

imagery, intelligence, weapon solutions, or collateral damage estimates. Targeting data is stored in an electronic repository known as the Modernized Integrated Database.

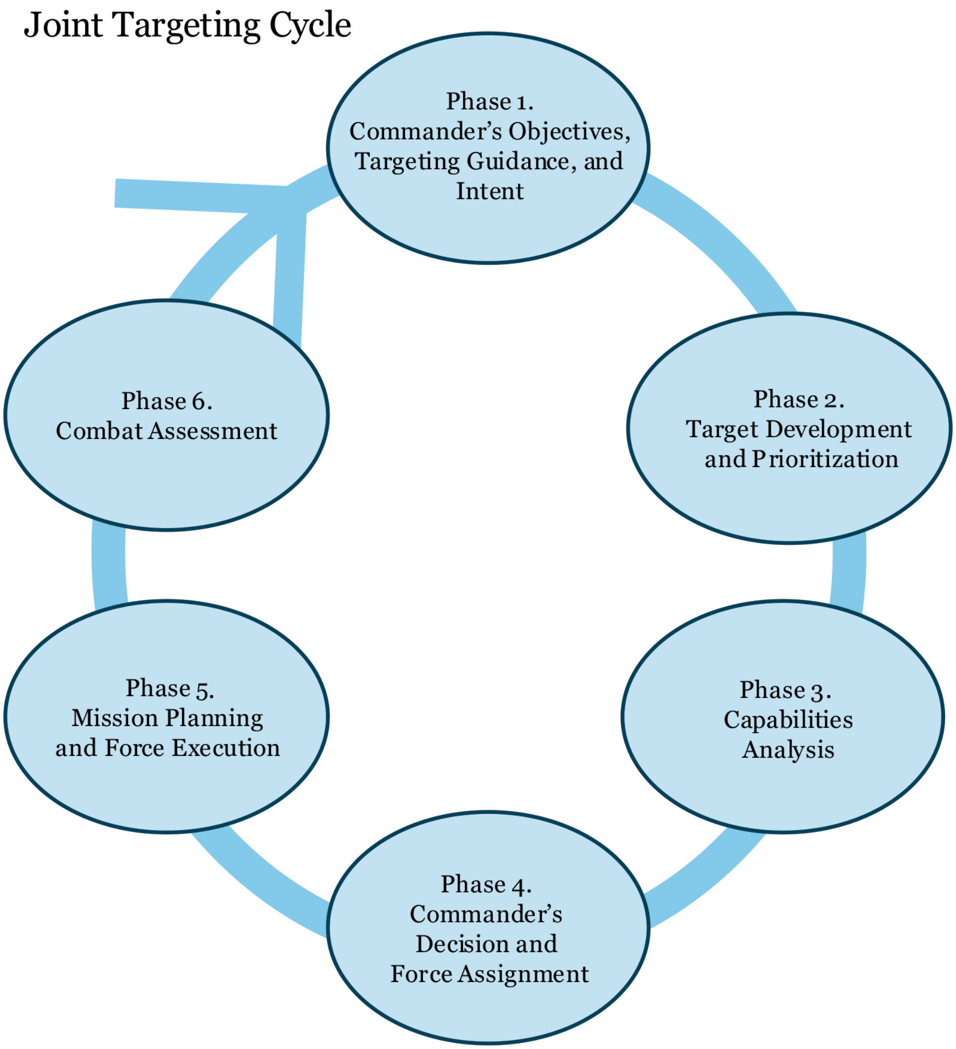

Figure 1. The six-phase iterative joint targeting process[7]

Targeting assessment is the final step of the joint targeting cycle, measuring tactical and operational progress. It includes battle damage assessment (BDA), where analysts compare pre- and post-strike data to evaluate physical and functional effects on targets and their broader systems. BDA results, combined with munitions performance reviews and reattack recommendations, form the combat assessment process. Proper targeting

7. JP 3-60, I-6.

assessment provides commanders with near-real-time insights into the effectiveness of tactical operations and the force's progress toward operational objectives.

This targeting framework—centered on analysis, prioritization, and assessment—moves from doctrinal concept to operational reality in actual combat. An analysis of six campaigns after the Persian Gulf War reveals how deliberate and dynamic targeting has evolved since 1995 and outlines the challenges that the Air Force must confront to ensure targeting readiness for future conflict.

Deliberate Force (Bosnia-Herzegovina, 1995)

Operation Deliberate Force was the first major test of Air Force targeting readiness after Desert Storm. The campaign was an outgrowth of NATO's Operation Deny Flight, which enforced a no-fly zone over Bosnia-Herzegovina. After a Serbian artillery strike in Sarajevo killed 38 civilians, NATO prosecuted an air campaign from 30 August to 14 September 1995. The operation degraded the Bosnian Serb Army's military capabilities while minimizing casualties, collateral damage, and political costs, with American targeting and intelligence playing a key role.[8]

Air campaign planners in Desert Storm had emphasized the importance of thorough target system analysis, a lesson many carried forward into Deliberate Force. In 1993, Allied Forces Southern Europe (AFSOUTH) began preparing target folders; by 1995, analysts had developed 444 Bosnian Serb Army targets, with the UN/NATO joint target board approving 87 AFSOUTH Deadeye campaign targets.[9] Air Force targeteers evaluated adversary sites and equipment for military value and potential collateral damage, creating a matrix to assist in selecting targets.

Precision-guided munitions played a crucial role in the campaign, comprising 70 percent of weapons used compared to less than 10 percent in Desert Storm.[10] Attention to detailed mensuration of aim points and weapon fusing resulted in precise strikes. PGMs reduced civilian casualties, with no refugees or atrocities reported.[11] The Allied Air Forces Southern Europe commander, Lieutenant General Michael Ryan, personally oversaw the selection of aim points, an approach made possible by the campaign's limited scale.[12]

Still, the assessment process revealed inefficiencies.[13] The battle damage assessment team, overwhelmed by the volume of data from satellites and unmanned aerial systems,

8. Christopher M. Campbell, "The Deliberate Force Air Campaign Plan," in *Deliberate Force: A Case Study in Effective Air Campaigning: Final Report of the Air University Balkans Air Campaign Study*, ed. Robert C. Owen (Air University Press, 2000), 87.

9. Tim Ripley, *Operation Deliberate Force: The UN and NATO Campaign in Bosnia 1995* (Center for Defense and International Security Studies, 1999), 164.

10. Benjamin S. Lambeth, *The Transformation of American Air Power* (Cornell University Press, 2000), 160.

11. Thomas Hughes, "Deliberate Force: Ambivalent Success," in *Air Power in the Age of Primacy: Air Warfare Since the Cold War*, ed. Phil Haun et al. (Cambridge University Press, 2021), 73.

12. Richard L. Sargent, "Deliberate Force Targeting," in *Deliberate Force*, 290.

13. Ripley, *Deliberate Force*, 258.

needed more preparation, personnel, and a standardized BDA policy. NATO had no permanent BDA staff assigned to the combined air operations center, making the process a bottleneck despite the campaign's small scale. The Air Force needed a comprehensive BDA doctrine and well-trained personnel before future conflicts.

Air Force targeteers performed admirably in Deliberate Force, even though gaps in doctrine, training, and formal processes for collateral damage estimation (CDE) and battle damage assessment persisted. The campaign's limited scale and narrow objectives helped obscure these shortcomings. Yet, these same deficiencies re-emerged as critical vulnerabilities in larger and more complex operations that followed. Deliberate Force succeeded despite them—but future campaigns were not as forgiving.

Allied Force (Kosovo and Serbia, 1999)

Allied Force was a US-led NATO campaign waged entirely with airpower and aimed at preventing Serbian human rights abuses in Kosovo. After Serbian paramilitary forces killed 45 civilians in Račak on 15 January 1999, NATO authorized air strikes. The campaign, lasting 78 days, was more prolonged and destructive than Deliberate Force. Contrary to expectations, airpower alone failed to force Serbian President Slobodan Milošević's concessions quickly. The extended campaign revealed significant deficiencies in targeting readiness, notably shortfalls in trained targeting analysts, which hampered imagery analysis, target discovery and development, and BDA.[14]

Campaign planning began 10 months before conflict initiation. The initial plan, Nimble Lion, included 250 targets developed by Airmen.[15] This list would grow to 976 targets as the campaign progressed, though target identification and approval proved difficult. Air Force personnel struggled to develop impactful targets without a coherent analysis of Serbian military vulnerabilities conducted before the campaign. As a result, targeteers had difficulty justifying the military necessity of strikes, leading to slow NATO approval processes.[16] By day 41, the combined air operations center claimed to lack defined policy objectives, forcing staff to infer goals from US President Bill Clinton's public statements.[17] Furthermore, planning and coordination suffered from degraded communications between NATO Allies due to interoperability issues, specifically a dearth of rapid and secure communications.[18] In this context, even core targeting functions—such as CDE—became more contentious and error-prone.

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14. Michael W. Lamb Sr., *Operation Allied Force: Golden Nuggets for Future Campaigns*, Maxwell Paper no. 27 (Air War College, August 2002), 10, https://apps.dtic.mil/.

15. Benjamin S. Lambeth, *NATO's Air War for Kosovo: A Strategic and Operational Assessment* (RAND Corporation, 2001), 11.

16. Lambeth, *NATO's Air War*, 201.

17. Richard Hand, "Who Should Call the Shots? Resolving Friction in the Targeting Process" (master's thesis, Air University, 2001), 56, https://apps.dtic.mil/.

18. Lambeth, *Transformation*, 213.

Despite the efficacy of CDE in Deliberate Force, the coalition passed over many targets in Allied Force due to overestimated civilian casualty risks. Some attributed this issue to an unproven method of estimating collateral damage.[19] Others cited American fears of losing domestic support or allied consensus as the primary motivation.[20] Whatever the reason, this observation showed a continuation of concerns over civilian casualties as a limitation for targeteers to contend with in modern air campaigns. Precision-guided munitions offer great appeal for policymakers and commanders seeking to avoid collateral damage, but they come with inherent limitations—namely, scarcity.

The US military expended nearly 8,500 PGMs during the campaign; an additional 30 days of air operations at the same rate might have depleted its PGM inventory.[21] While more a logistics and procurement issue than a targeting problem, this does point to the need to carefully analyze and select targets to optimize limited resources. The coalition spent many PGMs on unnecessary reattacks resulting from a slow battle damage assessment process. No BDA team was in place at the combined air operations center at the start of Deliberate Force, which contributed to needless follow-up strikes and the NATO coalition's broader inability to track the air war's progress.[22] Additionally, the lack of a dynamic targeting team slowed the identification and elimination of dispersed Serbian forces. The Yugoslav military had learned to disperse its equipment to survive air strikes, echoing Saddam's dispersal of Scud missile forces in the Gulf War. This trend of adversary equipment dispersal presented a targeting challenge for future conflicts, meaning Air Force targeteers could no longer focus solely on deliberate targeting.

Unmanned aerial vehicles appeared in previous air campaigns, but were featured more prominently in Allied Force, particularly in intelligence applications.[23] Air Force General John Jumper predicted after the war that they would be used increasingly in future conflicts and become key to targeting operations. This prediction was prescient, and Jumper could have made a similar prediction for cyber warfare. Allied Force featured the first American use of offensive cyber warfare to support an air campaign.[24]

Overall, the campaign highlighted recurrent Air Force targeting deficiencies. No centralized organization was responsible for target intelligence, leading to a lack of systematic analysis of the Milošević regime and Yugoslav Army prior to operations. CDE training and doctrine were still underdeveloped, and assessment processes remained inefficient. Dynamic targeting became more vital, though the Air Force still had not institutionalized a dynamic targeting cell within its operations center. The service had yet to fully address many of the targeting challenges identified in previous conflicts, and future operations tested these shortcomings.

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19. Lamb, *Allied Force*, 14.
20. Henriksen, *NATO's Gamble*, 198.
21. Lamb, *Allied Force*, 16.
22. Lambeth, *NATO's Air War*.
23. Anthony M. Schinella, *Bombs Without Boots: The Limits of Airpower* (Brookings Press, 2019), 58.
24. Lambeth, *NATO's Air War*, 112.

Enduring Freedom (Afghanistan, 2001 to 2002)

Operation Enduring Freedom sought to dismantle al-Qaeda and overthrow the Taliban after the 9/11 attacks. Led by US special operations forces with support from local military forces, airpower initially focused on targeting Taliban and al-Qaeda leadership. The early phase of the air campaign was successful in ousting the Taliban in less time than expected.[25] Unfortunately, the broader military effort to degrade al-Qaeda took longer than anticipated and ultimately never set conditions for a lasting democratic government in Kabul.

There was no pre-existing plan or analysis for dismantling the Taliban or al-Qaeda.[26] It would not have mattered much; aside from individual enemy leaders, there was little of strategic importance to bomb in Afghanistan. Some in the Air Force complained about the shortage of targets and the need for more connection between strikes and higher strategy.[27] This strategy-to-strike disconnect was likely more a product of airpower being ill-suited to coerce the target-scarce adversary and less of the service's inadequate targeting readiness. Yet, at the campaign's outset, the Air Force still lacked a dedicated organization for full spectrum targeting. Additionally, US Central Command's (CENTCOM) strict rules for BDA confirmation resulted in a slow, poorly coordinated process that could not measure the combat operations' impact on the enemy at a target system level. [28]

Enduring Freedom highlighted both the promise and the pitfalls of dynamic targeting. Improved data flow and tactics helped make time-sensitive strikes a standard feature of modern air campaigns, marking a significant operational advancement. Yet, the compressed timelines of dynamic targeting also contributed to higher-than-expected civilian casualties in early operations.[29] Two key takeaways emerged. First, the Air Force must ensure that weaponeering, point mensuration, and CDE processes are rapidly employable and consistently repeatable to match the pace of dynamic targeting. Second, building and sustaining a robust cadre of trained and certified analysts in these disciplines are just as essential for limited airpower campaigns as for large-scale combat operations.

Iraqi Freedom (Iraq, 2003)

The initial combat phase of Iraqi Freedom featured a rapid initial air campaign like the previous operation against Saddam Hussein over a decade before. Unlike in Afghanistan mere months before, Iraq in 2003 was a target-rich environment. Also, the US military demonstrated its commitment to deliberate planning for airpower integration in joint operations. CENTCOM developed a deep understanding of the Iraqi military's vulnerabilities and centers of gravity during a decade of military involvement in the country. By 2002, the

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25. Benjamin S. Lambeth, *Air Power Against Terror: America's Conduct of Operation Enduring Freedom* (RAND Corporation, 2005), 349.
26. Schinella, *Bombs*, 120.
27. Lambeth, *Air Power*, 97.
28. Lambeth, *Air Power*, 308.
29. Nicholas Blanchette, "Operation Enduring Freedom," in *Air Power in the Age of Primacy*, 116.

American campaign plan included 4,000 potential targets, broken into categories, that revealed a thorough knowledge of the threat.[30] This careful preparation resulted in a joint integrated prioritized target list with three days' worth of targets ready at the onset of hostilities.

Campaign planners at CENTCOM Air Forces (CENTAF) worked with national intelligence agencies, the CENTCOM intelligence and operations staffs, and the Joint Warfare Analysis Center from 2002 to 2003 to develop a target system analysis of Iraq and its military. One member working at CENTAF at this time noted that Air Force targeteers worked side-by-side with planners to tie all targets they developed for the campaign plan to the air commander's operational objectives. The air component hosted two targeting conferences in early 2003, where Air Force targeteers worked with other experts to review every target selected and refine every aim point for maximum effectiveness. Targeteers worked equally hard to determine the proper targets to include in the air campaign and to create a no-strike list of over 1,000 facilities. Overall, the target planning process, organizational collaboration, and Airmen's contributions seemed to match the vision of success outlined in Glock's 1994 article.[31]

The air campaign began on 21 March 2003, primarily to support ground operations. Most strikes were directed at dynamic targets instead of fixed facilities.[32] During the campaign, targeteers from the 480th Intelligence Group at Langley Air Force Base (AFB), a predecessor organization to what would become the Air Force Targeting Center (AFTC), provided specialized weaponeering support to deliberate target development efforts.[33] This support marked one of the earliest cases of a dedicated reachback targeting organization supporting an air war.

The dynamic targeting cell was a 25-person team of Airmen from various occupational backgrounds, including intelligence.[34] To say that this cell performed well would be an understatement; it developed over 3,000 targets and assigned over 2,000 for attack during the three weeks of major combat operations.[35] Targeteers were embedded throughout the combined air operations center sections, ensuring well-coordinated operations.

Assessments, however, remained an area of deficiency. The BDA process was overwhelmed in the campaign's early days, and "air planners had little sense of the progress they were making."[36] One key problem was the need for more timely intelligence products, namely satellite imagery. The service tried to mitigate this deficiency by using imagery and video

30. Benjamin S. Lambeth, *The Unseen War: Allied Air Power and the Takedown of Saddam Hussein* (Naval Institute Press, 2013), 21.

31. Lambeth, *Unseen War*, 34.

32. Heather Venable, "The Result is Never Final: Operation Iraqi Freedom," in *Air Power in the Age of Primacy*, ed. Phil Haun, 136.

33. Lambeth, *Unseen War*.

34. John M. Fyfe, *The Evolution of Time Sensitive Targeting: Operation Iraqi Freedom Results and Lessons* (Air University, College of Aerospace Doctrine, Research and Education, 2005), 11.

35. Lambeth, *Unseen War*, 205.

36. Venable, "Result," 137.

data from aircraft targeting pods to support the assessment process.[37] Even so, observers attributed many problems to the same old culprits: the absence of joint and service BDA doctrine, a shortage of qualified BDA analysts, and a lack of realistic training and exercise of the assessment process at the combatant command and within the air component.[38] The net result of these shortcomings was a slow, inefficient BDA process that failed to support operational commanders in their decision-making.[39]

These deficiencies aside, Iraqi Freedom marked the most prepared phase in the Air Force's history regarding overall targeting readiness. The service's familiarity with Iraq's military and its pre-war preparations in intelligence and targeting support enabled a successful air campaign. From target system analysis to target development and capabilities analysis, the Air Force demonstrated readiness with notable contributions from its reachback support units. Overall, the service performed well in preparing and executing the air campaign. Over the next eight years, while the Air Force remained engaged in sustained combat operations around the world, it would not face another major test of its deliberate targeting readiness until the rapid onset of the 2011 intervention in Libya.

Odyssey Dawn and Unified Protector (Libya, 2011)

The catalyst for an intervention in Libya came in February 2011 when protests began in Benghazi. An outcry from Libyans dissatisfied with Muammar Gaddafi's authoritarian rule escalated into armed resistance aimed at regime change. Gaddafi's violent crackdowns in response to the uprising triggered international condemnation. His allusions to a massive campaign to eliminate protesters brought his regime under additional scrutiny.[40] The United Kingdom and France were the first countries to call for an intervention to prevent political violence, and the UN passed a resolution to impose an arms embargo on Libya. America, meanwhile, quietly prepared to intervene.

On 19 March 2011, French planes dropped the first bombs on Libyan forces loyal to Gaddafi, beginning Operation Odyssey Dawn. The Libyan military, which some considered a "hollow and marginalized force" with a weak air defense system, was less threatening than some previous adversaries.[41] The coalition air campaign initially focused on integrated air defense targets and ammunition storage facilities but exhausted these strategic targets within a few days.[42] Therefore, discerning the state of the Air Force's deliberate targeting readiness when there were so few valuable targets at the start is difficult.

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37. Lambeth, *Unseen War*, 183.
38. Lambeth, *Unseen War*, 273; and Fyfe, *Evolution*, 36.
39. Hugh Curry, "The Current Battle Damage Assessment Paradigm Is Obsolete," *Air & Space Power Journal* 18, no. 4 (2004), https://www.airuniversity.af.edu/.
40. Schinella, *Bombs*, 237.
41. Frederic Wehrey, "The Libyan Experience," in *Precision and Purpose: Airpower in the Libyan Civil War*, ed. Karl P. Mueller (RAND Corporation, 2015), 45–46.
42. Schinella, *Bombs*, 249.

Another reason this is challenging is that America made the decision early to limit the extent of its involvement relative to its previous humanitarian interventions in Bosnia and Kosovo.[43] As Air Force Lieutenant General Ralph Jodice II noted, no more than four US fighters operated in Libya at a time, and the United States only contributed about half of the coalition's air strikes during the Odyssey Dawn phase.[44] Once the campaign flipped to Unified Protector with NATO in the lead, America's military operated in a supporting role until the combat operations' end in October 2011.

Only 21 days passed between the time the US military began crisis action planning and the first airstrikes in Libya, and there was almost no current intelligence on the disposition of Libyan forces from which to initiate the planning process.[45] One senior Air Force targeting officer later recalled that at the outset of planning, many of the targeting records on Libyan military facilities were two decades old.[46] Much of the planning occurred at US Air Forces in Europe, with key support from the newly formed Air Force Targeting Center. The AFTC provided 78 percent of the coalition's targeting materials, which was crucial since many coalition partners had limited targeting capabilities.[47]

Coalition forces made it a point to avoid collateral damage; post-conflict analysis indicated that they minimized harm to noncombatants and damage to civilian infrastructure during the seven-month engagement.[48] Unfortunately, in Odyssey Dawn, BDA was once again an ad hoc process. After the conflict, the AFTC proposed internally "rewriting BDA procedures" and "reinvigorating training programs" to ensure BDA readiness was not a problem in future campaigns.[49]

Two other targeting themes stand out from the Libyan operations. First, Gaddafi's forces adopted insurgency tactics, including slowing down the conflict's pace to erode US resolve, concealing forces from airpower, commingling forces in cities, and using human shields to deter NATO airstrikes.[50] Many Libyan forces abandoned their military vehicles in favor of the same types used by rebel forces to confuse the coalition's dynamic targeting efforts.[51] In the age of high-tech precision warfare, these tactics continued a trend of adversaries using low-tech dispersal, camouflage, and deception to confound targeteers. Despite challenges inherent in countering such tactics, the Air Force must anticipate them in future conflicts.

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43. Christopher S. Chivvis, *Toppling Qaddafi: Libya and the Limits of Liberal Intervention* (Cambridge University Press, 2014), 5.
44. Schinella, *Bombs*.
45. Deborah Kidwell, "The US Experience: Operational," in *Precision and Purpose*, 113.
46. Retired Colonel Mike Flaherty, USAF, e-mail message to author, 14 May 2024.
47. Kidwell, "US Experience," 126.
48. Wehrey, *Libyan Experience*, 47.
49. Kidwell, "US Experience," 127.
50. Tami Davis Biddle, *Air Power and Warfare: A Century of Theory and History* (US Army War College Press, 2019).
51. Wehrey, *Libyan Experience*, 55.

Second, the coalition did not expand the list of potential targets to include Libyan infrastructure until late in the conflict.[52] This continues the trend of politicians, commanders, and planners to search for more targets near the air campaign's end—what one airpower analysis refers to as the "dynamic limits of airpower," noting that a lack of available developed targets typically factors in restricting the pace of air strikes. In response, the analysis argues for the long-term development of human capital and supporting career fields—presumably, those related to intelligence and targeting—that can sustain the pace and effectiveness of air campaigns over time.[53]

Is target scarcity during an air campaign a result of chronic under-resourcing or simply an endemic condition related to the challenges of coercion? The next major air campaign after Libya provides further insight into this dilemma. While the Air Force made significant strides in targeting readiness, the operations in Libya suggest that the limited availability of suitable targets and the tactics employed by adversaries continually pose challenges to airpower's employment.

Inherent Resolve (Iraq and Syria, 2014 to 2018)

Operation Iraqi Freedom did not eradicate al-Qaeda in Iraq. Instead, the group morphed and expanded over time, eventually rebranding itself as the Islamic State in Iraq and Syria (ISIS) around 2012. When ISIS declared itself a caliphate and staked its sovereignty over a 423-mile swath of land on 29 June 2014, America had no war plan ready or in development, much less any validated targets, to counter its rise.[54]

Eventually, America assembled and led a coalition of 82 nations to defeat ISIS in Operation Inherent Resolve, emphasizing air strikes and support for proxy forces instead of direct ground involvement. The United States struggled to develop a comprehensive strategy in the campaign's early days, relying on dynamic strikes and minimal kinetic exposure in support of a "limited risk, limited liability" operation. For over a year, there was no deliberate targeting campaign against ISIS. American aircraft flew 949 combat sorties and expended munitions on only 100 of them over the first three weeks of air strikes in Inherent Resolve. By comparison, the US Air Force had flown 3,500 combat sorties in that same period during Deliberate Force.[55]

While some have pointed to the rapid rise of the Islamic State and the limited intelligence available about the group early in the conflict as a hindrance to planning, others have cited the lack of deliberate targeting readiness as the primary reason for the air

52. Kidwell, "US Experience," 130.

53. Karl P. Mueller, "Victory Through (Not By) Airpower," in *Precision and Purpose*," ed. Karl P. Mueller (RAND Corporation, 2015), 383.

54. Becca Wasser et al., *The Air War Against the Islamic State: The Role of Airpower in Operation Inherent Resolve* (RAND Corporation, 2021), 85.

55. Wasser et al., *Air War*, 27.

campaign's sluggish start.[56] Former US Air Force Chief of Staff General Mark Welsh blamed this lack of readiness on manning cuts between 1992 and 2013 that drained expertise within the service.[57] Whatever the reason, a marked shift occurred after then-Lieutenant General Charles Q. Brown Jr. took command of AFCENT in June 2015.

Brown quickly tasked his staff with fixing the deliberate targeting process, which he called "broken."[58] In hindsight, the process may have been less inoperative than underutilized. Four months after Brown's claim, coalition aircraft were dropping bombs in high numbers on ISIS oil infrastructure for Operation Tidal Wave II, a deliberate targeting campaign designed to deny the Islamic State revenue from oil sales. Three months later came Operation Point Blank, featuring strikes against ISIS cash resources. Of all the case studies reviewed for this research, the air campaign against ISIS was the only one that moved from primarily dynamic strikes to a sustained period of deliberate targeting; typically, dynamic targeting becomes prevalent after exhausting initial target lists. Even so, dynamic targeting accounted for 85 percent of strikes in Inherent Resolve.[59]

The quick turnaround in the effectiveness of deliberate targeting occurred because targeteers and intelligence analysts were ready to support when needed. All-source intelligence analysts at the AFCENT headquarters at Shaw AFB were critical in bolstering the command's targeting operations in late 2015.[60] The combined air operations center in Qatar leveraged reachback analysis from the Air Force Distributed Common Ground System, a global real-time intelligence fusion organization, as well as the newly established 51st Intelligence Squadron. The AFTC set up the Target Development Cell to conduct a systems analysis of the Islamic State and develop targeting nominations for the air component.[61] This reachback analytic and targeting capacity, latent in the war's early stages, became critical to accelerating the pace of the air war against ISIS. For a campaign "plagued by hitting targets of opportunity instead of targets of strategic value" for so long, the leadership decision to prioritize deliberate targeting paid off quickly. Fittingly, as his time in AFCENT's command neared its end, Brown noted the air component's return to deliberate targeting fundamentals as his most significant accomplishment.[62]

The reachback targeting and analysis enterprise responded quickly once the joint force air component commander prioritized deliberate targeting and intelligence-gathering. By the end of 2015, the Inherent Resolve coalition was conducting strategic air campaigns against sources of ISIS strength despite initial setbacks. Although dynamic targeting remained a critical process throughout the conflict, the switch to deliberate targeting validated

56. Wasser et al., *Air War*, 51.

57. Benjamin S. Lambeth, *Airpower in the War Against ISIS* (Naval Institute Press, 2021), 215.

58. Lambeth, *ISIS*, 68.

59. Lambeth, *ISIS*.

60. Lambeth, *ISIS*, 81.

61. Chance Smith and Steve Rust, "Geographic Component Network Analysis: A Methodology for Deliberately Targeting a Hybrid Adversary," *Joint Force Quarterly* 88, no. 1 (2018): 75.

62. Lambeth, *ISIS*, 81.

the coalition's ability to harness its intelligence and targeting strengths, turning a flagging air campaign into one capable of methodically destroying ISIS' infrastructure and damaging its ability to wage war.

Lessons Learned

Over the past three decades, the Air Force's targeting readiness has improved in many areas, reflecting important institutional progress. While some practices deserve reinforcement, other persistent shortcomings demand corrective action. To that end, this analysis distills nine key lessons from the air campaigns discussed to guide future improvements in targeting readiness and effectiveness, emphasizing the enduring importance of thorough pre-conflict preparation, technical proficiency, and sustained operational and organizational discipline. While not comprehensive, they address recurring gaps in performance.

Other important factors—interoperability with coalition partners, for example—merit further research and analysis.

Systematic analysis of adversaries is necessary for an effective targeting campaign.

Airpower's coercive ability is amplified through robust peacetime analysis of potential enemies. Targeting campaigns based on sound nodal analysis yield better results, as seen in Deliberate Force and Iraqi Freedom. Even when delayed, as in Inherent Resolve, a systematic targeting campaign can still aid the Air Force in achieving success. Finding enemy vulnerabilities through target system analysis is vital in planning and waging effective air campaigns.

Planners must conduct adversary target system analysis, preferably well ahead of the initiation of hostilities, to run a coherent air campaign with tactical effects tied to strategic objectives.

Preplanned target lists will be exhausted during an air war.

Since Desert Storm, no air campaign has achieved its objectives without air component commanders noting a lack of worthwhile deliberate targets. Target shortages occurred in robustly planned conflicts like Deliberate Force and unplanned ones like Odyssey Dawn. Shortages also appeared in air campaigns with early intense bombings, like Iraqi Freedom, and more measured ones, like Allied Force. Endemic target scarcity likely stems from a combination of inadequate planning, adversary resilience, the adaptive nature of target systems, and enemy efforts at denial and deception. Commanders must have a plan before a crisis to enable their organizations to perform the deliberate targeting process at the speed of relevance, before and during conflict.

Combatant commanders and combined force air component commanders, in conjunction with the National Geospatial-Intelligence Agency and the Defense Intelligence Agency, must prioritize target record currency in the Modernized Integrated Database to enable the creation of robust target lists during crisis planning. Additionally, deliberate target development should be a focal point in all major combat exercises to ensure the force can operate the joint targeting process at speed and scale in combat.

Collateral damage mitigation and civilian casualty restraints are facts of modern air war.

National leaders have imposed restrictions on air forces to limit death and destruction in every significant air campaign since World War II. Military members must remember that targeting restrictions and rules of engagement serve a broader purpose: they allow strategic audiences to understand military violence as appropriate, politically and morally acceptable, and legitimate.[63] This understanding is especially important in today's hyperconnected world, where the audiences of US operations extend beyond the enemy and its borders and a compelling strategic narrative is an increasingly important variable in tallying victory and defeat.[64] Military instruments serve policy objectives, and airpower as a coercive tool must operate under restraints in limited war.

Weaponeering, CDE, and precise point mensuration have benefitted from career specialization, continual training, and doctrinal maturation. The professionalism of the Air Force targeting community is evident in its readiness in these areas at the outset of all air campaigns over the past three decades. These must remain areas of training specialization and should be increasingly practiced in major combat exercises.

Precision-guided munitions will become scarce during an air war.

PGMs are limited and expensive but vital for military commanders to make progress in an air campaign under rules of engagement. None of the campaigns studied here approached the intensity of World War II, yet the US military still ran low on PGMs in many cases. Policymakers and commanders must either succeed in energizing the defense industrial base to produce these weapons more expeditiously in peacetime or be prepared to use less precise weapons against some target sets in major combat operations.

Commanders must prioritize selecting critical enemy vulnerabilities as priority targets and maximizing the inclusion of nonkinetic targeting options at an air campaign's start to conserve PGM stocks. Additionally, policymakers and military leaders should predetermine target sets where less precise weapons are acceptable for prolonged conflicts.

Targeting assessment has been plagued by a lack of readiness.

Apart from the most recent engagement against ISIS in Iraq and Syria, the Air Force's readiness for the assessment phase of the joint targeting cycle could have been better. In four cases, leaders noted the inadequacy of targeting assessment in understanding air

63. David A. Koplow, *Death by Moderation: The US Military's Quest for Useable Weapons* (Cambridge University Press, 2010), xi.

64. Emile Simpson, *War From the Ground Up: Twenty-First-Century Combat as Politics* (C. Hurst, 2018), 74.

campaign progress. The Air Force Targeting Center's focus after Odyssey Dawn on training and certifying BDA analysts and exercising the process paid off during Inherent Resolve. Yet, these gains were limited to phase one (physical damage) and phase two (functional damage). No examples exist of an analytic team effectively assessing damage to the enemy target system (phase three) mid-conflict. It is worth considering if analysts have reached the limits of clarity in targeting assessment, a question that warrants further interdisciplinary research in systems thinking and data analysis.

Training and certifying BDA analysts and exercising the assessment process before conflict improves readiness. Every combined force air component commander should ensure their command has a plan to surge BDA support in conflict, they routinely exercise the assessment process, and a strong relationship exists between their intelligence, operations, and operations research teams.

Reachback targeting support is not new but remains necessary.

In preparing for Kosovo, the air component called on units spread across five countries for target planning. Prior to the 2003 Iraq air campaign, CENTAF called on the Joint Warfare Analysis Center and Langley AFB personnel for systems analysis and targeting support. In both cases, the air campaigns benefited from outside expertise. The best action the Air Force could have taken was to make reachback targeting more accessible to CFACCs before and during a crisis, which it did by establishing the AFTC. In 2011, the AFTC produced 78 percent of the targeting materials for the Odyssey Dawn/Unified Protector air campaign and supported the full spectrum of target development and assessment tasks during Inherent Resolve.

The Air Force made the right move in establishing the AFTC (now the 363rd Intelligence, Surveillance, and Reconnaissance Group) as a single focus point for deliberate targeting support. Service leaders should recognize its positive impact on targeting readiness and avoid reducing its capacity.

Dynamic targeting is an important Air Force function.

Finding and striking emerging targets is critical due to the persistent shortage of deliberate targets in conflict and adversaries' efforts to counter America's advantages in precision weaponry and battlespace awareness through dispersal and deception. The Air Force must retain and mature its ability to find, fix, and finish targets in near-real time. While dynamic targeting shares similarities with deliberate targeting, it requires greater speed, adaptability, and understanding of current operations. As technology advances, the need to operate faster than the adversary will make dynamic targeting even more critical.

Effective coercion with air forces involves dynamic targeting, which requires trained personnel, advanced technology, and codified processes. Targeteers must be skilled in both deliberate target development and dynamic target prosecution.

Targeting will be joint, combined, or (likely) both.

The United States conducted all six campaigns in this analysis as part of a multinational coalition, and in all but one—Allied Force—it operated alongside other service components. This trend shows no sign of reversing.

Targeting doctrine, training, equipment, and procedures must be joint and combined by design to prevent operational setbacks caused by interoperability shortfalls.

Targeting expertise is always in demand—and must be deliberately cultivated across career fields.

The core purpose of an air force is to deliver or credibly threaten violence in, from, and through the air in support of national policy objectives. That mission depends on targeting excellence, which requires deep technical mastery and broad interdisciplinary understanding. Targeting draws on intelligence, operations, strategy, law, psychology, and history, and as such, no single Air Force Specialty Code (AFSC) owns it. Historically, the Air Force cultivated this expertise in a dedicated targeting officer career field—one that contributed significantly to the Gulf War's targeting successes. Yet, the service eliminated that field in the post–Cold War drawdown and the consolidation of intelligence AFSCs in the 1990s, which contributed to a gradual erosion of targeting expertise.[65]

Rebuilding this capacity requires more than reestablishing an enlisted targeting pipeline; it demands intentional career development for officers in both intelligence and operations. A viable model includes early assignment to a bomb-dropping unit, followed by Joint Targeting School, experience at an air operations center, and ideally, mentorship at the 363rd Intelligence, Surveillance, and Reconnaissance Group. This pathway is not prescriptive, but merely one example of a model to foster targeting excellence. Such cross-functional development can prepare officers to lead—rather than merely support—the targeting enterprise across the full spectrum of air operations.

The Air Force must develop targeting leaders deliberately across both intelligence and operations officer career paths. While technical specialization is essential for target development tasks, effective leadership in targeting demands breadth, joint fluency, and campaign-level experience. The Air Force should institutionalize a development path that includes early exposure to operational units, formal targeting training, and experiential learning in air operations centers and specialized reachback. Campaign planning and targeting should be core elements of intelligence officer training and broader professional military education, ensuring the joint targeting cycle becomes a unifying concept across airpower disciplines.

65. Glock, "Evolution."

SPACE OPERATIONS

The Space Rescue Professional

Operationalizing Guardians for the Future

Benjamin J. Johnis
Robert A. Bettinger
James W. Dean

The escalating competition in space exploration demands a dedicated space rescue capability. This article argues for the establishment of a space rescue professional (SRP) career field within the Department of Defense and the US Space Force. By harnessing existing US Air Force combat rescue expertise and partnering with the National Aeronautics and Space Administration, the Space Force can rapidly develop a robust SRP program with the warrant officer corps as its backbone. This article addresses a critical gap in national space policy to outline a cost-effective dual-service training pipeline and SRP operational roles. Such an investment safeguards astronauts, bolsters US leadership in space by operationalizing Guardians, and paves the way for a future where space exploration prioritizes human safety.

The shifting tides of technological evolution in space provide immense opportunities for governments to expand instruments of national power and capability. They also reveal their vulnerabilities in their lack of organic technical experts to enable such technologies. Amidst the rise of generative artificial intelligence (AI), the National Aeronautics and Space Administration's (NASA) ambitious human spaceflight exploration, and the emergence of the US Space Force, robust space safety assurance is paramount, demanding strategic talent management across the government. The competition for highly qualified Guardians could decide the United States' ability to champion emergent capabilities in the space domain portfolio.

Space rescue is a critical emerging mission and a pivotal integrated deterrence mechanism that demonstrates opportunities to operationalize space professionals. The March 2025 rescue of US astronauts Suni Williams and Butch Wilmore—who spent 286 days in space due to the lack of national rescue resources—serves as a stark reminder that space isolation can occur long before the Moon is reached.[1] To perform national space rescue

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1. Anna Young, "Rescued Astronauts Suni Williams, Butch Wilmore Reveal Failures on the Boeing Starliner Were Far Dire [*sic*] Than Originally Reported," *The New York Post*, 3 April 2025, https://nypost.com/.

missions in cislunar space by the late 2030s, the Department of Defense and Space Force must initiate the effort to organize, train, and equip space rescue professionals (SRP) without delay. The US Air Force and Space Force are well-positioned for this task, and they retain the operational authorities to mitigate the risk of space isolation through US Space Command (USSPACECOM). This is the call for action, the solicitation for talent, and an opportunity to shape unity of command for the most complex personnel recovery (PR) concepts.

The Space Rescue Agenda: Competing with China

China's lunar aspirations pose potential friction points for the NASA Artemis program as they share overlapping geographic interests. The Artemis schedule and China's projected lunar plans indicate both the United States and China will sustain a permanent presence in the Moon's south pole region on or around the mid-2030s.[2] Artemis contract delays affect the critical path of this plan; however, China is on a firm trajectory to succeed on the timeline.[3] This forward-leaning posture reflects China's broader strategy in its rivalry with the United States not merely to match US capabilities but also to shape the emerging global order on its own terms. As Beijing views competition with Washington through an ideological lens, space becomes more than a theater of exploration—it becomes a domain where values, norms, and influence are contested.[4]

Balancing risk and reward are a central consideration in the decision to mature a US space rescue program. The risk of isolation in space—where an individual becomes separated from their unit while participating in a mission or activity in space—should dictate the measure of crisis planning and response. While it may seem relatively early to consider the development of space search and rescue (SAR) programs, China is already setting the pace of space rescue interoperability.[5]

China hosted the first-ever international lunar search and rescue conference in 2022 and is already postured with both a dedicated rescue crew and a spacecraft capable of responding to on-orbit emergencies, a program reportedly initiated in the wake of the 2003 Columbia disaster.[6] This capability is not just symbolic; it signals a broader strategic intent. China has outlined an ambitious agenda to secure a commanding position in

2. *International Lunar Research Station (ILRS): Guide for Partnership* (China National Space Association [CNSA] and Roscosmos, June 2021), http://www.cnsa.gov.cn/.

3. Eric Berger, "China May Use an Existing Rocket to Speed Up Plans for a Human Moon Mission," *ArsTechnica*, 2 September 2021, https://arstechnica.com/.

4. Paul Charon, *Strategic Foresight in China: The Other Missing Dimension,* Foresight Series (ISS [European Union, Institute for Security Studies], March 2021), https://www.jstor.org/.

5. Andrew Jones, "China's Next Crewed Spacecraft Is Ready for Potential Space Station Rescue Mission," Space.com, 7 June 2022, https://www.space.com/.

6. Jones, "Crewed Spacecraft"; and Benjamin J. Johnis and Peter Garretson, "Strategic Implications of China Winning the Space Rescue Race," Cislunar Security Conference, Johns Hopkins University Applied Physics Laboratory, Laurel, MD, December 2023.

cislunar space by establishing the China-Russia International Lunar Research Station, aiming to reap what it views as the strategic value and immense potential of the future space-based economy.[7] This proactive stance demonstrates that China not only possesses the will but also the operational capacity to lead in space rescue operations.

Both China and the United States bear significant risks of space isolation in their future endeavors, yet there are strategic consequences of a Chinese taikonaut or even a Russian cosmonaut successfully rescuing a distressed astronaut in space. The lack of US policy and minimal capacity to achieve a space recovery reveals a leadership vulnerability China is postured to exploit. A successful Chinese-led space rescue, therefore, would not just be a technical achievement but a powerful demonstration of leadership aligned with the Chinese Communist Party's vision of a "community of common destiny for mankind."[8] Such a possibility should serve as a wake-up call for the United States.

As outlined in the *National Security Strategy*, American interests lie in preserving leadership in space, yet current US space policy remains nascent and neglects to address the challenge of space isolation head on.[9] Furthermore, failing to competently respond to a crisis in space, especially one that leads to the loss of national space explorers, would severely undermine public support and cast doubt on the viability of future space endeavors.

At first glance, the most economical approach might seem to be assuming the risk of inaction, effectively shifting the burden and cost of developing space rescue capabilities onto competitors. Yet this strategy carries serious consequences, as it could ultimately leave US astronauts dependent on China for rescue, conceding both capability and leadership in a critical domain. China's growing rescue capabilities could also enable the use of "gray space," or gray-zone tactics in space—an operational frontier that thrives below the threshold of armed conflict yet holds enormous geopolitical consequences—subtly pressuring the United States and its partners without breaching the threshold of armed conflict. As with its actions in the South China Sea, a seemingly humanitarian space rescue mission could be strategically leveraged to showcase China's dominance, reshape global norms, or extract political concessions. In both terrestrial and space domains, China can operate in a way that blurs the line between cooperation and coercion, advancing its interests while avoiding direct confrontation, all while testing the resolve of its competitors and redefining the status quo.[10]

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7. *International Lunar Research Station*.

8. Charon, *Strategic Foresight*; and Jen Rae Wang, "New Space Policy Directive Calls for Human Expansion Across Solar System," National Aeronautics and Space Administration, news release, 11 December 2017, https://www.nasa.gov/.

9. Joseph R. Biden Jr., *National Security Strategy* (The White House, 2022), https://bidenwhitehouse.archives.gov/.

10. Bonny Lin et al., *A New Framework for Understanding and Countering China's Gray Zone Tactics*, RBA591-1 (RAND Corporation, 30 March 2022), https://www.rand.org/.

Numerous researchers across government and private institutions have highlighted the risk of space isolation.[11] Yet federal collaboration to conduct in-space rescue is lacking, and executive ownership of the national system concept remains undeclared. While China has shown a clear determination to develop space rescue capabilities, the race for dominance in this critical domain is still wide open—and the stakes have never been higher. Fortunately, the US National Search and Rescue Committee (NSARC) is identifying requirements to integrate space rescue into the national framework.

The Need for a National Space Search and Rescue System

The NSARC is comprised of eight government entities to ensure seamless collaboration during a crisis: this includes the Departments of Homeland Security, Defense, State, Transportation, Commerce, and Interior as well as NASA and the Federal Communications Commission. In September 2024, the committee presented the NSARC Space SAR Working Group recommendations concerning the establishment, organization, and implementation of a space search and rescue system, framing the problem set by aligning national and international demand signals messaging for a collaborative system.[12]

The NSARC cites the White House *National Cislunar Science and Technology Strategy* as a foundational document that provides specific guidance on advancing technologies such as communications and positioning, navigation, and timing services to achieve astronaut SAR success.[13] In its findings, the working group identified 10 key focus areas that describe essential tasks to achieve a space SAR system by the 2030s (table 1). Yet while the NSARC recommendations define what the mission is, the *who* is yet to be determined.

The question of who owns the national responsibility for space rescue is not merely bureaucratic—it is also strategic and likely requires a decision at the presidential level. The NSARC is taking a leading role in shaping that future, with its Space SAR Working Group actively developing a position paper to guide a whole-of-government approach to space safety and astronaut recovery. This foundational work sets the stage for a national space rescue system. The National Space Council, which advises the president on space policy, is uniquely positioned to champion this initiative and elevate space rescue as a matter of national priority. Meanwhile, the Department of Defense is investing in analytical efforts to define its role in future space crises, with the Space Force and USSPACECOM serving as key operational stakeholders.

11. B. J. Johnis, "Lunar Search and Rescue: The Next Step for Human Spaceflight Recovery" (master's thesis, Air Force Institute of Technology, 2023), https://scholar.afit.edu/.

12. Rick Button, "Space Search and Rescue [SAR]," paper presented at the 10th International Search and Rescue Conference, Kuala Lumpur, Malaysia, 9 September 2024.

13. Cislunar Technology Strategy Interagency Working Group, *National Cislunar Science and Technology Strategy* (National Science and Technology Council, November 2022), https://bidenwhitehouse.archives.gov/.

Table 1. Recommendations for a space search and rescue system[14]

#	Space SAR System Recommendations
1	The United States should study what existing or novel international body could provide the coordinating framework for space SAR, comparable to the International Civil Aviation Organization (ICAO) and International Maritime Organization (IMO), which provides the international framework for their respective aeronautical and maritime global SAR systems.
2	In alignment with the IMO's SAR Convention and the ICAO's Chicago Convention – Annex 12 (Search and Rescue), the United States should explore the gaps within the international legal framework for space activities and consider novel mechanisms to align global space SAR capabilities.
3	In alignment with the US National Space Council, determine if, when, and which federal agency should assume responsibility as federal space SAR coordinator.
4	If a federal space SAR coordinator is established, then revise the National Search and Rescue Plan to address the global and US space SAR system-related engagement, organization, and administration.
5	The United States should establish the space SAR regions, defined as space above the Earth's airspace. Promote this understanding with other international space authorities and SAR services.
6	The United States and international space authorities and SAR services should adopt the use of spacecraft flight segments in establishing policy, requirements, and guidance for the organization, coordination, and conduct of space SAR.
7	The United States should adopt and promote international SAR emergency phases (uncertainty, alert, and distress) for a spacecraft and the personnel onboard the spacecraft requiring SAR assistance.
8	NSARC should continue to support and promote the US position concerning the definition of outer space.
9	Space SAR must be considered a federal government function. Effective coordination and cooperation between aeronautical, maritime, and space SAR coordinators need to be established.
10	Global and US space SAR system coordination and operations should be funded by the participants, who shall not seek reimbursement from those who received those services.

The space rescue concept as a Space Force service task was formally presented to the chief of space operations for strategy, plans, programs, and requirements at the 2024 Space Force Futures Concept Summit.[15] Additionally, USSPACECOM is scheduled to host a lunar SAR exercise—Apollo Watchtower—in fall 2025. Meanwhile, defense researchers continue to sound the alarm on the growing personnel recovery gap in the space domain, shaping national discourse and urging senior leaders to act.

Presuming Space Force and USSPACECOM adopt the space rescue mission in support of the national space program, the authors argue that human infrastructure will remain a significant long-term challenge. While the satellites and associated services can be outsourced, space rescue professionals must be bred within the Defense Department to provide expertise across the executive branch.

14. Button, "Space SAR."
15. Benjamin Johnis and Tyler Bates, "Space Search & Rescue Personnel Recovery Functional Concept," presentation, US Space Force Futures Concept Summit, Colorado Springs, CO, June 2024.

The Space Rescue Professional: Human Infrastructure

Organizing a new community with human infrastructure and resources is an exhaustive process. The DOD personnel recovery system enjoys a rich history of expertise and rescue-specific hardware spanning back to the earliest conflicts in the nation. Space rescue is an element of PR in the space domain and should evolve from the community of terrestrial experts who mitigate the risk of isolation in their respective domains.

The joint force offers several PR-capable elements, but few are groomed as PR experts from cradle to grave like Guardian Angel Weapon System (GAWS) members. Since 2000, GAWS has played a vital role in ensuring the safety of human spaceflight operations. Unlike a traditional weapon system, GAWS is not composed of machines but highly skilled personnel. These include combat rescue officers (CROs), pararescuemen (PJs), and survival, evasion, resistance, and escape (SERE) specialists. Their mission transcends combat zones as they support the full spectrum of national PR missions.[16]

GAWS operates under a powerful motto: "So that others may live . . . To return with honor." This commitment persists not only in wartime but also in peacetime emergencies. The dedication of GAWS personnel is evident in their impressive record. They have not only directed over 12,000 lifesaving combat missions but also spearheaded the rescue of more than 5,000 civilians during natural disasters and humanitarian crises.[17]

The Guardian Angel talent pool provides adequate technical expertise for an Air Force-Space Force transitional period required to shape the space rescue professional career field. This transitional partnership presents benefits and challenges. The war in Afghanistan is over, and the deployment tasks have been reduced across the world. The 66th Rescue Squadron was inactivated on 1 June 2023, and the 58th was inactivated on 18 June 2025, integrating forces into units at Davis-Monthan Air Force Base, Arizona.[18] Despite the reduction in deployments, Guardian Angels strive to retain talent, compensating its career fields with reenlistment bonuses and incentive pay for special-duty qualifications. Still, retention shortfalls and the high cost of retraining new members can cripple the ranks of special warfare Airmen. To achieve buy-in from enlisted Guardian Angel members, the Air Force and Space Force must entertain creative strategies.

Reoptimize for Great Power Competition

At the Air and Space Forces Association's 2024 Warfare Symposium, then-Secretary of the Air Force Frank Kendall announced his plan to reintroduce warrant officers into the Air Force—a plan made in conjunction with the Department of the Air Force's aims

16. "Air Force Special Warfare," US Air Force [USAF, website], accessed 1 April 2025, https://www.af.mil/.
17. "Combat Rescue Officer 13DXA," USAF, accessed 31 March 2025, https://www.af.mil/.
18. 355th Wing Public Affairs, "66 RSQ Inactivates June 1," Nellis Air Force Base, 1 June 2023, https://www.nellis.af.mil/; and David Wichner, "Davis-Monthan to Lose A-10s but Gain Rescue Units in Air Force Plan," tucson.com, updated 6 August 2022, https://tucson.com/; and Devlin Bishop, "58th Rescue Squadron Inactivation," Davis-Monthan Air Force Base, 24 June 2025, https://www.dm.af.mil/.

to reoptimize for great power competition. Secretary Kendall stated that the department "needs operational units with all the capabilities they need to deter and compete with our pacing challenges and ready to enter a conflict on short or no notice," and that "in those units we need the right mix of skills necessary for high-end combat and to ensure technological superiority, particularly in information technology and cyber."[19]

Nearly 60 years after its sunset of the warrant officer corps due to budgetary constraints and its 1958 introduction of enlisted grades E-8 and E-9, the Air Force has revived the model with two new specialties: 17W (Warfighter Communications & IT Systems Operations) and 17Y (Cyber Effects & Warfare Operations). Unlike their Cold War-era predecessors, these new warrant officer roles are explicitly shaped by national security imperatives and talent management needs in an era of great power competition.[20]

Chief of Space Operations General B. Chance Saltzman echoed this strategic shift, aligning with Secretary Kendall's call to stand up a Space Futures Command, one that prepares "joint-minded warfighters who understand the battlefield context of the space domain and are fully equipped to act within it."[21]

In this context, space rescue emerges as a quintessential gray-zone mission, which special operations-peculiar human capital is required to execute. Highly trained, technically proficient rescue professionals can outcompete near-peer adversaries not through mass but through agility, precision, and readiness. As China continues to refine its gray-zone playbook with integrated military, paramilitary, and information operations, the United States must respond with similarly agile, adaptive capabilities.

Developing a dedicated cadre of SRPs as a warrant officer field offers precisely this counterweight: an altruistic, values-driven capability that projects resolve, preserves life, and signals domain mastery. In an era where China may seek to exploit space emergencies for strategic advantage, rescue emerges as a soft power delivering high-visibility operations for narrative shaping. The SRP career field equips the United States with the organic capability to contest that space, both literally and figuratively. Through this lens, space rescue is a strategic instrument of integrated deterrence and a subtle yet potent signal of American leadership in the domain.

The Space Rescue Professional Warrant Officer

The space rescue professional will carry the burden of responsibilities across tactical, operational, and strategic levels of impact. To recruit and retain a professional operating at this level, the Space Force should offer a warrant officer Air Force Specialty Code to all 7-level enlisted craftsman SERE and pararescueman applicants. This core of enlisted

19. Secretary of the Air Force Public Affairs (SAF/PA), "Air Force to Begin Accepting Warrant Officer Applications," USAF, 25 April 2024, https://www.af.mil/.

20. SAF/PA, "Air Force."

21. SAF/PA, "Saltzman Outlines Plan to Reoptimize Space Force for Great Power Competition," USAF, 13 February 2024, https://www.spaceforce.mil/.

professionals is critical to drafting the foundational policy and guidance for a budding career field. The inception of a warrant officer rank compensates the candidates financially and provides a narrowly focused path to cultivate a highly specialized duty that will define the future of crisis response in space.

Unlike commissioned officers, warrant officers maintain their technical specialty, unconcerned with traditional paths outside their field, seeking trajectories to command. The priority is to excel at the specialty, not leading people or assuming additional duties. This is precisely the focus and scope of talent required to succeed in creating the first-ever space SAR system as described by the NSARC.

The transition from enlisted Airman to warrant officer Guardian is not arbitrary. For clarity, no such pathway exists currently. Yet as the Space Force functionally resides under the Department of the Air Force, it therefore reaps the benefits of department support. Since the Air Force designed a pathway from enlisted to warrant officer, the Space Force enjoys the ease of transition by extension. Currently, Airmen can be directly assigned to the Space Force, supporting the chief of space operations in areas where the service lacks expertise as the new service is still growing. Therefore, in the early stages of SRP development, there is less concern over what service tapes are sewn on the uniform as long as the shoulder patches align with the Space Force mission. Given a cadre of space rescue professional warrant officers grown from PJs and SERE specialists, commanded by SRP officers filled by CROs, rescue pilots, and special warfare officers, the Space Force is prepared to operationalize Guardians in space.

Space Rescue Professional Development

Academic and government researchers are fully engaged in space rescue matters. Crucial turning points—from the setting of national direction and priorities in the *Cislunar Science and Technology Strategy* to China's hosting of the 2022 International Lunar SAR Conference to the upcoming Apollo Watchtower game series—make it abundantly clear: the skills and knowledge required for SRPs are in high demand. The government must grow this capability organically to answer the nation's call.

The transition from counter-terror to great power competition drives the need to outperform China and Russia in new domains. Coalitions, treaties, and international consortiums are vital elements of integrated deterrence strategies against competitors. The Guardian Angel Weapon System matured during the Global War on Terror, shaping personnel recovery support packages for counter-terror missions across Southeast Asia. Combat rescue officers have spent their entire existence operationally focused on countering terror by executing tactical maneuvers.

In sharp contrast, the SRP is asked to be proficient in tactical execution but keen on strategic effects, such that each mission carries the risk of an international incident. Just before the attack on 11 September 2001, the combat rescue officer career field was conceived by senior leaders in the PJ and SERE career fields. There was a growth phase that required a blended approach of insights and expertise from the enlisted fields they would represent.

Over the years, CROs morphed from the product of conceptualization into thought leaders that helped shape Air Force Special Warfare.

There are many parallels to draw between the CRO and SRP. While the former is asked to operate at the tactical level, their failures also can have strategic effects. This becomes even more significant for an SRP who cannot execute any mission without the world's attention. They must think tactically and strategically at every turn. They must understand the institutional challenges and legal constraints of the Defense Department, NASA, and allied and partner nations. Combat rescue officers gained inspiration and mentorship from PJs and SERE. The space rescue professional is an obvious first cousin to the GAWS family. The communities share overlapping training requirements, providing a financially advantageous pipeline for the new career field. The special warfare training program sets the right conditions for candidates, with less emphasis on combat and more focus on the true enemy of an astronaut: natural threats of the space domain. Figure 1 contextualizes a cost-effective solution to producing a nascent SRP capability by similarly sharing resources as demonstrated in the dual-service Officer Candidate School.

Building a robust space rescue capability does not require starting from scratch. As highlighted earlier, academia and government are actively defining the skillset needed for SRPs. Fortunately, existing PJ and select SERE specialists have already completed the baseline training and advanced skills portion of their training. This strong foundation allows a focus on additional training on space-specific areas such as space medicine and technical familiarity with astronaut equipment.

The First Air Force (Air Forces Space) Detachment Three (Det 3) coordinates DOD contingency support for US human space flight programs.[22] Det 3 possesses the expertise to manage a comprehensive training program for SRPs. This includes both advanced training and on-the-job experience for recruits. The proposed training pipeline demonstrates that leveraging Det 3 capabilities is significantly more cost-effective than building a new force within NASA and less risky than outsourcing the mission (fig. 1).

Developing a mature SRP community requires time and collaboration. Initially, Det 3's training program can be adapted to create a space rescue apprentice course that seamlessly integrates civilian, contractor, and military personnel. This combined approach allows the SRP community to mature while ensuring it can regularly meet mission requirements. The Department of Defense already offers approximately 91 percent of the necessary training required for an SRP. Furthermore, Det 3 maintains and provides all mission-critical equipment to perform terrestrial astronaut recovery, from parachutes to jet skis, eliminating the need for significant additional investment.

22. "Detachment 3," CONR-1AF (AFNORTH & AFSPACE), accessed 3 April 2025, https://www.1afa.acc.af.mil/.

Figure 1. Space rescue professional training pipeline

The proposed SRP model prioritizes a long-term investment that will ultimately reduce transaction costs for the entire US government. As the capability matures, the SRP will need to expand technical expertise into uncharted territories, but the core skills are earned in terrestrial rescue operations.

Employment of the Force

Terrestrial Rescue

The SRP is neither a pararescueman nor a SERE specialist, but they do share a similar mindset and a core set of skills. The unique talents of an in-space rescue operator are unknown to the world, but the only way to mature the role is by constant exposure to the problem. SRP operators will gain the most experience through the terrestrial rescue of astronauts. Det 3 requires rescue professionals to support every astronaut recovery mission, but capability is limited. The Guardian Angel Weapon System has sourced the astronaut recovery bill since the Gemini program.

The SRP will provide much-needed relief to GAWS and allow a non-combat career field to focus narrowly on risk mitigation for the NASA commercial crew program. Under Det 3, space rescue professionals will coordinate, command, and control DOD forces during nominal and contingency rescue, recovery, and retrieval operations for human spaceflight programs. The current force laydown offers expertise and capability at both Patrick Space Force Base (SFB), Florida, and the Johnson Space Center in Houston, Texas. Det 3 mans the Support Operations Center at Patrick SFB, to synchronize coordination efforts with NASA and the Combined Space Operations Center at Vandenberg SFB, Colorado. The mission calls for asset staging and rescue team delivery after the capsule splashes down. The reentry often occurs on the eastern coastline of America, but it can vary based on the return vehicle or the supporting nation.

During the execution phase, SRPs would operate under the USSPACECOM commander potentially under a personnel recovery task force, designed to employ a joint team of rescue experts organized, trained, and equipped by the services to meet the geographic combatant command requirements. A personnel recovery task force inherently directs humans, hardware, and support personnel dedicated to the mission set. Unity of command is a critical aspect of a PR mission, but who commands the mission for in-space rescue? The White House makes it clear that NASA is the supported executive agency in human spaceflight exploration, but crisis response has always remained a shared responsibility between the State Department and the Defense Department. The PR task force construct, led by SRPs, allows for joint-interagency and international collaboration. As space law and executive policy evolve, the space rescue professional will rise to the occasion, offering solutions to the geographic combatant commander and the nation writ large.

In-Space Rescue

Assuming American space policy does not take any dramatic shifts, the US government will invest in a commercial space station in low Earth orbit, and NASA astronauts will have a permanent presence on the lunar surface. A commander owns the risk-to-force decisions in DOD missions. Given the great national implications of humans in space, Artemis risk decisions are delegated to NASA leadership. With minimal personnel in space, the risks are manageable yet high, nonetheless. SRP capabilities buy down the risk through blended experiences of DOD operations and space expertise. Early missions can be mitigated using autonomous spacecraft or early return vehicles.

There are some cases where astronauts may need immediate support in space, in orbit. Once an SRP meets craftsman-skill level requirements, they are well suited to enter astronaut training with a focus on crisis response, to rapidly treat patients suffering medical or trauma-based injuries. Medical evacuations from space will eventually occur. Contemporary crewed space vehicles are not optimized for medical evacuation, nor do they offer operating space for medical professionals to treat patients en route from a station through reentry and back to definitive medical care. A crewed lifting body spacecraft offers the SRP room for a supine patient workstation, minimal g-forces on reentry, and a smooth autonomous landing at a runway with medical facilities.[23]

Since the retirement of the Space Shuttle, the Sierra Space Dream Chaser is the only lifting body in operation, albeit a crewed version does not exist yet.[24] SRPs and emergency crew vehicles can be stationed in orbit or placed on alert status from Earth.

In recent history, an SRP crew on alert may have saved astronaut's lives. In December 2022, a suspected micrometeoroid struck the Soyuz MS-22 crew capsule docked with the International Space Station (ISS) and sprang a radiator coolant leak. NASA and the Russian Space Agency solicited SpaceX to prepare for rescue options with its autonomous Crew Dragon.[25] In June 2024, NASA astronauts Wilmore and Williams launched aboard Boeing's Starliner for what was intended to be a routine crew flight test to the ISS. The Starliner experienced significant mechanical frustrations on its inaugural flight but eventually docked with the orbiting outpost. Because of ongoing thruster and valve issues, however, NASA and Boeing decided against flying Starliner back to Earth. Instead, the astronauts returned on a separate SpaceX Crew Dragon vehicle, which safely brought them home after spending nine months in space.[26]

The probability of an off-nominal mission or mechanical failure is difficult to assess, but the risk only increases as astronauts travel beyond Earth's orbit, venturing to the Moon and deeper space. This danger is further amplified by the emergence of new spacefaring nations attempting human spaceflight without prior operational experience. Although only three countries—Russia, the United States, and China—currently possess independent human launch capabilities, the global push toward space exploration has led more countries to contribute spacecraft, systems, and technology to space missions.[27] These components, often experimental or first-of-their-kind, are stitched together into missions where failure in a single system can have cascading and fatal consequences.

Historically, NASA's space program served as the backbone of crewed exploration, but today, human spaceflight is increasingly a multinational and commercial endeavor

23. Johnis, "Lunar Search."

24. "Revolutionizing Space: Dream Chaser®," Sierra Space [website], accessed 3 April 2025, https://www.sierraspace.com/.

25. Agence France-Presse, "Russia Confirms Rescue of Stranded Cosmonauts with a Replacement Mission," Science Alert, 12 January 2023, https://www.sciencealert.com/.

26. Eric Berger, "Starliner's Flight to the Space Station Was Far Wilder Than Most of Us Thought," *Ars Technica*, 1 April 2025, https://arstechnica.com/.

27. Wessel Wessels, "The Only Countries Capable Of Human Spaceflight – and the Rockets They Use," Headed for Space, accessed 17 April 2025, https://headedforspace.com/.

where hardware from multiple nations with young space programs must function in harsh environments. These realities set the conditions for SRP alert crews, standing by to respond to any spaceborne national crisis.

Lunar Surface Search and Rescue

The NASA Artemis campaign aims to place humans back on the Moon with the intent to launch a Moon-to-Mars initiative using the lessons learned from lunar surface missions. The *National Cislunar Science and Technology Strategy* and the Defense Advanced Research Projects Agency's (DARPA) 10-year lunar architecture study are prime indications that astronauts will travel beyond low Earth orbit indefinitely.[28] With US sights on the nearest body of mass, astronauts are at risk of isolation with no reasonable access to rescue capability.

NASA is empowered to assume this level of risk, but the loss of a single astronaut due to neglect could lead to irreversible policy shifts. The risk can be mitigated through tiers of support and preparation. The first objective is and always will be self-recovery, to avoid the potential for further loss of life. An SRP may be the best tool for the job, but space is limited on the Artemis Base Camp. As astronauts venture further into the lunar landscape, they will require a staging of autonomous vehicle partners, ready to deliver aid and resources. Space rescue mission operators must be proficient in AI integration for space operations. This includes utilizing AI decision-making for complex, time-sensitive rescues, and guiding machine learning-driven autonomous navigation systems for rapid response and hazard avoidance.[29]

Similar to the Guardian Angel Weapon System, SRPs are tailored advisers for the USSPACECOM commander. They should staff the theater Joint Personnel Recovery Center (JPRC) during all extravehicular activities, where astronauts are operating in their suits outside of a controlled atmosphere or habitat. Given the proper contracts, the JPRC staff will be trained and equipped to assume custody of surface vehicles supporting any crisis on the surface. As space medicine and crisis response experts, the SRP will have rehearsed various scenarios in exercises alongside NASA and international partners to prepare for the worst. SRPs are a force multiplier to support NASA, ensuring the national space mission does not end in tragedy due to a lack of manpower and expertise in emergencies. Eventually, lunar operations will grow in scale and emergency services will be necessary for the number of humans operating on the surface. There will be an inflection point, perhaps in the 2040s when NASA sustains a permanent presence on the Moon. To properly mitigate risk, SRPs should be forward-staged on the surface, prepared to conduct a tactical response for lunar contingencies.

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28. Defense Advanced Research Projects Agency, *10-Year Lunar Architecture (LunA-10) Capability Study*, presolicitation, SAM.gov, updated 5 September 2023, https://sam.gov/.

29. Jam Canda, "The Future of AI in Space Exploration and Research," *Medium*, 6 April 2024, https://medium.com/.

The proposed Lunar Gateway is a space station orbiting the Moon. Early Artemis missions detail a four-person crew, with two staged on the Gateway, and two descending onto the lunar surface for the remainder of the mission. The surface crew will utilize a lander that can perform elevators to and from the Gateway with the option to return to Earth on the same vehicle they arrived in.[30] The Gateway is another ideal staging base for an SRP. It is optimal to sustain emergency return vehicles that provide redundant capability in lunar orbit. If there is a failure of systems, a replacement may not arrive in time. SRPs paired with a lifting body crew return vehicle provide astronauts with the greatest chance of survival in an emergency.

The SRP Lifecycle

To better understand the unique rhythm and demands of this career field, imagine the journey of a single SRP operator from their arrival at Patrick SFB to the culmination of a career marked by deployments across the solar system. This hypothetical narrative captures the professional development and mission tempo of an SRP through cycles of training and space deployment, highlighting the deep institutional knowledge that shapes the individual behind this newly formed title. A fresh recruit in the pipeline completes a series of challenges alongside their PJ and SERE peers, culminating in a capstone opportunity at Patrick SFB, where they begin space rescue training.

Their cadre of instructors will have just recovered from space deployment. A space-hardened SRP with institutional and practical knowledge is the ideal instructor for the next generation of Guardian operators. The first duty station is at one of the key locations required to perform the terrestrial rescue mission: Patrick SFB; Pearl Harbor-Hickam AFB, Hawaii; or Joint Base Charleston, South Carolina. Here, they will learn and operate as a tactician, perfecting their craft of technical space rescue while earning upgrade training with commercial and government space organizations.

The next duty station in the career path is to manage the relationships with the customer base. Here, their tactical experiences prepare them to coordinate terrestrial recovery missions at the operational level. This mission is performed with commercial crew program participants dependent on their force structure, such as the SpaceX Hawthorne Mission Control Center, California.

Space rescue professionals selected for deployment are eligible to enter the NASA astronaut program, preparing for temporary duty on one of three stations: Low Earth Orbit Space Station, the Lunar Gateway, and the Artemis Base Camp on the Moon. SRPs can practice and research space medicine and validate the crisis response tactics, techniques, and procedures to ensure a well-functioning program. Upon completion of the Air Force-Space Force SRP transition and subsequent deployment of SRPs to space, the operators will achieve a sustainable deployment-dwell period that fosters continued growth of the career field and reduces

30. Tracy Gill, "NASA's Lunar Orbital Platform-Gateway," paper presented at the 45th Space Conference, Cape Canaveral, FL, 28 February 2018, https://commons.erau.edu/.

the exposure to radiation over the lifespan or career. Post-deployment the SRP is ready to man the Joint Personnel Recovery Center at Johnson Space Center, return to the schoolhouse as cadre, or lead a terrestrial space rescue unit. The deployment-dwell periods are based on radiation exposure and mission demand. This cyclical rotation between training, terrestrial rescue, space deployment, and leadership positions ensures a well-rounded, experienced force prepared to face any space rescue challenge.

Conclusions

The urgency for a dedicated space rescue capability is undeniable. China's lunar ambitions and the recent near misses on the International Space Station highlight the potential dangers astronauts face. Fortunately, the groundwork for space rescue is already underway. The 2024 US National Search and Rescue Committee recommendations establish a clear path for a US-led space search and rescue system. Academic meetings like the Cislunar Security Conference and ASCEND [Accelerating Space Commerce, Exploration, and New Discovery] Conference showcase the growing interest in space rescue solutions.

With a timeline established by the White House and NASA and momentum building in academic circles, the Space Force has a unique opportunity to leverage existing expertise from the Air Force Guardian Angel Weapon Systems to create a world-class warrant officer corps and space rescue professional program. This investment will not only safeguard American astronauts but also solidify US leadership in space. The future of space exploration hinges on the United States' ability to ensure the safe return of its bravest explorers. It must act swiftly and establish an SRP program to usher in a new era of space exploration with human safety at its core by operationalizing Guardians and ensuring the continued success of American space endeavors.

Electrifying delta-v for the Space Force

John Cserep

A little-noticed patent concerning propellantless space propulsion technology issued in late 2022 could lead to a remedy for key deficiencies in Space Force capabilities and transform the US space enterprise in the areas of orbital maneuver, proximity operations, and especially survival against pacing threats. Drawing from publicly released information, patent filings, presentations, interviews, and personal conversations with the author, this article investigates electric thrust—apparently from zero point fluctuations—which enables unlimited freedom of maneuver and non-Keplerian orbits, presents intractable problems for attackers, and obviates the need for on-orbit refueling. Such technology is key to meeting the Space Force's objectives for a resilient and effective force.

Urgently-needed improvements in maneuverability and survivability of assets in space are directly related to the need for improved on-demand propulsive acceleration, or delta-v. This in turn is tied to the availability of propellants for on-orbit maneuvering thrusters, which has long been the limiting factor for evasion from attack, avoidance of orbital debris hazards, retasking to support operations, and end-of-life disposal. The clear requirement is for increased on-orbit propulsive capability, which is presumed to require providing more propellant and using it more efficiently. But is this the only answer?

US patent #11511891 represents a breakthrough in propellant-less propulsion, replacing traditional thrusters with electromagnetic forces generated by a revolutionary "physics package" employing a divergence of electric fields.[1] This effect—demonstrated repeatedly in laboratories and under vacuum conditions—is the climax of a century-long pursuit of all-electric propulsion based on asymmetric capacitors. Starting in the 1920s, American scientist T. Townsend Brown and his many successors have repeatedly produced tantalizing evidence of a link between the forces of electromagnetism and gravity. Theoretical understanding has been lacking, however, preventing engineering improvements that might allow laboratory one-offs to achieve practical utility.

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1. Andrew Neil Aurigema and Charles Raymond Buhler IV, System and Method for Generating Forces Using Asymmetrical Electrostatic Pressure, US Patent 11511891B2, filed 19 November 2019, and issued 29 November 2022, https://patents.google.com/patent/US11511891B2/en.

Background

This understanding changed when, in the period from 2020 to 2021, researchers in Florida moonlighting from the US space program established the equations of force that result from diverging electric fields. No magnetism is involved, only high electric field intensities created by electric charges at high voltages but extremely low currents, thus consuming astonishingly little power. The resulting implementation and its related patent claims went through 12 months of scrutiny by both the National Aeronautics and Space Administration (NASA) and the Defense Department prior to the United States Patent and Trademark Office issuing a foundational utility patent—not merely a provisional one—to the inventors, NASA physicist Charles Buhler and engineer Andrew Neil Aurigema, who started Exodus Propulsion Technologies LLC to further develop and commercialize this revolutionary technology. Lab-scale prototypes are currently producing thrust levels suitable to satellite propulsion (millinewtons, mN) and are scalable, while ongoing materials research and efficiency improvements have steadily raised thrust levels and thrust-to-weight ratios achieved.[2]

Such propulsion is a major advance over currently available thrusters. Because these use electric fields to ionize and accelerate propellant rather than heating via conventional chemical reactions, such thrusters are often marketed as "electric." This is misleading, however, since these electric ion thrusters are still just rockets, entirely dependent on propellant and useless once their supply runs out. The truly all-electric propellantless devices can never run out of fuel because they simply do not use any. The devices' specific impulse—the conventional metric for rocket engine efficiency—would technically be calculated as infinity. Once charged up, Exodus devices continue to generate a force as long as the charge remains, much like electrostatic repulsion—the Coulomb force, or the amount of force between two electrically charged particles—remains as long as like charges are present.

Buhler has led the development of the theory behind the Exodus technology. He leads NASA's electrostatics and surface physics lab at the Kennedy Space Center, where his team addresses mitigation measures for lunar dust, among other things. After over 30 years of studying electromagnetic theory as it might apply to propellantless propulsion, Buhler co-founded Exodus, where he serves as chief scientist.

After the company recently emerged from years in "stealth mode," Buhler is now discussing his theory and how it fits within currently accepted foundations of physics.[3] He and Aurigema discovered that a force occurs in the presence of intense but diverging electric fields resulting from a unique, separate manipulation of embedded and mobile electric charges. Significantly, these researchers have achieved the ability to model their

2. Author's personal communications with Charles R. Buhler and Andrew N. Aurigema.

3. See, for example, Christopher Plain, "NASA Scientist Says Patented 'Exodus Effect' Propellantless Propulsion Drive That Defies Physics Is Ready to Go to Space," *The Debrief*, 19 July 2024, https://thedebrief.org/.

devices computationally, reflecting a theory which led to designs that produce experimental results as predicted—all are in agreement.

In recent years, other claims of propellantless thruster inventions have appeared. Much attention was attracted beginning in 2001 by the so-called EmDrive, an asymmetric resonant microwave cavity.[4] Claims of thrust generation were exhaustively tested by Dresden University of Technology; no net thrust was found, and no further work appears to be occurring on this device.[5] An offset-rotating mechanical device, called a centrifugal impulse drive, is claimed to produce net thrust without propellant. It was exhibited for the first time at the SpaceCom 2024 conference by Quantum Dynamics Enterprises Inc., but no patent has been issued and no demonstration in vacuum has been performed so far.[6] Finally, the IVO Limited company recently has claimed an all-electric "quantum drive" with similar properties to the Exodus thruster, though no patent has been granted.[7]

Implications

Assuming eventual success of propellantless thruster technology, the implications for space applications are simply immense, and for the specific needs of the Space Force, they are immediately game-changing. These include the following: the implications for meeting current requirements, the entirely new capabilities which become possible, and the additional possibilities that can be expected from further engineering improvements in taking advantage of new physics devices which can produce thrust indefinitely with little or very little power input.

The prospect of unlimited freedom to maneuver presents intractable problems for an attacker, no matter what anti-satellite weapon is used. Ground-based lasers, jammers, and missiles all require their operators to first pick out their target from among an increasingly bewildering cosmos of satellites of all kinds, with as many as 48 more being added by a single SpaceX launch. The one exploitable weakness an attacker can depend on today is the predictability of the orbit of its target. But propellantless propulsion enables "maneuver without regret," allowing constant orbital modifications without cost, making literally every overhead pass different from the one before.[8]

Space-based or co-orbital attackers will face the same problem, and limited by their own fuel, they will have little hope of chasing down a constantly accelerating and decelerating target. By thus complicating the enemy's targeting challenges, what one analysis

4. emdrive.com (website), accessed 2 February 2025, http://www.emdrive.com/.

5. Martin Tajmar, Marcel Weikert, and Oliver Neunzig, "High-Accuracy Thrust Measurements of the EMDrive and Elimination of False-Positive Effects," *CEAS Space Journal* 14 (2022), https://link.springer.com/.

6. Quantum Dynamics Enterprises Inc. (website), accessed 23 May 2024, https://qde-inc.com/.

7. IVO Limited (website), accessed 30 January 2025, https://ivolimited.us/.

8. See Brigadier General Kristin L. Panzenhagen, program executive officer for the Assured Access to Space directorate, as qtd. in Greg Hadley, "Dynamic and Responsive: Space Force Leaders Plan for a New Kind of Operations," *Air & Space Forces Magazine*, 20 December 2023, https://www.airandspaceforces.com/dynamic-responsive-space-force-operations/.

calls "maneuver warfare in space" can be fully exploited.[9] This could include "super-orbital" vehicles traveling faster than orbital mechanics require, accelerating Earth-ward to maintain a circular path while outrunning threats.

Likewise, proximity operations in space become vastly more practical when the maneuvering fuel budget is a thing of the past. Fly-by inspections, rendezvous for repairs and upgrades, and even debris cleanup missions will be affordable. There will be no need to invest in on-orbit refueling: no tankers, no fuel depots, no fill ports, or tricky handling of liquids. The Space Force has been preparing for such a future, marshalling resources and alerting industry to anticipated needs for extra fuel sources on orbit.

More recently, however, public statements by Chief of Space Operations General B. Chance Saltzman indicate second thoughts about the economics of refueling in a future paradigm which will also emphasize proliferating small satellites.[10] These are intended to be replaced frequently so as to enable frequent technology refresh, but this short design life makes the idea of refueling questionable. As a *SpaceNews* analysis noted shortly after General Saltzman's remarks, "Redesigning these satellites [adding fill ports] for a 15-year design life so they can be refueled would compel the US Space Force to rely on absurdly obsolete computers for most of the satellites' orbital life."[11] Satellite refueling ports are not free and have not even been demonstrated in space yet, and fluid transfer in zero-g is considered risky by some. Skeptics argue that without refueling, even cheap satellites will last for years, and the Space Development Agency's Proliferated Warfighter Space Architecture constellation's satellites are designed for at least five years on orbit.[12] How long should Space Force satellites really last?

Yet, there are clear exceptions, such as expensive spy satellites and large geosynchronous equatorial orbit satellites, as both General Saltzman and the head of Space System Command's Commercial Space Office have emphasized.[13] Contrary to the commercial world, some of the Pentagon's needs do not change that much. So long as an asset remains useful and continues to operate, why not leave it in service? Thus, the need for extended maneuvering ability is not exactly the same as the need for additional propellant. These have been synonymous in the past, but with propellantless electric thrusters the Space Force can buy only what it needs. If fuel-based thrusters are about to become dinosaurs, it is best that the Space Force recognize this before over-investing in an obsolescent paradigm.

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9. Christopher Stone, *Maneuver Warfare in Space: The Strategic Mandate for Nuclear Propulsion* (Mitchell Institute for Aerospace Studies, 2022), https://mitchellaerospacepower.org/.

10. Sandra Erwin, "Saltzman: Space Force Still Grappling with Refueling Math," *SpaceNews*, 30 April 2024, https://spacenews.com/.

11. Charles Beames, "Why the Math on Refueling Just Doesn't Add Up," *SpaceNews*, 9 May 2024, https://spacenews.com/.

12. Josh Luckenbaugh, "JUST IN: Space Development Agency Preparing for New Satellite Solicitations," *National Defense*, 19 November 2024, https://www.nationaldefensemagazine.org/.

13. Colonel Rich Kniseley, as qtd. in Sandra Erwin, "Space Force Plans Deep-Dive Study on Pros and Cons of Orbital Refueling," *SpaceNews*, 20 May 2024, https://spacenews.com/.

It may be that "it is already much cheaper to build and launch new satellites than it is to refuel them," but this takes no account of survivability.[14] The point of maneuvering Space Force assets is not merely to remain in a desired stable orbit but to remain alive in wartime. The conventional expectation of three-to-five-year satellite lifetimes will only apply in peacetime. Thus, for reasons of both practical economics and wartime resilience, Space Force assets need maneuvering capacity without the logistical burden of fuel infrastructures in orbit. With propellantless thrusters, the Space Force can have the best of both worlds.

In addition, the replacement of propellant tanks in satellite designs with compact electric propulsion will reduce overall vehicle size and weight. Based on the current state of the art, Exodus thrusters are of a size comparable to conventional thrusters of the kind commonly used today for the same thrust level, while eliminating fuel tanks entirely. For example, a Busek model BHT-600 Hall thruster offering 40 mN weighs 2.6 kilograms (kg) and is typically paired with 100 kg or more of propellant. The benefits of this alone are huge, starting with launch costs and including less obvious advantages such as reduced satellite cross section. The latter translates into reduced susceptibility to being struck by orbital debris or a deliberate pellet ring attack, in addition to being a smaller target for any other weapon.

Applied to current systems under development, these benefits could be enjoyed by the Joint All-Domain Command and Control constellations, the Evolved Strategic Satellite Communications system, and others on the way. Fortunately, the Space Force anticipated the likely opportunities that emerging technologies would offer for these major programs, and the acquisition strategies facilitate tech insertion throughout the systems' production lifetime.

Nuclear Thermal Rocket Alternative

This new technology's advantages contrast dramatically with long-advocated nuclear thermal rocket (NTR) propulsion, a technology approach being advanced by the Defense Advanced Research Projects Agency (DARPA) under a program dubbed DRACO (Demonstration Rocket for Agile Cislunar Operations).[15] Such technology aims to provide a qualitatively different kind of propulsion, capable of very high thrust but still fuel-limited. Thus any host asset would need to be designed for the high accelerations an NTR thruster would produce. How many space asset designs could justify the cost, design impacts, and mass of an attached NTR simply to provide maneuvering thrust?

Another key justification exists for NTR, however: extended high thrust for cislunar or interplanetary missions. These are quite different from the near-term needs of Space Force orbital assets, of course, but even an aspirational system for such long-range missions

14. Beames, "Math on Refueling."

15. "DRACO: Demonstration Rocket for Agile Cislunar Operations," Defense Advanced Research Projects Agency (DARPA), accessed 29 January 2025, https://www.darpa.mil/.

could be served by the low-thrust propellantless systems, because the latter can continue thrusting indefinitely. Over days and weeks, a little acceleration adds up quickly. Since the impacts to the host vehicle are minimal, its structural mass can remain low, with synergistic effects including an even shorter travel time for a given thrust. So, given an emerging low-thrust propellantless capability, even the hypothetical long-distance missions may not favor technologies such as NTR and certainly will not require them.

In the over 60 years of NTR technology's history, its expense, hazards from its nuclear core and exhaust, testing limits, and formidable political hurdles have never all been surmounted. If all-electric thrusters of even low thrust levels prove out, elaborate alternatives like NTR may never be needed.

As for existing satellites, these too could benefit from propellantless propulsion technology thanks to the retrofit capability being devised now by Northrop Grumman Corporation for its mission robotic vehicle (MRV). Designed to extend satellite lifetimes by providing supplemental propulsion of the conventional type, Northrop Grumman's system in its initial iteration simply grapples the customer satellite and maneuvers it, for up to five additional years. The next generation system will carry propulsion systems in a standalone package which the MRV will attach to the host satellite, leaving the servicing vehicle free to move on to the next customer and attach more propulsion units.[16] These units could just as easily be propellantless electric propulsion systems, allowing the Space Force to leverage an emerging commercial servicing capability to upgrade its legacy fleet. Equipping the MRV itself with propellantless thrusters will make its operation much more economical and straightforward, eliminating refueling stops. It would also become practical to use MRVs to perform debris cleanup in any and all orbits.

All these innovations will directly address the number one operational imperative defined by former Secretary of the Air Force Frank Kendall: "Defining resilient and effective space order of battle and architectures."[17] Additionally, of the key focus areas identified by former Space Force Chief Technology and Innovation Officer Dr. Lisa Costa, the new thrusters address these: 1) improving freedom of action in space, 2) improving survivability and resilience, and 3) improving mobility.[18]

New Capabilities

Consider now some entirely new capabilities enabled by the all-electric propulsion breakthrough. Thrust levels demonstrated in laboratories allow the possibility of satellites

16. "Space Logistics," Northrop Grumman (website), accessed 3 April 2025, https://www.northropgrumman.com/.
17. Erwin, "Space Force Plans."
18. Lisa Costa, remarks, 2022 Air Force Association Air, Space and Cyber Conference, 19–21 September 2022, National Harbor, Maryland; and see also Nick Adde, "Six Space Technologies the USSF Needs in Order to Maintain the US Advantage," *Air & Space Forces Magazine*, https://www.airandspaceforces.com/.

positioned in entirely new ways which do not even qualify as orbits. No longer limited by Kepler's laws of motion, space systems could:

- maintain a geostationary position while being much closer to the Earth than 35,786 kilometers or 22,300 miles, making their payloads more effective in observing the Earth or relaying communications;
- sit above one of the Earth's poles, continually observing and relaying over the northern or southern hemisphere, with a horizon defined by the chosen altitude;
- cross the sky faster than any satellite, unpredictably, by accelerating inward toward the Earth so as to exceed the orbital speed of satellites at the same altitude;
- maintain a position identical to the sidereal background—that is, remaining stationary in the absolute sense, rather than geostationary—so as to "disappear" into the starfield as observed from Earth; and
- "impersonate" enemy space systems by appearing to orbit directly beneath them, as seen from the ground, while in fact maintaining a safe separation distance at a lower orbit, thus daring an attacker to risk their own space asset in order to attack US ones.

Other uses will no doubt emerge as creative Guardians grasp the new possibilities of non-Keplerian orbits.

In addition, deflection of threatening asteroids to avoid collision with Earth becomes much more practical if a source of constant thrust can be affixed to the threat. Fuel-based rockets never offered a practical means of doing this, but a propellantless system finally would.

Occasional remarks from Space Force leaders suggest an interest in safeguarding cislunar space via some sort of future patrol ship capability. With electric propulsion, a patroller could be made by updating the Cold War-concept known as Blue Gemini. This was a proposal to make an Air Force-owned and -operated version of the two-man Gemini capsule, which at the time was the state of the art in the civilian space program.[19]. The Orion capsule from NASA's current Artemis program is designed for reuse after reentry and refurbishment, and thus quite a lot of what it includes is extraneous to a potential cislunar patrol mission.[20]

For a conceptual "Blue Orion" variant, consider a capsule sent to space for permanent stationing, with no intention to return it to Earth. Based at a future space station such as those planned to succeed the International Space Station—and making sorties to the future Lunar Gateway station—the craft would need no heat shield, saving weight and expense. Its service module, which on Orion is devoted almost entirely to rockets and propellant tanks, could be replaced with a solid-state propellantless system. The existing

19. Dwayne A. Day, "A Darker Shade of Blue: The Unknown Air Force Manned Space Program," 12 September 2022, *The Space Review*, https://www.thespacereview.com/.

20. See Charles S. Galbreath, *Securing Cislunar Space and the First Island Off the Coast of Earth* (The Mitchell Institute for Aerospace Studies, January 2014), https://www.mitchellaerospacepower.org/.

parachute compartments could be repurposed to host a remote manipulator arm, operated from within the capsule by the crew. Compared to a standard NASA Orion mission to the Moon, fewer crew might be needed as well, freeing up more volume for consumables or mission equipment. Under this concept of operation, only minor servicing of Blue Orion might be needed between missions, making permanent basing in space feasible.

As for weapon application concepts able to exploit continuous electric thrust, consider a kinetic impactor constantly accelerated over a long journey to the Moon on a free-return trajectory. Upon returning to Earth and reentering, it would be traveling at many times the speed of sound, as unstoppable as a meteor.

Conclusion

Of course, the industry is eager for such propellantless propulsion to someday replace rockets for space launch, "rocket cargo," and other demanding uses of high-thrust propulsion. The path to these applications lies through improvements in efficiency and maturation of the underlying fundamental technology principles as applied to propellantless propulsion. The inventors at Exodus say they have identified promising approaches to achieve this, and indeed all progress to date has been only that achievable by self-funded garage inventors.[21] The physics of the propulsion sets no limits on the improvements that can be engineered, nor on scaling. Once teamed with the Space Force's trusted prime contractors and their resources, remaining engineering obstacles will be fully addressed to evolve the technology as needed by Space Force systems. It is not too early for the Space Force to prepare for a new era beyond that anticipated by twentieth-century planners .

21. Author's personal conversations with Buhler and Aurigema.

Critiquing the US Air Force Academy's Core

Does It Satisfy the Need?

Mark Clodfelter

To prepare the nation's future Air and Space Force officers for tomorrow's wars, the US Air Force Academy must arm its graduates with the right balance of practical military skills and academic knowledge. A review of the Academy's current core curriculum reveals the need for a stronger foundation in the humanities, particularly in the study of history and literature. For these curriculum changes to occur, the Academy must meet the challenges to the status quo, including the reduction in civilian faculty, department parochialism, and the Academy's shift from an academic focus. Although warfighting skills are crucial, an understanding of the nature and character of war is what will ultimately define successful warrior-leaders of tomorrow.

In the Spring 2025 edition of *Checkpoints*, the quarterly magazine of the US Air Force Academy's (USAFA) Association of Graduates, Academy Superintendent Lieutenant General Tony D. Bauernfeind wrote, "We are in a Time of Consequence, facing threats from every corner of the world and in all domains. . . . At the end of their 47 months at our USAFA, our cadets will be the warrior-leaders our Nation deserves."[1]

Bauernfeind, a distinguished graduate from USAFA's class of 1991, rightly notes the challenges awaiting today's new lieutenants. He is also correct that the United States must have competent military leadership to negate the multitude of global dangers that it faces. Yet his assumption that graduates will have received the necessary education to serve as the "warrior-leaders our Nation deserves" merits examination, especially in terms of whether USAFA's core curriculum provides a solid foundation for the world that graduates will encounter.

Without a doubt, military studies and the associated training directed by the commandant of cadets are essential features of a service academy. Physical fitness is necessary as well. But how much time those components take from a cadet's day in comparison to how much involves academics also matters a great deal. As Bauernfeind observes, a cadet will spend almost four years at USAFA, and that time must be allocated to yield the maximum return on producing the best possible warrior-leaders.

The Academy's recently revised mission statement reads, "To forge leaders of character, motivated to a lifetime of service, and developed to lead our Air Force and Space Force

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1. Tony Bauernfeind, "Warrior Leaders Ready on Day 1," *Checkpoints*, March 2025, 14, 16.

as we fight and win our Nation's wars."[2] This is an update of the previous statement: "To educate, train and inspire men and women to become officers of character motivated to lead the U.S. Air Force and Space Force in service to our nation." Some critics of the new statement have bemoaned the absence of the word "educate"; yet regardless of whether the word appears, education remains the fundamental bedrock for creating a successful warrior-leader.[3]

The increasingly complex demands of twenty-first-century warfare underscore the level of intellectual development and flexibility of mind required of all future officers. For young men and women aged 18 to 22 years, an academic education is the most vital component of the months that they will spend in the foothills of the Rockies. Accordingly, it must receive the most time. The key concern, though, is how the time for academics should be allocated.

As a RAND analysis has suggested, USAFA's core curriculum emphasizes that the Air Force's foundation rests on technology, true as well for the recently created Space Force.[4] It notes, "The Air Force could be said to worship at the altar of technology," and such a focus "will ensure an open-ended future for flight (in airplanes and spacecraft) that, in turn, will ensure the future of the Air Force . . . [and] the continued expansion of flight-related technologies."[5] Thus, for USAFA to grant bachelor of science degrees in all disciplines makes sense. Graduates must understand the basics of how air and spacecraft function, along with specifics regarding both offensive and defensive weaponry that the two services can employ or that opponents can employ against them. Consequently, a fundamental knowledge of how the key components of the services work is essential for a new Air or Space Force officer.

More important, though, is a basic understanding of why those lethal elements might be useful in a given situation. The Air Force has the capability to place a "smart" munition in a single room of a structure that might house enemy leaders. Yet American decisionmakers, both political and military, must carefully consider the potential and unintended consequences of such an action, and the likelihood that the outcome might actually make the situation worse than it was before. In that regard, a greater emphasis on the humanities would benefit all Academy graduates.

Granted, new lieutenants may not immediately have to face such decisions, but cadets should certainly debate the pros and cons of lethal actions as a part of academic discussions. An essential component of a warfighter's psyche is to understand the essence of war, to include why it is fought, its definition of victory, and its indispensable "exit" considerations.

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2. "Motivated to Lead: Academy Mission," US Air Force Academy [USAFA, website], accessed 8 July 2025, https://www.usafa.edu/.

3. Mary Shinn, "New Air Force Academy Mission Statement Drops 'Educate,' Adds a Different Focus," *The Denver Gazette*, updated 27 May 2025, https://gazette.com/.

4. Carl H. Builder, *The Masks of War: American Military Styles in Strategy and Analysis* (The Johns Hopkins University Press, 1989).

5. Builder, *Masks of War*, 19.

If cadets do not grasp those notions, the United States risks making the mistake of Germany prior to 1945—developing officers who excel tactically and operationally, and who can produce seemingly sound war plans, but fail to provide strategic clarity to the civilian leadership because they are not equipped, from the beginning, to understand the nature and character of war despite their warfighting skills.

American warfighters must further appreciate that victory has different definitions that change from one conflict to the next. Foreign languages, philosophy, literature, law, and history offer valuable insights into deciphering the factors that cause nation-states—and non-state actors—to react in a particular manner to different provocations. The latter four of those disciplines further reveal the notions that have shaped what eminent historian Russell F. Weigley called the "American Way of War" and the impact that those ideas have had on past American military operations and portend for the future.[6] He argued that since 1861, a "strategy of annihilation" has been a chief characteristic of America's approach to armed conflict, along with "the problem of how to secure victory in its desired fullness without paying a cost so high that the cost would mock the very enterprise of waging war."[7] The desire to destroy an opponent's capability and will to fight, and to do so at a minimal cost in terms of both money and manpower, has remained a guiding principle in the nation's wars since Vietnam.

This article contends that the Academy faces a crisis regarding its core curriculum. While Academy graduates must be armed with essential warfighting skills, their success in future conflicts hinges on having a solid foundation in the humanities. Those disciplines provide the necessary understanding and appreciation of the moral, ethical, cultural, and sociopolitical aspects of war, all crucial concerns of a warrior-leader. Yet restructuring USAFA's core curriculum to include more humanities courses will not be easy. Civilian staff cuts, departmental parochialism, and an administrative shift away from academics toward training all present obstacles to changing the core. Yet, if the Academy is to succeed in its mission of producing competent warrior-leaders, the core must change.

Core Curriculum

The US Air Force Academy prides itself on its history of producing well-rounded officers with a broad-based liberal education. It distinguishes itself from other service academies as offering a "collaborative blending of rigorous academics, military training, character and leadership development, and competitive athletics" that cadets need "to succeed as airmen, guardians, and citizens."[8]

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6. Russell F. Weigley, *The American Way of War: A History of United States Military Strategy and Policy* (Macmillan Publishing, 1973).

7. Weigley, *American Way*, xxii.

8. "At the Center of Inquiry: Core Curriculum," USAFA, accessed 28 May 2025, https://www.usafa.edu/; and "Academic Outcomes," USAFA, accessed 9 July 2025, https://www.usafa.edu/.

This blend is evident in its academic program. In the four-year span culminating with the 2024–2025 academic year, all cadets, regardless of their majors, took 29 required semester-long courses spread across a variety of academic disciplines plus military studies and physical fitness. Those courses comprised USAFA's core curriculum—molded by the superintendent, the dean of faculty, and the department heads—to assure proficiency in achieving nine "institutional outcomes": critical thinking, engineering, principles of science, the human condition, leadership, clear communication, ethics and respect, national security, and the warrior ethos.[9] The majority of core courses consisted of engineering, science, and social science. The humanities—those academic disciplines that examine the human condition by exploring culture, history, language, and the arts—received much less attention.

In the standard course sequencing, freshmen took only core courses, consisting of between 13.5 and 17.5 semester hours and 13 courses total, unless they had validation or transfer credit. Of those core courses, only four were from the humanities: two in foreign language, one in English, and one in history. The remaining core courses addressed science, mathematics, and social science, along with military studies and physical education. Similar core requirements confronted sophomores, who, like freshmen, took only four humanities core courses—history, English, philosophy, and law.[10] (Although considered a social science by the Academy, "law" in this article is considered one of the humanities, given its focus on critiquing human behavior, its basis in cultural and historical factors, and its ties to philosophical notions about justice and morality.)

Juniors and seniors, most of whom could now take majors courses, still had a majority of core requirements outside of the humanities. Junior cadets had no humanities requirements, while seniors had just one—a course in philosophy—although seniors who majored in humanities disciplines could count certain electives in their major to help fulfill core requirements. For the juniors and seniors majoring in engineering, basic science, or mathematics, however, their exposure to the humanities was minimal if they took only the required core courses.

Cadets typically graduate with a total of 134 to 149 semester hours. The minimum graduation requirements are 128 semester hours of academic coursework, five semester hours of physical education, and the completion of four character and leadership programs as well as professional military education and leadership laboratory courses. Most academic majors require between 134 and 143 semester hours.[11] In contrast, the US Military Academy at West Point requires a minimum of 120 academic hours, while the US Naval Academy at Annapolis states that "in general, midshipmen must complete a minimum of

9. "Core Curriculum."
10. "Core Curriculum."
11. Hal Taylor, USAFA Registrar's Office, telephone conversation with author, 20 June 2025; and see also "Core Curriculum"; and "Graduating from the Academy: Curriculum," USAFA, accessed 19 June 2025, https://www.usafa.edu/.

137 semester hours." Both service academies have physical education, professional military education, and character-building requirements similar to those at USAFA.[12]

At the time of this writing, the core curriculum for cadets entering in the 2025–2026 academic year has yet to be finalized but in all likelihood will resemble the requirements guiding the 2024–2025 curriculum. The changes proposed in this article should be implemented by the start of the 2026–2027 academic year to ensure that USAFA's graduates are adequately—and rapidly—prepared to face the challenging environments that they will encounter. Ukraine, the Middle East, Africa, and Southeast Asia—regions with ongoing conflicts—are all potential destinations for new lieutenants; Russia, China, and North Korea could also produce turmoil that triggers American military action. The sooner that the recommended core modifications occur, the better prepared Academy graduates will be to deal with the trials that await.

Humanities Core

The humanities courses comprising the US Air Force Academy's core are vital components of a graduate's education.

Foreign Languages

The way in which a potential enemy—or ally—organizes and expresses their thoughts discloses much about how that entity will approach war. "Languages are the pedigrees of nations," Samuel Johnson wrote in 1773, and that observation remains valid in the twenty-first century.[13] USAFA requires two semesters of a foreign language to provide cadets with a basic understanding of how thoughts are formed and expressed outside of English. Those courses count toward providing proficiency in achieving USAFA's institutional outcome of a better understanding of the human condition. That knowledge includes a focus on one of eight "strategic languages," with Arabic, Chinese, and Russian comprising three of the eight. Cadets who take more than the two required courses can earn a foreign language minor in addition to their academic major.

Philosophy

Philosophy is also essential to a cadet's understanding of the world that they will face as an officer. Core courses in that discipline help fulfill the institutional objective of providing a better appreciation of ethics and respect. USAFA currently requires all cadets to take two philosophy courses: a course on ethics during the sophomore year and "Comparative

12. "Part 1: The Academic Program," US Military Academy, accessed 19 June 2025, https://courses.westpoint.edu/; and "Transcript Explanation," US Naval Academy, Office of the Registrar, accessed 19 June 2025, https://usna.edu/.

13. James Boswell, *The Journal of a Tour to the Hebrides with Samuel Johnson, LL. D.* (1785; Classic Literature Library), 73, https://classic-literature.co.uk/.

Religion" during the senior year. The sophomore course provides "a critical study of several major moral theories and their application to contemporary moral problems with special emphasis on the moral problems of the [military] profession" and highlights the "civic, cultural, and international contexts in which the U.S. military operates."[14] The senior course examines the "faith traditions" of the world's major religions, including Hinduism, Buddhism, Islam, Judaism, and Christianity, providing a basic understanding of the central religious tenets in the disparate environments where graduates will serve.[15]

Law

Rather than placing the core Law 220, "Law for Department of the Air Force Officers," in the ethics and respect category of institutional outcomes, the dean labels it as a required course to promote critical thinking. The course, which "covers general law knowledge and constitutional topics through examination of case law and texts," also develops communication and problem-solving skills through case study analysis. Students are given instruction on "how an area of law works in society, followed by its military application."[16] No doubt the class also addresses ethics and respect in its discussions, but placing it in the critical thinking category of institutional outcomes—along with core courses in economics and statistics—displays USAFA's inherent focus on science, engineering, and math. In addition, as the single law course in the core, and one designed to prepare cadets to serve as officers, it would seem better suited as a course for seniors rather than one for sophomores as it now stands. Still, regardless of where it appears in the curriculum, it is an essential part of officer development.

English

Two English courses also bolster the core, and both fall in the clear communication category of USAFA's institutional outcomes. Freshmen take the first, "Composition and Research," while sophomores take the second, "Intermediate Composition and Introduction to Literature." Clear writing is certainly a skill that every officer must have. The study of literature, though, receives comparatively scant attention, and that focus is one that would further speak to the human condition institutional outcome. The English department once offered a core course for seniors, "War Stories," but that course is now offered only as an elective that fails to garner the widespread participation that it received when part of the core. The course focuses on novels about the military, with many written by combat veterans. One former member of the faculty stated that three novels—*Once an Eagle* by Anton Myrer (1968), *The Conversion of Chaplain Cohen* by Herbert Tarr (1963), and *The Lionheads* by Josiah Bunting (1972)—shaped his concept of selfless leadership.

14. *Course of Instruction Handbook*, effective Fall 2024 (USAFA, 2024), https://www.usafa.edu/.
15. *Course of Instruction*, 428.
16. Randy Roughton, "Law Class Gives Cadets Legal Tools They Will Need as Officers," USAFA, accessed 3 June 2025, https://www.usafa.edu/.

Reinstating such a core requirement would not only help fulfill the institutional outcome of understanding the human condition but would also directly address the warrior ethos outcome.[17] At present, the only academic core courses that satisfy that institutional outcome are History 100, "Military History," and Military Strategic Studies 251, "Air Power and Joint Operations Strategy." The other courses conveying the warrior ethos are all physical education, which even includes choices of golf and pickleball for upper-class cadets.[18] With the current superintendent's emphasis on creating warrior-leaders, War Stories should return as a foundational course in the core. Bauernfeind himself has stated, "Warfighting is not a job—it is a mindset."[19] Making that course a requirement for all cadets would emphasize that conviction.

History

History is another critical component of the core. As famed Prussian military philosopher Carl von Clausewitz noted, the study of history involves an understanding of both physical and moral causes and effects, with the physical representing "the wooden hilt" of a sword, and the moral representing "the precision metal, the real weapon, the finely-honed blade." He argued that history "provides the strongest proof of the importance of moral factors and their often incredible effect: this is the noblest and most solid nourishment that the mind of a general may draw from a study of the past."[20]

Before 1986, three history courses—world, American, and military—were required of all cadets. In that year, the requirement for American history disappeared, with the rationale being that cadets had already received a sufficient background in that course in high school. That belief has changed, as the superintendent recently decided to return American history to the core, but that decision also resulted in world history's removal as a core course—an error of equal magnitude to the omission of American history as a core requirement.

In short, these events all contributed to Russian President Vladimir Putin's paranoia that Western concepts and military might could ultimately bring Ukraine into NATO and the European Union, creating a potent enemy on his southern border—and to Putin's desire to create a new Russian empire. To help resolve that war in a satisfactory manner, American leaders at all levels must consider those factors from Russia's past.

Furthermore, junior officers as well as generals must be able to explain the rationale for their nation's actions to subordinates—and to allies and partners—because all of those wearing the uniform should understand why their country may ultimately put them in harm's way. America's national security faces threats from not only Russia, but also China,

17. Randy Roughton, "Cadets and War Stories: Studying War's Human Impact," Defense Visual Information Distribution Service, 7 October 2024, https://www.dvidshub.net/.

18. "Core Curriculum"; and *Course of Instruction*.

19. Bauernfeind, "Warrior Leaders," 14.

20. Carl von Clausewitz, *On War*, ed. and trans. Michael Howard and Peter J. Paret (Princeton University Press, 1976), 184–185.

Iran, North Korea, and a proliferating number of terrorist entities, further highlighting the need for a knowledge of world history. America's military suffered from an ignorance of the historical and cultural background of Vietnam in the 1960s, and a similar hubris led to failures in Afghanistan and Iraq in the twenty-first century.

As an Air Force officer and former USAFA instructor who had served in Afghanistan writes, although military academy graduates are "educated as engineers and technicians," when they are deployed to countries like Iraq or Afghanistan, they must "negotiate the 'human terrain' of cultures utterly foreign to them." Without an understanding of the broad, sociohistorical context in which they exist, they are at a clear disadvantage: "Lacking knowledge of their own history as well as the history of the cultures they walk among, it is hardly surprising that they make little progress, despite hard work and honorable intentions."[21] The recognition of this context's significance is not new. This imperative has been made by the world's greatest strategists across time, perhaps most notably Sun Tzu: "Know the enemy and know yourself; in a hundred battles you will never be in peril."[22]

Likewise, American leaders—at all levels—must understand and appreciate the motivations of the nation's Allies. Israel's past reveals that its recent assault on Iran's leadership and nuclear facilities should not have been unexpected. The Israelis have demonstrated on numerous occasions that when they perceive an imminent threat to their survival, they will respond with lethal force. The 1967 Six Day War, the June 1981 attack on Iraq's Osirak nuclear reactor near Baghdad, and the September 2007 bombing of the Syrian nuclear reactor at al-Kibar all illustrate Israel's willingness to resort to a first strike if deemed necessary to protect its populace.[23] A core course in world history, chronicling the rise of antisemitism that culminated in the Holocaust, the growth of the Zionist movement, and the Middle East tensions stemming from Israel's 1948 creation as a nation, should be an essential component of an Academy graduate's education.

As the June 2025 American attacks on Iran demonstrate, along with the 40,000 American service members serving in the Middle East, the new lieutenants comprising the Air and Space Forces have a high probability of encountering turmoil in the Middle East during their careers, and many will likely serve in that area. Without a required course in world history, they will not gain the background needed to operate successfully in that environment, because it is not provided elsewhere in the Academy's core curriculum. Moreover, they will be bereft of a broader understanding of world events.

21. W. J. Astore, "America's Military Academies Are Seriously Flawed," *Bracing Views*, 17 December 2014, https://bracingviews.com/.

22. Sun Tzu, *The Art of War*, trans. Samuel B. Griffith (Oxford University Press, 1963, 1971), 84.

23. See "Israel Admits Striking Suspected Syrian Nuclear Reactor in 2007," BBC News, 21 March 2018, https://www.bbc.com/.

USAFA has tried to resolve the core world history dilemma by directing cadets who validate the new American history requirement to take world history instead. But that "fix" only compounds the problem. When American history was required by then-Superintendent Lieutenant General Michael Gould as a "trial core course" for all freshmen in academic year 2013–2014, only a small number of cadets placed out of it with high Advanced Placement (AP) American history test scores, which is likely to happen again. Of the 1,190 prospective cadets arriving in the summer of 2013 as future members of the class of 2017, just 115 (9.7 percent) had the AP test scores to validate it.[24] Thus, the current mandate will likely produce a majority of graduates without an understanding of world history, and that is unacceptable for future Air and Space Force leaders.

In the 2024–2025 academic year, all freshmen took military history, while sophomores took world history. Whether the history department can implement the new requirement for American history in the 2025–2026 academic year and whether the world history core course will in turn disappear for most cadets, remain uncertain at this juncture. Regardless—as is true at both West Point and Annapolis—three one-semester history courses should be centerpieces of USAFA's core. In short, the Academy fails in its mission to produce competent officers unless its graduates have a basic background in their nation's past, a fundamental knowledge of how history has shaped potential enemies and allies, and a sound comprehension of how the profession of arms has developed through the centuries. All are vital components of a future military leader's education.

The core military history course already includes the superintendent's desire for a focus on "managing operational risk," as it stresses how all sides in past conflicts have sought to achieve their wartime goals while minimizing losses.[25] The emphasis on risk ties directly to the cultural and political foundations that guide each state—or non-state actor—in its behavior, notions reflected in American and world history core courses. In 1962, President John Kennedy highlighted the importance of understanding our nation's past:

> There is little that is more important for an American citizen to know than the history and traditions of his country. Without such knowledge, he stands uncertain and defenseless before the world, knowing neither where he has come from nor where he is going. With such knowledge, he is no longer alone but draws a strength far greater than his own from the cumulative experience of the past and a cumulative vision of the future.[26]

That fundamental knowledge is critical for an American military officer.

24. Author communication with Brigadier General Mark Wells, USAF, Retired, former history department permanent professor and head.

25. Bauernfeind, "Warrior Leaders," 15.

26. John F. Kennedy, "JFK Writes About Our Nation's Memory," *American Heritage* 59, no. 4 (2009), https://www.americanheritage.com/.

Challenges to Changing the Core

To initiate these crucial changes to the core curriculum, the US Air Force Academy must address three issues: the potential loss of civilian professors, the often-parochial views of Academy department chairs, and the superintendent's desire for additional training courses that do not necessarily have an academic focus.

During his confirmation hearing in January 2025, Secretary of Defense Pete Hegseth called for removing many civilian professors at service academies and replacing them with military faculty. At the time of this writing, this initiative is underway. Currently, USAFA has 491 faculty members, of whom 308 (62.7 percent) are military and 183 (37.3 percent) are civilians.[27] In April 2025, Bauernfeind suggested cutting civilian faculty positions without hiring officers to replace them, to increase the military faculty's presence to 80 percent of the total.[28] He has also stated an interest in seeing these cuts for the Fall 2025 semester.[29]

The Academy's Acting Dean of Faculty Colonel Steven Hasstedt announced in early July 2025 that USAFA would eliminate 140 civilian positions. That total included at least 50 civilian faculty members who had already departed through a voluntary deferred resignation program without their positions being backfilled.[30] "Involuntary separations" could then result through a reduction in force if the Academy fails to find additional funding to pay a $10 million shortfall in fiscal year 2025 civilian pay.[31]

Such moves present several challenges. For one, civilian cuts risk eliminating a significant number of faculty members with doctorates, which could in turn jeopardize the Academy's ability to achieve accreditation. Secondly, suitable officers—particularly those with warfighting experience—to replace civilian faculty members can be difficult to recruit. To teach at USAFA, officers must have at least a master's degree and expertise in the desired academic discipline. During the Academy's first four decades, departments frequently sponsored selected officers to attend graduate school, with the Air Force footing the bill, likely negating substantial cost savings. Officers with a master's degree from a civilian university—earned typically within a year-and-a-half to two years—would spend two or three years teaching at USAFA, a process which removed them from their primary career field for four to five years.

This "time sink" is a concern for pilots and other officers in key warfighting specialties. Air Force leaders determined that the time lost from a new instructor's primary career field was too great, which was why civilian professors were considered a more efficient—

27. Mary Shinn, "Air Force Academy Superintendent Proposes Cutting Civilian Staff," *The Denver Gazette*, updated 2 May 2025, https://gazette.com/; and see also Jeff Arnold, "Air Force Leader Seeks Civilian Faculty Cuts: Report," NewsNation, 4 April 2025, https://www.newsnationnow.com/.

28. Shinn, "Superintendent"; and Arnold, "Faculty Cuts."

29. Mary Shinn, "Air Force Academy Eliminating 140 Positions, No Cuts to Majors Planned," *The Denver Gazette*, 6 July 2025. https://gazette.com/.

30. Brett Forrest, "Internal Email Confirms Air Force Academy Cutting 140 Civilian Staff, Facing $10 Million Pay Shortage," KOAA News5, 3 July 2025, https://www.koaa.com/.

31. Forrest, "Internal Email."

and cheaper—alternative. The Air Force's severe pilot shortage—with 1,150 empty pilot billets in 2024 alone—further limits the likelihood that pilots will teach at the Academy.[32]

In addition, civilian manpower losses would—according to the dean's office—likely result in eliminating some majors, because the faculty would have to focus on core courses, and majors' courses would receive secondary attention. As a former distinguished visiting civilian professor speculated, while upper-class cadets might be allowed to finish their majors, certain majors for current freshmen and sophomores might disappear, and programs with fewer than 15 cadets may be eliminated entirely.[33] Finally, the proposed loss of faculty members could tax the remaining faculty, who must cover current core courses as well as their own normal courseload.

In the meantime, a fair number of USAFA's civilian faculty are former Air Force officers, many of whom are Academy grads, well-versed in understanding—and relating to—the challenges that cadets face while attending USAFA. Those individuals have the background and experience exceeding that of active-duty Air Force officers, and their loss would be profoundly felt. Such expertise should be acknowledged and used to enhance the warrior ethos desired for faculty members. Relying on academically qualified retired officers would enable humanities departments to increase their manning and thus, their core offerings.

Another impediment to changing the core is that the department heads—the colonels and tenured permanent professors of USAFA's academic departments—have a stake in what courses cadets are required to take. Department manning results from the number of core courses offered along with the number of cadet majors in that discipline. Generally speaking, the more core courses offered, the more students—and hence more staff and funding—is directed to that department. While the superintendent, with recommendations from the dean, makes the final decision regarding the courses comprising the core, the department heads carry a great deal of weight in that determination.

USAFA's 21 academic departments fall within four overarching disciplines: basic sciences, comprising biology, chemistry, physics and meteorology, and mathematics; engineering, including aeronautics, astronautics, civil and environmental engineering, computer and cyber sciences, electrical and computer engineering, mechanical engineering, and systems engineering; humanities, consisting of languages and cultures, English and fine arts, history, and philosophy; and social sciences, comprising behavioral science and leadership, economics and geographical sciences, law, management, military strategic studies, and political science. Department heads from each of those disciplines serve as division chairs, and those four individuals traditionally have more sway in determining core courses than the other 17 department heads.

To modify the core, the dean asks for input from the department heads. Customarily, the department heads in basic sciences tend to support one another, as is also the case for

32. Shinn, "Superintendent"; and see Audrey Decker, "Pilot Shortage: New Report Calls for More Air Force Fighters and Larger Reserve," *Defense One*, 24 January 2025, https://www.defenseone.com/.

33. Shinn, "Superintendent"; Decker, "Pilot Shortage"; and see also Shinn, "140 Positions."

those in engineering, the humanities, and social sciences. Given that 29 academic courses comprise the core curriculum, adding a core course for one department has usually meant that another department must surrender one. Given the impact on department manning, department heads are understandably loath to relinquish a course that bolsters their manpower. Still, with only nine core courses currently coming from the humanities, the addition of two more—War Stories and world history—would still leave a preponderance of basic sciences, engineering, and social sciences dominating the curriculum—while making USAFA's new lieutenants better equipped to face the environment that they will encounter in the twenty-first century.

Bauernfeind wants to upgrade military training so that all cadets will enhance the warrior ethos by being prepared "to shoot, move, communicate, medicate, and automate."[34] Although those skills are definitely desirable, their development should not take time away from academics. The preferred proficiencies could be achieved by devoting less attention to the "drill" that consists of squadrons marching around the terrazzo and more to weapons expertise and life-saving medical skills. In fact, Bauernfeind's proposal to have the 40 cadet squadrons emphasize the A-staff functions that parallel real Air Force operational divisions is a sound one. It should help prepare cadets for the missions that they will face after graduation. As Bauernfeind states, "Through rigorous, adversary-focused military training, a nationally recognized academic program, and a culture of highly competitive athletics, we will develop graduates who exemplify unwavering courage and a deep commitment to honor and integrity."[35] Such a vision for the Academy offers the balance of military skills and academics that would produce successful warrior-leaders of the future.

Conclusion

Revamping the US Air Force Academy's core curriculum with additional humanities courses is necessary to ensure that the Academy produces the most thoroughly prepared graduates to serve as the future warrior-leaders of the Air and Space Forces. Doing so will not be easy. Inertia, and perhaps hostility, may come from some department heads, who may resist the idea of either adding or subtracting from their and their colleague's current course load. USAFA will need to maintain a minimum faculty of 400 to ensure adequate coverage for core courses as well as to offer academic majors.[36] Modifications in the focus of military training may be necessary. Of special note, Brigadier General Linell A. Letendre, the dean of faculty since 2019, retired on 30 May 2025, and a new dean's search has begun. In the interim, Bauernfeind, with advice from Hasstedt and the department heads, should revamp the core curriculum as soon as possible to guarantee that graduates are fully equipped to meet the challenges that they will face.

34. Bauernfeind, "Warrior Leaders," 15.
35. Bauernfeind, "Warrior Leaders," 16.
36. Shinn, "Superintendent."

The newly appointed Academy Board of Visitors—a congressionally directed oversight committee that offers insight and guidance on issues such as culture, morale, and curriculum—met at USAFA in early August 2025. Members offered their own recommendations for changing the curriculum, including a request to add a required course in world history to the core. Yet, in the final analysis, Bauernfeind, assisted by Hasstedt and the department heads, will decide the structure of USAFA's curriculum for the future. To achieve the Academy's mission of providing the nation with competent military leadership, they will need to heed the advice from the board and ensure that the humanities play an increased role in the core.

Diplomats in Fortresses

The 1938 "Good Will Flight" to Argentina

Shane P. Reilly

In 1938, the US Army Air Corps tasked the 2nd Bombardment Group with a goodwill mission to Argentina. Although this little-known event would not take on the significance of similar peacetime missions in the service's history, the multi-stop expedition of the flight of YB-17 heavy bombers demonstrated the broad potential of a singular show of soft power. While it affirmed American airpower to the United States' neighbors, the mission also served to validate the bombers' capabilities and led to innovations in training and flying. For the Airmen involved, the mission tested their physical limits, matured aircraft commanders, and led to the creation of a small cadre of leaders for the impending conflict, setting the foundation for the future US Air Force.

In the years leading up to World War II, American ally Argentina found itself indirectly caught in the grip of events transpiring in Europe. The South American nation's population included more than 500,000 German settlers. The previous Argentinian administration had developed working relationships with *Wehrmacht* military advisers and purchased German military equipment, including the tri-motor Ju-52 transport.[1] American Secretary of State Cordell Hull later expressed his concerns about the growing influence of regional fascist sympathizers, stating that the "danger to the Western Hemisphere was real and imminent" in its "indirect form of propaganda, penetration, organizing political parties, buying some adherents, and blackmailing others."[2]

Following a request from officials at the US State Department to send a flight of bombers to Argentina for the presidential inauguration, Secretary of War Harry H. Woodring refused the mission, citing high operational costs. Yet his deputy, Assistant Secretary Louis A. Johnson, recognized the potential value in the expedition, and unbeknownst to Woodring, he met with President Franklin D. Roosevelt, who approved the mission.[3]

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1. Richard L. McGaha, "The Politics of Espionage: Nazi Diplomats and Spies in Argentina: 1933–1945" (PhD diss., Ohio University, 2009), 49.

2. Stetson Conn and Byron Fairchild, *The United States Army in World War II, The Western Hemisphere: The Framework of Hemisphere Defense* (Government Printing Office, 1989), 6.

3. DeWitt S. Copp, *A Few Great Captains: The Men and Events That Shaped the Development of U.S. Airpower* (Double Day, 1980), 406.

In early February 1938, Lieutenant Colonel Robert Olds Sr., commander of the 2nd Bombardment Group (2 BG), received orders from Major General Frank M. Andrews, General Headquarters Air Force (GHQAF) commander, to take a half-dozen new YB-17s to the Argentine capital of Buenos Aires and conduct a flyover at incoming President Robert Ortiz' inauguration on 20 February. Ortiz himself distrusted German diplomats and preferred to strengthen relationships with his northern neighbor.[4]

While the State Department proclaimed it to be a friendly gesture—a "public relations" effort to promote American airpower—the mission served multiple purposes.[5] Although it would reach neither the historical nor political significance of other similar peacetime missions from a decade earlier—such as the 1924 around-the-world flight of four Douglas cruisers or the 1926 Pan American goodwill flight through Mexico and Central America—the 1938 flight was more than a perfunctory, ceremonial operation. The flight of six YB-17 bombers reflected the contentious environment within the War Department as the Army Air Corps struggled with its relevance, attempting to develop its strategic bombing capabilities, procure and test new weapons, and compete for resources in a fiscally constrained environment.

At the service level, for the 2 BG commander, the mission was an opportunity to test a revolutionary weapons platform and its crews and prove its worth to skeptics in the War Department. Adding these new planes to the inventory brought Army planners one step closer to fulfilling Brigadier General William "Billy" Mitchell's vision of a long-range, strategic bomber force—a vision formed in the years following World War I.

The mission also required extensive planning, promoting civil-military relations in regions with little to no American military presence. For civilian and uniformed leaders in Washington and Langley Field, Virginia, it was an opportunity to demonstrate American soft power using military hardware, by confirming the United States had the ability to protect its interests in the Western Hemisphere, including the strategically vital Panama Canal Zone (PCZ). In the context of increasing military aggression by Germany and Japan, the mission held an important strategic purpose: "Franklin Roosevelt was sending a message to Berlin and Tokyo: the United States had the most advanced, state-of-the-art bomber in the world with a capacity to fly long distances."[6] Although it occupies a relatively small corner in Air Force history, the Argentine expedition provides insight into how a single airpower mission conveyed multiple messages to a wide-ranging audience.

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4. McGaha, "Espionage," 61.
5. Walter Kozak, *The Life and Wars of General Curtis LeMay* (Regnery Publishing, 2009), open source, 20, https://archive.org/.
6. Kozak, *Life and Wars*.

Receiving the Mission

At age 41, Olds was a seasoned aviator, earning his wings in 1918 and graduating from the Air Corps Tactical School in 1928. As a captain, Olds served as an aide to Mitchell and later as the chief, inspection station, under Andrews at GHQAF. He understood the mission's importance and the training opportunity it offered as well as its aims—"to accomplish a Good Will flight to Buenos Aires, Argentina," to complete "visits of courtesy to the Republics of Argentina, Chile, and Peru," and to "test the mettle of our sleek Flying Fortresses, greyhound of military aviation."[7][8]

Pilots and aircrews had less than a year of experience with the new YB-17 bomber, the first one having arrived at Langley Field in March 1937. Olds and his crews flew the aircraft relentlessly after its arrival. By January 1938, the men of the 2 BG had traveled 679,000 miles and spent more than 141 hours in the air. The Buenos Aires undertaking, however, marked the longest single goodwill mission for the Army Air Corps and required the crews to continuously operate for unprecedented periods.[9]

The four-engine heavy bomber remained in a testing stage and was not approved by War Department officials for full production. To many senior officers in Washington, the "Flying Fortress"—a term coined by a *Seattle Times* writer—was an expensive and dangerous platform. The Boeing product cost $302,000 per unit, vastly exceeding the costs of contemporary twin-engine bombers such as the B-10B at $72,000 and the B-18 at $105,000.

For aviators such as Andrews and Olds the capabilities provided by the YB-17 were worth the cost. The Boeing system carried a normal 2,500-pound (lb.) payload—maximum payload was 10,400 lb.—more than 2,260 miles with a top speed of 295 miles per hour (mph) while cruising at 217 mph. Its twin-engine contemporary, the Douglas B-18 Bolo, carried 4,000 lb. of bombs up to 1,100 miles with a maximum speed of 167 mph. The Flying Fortress design included an auto-pilot feature and five machine gun mounts for self-defense. The four-engine design provided power that generated the aircraft's speed and ability to carry a larger bombload over greater distances than its contemporaries, including the Japanese Mitsubishi G3M "Nell" or the Luftwaffe's Heinkel 111, both in active combat service in China and Spain, respectively.

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7. Robert Olds, "Our Flight to South America," *Popular Aviation*, August 1938, reprinted by the Vintage Aircraft Association, 19 April 2018, https://eaavintage.org/.

8. "Major General Robert Olds," US Air Force [USAF, website], accessed 29 January 2025, https://www.af.mil/; and Charles A. Ravenstein, *The Organization and Lineage of the United States Air Force*, USAF Warrior Studies (Office of Air Force History, 1986), 6.

9. "Army and Navy: Friendly Fortresses," *Time*, 28 February 1938, https://time.com/.

The speed and armament gave the YB-17 unique defensive capabilities, and the airframe's rugged design allowed crews to operate it at primitive airfields, enabling its strategic reach. The bomber's range also made it useful for coastal anti-ship patrols and shoreline defense, a critical mission during the Army's Interwar era (1919–1939). The YB-17 was the only Army Air Corps aircraft with the capability to reach Hawaiian shores from the continental United States.

The ambitious Argentinian mission would push the men and their machines to their limits. In addition to the normal pre-, mid-, and post-flight crew requirements, the colonel directed his officers to follow an exhaustive social schedule during the multi-stop exercise. Officers including Captain Robert Travis of the 49th Bombardment Squadron—who later commanded the 2 BG during World War II—understood the intense pressure placed on the group: "We knew if a YB[-17] was crashed, we could probably say goodbye to the Nation's bomber program."[10] Even a young officer such as Travis recognized that any major damage to the platform or any fatalities would lead to the capability's eventual elimination.[11]

Planning the Mission

Olds exemplified the timeless, dual nature of a successful unit commander. While he clearly understood the strategic nature of the mission, at the tactical level he used the opportunity to develop individual Soldiers and build cohesion among his aircrews. Olds selected some of his most seasoned pilots and tasked his squadron commanders to command individual planes (table 1). A reporter from the *Air Corps Newsletter* noted these efforts in March 1938, that "every airplane was manned by its regularly assigned crew; and no substitution of 'specially qualified' men were made."[12]

While flying was the officer's primary focus, the mission's complexity required staff and flight planning, including weather assessment, logistical coordination, and other basic unit functions. Olds expected all officers—except for aircraft commanders—to perform their staff duties as they pertained to the mission in addition to their role on the aircraft.

In addition to the commissioned officers—command pilot, co-pilot/engineer, bombardier, and navigator—each crew included two enlisted radio operators and a pair of mechanics. Table 1 illustrates how the group commander delegated non-flying responsibilities to the men in his command.[13] Officers performing piloting duties did not receive additional duty assignments.

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10. Edward Jablonski, *Flying Fortresses: The Illustrated Biography of the B-17s and the Men Who Flew Them* (Doubleday, 1965), 13; and "Brigadier General Robert F. Travis," USAF, accessed 8 January 2025, https://www.af.mil/.
11. Jablonski, *Flying Fortresses*, 13; and "Brigadier General Robert F. Travis."
12. Information Division, Air Corps, "Argentine Flight Proves Excellent State of Training in the GHQ Air Force," *Air Corps Newsletter* XXI, no. 5 (1 March 1938): 4, https://media.defense.gov/.
13. 2 BG, "Plan for 2 BG," 1–2.

Table 1. Task organization chart of 2nd Bombardment Group February 1938 flight to Argentina[14]

Grp A/C Num	A/C Num	Crew Size	Sqdn	Pilot	Co-Pilot	Additional Duty (Co-Pilot)
10	36-155	9	HQ	Olds, Robert, Lt Col*	McReynolds, Edwin R., Maj	S4/Engineering
51	36-156	8	20th	Meloy, Vincent J., Maj†	Harvey, Alvin L., Capt	N/A
52	36-159	8	20th	Harding, Neil B., Capt	Gibbs, David R., 1st Lt	S2 (Intelligence)
80	36-151	8	49th	Haynes, Caleb V., Maj†	Mosley, Thomas L., 1st Lt	Asst. S4/Eng
82	36-158	8	49th	Smith, Archibald Y., Capt	Cousland, Cornelius, Capt	S1/Finance
61	36-153	8	96th	George, Harold L., Maj†	Alkire, Darr H., Capt	N/A
Total Personnel		49				
Other officers with additional duties: Capt Robert B. Williams (S3 [Operations], HQ Sqdn, A/C 10); 1st Lt Curtis LeMay (Asst. S3 [Operations] 49 BS, A/C 80); 1st Lt Edwin L. Tucker (Communications, HQ Sqdn, A/C 10); 1st Lt Richard S. Freeman (Mess and Billeting, 49 BS, A/C 82), and 1st Lt Torgils G. Wold (Metro Service, 20 BS, A/C 51)						
Key: * Group commander † Squadron commander						

14. 2nd Bombardment Group (2 BG), "Plan for 2nd Bombardment Group Flight to Buenos Aires, Argentina and Return, February 11, 1938" ["Plan for 2 BG"], 1–2, 2 BG History Supporting Documents, 1938, Air Force Historical Research Agency [AFHRA], Maxwell Air Force Base, Alabama.

The group commander used the opportunity to test individual stamina. For example, he assigned individual navigators to three ships and pairs of navigators to each of the others. Olds was curious about the effects of sleep deprivation and how it affected the navigator's job, which required use of multiple instruments, precise calculations, and great attention to detail to help determine the aircraft's course and location.

Olds also established standard procedures for the flight, including a pre-flight checklist, written on a 6 x 8-inch card for each crew member. He hoped that this method would help avoid the tragic oversight that had resulted in the deadly crash of the Boeing Model 299 during a demonstration flight in October 1935.[15] Other standing orders noted that his "flagship" plane—emblazoned with the number 10—would be the first to take off and land, the exception being another aircraft in distress that needed to land first. Planes would take off at three-to-four-minute intervals to create about 10 miles between the aircraft when aloft. Each aircrew received the responsibility for navigating to the assigned destination. Olds directed his ship personnel to radio airfield departures, hourly position reports, and any changes of course. Once 25 to 30 miles from the destination, the armada would converge and fly into the airport as a group.[16]

Navigation planners relied on a variety of maps including ones found in *National Geographic* magazine and specialized versions published by the Navy Department's hydrographic office that contained information on the coastlines. The 2 BG's flights to and from Buenos Aires also required considerable civilian support. The massive nature of the mission, covering more than 11,000 miles and two continents—including areas with no American military presence—required an extensive logistical network beyond the contemporary capabilities of the Army Air Corps. Personnel and support from Pan-American Grace Airways, known as Panagra, provided additional data on Central and South American locations. Panagra, which offered flights between the North and South American continents including the Panama Canal Zone, staffed and operated airfields complete with the logistical capabilities required to maintain flight operations and regional communication platforms. Olds and his staff also coordinated with other regional civilian aviation companies to furnish such critical capabilities.

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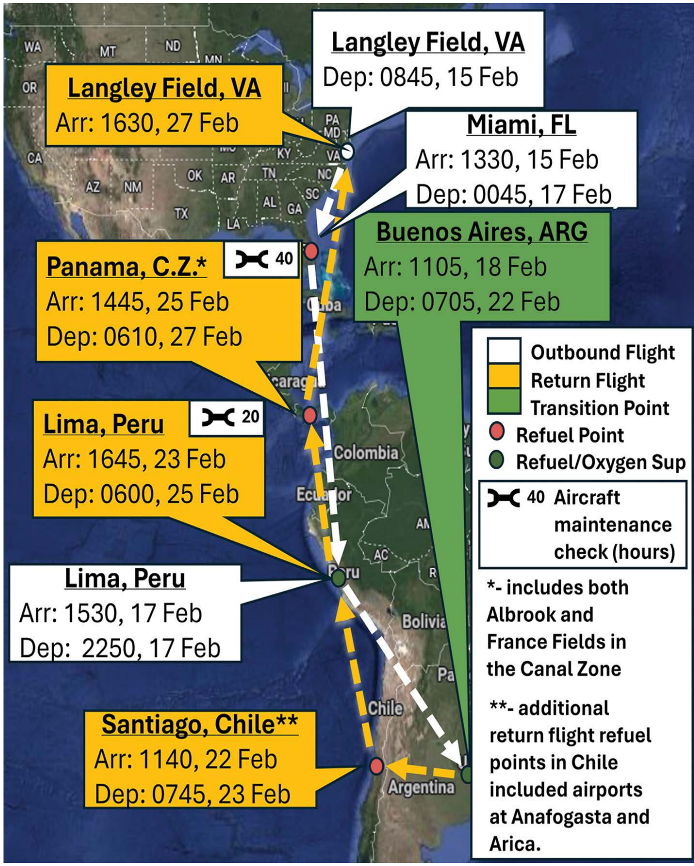
15. Irving Brinton Holley Jr., *Buying Aircraft: Materiel Procurement of the Army Air Forces*, United States Army in World War II Special Studies (US Army Center of Military History, 1964), 142; and Maurer Maurer, *Aviation in the U. S. Army, 1919–1939* (Office of Air Force History, 1987), 354.

16. 2 BG, "Good Will Flight to South America and Return, March 10, 1938" ["Good Will Flight"], 2 BG History Supporting Documents, 1938, 11, AFHRA.



Start	Dest.	Ditance (miles)	Flt Time (Hr: Min)	Avg Speed (mph)
Langly Field, VA	Miami, FL	814	5:45	N/A
Miami, FL	Lima, Peru	2,644	14:35	195.5
Lima, Peru	Bueno Aires, ARG	2,278	12:1	186
Bueno Aires, ARG	Santiago, Chile	810	4:35	175
Santiago, Chile	Lima, Peru	1,575	9:00	175
Lima, Peru	Albrook Airfield, C.Z.	1,556	8:45	178
France Field, C.Z.	Langly Field, VA	1,975	10:20	191
Total		**11,562**	**65:25**	**183.4**

Figure 1. Flight plan information for 2nd Bombardment Group Argentina flight[17]

17. "Pan American-Grace Airways Panagra, Timeline: 1928–1949," Braniff International Airways [website], accessed 6 February 2025, https://www.braniffinternational.com/.

The mission required an extensive air and ground radio network, incorporating military and civilian capabilities. Group communications officer 1st Lieutenant Edwin Tucker created or integrated three networks. An air-to-air version enabled communication between the aircraft commanders and crews. For military air-to-ground, operators from the 2 BG contacted Army stations at Langley Field, Miami International Airport, and airfields in the PCZ. For communications in South America, the aviators relied on a series of 19 communication stations operated by Panagra and Panair do Brasil, or Panair. These private companies had the only interconnected aviation radio systems in South America. Non-military transmission locations proved critical due to the lack of American military or civilian infrastructure in the region. The extensive communications network required for the mission exemplified US military and regional civilian cooperation and helped strengthen diplomatic bonds between the hemispheric neighbors.[18]

Mission Execution

The mission would begin with a short hop from Langley to Miami, Florida. The flight complement would rest there, then ready their aircraft for the flight to Lima, Peru. After a two-day stay, the formation would head for Buenos Aires. Following a few days in the city, the fleet would depart and fly over the high elevations of the Andes Mountains to Santiago, Chile, where they would overnight. The flight path would then take the group north back to Lima and then to the PCZ with stops at two airfields, Albrook and then France Field, where ground personnel would prepare the flight for its final leg back to Langley. The plan identified 25 contingency fields throughout South America for emergency landings due to mechanical or medical issues.[19]

Figure 1 provides an overview of the roundtrip mission to Buenos Aires, including the mileage and flight hours. It also includes refueling stops, oxygen resupply, and aircraft maintenance locations. What the diagram does not show is the varying weather patterns that aircrews had to contend with, especially in the equatorial areas.

On Tuesday morning, 15 February 1938, Olds initiated the expedition by angling the nose of the No. 10 Flying Fortress off the runway at Langley Field. The six-ship flight reached their first stop, Miami International Airport, that afternoon. The stop began what became a regular routine for air and ground crews—post-operations checks, fuel and oil replenishment, flight planning, and if time permitted, rest.

Following a day in the "Sunshine State," just after midnight the planes departed for the longest segment of the mission, more than 2,640 miles in a single hop. The segment tested the aircrew rest plans, which Olds had established during pre-trip planning, calculating that an aircrew could fly a maximum of 10 hours before needing a break. The bombardier (assistant navigator) served as the officer relief in a three-hour rotation system. He switched out with—in order of precedence—the navigator, co-pilot (engineer), and the aircraft

18. 2 BG, "Enclosure 2: Communications Plan," 1, in "Plan for 2 BG."
19. 2 BG, "Fields South of Panama," 1–2, 2 BG History Supporting Documents, 1938, AFHRA.

commander (pilot). The group commander expected navigators without assistants to work as much as physically possible. [20]

Reports of severe weather between Central and South Americas forced the fleet to increase altitude and divert westward out to sea. Olds' ordered his aircrews to employ their ships' oxygen as their adjusted altitude averaged around 17,000 feet. More than 14 hours later, after regaining their original course, the YB-17 group arrived in Lima. A few hours before approach, Plane No. 51, piloted by Major Vincent J. Meloy, encountered problems with a propeller governor, which created a severe aircraft vibration. Yet despite this, Meloy was able to bring the aircraft into the Panagra field with the rest of the fleet.[21]

At the first international stop in the flight, host nation representatives greeted the weary flyers. Following standard ground operations, including receiving more than 13,100 gallons of fuel, the aviators readied their birds for liftoff in seven hours. Olds directed the crew of A/C No. 51 to remain in Lima, repair the defective engine governor, and then rejoin the others in Buenos Aires. Since the YB-17 remained in a pre-production status, repair parts were not widely available, forcing aircrews to stock their bombers with available replacement components and create an organic maintenance capability.[22]

Navigators kept the pilots on the 2,278-mile southwestern course that took the bombers through a pass in the Andean Mountain Range enroute to El Palomar Airfield in Buenos Aires. Shortly after 1100 hours, 18 February, the fleet began landing.

The new aircraft posed their own unique challenges to the operators. Major Harold George, flying A/C No. 61, received priority authorization to land due to a problem with one of the engine's exhaust collector rings. He brought the aircraft in at 1130, followed by Olds and the others. In the meantime, Meloy and his crew departed Lima that morning after replacing the governor. The 2 BG's arrival in Argentina became the first in a series of stops that merged military with formal diplomatic functions.[23]

The aviators were met by American officials—including the US ambassador to Argentina Alexander Weddell—and members of the Argentinian government. Unlike at Lima, however, limousine drivers chauffeured the officers to the Alvear Hotel in Buenos Aires while the enlisted crew members remained at the barracks on El Palomar Airfield. Although an integrated group when aloft, the group commander preferred to maintain the customary separation between officers and enlisted men in his billeting plan. Olds' standing orders required an enlisted crew member to remain onboard the parked aircraft at each stop "to cope with any unforeseen circumstances [such] as fire," except for the PCZ airfields.[24]

In the early evening of 18 February, a limousine containing Weddell picked up the group commander and took him directly to Ortiz' residence. In his role as an unofficial uniformed diplomat, Olds presented the Argentinian leader a letter from Roosevelt in

20. "Good Will Flight," 12, 33.
21. Olds, "Our Flight"; and "Good Will Flight," 2.
22. "Good Will Flight," 3.
23. "Good Will Flight," 3.
24. "Good Will Flight," 7.

which the US president expressed his hope that the United States and Argentina would "continue to cooperate efficaciously and wholeheartedly for the preservation of peace" as well as "his earnest desire in the furtherance of a constructive and fruitful policy of inter-American cooperation."[25] The combination of the note from the American commander in chief and the presence of modern, long-range strategic bombers clearly indicated US support for Ortiz and his stand against fascism.

This stop marked the transition of the Army pilots, navigators, and bombardiers to diplomats, manifesting in the change of their duty uniforms from olive drab green flight gear to white service caps, dress coats adorned with gold aviator's wings, and black pants. The aircrew found their post-operation itineraries filled with receptions at the Argentinian officers' club and American and British embassies, an afternoon at the horse races, and other social events.[26]

Ground crews from the 2 BG tracked A/C 51's flight and recommended an auxiliary airfield to the ship commander due to the worsening weather. The situation was emblematic of Olds' leadership in that it ensured support for his aviators and crews but at the same time allowed them to mature through navigating difficult situations. On Friday afternoon, Meloy and A/C 51 safely landed at El Palomar Airdrome despite a driving rainstorm.

On Sunday, the four-engine fleet took to the skies flying over Buenos Aires during the inauguration festivities. As planned, American bombers successfully celebrated Ortiz' presidency as an affirmation of democratic rule, acting as "the bearers" of Roosevelt's message of peace.[27] The event, described by *The New York Times* as a "colorful ceremony amid widespread popular acclaim," highlighted Argentina's status as a friend and ally of the United States.[28]

On the next day, President's Day, crews prepared for the return trip north. At El Palomar ground personnel loaded gas and oil into the six aircraft for the flight's next leg, and Panagra staff replenished the fleet's oxygen supplies.[29] Olds then led his YB-17 formation westward in an 810-mile flight to Santiago, Chile, minus one aircraft. When moving across a concrete ramp in Buenos Aires, the wheel on the right landing gear of A/C No. 82, piloted by Captain Archibald "Archie" Smith fell through an unsupported manhole cover.

By lunchtime all five bombers were on the ground in Santiago. Once more American and host nation officials rolled out the diplomatic welcome mat to the travelers. Argentinian ground crews used railroad jacks to free Smith's aircraft following a three-hour ordeal. He

25. Special to *The New York Times*, "Roosevelt Urges Amity in Americas," *The New York Times*, 22 February 1938, https://www.nytimes.com/.

26. "Good Will Flight."

27. Special to *The New York Times*, "Roosevelt."

28. John W. White, "Ortiz Inaugurated amid Wide Acclaim by the Argentines," *The New York Times*, 21 February 1938, https://www.nytimes.com/.

29. "Good Will Flight."

landed A/C No. 82 later and rejoined his fellow officers at their hotel lodging; the enlisted Soldiers stayed at a separate hotel nearby.[30]

On the 23rd, Flagship No. 10 lifted off from the airport in Santiago and proceeded on a northward course that parallelled the Chilean Coast and ended in Lima. Once again, the flight was short by one aircraft. Aircraft 82 had a broken starter on one of its engines. Olds directed Smith to fly to Arica—almost two-thirds of the way between Santiago and Lima—and remain there overnight after completing repairs since the Lima airport did not have night operations capabilities.[31] Smith landed in Arica, and he and his men quartered in civilian billets there. Meanwhile, by late afternoon that same day, the five-ship flight had touched down in Lima. Olds had his crews conduct 20-hour checks prior to the flight's return legs. The officers and enlisted checked into separate hotels for their overnight stay.

At noon on the 24th, Smith brought No. 82 into Lima. Olds' original plan was to depart that morning, but he shifted the timeline 24-hours to the next morning to allow Smith to rejoin the flight, to give his personnel more rest time, and to "pay the customary calls of courtesy" to senior Peruvian officials. Following the maintenance checks and filling the fuel and oil tanks, the YB-17s departed at 0600, 25 February.[32]

The group headed on a 1,556-mile flight to Albrook Field in the PCZ. The aircraft arrived in the American possession just after 1500. After they landed, the PCZ Governor Clarence S. Ridley and American officers greeted the crews as they deplaned. The commissioned personnel stayed with their permanent party counterparts and the enlisted men rested at the airfield barracks.

On the morning of the 26th, the heavy bombers departed Albrook for France Field, located more than 30 miles away on the northern side of the isthmus.[33] Once there, Olds directed his aircrews to perform 40-hour maintenance services. Ground crews once more topped off the fuel tanks and oil for the final 1,975-mile push to Virginia.[34]

Aircraft No. 10 ascended into the early morning Panamanian sky at 0610 on Sunday, 27 February. During the journey, including the final "leg" to Virginia, Olds directed his navigators to employ dead reckoning to ensure the aircraft remained on course. In this complex technique, the navigator combined multiple variables such as time, air speed, distance, and direction, and then incorporated adjustments for velocity and windspeed to estimate "the time to arrive at each checkpoint and the destination." The bombers regrouped over Norfolk Naval Station and began landing on Langley Airfield, where Andrews waited to greet them on the tarmac.[35]

30. "Good Will Flight," 8, 35.
31. "Good Will Flight," 4.
32. "Good Will Flight," 8, 17.
33. "Good Will Flight," 5, 7, 12.
34. "Good Will Flight," 5, 12, 17.
35. "Good Will Flight," 5.

In less than two remarkable weeks, aviators and aircrews from the 2 BG flew more than 65 hours in the air, covering more than 11,560 miles. All aircraft returned undamaged—although there was one mishap and multiple engine issues—with no injuries incurred during the mission.

The mission provided an example of a successful military and civilian venture. The lack of US aviation support and communication infrastructure in South America created a reliance on host nation businesses to provide airfield and logistical support, including fuel, oil, oxygen, communication stations, and life support facilities that ensured the safe passage of Olds' fleet.

The YB-17's range ensured that even without local airfields and support the bomber had the ability to reach northern South American countries including Peru, Ecuador, Colombia, and Venezuela through use of PCZ bases. Olds made radio addresses in Lima, Buenos Aires, and Santiago as part of the mission's strategic messaging campaign. The plane and the commander of A/C 10 caught the attention of foreign officers, including representatives from the British Royal Air Force (RAF). RAF Air Attaché Air Commodore T. E. B. Howard remarked that the YB-17 "looks most impressive and gives one an interesting idea of what may be expected in the future." The commodore was also "impressed with the demonstrations of flying in various formations by the B-17 bombers under Colonel Olds' leadership."[36]

The flight left its mark on local citizens as well, signaling the extent of American airpower. In Lima, for example, *The New York Times* reported that "the airport and surrounding lawns were packed with onlookers as the giant bombers descended from the skies." The crew was greeted with much pomp and fanfare, while the event was lauded as "the first time the Peruvian public had been able to see aircraft the size of the B17 bombers."[37] A reporter from the Peruvian newspaper *El Comercio* praised "the technical knowledge of North American aviation and the skill of its pilots."[38]

Senior American military and government officials also commended the United States for the mission's success, noting how it served as "proof of the definite value of long-range bombers for national defense."[39] For example, Chief of Staff of the US Army (CSA) General Malin Craig hailed Olds' mission as "a demonstration of speed, range, and navigational accuracy unexcelled by any military planes in the world." The CSA later escorted Olds to the White House for a personal audience with Roosevelt.[40]

For leading the expedition, Olds received the Distinguished Flying Cross and the Mackay Trophy. The 1912 award recognized "the most meritorious flight of the year by

36. Copp, *Captains*, 391.

37. Special cable, "Lima Crowds Hail 'Flying Fortresses,'" *The New York Times*, 18 February 1938.

38. Associated Press, "U.S. Flyers Reach Buenos Aires After Perfect Hop over Andes," *The Evening Star*, 18 February 1938, https://chroniclingamerica.loc.gov/.

39. Scottie L. Zamzow, "Ambassador of American Airpower" (master's thesis, Air University, 2008), 45.

40. Associated Press, "U.S. Flyers"; and Zamzow, "Ambassador," 44.

an Air Force person, persons, or organization."[41] At the awards ceremony, the secretary of war and Army officials honored the 2 BG as a whole: "All 49 men were saluted for their high degree of skill in pilotage and navigation in accomplishing the 10,000-mile [*sic*] mission."[42] On a broader scale, the Air Force would later deem the 2 BG mission to be one of the "great expeditions of the first generation of human flight."[43]

Aircraft Design

In addition to its sociopolitical impacts, the Argentinian expedition provided valuable feedback on the YB-17 as a strategic weapon. Olds' notes on the machine included his assessment of interior design—particularly the navigator's area—the engines and durability, and 72-hour repair kits, which contained 113 different line items of parts and an additional 217 "D. P. stock" items for self-sustainment.[44]

Olds' main concerns for the navigator's duties were cabin size and the observation hatch. The work area for these specialists contained a chair, a desk, and a bunk area that permitted navigator teams to rest. Yet it lacked storage for instruments, and the desk was too small for the charts. Its location along a central gangway also meant periodic interruption from transiting crew members. The YB-17's design also included an observation hatch that prevented the navigators from making low observations behind or in front of the plane. When opened during flight, the hatch caused unsecure documents to fly out of the cabin. Finally, the design of the gun blister, which navigators used to take readings, prevented the observer from viewing a "body low on the horizon," while the poor-quality glass caused refraction errors. To address these issues, Olds recommended a larger desk, storage, and work areas for the navigator and a better designed hatch with "ground plate glass to permit accurate observations."[45]

Although three of the aircraft encountered engine issues, Olds concluded that the "engines, and accessories withstood admirably, a grueling test conducted at remote distances from normal sources of supply and maintenance."[46] He also noted that the durable YB-17 could operate from the same remote airfields as its smaller rival, the twin-engine B-18, needing only two-feet of "top crust . . . over an unstable base influenced by tidal action."[47]

While Olds confirmed that the 72-hour part kits and additional repair items proved adequate for the two-week mission, a bit of luck factored into the aircraft returning as a

41. "Good Will Flight," 12; and "Clarence H. Mackay Trophy," National Air and Space Museum, accessed 6 February 2025, https://airandspace.si.edu/.

42. *The Air Force Story: Chapter VI, Prelude to War, 1937–1939* (Department of the Air Force, 1953), https://archive.org/.

43. *Air Force Story*.

44. 2 BG, "Kit: Airplane Engineering 72-Hour Maintenance and Supplies," n.d., 1-4; and "Airplane Type YB-17," n.d., 1-8.

45. "Good Will Flight," 39.

46. "Good Will Flight," 36.

47. "Good Will Flight," 33.

collective unit. In his after-action report, he noted the flight's inability to bring large items such as jacks and spare tires. If an aircraft required such items, "the airplane concerned would have remained in South America until the arrival of supplies from the U.S. by boat."[48] Overall, he praised the efforts by the military and civilian ground crews to keep the aircraft flying. Such collective efforts portended the strong partnerships that would help win the global conflict set to begin in less than two years.

Life Support Aloft

In addition to providing feedback on the machines, the expedition gave insights into the human element, including aircrew physiology and life support. Olds noted that the pilots, co-pilots, and navigators reached the limits of their endurance at the 10-hour mark. The expedition leader cautioned that at altitudes between 10,000 and 15,000 feet, "the lack of sleep was a greater detriment to efficiency than the lack of oxygen."[49] He established a 3-hour rotation that incorporated the bombardier/assistant navigator to ensure adequate rest and safe flying. Due to the navigator's complex role, Olds recommended that an assistant navigator was mandatory and that they work in four-hour shifts. Furthermore, he stressed that an aircrew required a minimum of four officers for long missions or risk "decreasing the capabilities of the airplane by 25%."[50] Oxygen supply and the delivery method were also concerns noted by the 2 BG commander. His long-term solution was the incorporation of pressurized cabins to meet the continual need for oxygen when operating at altitudes greater than 10,000 feet.

Olds also expressed concerns with the contemporary bottle and mask system, particularly when used by specialized crew members such as navigators, who required both hands to do calculations, determine locations, and verify courses on a map. The handheld system required the user to hold a tube to their mouth without biting the tube since that would restrict oxygen flow. One crew member tied the tube under their nose with a handkerchief, which was uncomfortable but freed both hands for work. Olds suggested a new system that fit around the user's head and under their nose, thus allowing for the use of both hands.[51] These observations provided critical feedback to senior Air Corps leaders on life support system modifications that increased both the survivability and efficiency of bomber crews during high-altitude operations.

Robert Olds' Legacy

Olds' leadership made a lasting imprint on the officers and men who flew with him—many later destined for senior positions. As the Air Force would note, the 2 BG mission

48. "Good Will Flight," 35.
49. "Good Will Flight," 38.
50. "Good Will Flight," 33.
51. "Good Will Flight."

roster of the goodwill flight pilots "sounds like a roll call of America's World War II air leaders."[52] Crew included 1st Lieutenant Curtis LeMay, who served as a navigator, describing Olds as "pure gold," with an "exuberance and enthusiasm" that kept "a blaze hot in the hearts and minds of his subordinates."[53] George also spoke highly of Olds, stating that he "had a brilliant mind and with it the capability of grasping all the complexities of a situation and making accurate decisions."[54] In addition to LeMay and George, Meloy and Major Caleb Haynes reached flag officer rank. Olds also helped train a new corps of officers for the impending conflict. The other pilots of the six-ship flight—Smith, Captain Neil "Chick" Harding, Major Cornelius Cousland, and Captain Darr Alkire—all went on to attain the rank of colonel and commanded bomber groups in Europe during the Second World War.

By 1943 Olds commanded the Second Air Force, based at Fort George Wright, Washington. Unfortunately, he did not live to see the end of World War II, his intense work habits and dedication likely affecting his health. He medically retired in February 1943 and checked into the hospital at Davis-Monthan Field in Tucson, Arizona. Olds passed away from a heart-related condition two months after being admitted.

Olds' legacy lived on through the men and machines that he served with. The captains and majors he mentored during the Buenos Aires flight now wore eagles and stars on their shoulders, leading armadas of the platform he helped validate, all while doing their part to help bring the world's largest conflict to an eventual, but as of April 1943, undetermined conclusion.[55]

Postscript

The "Good Will Flight" validated the machines as well as the men of the 2nd Bombardment Group. The YB-17s stayed aloft for more than 65 hours and safely carried their personnel more than 11,600 miles, at altitudes exceeding 20,000 feet. The planes encountered some mechanical issues, but nothing catastrophic.

Designers at Boeing made refinements to the plane based on operational reports from the 2 BG. Four months after Olds' expedition, the War Department placed an order for 38 B-17Bs, approving full production of the bomber. The new model included a turbosupercharger on each engine for greater power and reliability, a redesigned nose to improve bombardier functions, and the addition of a dome on the cabin specifically for navigator use. The first B-model flew in June 1939 and established the foundation for the Air Corps' heavy bomber force. By 1940, Air Corps designers introduced the B-8 oxygen mask that stretched around the wearer's head and covered their mouth and nose. The information

52. *Air Force Story*.
53. Curtis E. LeMay, with MacKinlay Kantor, *Mission with LeMay* (Doubleday, 1965), 132.
54. LeMay, with Kantor, *Mission*, 131.
55. "Olds."

gathered by the 2 BG commander and his aircrews provided critical feedback to senior Air Corps leaders and manufacturers.[56]

In a broad sense, Olds' leadership during the Buenos Aires flight provides an example of maximizing an opportunity. Within the context of a singular peacetime training mission he was able to help enforce regional American policy by "showing the flag," utilizing what many viewed to be an expensive and dangerous weapons platform, while at the same time validating its worth as well as affirming US airpower across the international arena. Perhaps most importantly, he trained and mentored his crews both collectively and individually. Many of these men would come to lead the Army Air Forces to victory during World War II and in the United States Air Force during the Cold War, providing examples for the leaders of the Air Force today.

56. Ray Wagner, *American Combat Planes of the 20th Century: A Comprehensive Reference* (Jack Bacon, 2004).

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