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Rethinking Airpower in the 21st Century

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FROM THE EDITOR

Dear Reader,

A scholarly journal is the historical record of the human mind exploring novel ideas and testing the veracity of those ideas against what has already been imagined and proven or disproven. The final, honed expression of these ideas is the result of a lengthy gestation period that includes reviews by one's peers in the relevant field or fields of study, and then edits from developmental, substantive, and grammar and syntax perspectives, all intended to enhance clarity and excellence in expression.

The other components of a journal such as *Æther: A Journal of Strategic Airpower & Spacepower*—cover, masthead, table of contents, fonts, text placement, and graphics—are the patient, detailed work of expert production professionals and the artistic hand and mind of skilled illustrators. Finally, journals appear online and are promoted on social media due to innovative web designers and marketing experts.

It's a labor of love, intellect, and fine tuning on the part of the authors, but it also represents a deep investment of time and expertise by a number of other professionals. With this in mind, Team *Æther* is proud to introduce its Fall 2024 issue.

As you will read in the following pages, the military forces of the world find themselves in this third decade of the twenty-first century at the dawn of a new era in air and ground domain control, superiority, and supremacy. The war in Ukraine has been a clarion call regarding the role of small, uncrewed air systems in today's battlespace and, if possible, raising more questions than ready answers about the future of combat. As some of the authors here have noted, the US Air Force in particular is looking at the effective end of 70 years of uncontested global air superiority with the tragic death of three service members in January in a Houthi drone attack in western Syria.

In a scholarly vein, this dedicated issue of *Æther* presents a number of curated ideas regarding the future of airpower, and more specifically, what notions of air superiority, air supremacy, and air dominance mean in the near, mid-, and long terms.

The Vice Chief of Staff of the Air Force General James Slife leads the issue, calling attention to the fact that the rise of small, uncrewed air vehicles requires the Air Force to examine and answer the question of how it works with sister services to accomplish the missions that lie ahead. Kelly Grieco and Max Bremer, whose 2021 *Parameters* article first coined the term *air littoral*, argue for open innovation, multiuse technology, and

perpetual vigilance, as well as learning from adversaries' development of new technology, new strategies, and the inevitable failures and weaknesses in combat execution.

Advances in technology and sufficient production require consistent and persistent funding. Jennifer Kavanagh proposes a new business model that prioritizes capabilities over programs and production at scale with a workforce equipped to perpetually upgrade systems and software. Michael Kreuzer then moves the discussion to the underlying assumptions themselves: namely, what is airpower today, and crucially, do we need airpower to win? Asked differently, does air superiority guarantee victory in a battlespace increasingly fought at the level of the air littoral? These questions beg another, raised recently by Nora Bensahel and David Barno—whither the Air Force itself?

David Giffen picks up this thread, calling for the Army to be assigned ownership of the key terrain of this horizontal and vertical liminal space—the air littoral—thus providing ground force commanders the capabilities and authority to successfully execute combat operations. Indeed, the liminality of this space is key. Branden Gulick concludes the dedicated issue with an exploration of notions of irregular warfare and complexity as methods to rethink the air littoral, which is at once a cognitive and physical space.

As always, on behalf of Team *Æther*, thank you for taking the time to read our dedicated issue. If you find the ideas presented herewith useful or you find them wanting, please feel free to submit a well-reasoned and researched response for publication consideration.

~The Editor

AIRPOWER AT ANY SCALE

General James C. Slife
US Air Force

The scaled-down forms of airpower—small uncrewed vehicles in particular—can no longer be seen as a nuisance or a tax but should instead be seen as an ecosystem with both defensive requirements and offensive potential. The possibilities of these new capabilities drive us toward another key question: How can airpower work together with our sister services to achieve victory together?

On January 28, 2024, the United States Air Force lost its 70-year claim that no American has been subject to air attack, when an Iranian-backed uncrewed aerial system (UAS) killed three American service members.[1] One hundred thirty days later, Ukraine claimed the world's first kill of a fifth-generation fighter using another UAS deep in Russian territory.[2][3] This strike reprised another Ukrainian success two years prior, when a Bayraktar UAS reportedly played a key role in the sinking of the Russian cruiser *Moskva*.[4] One event might be a fluke, but two is a pattern, and three demands action. These scaled-down forms of airpower can no longer be seen as a nuisance or a tax but should instead be seen as an ecosystem with both defensive requirements and offensive potential.

Changes in technology upend our comfortable ways of doing business, and combat advantages those who can capitalize on these changes. Prior to World War II, Germany harnessed wireless communication to integrate tanks and airpower in the Blitzkrieg and harnessed the Spanish Civil War as a proxy war to perfect these concepts

General James Slife is the Vice Chief of Staff of the US Air Force.

1. C. Todd Lopez, "3 U.S. Service Members Killed, Others Injured in Jordan following Drone Attack," January 29, 2024, US Department of Defense (DoD), https://www.defense.gov/.

2. Brad Lendon, "Ukraine Says Deep Drone Strike Destroys Rare Russian Su-57 Stealth Fighter," CNN, June 10, 2024, https://www.cnn.com/.

3. Justin Bronk, Royal United Services Institute (RUSI), "Damaged Su-57 Emphasises the Vulnerability of Russian Airbases near Ukraine," June 28, 2024, https://www.rusi.org/.

4. David Hambling, "Ukraine's Bayraktar Drone Helped Sink Russian Flagship Moskva," *Forbes*, April 14, 2022, https://www.forbes.com/.

and technologies.[5] As a rising revanchist power, Germany was able to navigate institutional change; on the backdrop of success, organizational change is slower and more difficult, as demonstrated in the US Navy's adoption of airpower.

At first glance, the attack on Pearl Harbor seems an indictment of the Navy of the time, but this reading is simplistic and incomplete. The Navy had long been studying the role of aviation in maritime war, conducting war games and making investments in order to field naval airpower alongside the battleship.[6] Therefore, the force was prepared when the Pearl Harbor attack shifted the Navy to a carrier-centric force literally overnight. Without the pioneering work done by Admirals William A. Moffett and Harry E. Yarnell in the interwar period, it is difficult to imagine how that force could have achieved the successes at the Coral Sea and Midway.

We Airmen must ask ourselves, "Is this our battleship moment?" Just as the pioneers of naval aviation were able to imagine complementary forms of seapower and adopt them into their force, we must do the intellectual and organizational work required to weave these disruptive technologies into our understanding of airpower. Are we pursuing sixth-generation air superiority capabilities, or only a sixth-generation aircraft? Our force cannot responsibly bet that we will have the time and space to recover from getting this one wrong, especially when there is so much evidence available. Conversely, if our force pioneers disruptive change, our strategic competitors will find themselves at risk of operational surprise and thereby be deterred.

There are good reasons to fear such a surprise. Small uncrewed vehicles played an outsized role in offsetting Russia's massive overmatch in Ukraine, turning a three-day operation into a two-and-a-half-year stalemate. Over the course of one week in Avdiivka, the Ukrainian "Army of Drones" claimed 428 Russian military vehicles, obliterating a motor-rifle brigade's worth of equipment and accounting for 53 percent of all destruction for the entire force during that time period.[7] In order to cross the Dnepr River during the Kherson Offensive, the Ukrainians first hunted the pilots of adversary small-UAS (sUAS) and destroyed enemy jammers, then interdicted Russian supply depots and reinforcements, and lastly provided fire support to Ukrainian marines. Longer-range UAS provide Ukraine a means for strategic attack against long-range bomber airfields and oil refineries, offsetting Russian volleys of Shahed UAS used as terror weapons.[8]

These are airpower missions: suppression of enemy air defenses, interdiction, close air support, strategic attack, and even offensive counter-air. The effects simply arrive in a smaller, often distributed, format. In the difficult opening phases of World War II, the British Special Air Service conducted offensive counter-air from jeeps, burning

5. Andrei A. Kokoshin, *The German Blitzkrieg against the USSR, 1941* (Cambridge, MA: Harvard Kennedy School, Belfer Center for Science and International Affairs, 2016), https://www.belfercenter.org/.

6. *American Heritage*, s.v., "Early Warning," by Thomas Fleming, accessed July 1, 2024, https://www.americanheritage.com/.

7. Iryna Voichuk, "'Army of Drones' Project's UAVs Hit 428 Pieces of Russian Equipment in One Week," Euromaidan Press, October 16, 2023, https://euromaidanpress.com/.

8. David Axe, "Ukrainian Drones May Have Flown a Record 1,100 Miles to Target Russian Bombers at Their Northern Base," *Forbes*, July 27, 2024, https://www.forbes.com/.

Stukas on the ground.[9] This small-scale airpower is our generation's Lewes bombs, an asymmetric means to use otherwise-denied airspace and offset our adversary's growing strength in the air. We must not allow ourselves to be "affixed by our prefix," only seeing the future fight through the lens of our past platforms. If it operates in the air domain, it is airpower.

While the character of war changes with technology, its nature remains the same. Even as the forms of airpower change, airpower functions remain evergreen. Judging by those functions, these denizens of the so-called air littoral undeniably qualify as airpower and fit well under the basic principles set forth by a few great captains a century ago.[10] Small-format airpower does not replace the stalwart technologies of traditional aircraft but serves as a necessary complement and an incompatible problem for an adversary.

Ukraine demonstrates the value of an air war inside an air war, and while not all technologies and tactics translate between theaters, some surely do. The Russians have quickly adopted these technologies—with no shortage of help from the Iranians—and our competitors in the Pacific are quickly adapting to these technologies on both offense and defense. We do not have a choice whether or not to observe these lessons, but we do have a choice whether or not to learn. Our adversaries have already made their choice, and it behooves us to pay attention.

In this challenge there is great opportunity. In World War II, the US Army Air Forces produced more than 35,000 heavy bombers—seven times our entire current fleet in bombers alone. There are few better expressions of mass in warfare than the wings of the Eighth Air Force thundering in combat box formation.[11] Exponential growth in the cost of aircraft compelled the Air Force to turn away from mass in the Cold War, and our force lost the art of commanding truly large numbers of forces. Now, with capabilities that traverse the trade space between platforms and munitions, affordable large-scale production runs are within our reach. Mass is back. Let us imagine what we might do with it as Airmen.

Culture and strategy go hand-in-hand, and the cultural implications of these technologies are profound. During World War II, aircraft were relatively simple, comparatively low cost, and accessible to most Airmen. Since the Cold War, the complexity of aircraft increased exponentially, driving higher costs and smaller fleets. As a result, the physical expressions of airpower have become more distant from an Airman's day-to-day life. Small-UAS technology reverses this trend by democratizing aviation, providing an opportunity for every Airman to gain a practical understanding of airpower principles.

Perhaps, just as every Marine is a rifleman, every Airman might learn to employ small-format airpower in the course of their professional training. Beyond building a culture of

9. Ben Macintyre, *Rogue Heroes: The History of the SAS, Britain's Secret Special Forces Unit That Sabotaged the Nazis and Changed the Nature of War*, 1st ed. (New York: Crown, 2016).

10. Dewitt S. Copp, *A Few Great Captains: The Men and Events That Shaped the Development of U.S. Air Power* (McLean, VA: Epm Pubns Inc, 1989).

11. "'Combat Box': Bomber Formations," National Museum of the United States Air Force, accessed July 1, 2024, https://www.nationalmuseum.af.mil/.

"air mindedness," there is direct combat utility here: organic surveillance and strike capabilities would provide clear value in an agile combat employment environment.

The strategic implications of these technologies are equally expansive. Prior to the arrival of these technologies, authoritarian regimes boasted a comparative advantage in using mass, since large volumes of low-cost mass resulted in high loss rates. They were far less sensitive to casualties, so they could deploy and lose large volumes of lower quality hardware, so long as there was more grist for the mill. With large numbers of affordable, automated platforms, free nations can now respond in kind. Moreover, in World War II the US Army Air Forces' response to Axis terror weapons was to convert "war-weary" B-17s into UAS cruise missiles designed to target the V-1 and V-2 launch sites.[12] Today's automation might similarly provide a means to conjure new capabilities with the kit we already have in the cupboard.

From a defense industrial base perspective, these technologies rekindle the forges of the "arsenal of democracy" by unleashing the military potential of the civilian production base. Due to the highly specialized nature of advanced aircraft, traditional aerospace companies cannot affordably retain surge capacity or easily repurpose civilian production lines. There will always be a need for these exquisite forms of airpower, but the Collaborative Combat Aircraft and Enterprise Test Vehicle are meant to open up a broader allied defense industrial base through dual-use technologies and commercial production processes.[13] Ukraine was able to rapidly repurpose large swaths of its industrial sector toward producing this small-format airpower. The rapidly growing commercial market for sUAS provides a formidable strategic industrial reserve—that is, if we are able to harness and employ these technologies effectively in the air fight.

Mass is not the only hand that can be played with these capabilities. The air littoral provides a space for skirmishing strategies, where relatively inferior capabilities can create disproportionate effects against superior forces through diversions and harassment. Despite losing every single aircraft, the Doolittle Raid was an operational success because it forced a long-term and low-value commitment of Japanese fighter forces to the homeland.

Similarly, Colonel Phil Cochran's and Colonel John Alison's Air Commandos tied down larger adversary formations through a long-term skirmishing strategy. In classic battles of antiquity, weaker forces have vexed and even defeated larger forces through the clever choice of terrain and timing—in particular, the Battle of Leuctra (371 BCE), where Theban peltast skirmishers prevented the main body of the Spartan force from engaging. This allowed the Theban phalanx to concentrate on a flank of the Spartan line and ultimately the collapse of the entire Spartan line. The Battle of Lechaeum (391 BCE) is another example of the power of ambushes and harassment against a stronger force.[14]

12. Jack Olsen and John Gresham, *Aphrodite: Desperate Mission* (New York: ibooks, 2004).

13. "Four Companies Selected for USAF, DIU Enterprise Test Vehicle Project," Defense Innovation Unit, accessed July 28, 2024, https://www.diu.mil/.

14. Xenophon, *Hellenica*, vol. 1, trans. Carleton L. Brownson (Cambridge, MA: Harvard University Press, 1918).

Even better, the combination of a weaker skirmishing force and a stronger decisive force creates multiple dilemmas for an adversary. Airmen must learn to play both the strong and weak hands, and small-format airpower provides them the means to relearn the latter.

Finally, these capabilities provide an avenue to improve our integration with the Joint Force. The Cold War division of roles and missions between the Army and the Air Force, commonly known as the Key West Agreements, centered on who owned what type of aircraft. The Army had become reliant on organic liaison aircraft during World War II—in part a product of the birth of the independent Air Force. The Army was hesitant to give up these aircraft, and the Air Force was reluctant to receive them.

This mission space gave way to rotary-wing aviation, which largely became the purview of the Army. Unfortunately, technology did not always so neatly abide by these distinctions, contributing to the costly experience of the cancelled AH-56 Cheyenne.[15] This problem will become acute with small-format airpower. One prototype offers the option to swap between propeller, jet, and electric propulsion; almost all feature vertical or short take-off and landing capabilities using a mix of rotary and fixed-wing techniques.

If these aircraft are neither fish nor fowl, then perhaps new thinking is in order. We might consider a world where an Airman drops a cluster bomb full of sUAS to an Army commander as a "single serving Air Force" or a world where an Army commander launches a swarm of sUAS forward to conduct interdiction using Air Force long-range datalinks. The possibilities of these new capabilities drive us toward another key question: How can airpower work together with our sister services to achieve victory together?

This *Æther* issue devoted to the air littoral is sorely and urgently needed to address these pressing questions. Airmen will rise to the challenge, as they always do, and will master these new expressions of airpower. We, as an institution, must support them in doing so. This is not simply a question of technology and tactics. Our Air Force must consider what forms of doctrine, organization, training, leadership, people, logistics, and policies are required for these new capabilities. We must consider this problem from many angles, but we must do so quickly and move out decisively. Toward that end, I enthusiastically recommend the work of the authors of this volume and the tireless efforts of the editors. Thank you for joining me in opening this new chapter of our shared airpower story. **Æ**

15. Ian Horwood, *Interservice Rivalry and Airpower in the Vietnam War* (Fort Leavenworth, KS: Combat Studies Institute Press, 2006).

CONTESTING THE AIR LITTORAL

Kelly A. Grieco
Maximilian K. Bremer

The diffusion of small uncrewed aerial systems, mobile air defense systems, and one-way attack drones is rapidly changing the character of war, with US adversaries gaining new ways to contest the air domain. The traditional notion that air superiority is won or lost in the "blue skies"—the medium and higher altitudes where fighters and bombers typically operate—is outmoded. Even if an air force manages to gain blue-skies air superiority, the airspace below these altitudes—called the air littoral—remains contested. Absent a significant revision in US Air Force thinking and operations, the service risks ceding control of the air littoral to the adversary as well as other services. Instead, the US Air Force should drive a reinvention of airpower concepts, including that of air superiority, as well as the close air mission, to fulfill its purpose and role as experts of the air domain.

As the character of war rapidly evolves, driven by new technologies from artificial intelligence and additive manufacturing to small uncrewed aerial systems and one-way attack drones, the Air Force must change with it. Chief of Staff of the Air Force General David W. Allvin has said that nothing less than a "reinvention of our Air Force and airpower into the future" is required, including rethinking the concept of air superiority itself.[1] "Our traditional conception of what things like air superiority mean has changed," Vice Chief of Staff General James C. Slife confirmed, observing that "quadcopters with a hand grenade can kill an American just as easily as a MiG or Su[khoi] can."[2]

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1. Chris Gordon, "Allvin: Drones, New Technology Driving 'Reinvention' of Airpower and USAF," *Air & Space Forces Magazine*, February 13, 2024, https://www.airandspaceforces.com/.

2. James C. Slife, "The Future of Warfare: Preparing the US Military Forces for Competition and Contestation" (panel discussion, Global Security Forum 2024: Gathering Strength in a Gathering Storm, Center for Strategic & International Studies, Washington, DC, April 24, 2024), transcript available at https://csis-website-prod.s3.amazonaws.com/.

Three years ago, the authors warned about the need for new thinking in the pages of *Parameters*, writing at the time, "The airspace between ground forces and high-end fighters and bombers is quickly emerging as the more challenging and important contest for air control." The article further noted that "addressing this threat demands more than technological solutions; it requires a paradigm change in American military thinking about verticality." The authors termed this airspace the *air littoral*, defining it as "the area from the Coordinating Altitude to the Earth's surface, which must be controlled to support land and maritime operations and can be supported and defended from the air and/or surface," and proposing a volumetric concept of air control, localized in time, planar distance, and altitude.[3]

The war in Ukraine—where mobile ground-based air defenses and small drones of various types, from commercial quadcopters and first-person view racing drones to military-grade system, crowded the skies—has offered grim confirmation of the critical importance of this airspace.[4] As defense analysts and practitioners have struggled to make sense of these developments, the term air littoral has entered the airpower lexicon.[5]

Building on this earlier work, this article argues a new way of thinking about the air domain is broadly relevant to future fights, especially the defense of the status quo in a Taiwan contingency. Absent a significant revision in thinking and operations, the US Air Force risks ceding control of the air littoral to the adversary as well as other services. The US Air Force has long extolled the virtues of offense. The belief that the "best defense is a good offense" is so powerful and so pervasive that some even say the service suffers from a "cult of the offensive."[6] But there is a notable exception: current thinking about the air littoral.

To the extent the Air Force is at all concerned with the air littoral, it has focused more narrowly on tactical defense—that is, countering the threat from small drones. That is unfortunate, because as much as air warfare favors tactical defense over offense in the blue skies, the reverse is true in the air littoral—where tactical offense has the advantage while strengthening the operational defense, also known as air denial. By failing to address the implications of these changes, the Air Force is missing an opportunity to strengthen both deterrence and warfighting capability against great power challengers such as China and Russia.

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3. Maximilian K. Bremer and Kelly A. Grieco, "The Air Littoral: Another Look," *Parameters* 51, no. 4 (Winter 2021–22): 68, https://press.armywarcollege.edu/.

4. Maximilian K. Bremer and Kelly A. Grieco, "In Denial about Denial: Why Ukraine's Air Success Should Worry the West," *War on the Rocks*, June 15, 2022, https://warontherocks.com/.

5. See, for example, David Barno and Nora Bensahel, "Drones, the Air Littoral, and the Looming Irrelevance of the US Air Force," *War on the Rocks*, March 7, 2024, https://warontherocks.com/; and Zachary Kallenborn, "Information Warfare in the Air Littoral: Talking with the World," Airpower after Ukraine, Atlantic Council, August 30, 2022, https://www.atlanticcouncil.org/.

6. John R. Carter Jr., "Airpower and the Cult of the Offensive" (master's thesis, School of Advanced Air and Space Studies, Maxwell AFB, AL, April 1998), 5, https://apps.dtic.mil/.

A Blue Skies Tradition

The US Air Force has a proud tradition of air superiority, if not air supremacy, in most of its past military conflicts. Joint Publication (JP) 3-01, *Countering Air and Missile Threats*, defines air superiority as "that degree of control of the air by one force that permits the conduct of its operations at a given time and place without *prohibitive* interference from air and missile threats."[7] The highest level of control is air supremacy, wherein the enemy is "incapable of *effective* interference within the operational area using air and missile threats" (emphasis added).[8]

For much of the last century, control of the air was seemingly won or lost in the blue skies—that is, the medium- and higher-altitude airspace where high-end fighters and bombers typically operate—whether that battle was fought between attacking formations and defending fighters or between attacking aircraft and surface-to-air missiles (SAM).

The contest for air superiority over Western Europe between 1942 and 1944, for example, saw Luftwaffe fighters fly high-altitude interception operations over the North Sea and northern Germany against the US Army Air Forces' Eighth Air Force.[9] A similar story repeated itself in the skies over North Vietnam almost three decades later, but this time the decisive contest was waged between US warplanes and North Vietnamese ground-based air defenses. For the first time, the United States confronted a fully integrated air defense system of Soviet-built SA-2 Guideline SAMs and anti-aircraft guns linked to fire-control radars. The SAM added a new and lethal menace to aerial warfare.[10]

This blue-skies air superiority contest has grown ever more challenging, however, particularly with the introduction of phased-array radars and mobile long-range SAMs in the late 1970s.[11] The Air Force invested heavily in stealth and precision munitions to try to regain an advantage in the blue skies.[12] Yet in the years since, China has developed more advanced radar systems, including VHF- and UHF-band radars, and now possesses one of the largest advanced long-range SAM arsenals in the world, with sufficient reach to deny US aircraft the benefit of a high-altitude sanctuary.[13]

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7. *Countering Air and Missile Threats*, Joint Publication (JP) 3-01 (Washington, DC: Chairman of the Joint Chiefs of Staff [CJCS], 2024), I-5.

8. JP 3-01, I-5.

9. Donald Caldwell and Richard Muller, *The Luftwaffe over Germany: Defense of the Reich* (Barnsley, UK: Pen & Sword Books Ltd., 2014).

10. David Hampton, *The Hunter Killers: The Extraordinary Story of the First Wild Weasels, The Band of Mavericks who Flew the Most Dangerous Missions of the Vietnam War* (New York: Harper Collins, 2015).

11. Marshall L. Michel III, *The Eleven Days of Christmas: America's Last Vietnam Battle* (New York: Encounter Books, 2002), 239.

12. Benjamin S. Lambeth, *The Transformation of American Air Power* (Ithaca, NY: Cornell University Press, 2000).

13. *Military and Security Developments involving the People's Republic of China 2023* (Washington, DC: Department of Defense, 2023), https://media.defense.gov/.

Airpower traditionalists, however, see a future that looks like the past. They prioritize countering these high-end threats on the assumption that US air control turns mainly, if not exclusively, on the contest in the blue skies. To them, the answer is simple: sustained and expensive investments in next-generation aircraft technology will be enough to recapture America's airpower advantage. "Advances in autonomy and other uncrewed systems technologies have created a unique opportunity to combine the lethality of 5th and 6th generation fighters with CCA [collaborative combat aircraft] that are designed to disrupt and defeat China's counterair operations," argues a report from the Mitchell Institute for Aerospace Studies.[14] Simply put, changing technology has not changed thinking.

Similarly, in 2021, then-Commander of the Pacific Air Force General Kenneth Wilsbach, who currently leads Air Combat Command, referred to fielding more technologically advanced air superiority capabilities in the Indo-Pacific as an "urgent operational need," stating, "I am advocating for NGAD [Next Generation Air Dominance], and the weapons that go with NGAD are also important so we can stay relevant as our adversaries continue to advance."[15] In short, the most discussed threats to US air superiority are those aimed at restricting the Air Force's ability to access and exploit the blue skies, its historically prized altitudes.

But this blue-skies bias misses the broader point: air control is no longer exclusively contingent on the outcome of the contest in the blue skies, and solely prioritizing winning this fight will not deliver air superiority to the United States. Air Force operators need to be masters of the air, of the whole domain, not specialists only in one part.

Decoupling the Air Littoral from the Blue Skies

The notion that control of the air is won or lost in the blue skies was always a bit of a romanticized ideal. To be sure, if an air force achieved air superiority, it also gained a measure of control extending to the ground. But air control was never absolute. For example, when General Norman H. Schwarzkopf, the US and Allied commander, proclaimed "air supremacy" over the Iraqi air force on the tenth day of the Gulf War in 1991, the Iraqi air force had ceased all fixed-wing operations, and any Iraqi helicopters that still dared to fly were shot down. Yet Iraqi flak and short-range, mobile infrared anti-air missiles remained a serious threat, accounting for 71 percent of all coalition aircraft losses in the war.[16]

A similar story repeated itself in Kosovo a few years later. General John Jumper, commander of US Air Forces Europe, was able to declare air superiority, triumphantly

14. Mark A. Gunzinger, Lawrence A. Stutzriem, and Bill Sweetman, *The Need for Collaborative Combat Aircraft for Disruptive Air Warfare* (Arlington, VA: Mitchell Institute for Aerospace Studies, 2024), 4, https://mitchellaerospacepower.org/.

15. Kris Obsborn, "The US Air Force Is Going All In on 6th Generation Fighters," *National Interest*, May 17, 2021, https://nationalinterest.org/.

16. Lambeth, *Transformation*, 120.

claiming Allied warplanes could "go anywhere we want in the country, any time."[17] But this declaration was only strictly true above 15,000 feet. The skies were not clear at lower altitudes, where Yugoslavia's anti-aircraft artillery (AAA) and shoulder-fired, man-portable air defense systems (MANPADS) remained ever-present threats.[18] In the early years of the twenty-first century, the United States flew unimpeded in the blue skies over Iraq, Afghanistan, and elsewhere, but that success belied growing threats in and through the airspace closer to the surface.

The difference today is that the blue skies no longer offer the sanctuary they once did to US aircraft, but they also no longer confer the same operational and tactical advantages to the side in control of them. Air superiority in the blue skies was once a prerequisite for an air force to be able to freely operate specialized aircraft for other aerial missions—including battlefield interdiction and close air support; intelligence, surveillance, and reconnaissance (ISR); airlift; and medical evacuation—without incurring serious losses.

Today, however, air forces increasingly bypass the blue skies and instead access and exploit the air littoral—that is, the airspace between the Earth's surface and blue skies—to conduct many of these missions, especially ISR and direct attack. Simply put, what was once a nuisance and sideshow to the main contest in the blue skies is now critically important for air control.

Air Littoral

Three trends have converged to make the air littoral central to the contest for air control. First, the so-called Fourth Industrial Revolution continues to usher in technological breakthroughs in robotics, artificial intelligence, microelectronics, and additive manufacturing, among others. It is now possible to employ large numbers of small and cheap but lethal systems in the air littoral. In addition to numerous radar-guided AAA guns and MANPADS, small drones, loitering munitions, and cruise missiles offer new opportunities to access and exploit the air littoral.

Second, unlike previous high-tech revolutions in military affairs (RMA), today's technological breakthroughs are occurring in an era of open innovation. As one political scientist argues, these earlier RMAs occurred in a closed context, when government-funded programs underwrote the technological development of new weapon systems.[19] The technologies that drove past RMAs—nuclear weapons, stealth aircraft, and precision-guided munitions—had few commercial applications, allowing governments to limit access through secret programs, security classifications, and restrictive copyrights. In this context, the barriers of entry were high, with only the

17. Robert Hewson, "Allied Force, Part II: Overwhelming Air Power," *World Air Power Journal* (Winter 1999/2000): 110, qtd. in Benjamin S. Lambeth, *NATO's Air War for Kosovo: A Strategic and Operational Assessment* (Santa Monica, CA: RAND Corporation, 2001), 50, https://doi.org/.

18. Lambeth, *NATO's Air War*, 21–22.

19. Audrey Kurth Cronin, *Power to the People: How Open Technological Innovation Is Arming Tomorrow's Terrorists* (New York: Oxford University Press, 2020).

major powers possessing the financial, organizational, technological, and scientific resources required to build effective air forces.[20]

Closed innovation also made it possible for air forces with the most advanced aircraft and weapon systems to prevent—or at least delay—the transfer and proliferation of these military technologies and associated concepts of operation. Indeed, the US stealth and precision-guided munition advantages endured for nearly three decades before US adversaries, including Russia and China, closed the gap.[21]

Today, however, the commercial sector—rather than state-funded laboratories and weapons programs—are driving technological progress. Because these technologies—robotics, artificial intelligence, big data analytics, and 3D printing—are inherently dual-use, cheap, and easy to operate, they diffuse globally in short order. For example, Houthi rebels employ a mix of military- and commercial-grade drones, laden with explosives, for precision strikes. They also now field their own homegrown designs, obtaining easily accessible off-the-shelf engines, servo actuators, and electronics through a network of intermediaries and using 3D printers to create other components for their missiles and drones.[22] Open innovation thus levels the playing field, empowering a wide range of actors to contest and exploit the air littoral.

Multi-use technologies are not simply a "poor man's air force," however, as China is investing heavily in these areas to gain a military edge. Indeed, The People's Liberation Army already makes extensive use of off-the-shelf drones—the Chinese company DJI is the world's largest commercial drone manufacturer—and has accelerated efforts to build an "intelligentized" military and integrate them into operational concepts, including autonomous swarms for attritional warfare.[23] In 2023, for example, China's National University of Defense Technology tested a drone swarm capable of "self-repair," which overcame test jamming signals, restored communications links, and went on to find and destroy a target with loitering munitions—all without the help of a human operator.[24]

China also recently unveiled ASN-301 loitering munition similar to the Iranian Shahed-136 and Israeli Harpy and announced plans to develop what it termed a "new-type

20. Sebastian Ritchie, *Industry and Air Power: The Expansion of British Aircraft Production, 1935–41* (London: Routledge, 1997); and Ferenc Vajda and Peter Dancey, *German Aircraft Industry and Production, 1933–1945* (Warrendale, PA: SAE International, 1998).

21. Thomas G. Mahnken, "Weapons: The Growth & Spread of the Precision-Strike Regime," *Daedalus* 140, no. 3 (2011).

22. Max Mutschler and Marius Bales, "Liquid or Solid Warfare? Autocratic States, Non-State Armed Groups and the Socio-Spatial Dimension of Warfare in Yemen," *Geopolitics* 29, no. 1 (2024).

23. *In Their Own Words: The Science of Military Strategy 2020* (Maxwell AFB, AL: China Aerospace Studies Institute, 2022), https://www.airuniversity.af.edu/.

24. Alistair Gale, "China, US Test Intelligent-Drone Swarms in Race for Military AI Dominance," *Wall Street Journal*, August 19, 2023, https://www.wsj.com/.

loitering munition with super long-range."[25] The People's Liberation Army, like other militaries, intends to access and exploit the air littoral at scale to battlefield advantage.

Finally, these technological advances have opened new possibilities for broad occupation and persistence in the air domain. Since its inception, military aviation has demonstrated unique strengths and limitations. The medium of the air offers few obstacles, allowing aircraft and other airborne systems to achieve unmatched maneuverability, speed, and range to rapidly concentrate firepower where and when it is most needed. Air forces, unlike armies, however, cannot live in their primary domain—the effects of gravity and human endurance limit flight times.[26] Additionally, from the start, aircraft have been expensive systems, requiring highly trained pilots and massive supporting infrastructure to fly them. This reality inevitably limits the size of traditional air forces, even for the wealthiest of nations.

As a result of both limited flight times and aircraft numbers, the occupation of airspace could occur for a time, but it was ultimately ephemeral. Once friendly aircraft left the airspace, surviving adversary aircraft could return to access and exploit it. During the race for Tunis in November 1942, for example, the Allies flew nearly twice as many sorties as the enemy, but operating from more distant airfields, they could rarely loiter more than 10 minutes over the battlefield.[27] When Allied fighters were in the air, German Stukas returned to their nearby bases and waited for them to leave, returning unopposed to bomb and strafe Allied ground forces.[28] In short, it was impossible to persistently possess the air domain.

This paradigm—contesting and occupying the airspace temporarily via small numbers of expensive, crewed aircraft, and then leaving—has become increasingly outmoded. But large numbers of drones can achieve persistence indirectly, by continually rotating in and out of the air littoral.[29] Because they are so cheap and quick to build compared to traditional platforms, air forces might deploy, lose, and replace them in large numbers.

Consistent with this vision, the Pentagon's Replicator initiative aims to rapidly scale and deploy "multiple thousands" of autonomous drones with a per-unit cost ranging from tens of thousands to hundreds of thousands of dollars—not millions.[30] "Replicator is meant to help us overcome the PRC's [People's Republic of China's] biggest advantage,

25. Akhil Kadidal and Rahul Udoshi, "China Developing Long-Range Loitering Munition," Janes, July 26, 2023, https://www.janes.com/.

26. Phillip S. Meilinger, *Ten Propositions regarding Airpower* (Washington, DC: US Air Force Office of History, 1995), 2.

27. Rick Atkinson, *An Army at Dawn: The War in North Africa, 1942–43* (New York: Henry Holt, 2002), 184.

28. Daniel R. Mortensen, *A Pattern for Joint Operations: World War II Close Air Support, North Africa* (Washington, DC: Office of Air Force History and US Army Center of Military History, 2005), 61.

29. Maximilian K. Bremer and Kelly A. Grieco, "To Reinvent Itself, the US Air Force Must Go Big on Small Drones," *Defense News*, April 2, 20024, https://www.defensenews.com/.

30. Jim Garamone, "Hicks Discusses Replicator Initiative," Department of Defense (DoD), September 7, 2023, https://www.defense.gov/.

which is mass: more ships, more missiles, more people," Deputy Secretary of Defense Kathleen Hicks explained at the initiative's launch. Hicks reasoned, "We'll counter the PLA's mass with our own, but ours will be harder to plan for, harder to hit, and harder to beat."[31] For the first time in the history of aerial warfare, air forces can be built around cheap mass.

The contest for air control—particularly in the air littoral—thus increasingly favors the larger air force—the side with the advantage in sheer numbers of cheap, easy-to-produce systems and precision munitions. Air forces that remain wedded to costlier legacy systems—and legacy ideas about airpower and air control—will continue to build fewer but more expensive systems, risking irrelevancy. They will be limited in action and misaligned with future operational needs of the joint force.

Exploiting the Air Littoral

The future of air warfare will see a growing contest to occupy the air littoral, where drones and missiles of various types will be employed in massive numbers to saturate the airspace and wreak havoc and confusion on an adversary. Air forces can exploit the air littoral to advantage across multiple mission sets, especially air denial and the close air mission: surveillance and reconnaissance, communication, direct attack, and mobility.

Air Denial

The air littoral can support a strategy of blue-skies air denial, in which an air force aims to deny operational freedom to an adversary's air force without necessarily being able to control that airspace.[32] Air denial draws upon the concepts of British naval theorist Julian Corbett, who argued total command of the seas was impracticable. No navy could be everywhere at once due to the sheer size of the maritime domain.

For Corbett, command consists of control and denial. Even if a navy could not exclude the enemy from the sea, he maintained, it could still limit or deny the other side's ability to make effective use of the sea for its own purposes. "The most common situation in naval warfare," Corbett observed, "is that neither side has the command"—that is, "command is normally in dispute."[33] To deny command, he advised an active defense, in which a navy remained threatening as a "fleet in being" by staying active and mobile and conducted "harassing operations . . . to prevent the enemy from exercising control in spite of his superiority by continually occupying his attention."[34]

The air domain is similarly vast, and the last 30 years notwithstanding, the history of aerial warfare suggests the default condition is for command of the air to be in

31. Kathleen Hicks, "The Urgency to Innovate" (keynote address), National Defense Industrial Association, Washington, DC, August 28, 2023, transcript, https://www.defense.gov/.

32. Maximilian K. Bremer and Kelly A. Grieco, *Assumption Testing: Airpower Is Inherently Offensive* (Washington, DC: Stimson Center, 2023), https://www.stimson.org/.

33. Julian S. Corbett, *Some Principles of Maritime Strategy* (New York: Longmans Green, 1918), 77.

34. Corbett, 190.

dispute. Air denial is analogous to Corbett's concept of sea denial, in that it focuses on limiting another air force's ability to gain and exploit air superiority in military operations. A strategy of air denial aligns well with US political and military objectives: to maintain the territorial status quo in Europe and the Indo-Pacific and prevent the emergence of China's regional hegemony.[35]

These objectives require an airpower strategy that would make it both difficult and costly for China or Russia to quickly seize territory and present their conquests as a fait accompli. A Russian land grab in the Baltics, much less a Chinese amphibious invasion of Taiwan, is not feasible without air superiority—including in the air littoral. Russian forces have learned this bloody lesson in Ukraine over the last two years, and Chinese military writings consistently make the point that offensive amphibious and maritime operations are unlikely to succeed absent air superiority.[36] They are not wrong: one study found modern amphibious operations have succeeded only 14 percent of the time without air superiority.[37]

Ultimately, neither Russia nor China wants to start a war that it cannot win. As such, US airpower strategy and doctrine should be oriented toward the goal of convincing their respective leaders that they cannot obtain the air superiority required to mount successful offensive operations.

While a strategy of air denial has been used successfully in past wars—most famously in the 1940 Battle of Britain—the difference today is that technological advancements have opened new and more effective ways for the defender to contest both the lateral and vertical airspace. Notably, the mobility, density, and expendability of air defense systems and drones allow a doctrine of volumetric defense.

This type of defense layers the effects of cyber disruptions, electromagnetic jamming, air-based air defenses, and ground-based air defenses in increasing degrees of strength, both horizontally, from deep-strike to close-in capabilities, and vertically, from the blue skies to the air littoral. The outer layer consists of a mix of sensors, platforms with air-to-air missiles, cyber, electromagnetic capabilities, and ground-mobile long- and medium-range SAMs to cover the approaches from the blue skies. The inner layer includes thousands of anti-aircraft guns, short-range and man-portable SAMs, rockets, drones, and loitering munitions to deny control of the air littoral.[38]

Specifically, saturating the air littoral over attacking surface forces—whether in defending against a Chinese amphibious invasion of Taiwan or a Russian attack on a NATO Ally in eastern Europe—would create numerous hard-to-solve and time-consuming

35. Joseph R. Biden Jr., *National Security Strategy* (Washington, DC: White House, October 2022), https://www.whitehouse.gov/.

36. Lyle Goldstein, "The Hard School of Amphibious Warfare: Examining the Lessons of the 20th Century's Major Amphibious Campaigns for Contemporary Chinese Strategy," *Asia Security* 19, no. 1 (2022).

37. Ian Speller and Christopher Tuck, *Amphibious Warfare: Strategy & Tactics from Gallipoli to Iraq* (London: Amber Books, 2014).

38. Maximilian K. Bremer and Kelly A. Grieco, "In Defense of Denial: Why Deterring China Requires New Airpower Thinking," *War on the Rocks*, April 3, 2023, https://warontherocks.com/.

dilemmas for them before either could attain air superiority. Whereas the United States and its Allies and partners would have one problem to solve—how to parry the blow from attacking aircraft and missiles—attacking Russian or Chinese air forces would confront both air-to-air and ground-to-air threats in the fight to gain and maintain control of the air littoral.

Flying through a mostly open and featureless sky, larger crewed aircraft are inherently easier to locate and destroy than the mobile ground-based air defenses hunting them from terrain more favorable to cover and concealment. From the so-called "Scud hunt" in Iraq in 1991 to the current war in Ukraine, mobile air defenders, employing "shoot-and-scoot" tactics, in which they fire their missiles and quickly turn off their radars and move away, are challenging to find and eliminate.[39]

In addition to these SAM threats, continuous waves—and soon autonomous swarms—of small sensing, decoy, and weaponized drones could be used to mine the air littoral. In a twenty-first century version of the barrage balloon, large numbers of low-cost drones could both offer point defense and channel attacking aircraft into narrow flight corridors, forcing them to run a gauntlet of other air denial weapons.[40] Even if an attacking aircraft escapes a direct hit, it could still suffer mission kill from blast and fragment damage.

The attacker's expensive crewed aircraft could avoid flying in the air littoral, taking their chances in the blue skies, where the threat from long-range air defenses awaits them, but that would do little to protect their surface forces from continued surveillance and attacks from the air littoral. The United States and its Iraqi partners learned this lesson in Mosul in 2016 and 2017. Even though the United States had air supremacy in the blue skies, the Islamic State was still able to access and exploit the air littoral, employing quadcopters loaded with explosives that killed or wounded dozens of Iraqi soldiers and nearly bringing Iraqi ground operations "to a screeching halt."[41]

Enemy small drones create a difficult dilemma to solve—one that would put US adversaries on the losing end of the cost curve. Take ongoing US operations against Iranian-backed Houthis in the Red Sea: US Navy warships are using $2.1 million antiair missiles to intercept Houthi attack drones that cost as little as a few thousand dollars. As one DoD official stated, "The cost offset is not on our side."[42]

Similarly, the United States alongside other partners shot down approximately 300 Iranian attack drones and missiles headed toward Israel in April 2024, employing F-15E

39. Thomas A. Keaney and Eliot A. Cohen, *Gulf War Air Power Survey*, vol. 2 (Washington, DC: Office of the Secretary of the Air Force, 1993); and William Rosenau, *Special Operations Forces and Elusive Enemy Ground Targets: Lessons from Vietnam and the Persian Gulf War* (Web only: RAND Corporation, 2002), https://doi.org/.

40. Leslie F. Hauck III, and John P. Geis II, "Air Mines: Countering the Drone Threat to Aircraft," *Air & Space Power Journal* 31, no. 1 (2017), https://www.airuniversity.af.edu/.

41. David Larter, "SOCOM Commander: Armed ISIS Drones Were 2016's 'Most Daunting Problem,'" *Defense News*, May 16, 2017, https://www.defensenews.com/.

42. Laura Seligman and Matt Berg, "A $2M Missile vs. a $2,000 Drone: Pentagon Worried over Cost of Houthi Attacks," *Politico*, December 19, 2023, https://www.politico.com/.

fighters, destroyers, and Patriot missile systems. The operation was overwhelmingly successful, but it is reported to have cost at least 10 times as much to defend against the attack as it cost Iran to launch it.[43] This estimate may well be low, when accounting for fuel, maintenance costs, and staging support for high-end fighters.

This cost imbalance is driving the pursuit of cheaper countermeasures, including lasers and other directed-energy weapons, but the technological challenges remain daunting, as the director of the Navy Surface Warfare Division cautioned in early 2024.[44] For the foreseeable future, air denial will thus remain both easier and cheaper to achieve than trying to gain air superiority outright, including in the air littoral.

Close Air Mission

The US military today faces an acute dilemma: small numbers of larger, more expensive airframes and sensors are vulnerable and can expect high rates of attrition on the ground and in contested airspace while the growing reach of adversary long-range air-to-air and surface-to-air missiles risks pushing these assets back too far from the fight to be effective. As the *Air Superiority 2030 Flight Plan* concluded in 2016, "The increasing lethality and reach of adversary weapons will significantly increase the risk" to large surveillance platforms. It warns, "This will limit their ability to see and manage activities in the contested and highly contested environments."[45]

The US Air Force should anticipate and prepare to succeed in an operating environment characterized by the mutual denial of air superiority, especially early in a conflict against a near-peer such as China. Above all, this operational reality requires reimagining the close air mission. Rotational occupation of the air littoral with large numbers of small drones would allow the US Air Force to continue to provide aerial surveillance and reconnaissance, communications, direct attack, and mobility within contested airspace.

First and foremost, large numbers of small drones can create an "unblinking eye" over the battlefield to conduct reconnaissance and surveillance for the Joint force.[46] Joint operations depend critically on the air component for surveillance and reconnaissance. Air surveillance offers wide-area coverage to the Joint force for airborne early warning, battle management, command and control, and target detection and tracking.[47]

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43. Andrew Macaskill, "Israel's Defenses Would Trump Iran's in Any Air War, But at a High Cost," Reuters, April 18, 2024, https://www.reuters.com/.

44. Justin Katz, "'It's Hard': Navy Needs to Be Realistic about Laser Weapons, Admiral Says," Breaking Defense, January 11, 2024, https://breakingdefense.com/.

45. Enterprise Capability Collaborative Team, *Air Superiority 2030 Flight Plan* (Washington, DC: Department of the Air Force, May 2016), 8, https://www.af.mil/.

46. Rebecca Grant, "Toward an Unblinking Eye," *Air & Space Forces Magazine*, October 1, 2012, https://www.airandspaceforces.com/

47. Troy McLain and Gerrit Dalman, "Seize the Highest Hill: A Call to Action for Space-Based Air Surveillance," *Air & Space Power Journal* 32, no. 4 (2018): 32, https://www.airuniversity.af.edu/.

For the close air mission, the United States will need to complement existing capabilities with a mix of cheaper high-altitude surveillance platforms—balloons and drones—and numerous cheaper platforms operating in the air littoral. By rotating large numbers of small drones in and out of the air littoral, the US Air Force could achieve persistence indirectly over the theater of operations to close gaps in lower-altitude surveillance coverage and create a real-time surveillance picture.

In 2023, the deputy chief of staff for Air Force Futures proposed using small, inexpensive drones—estimated to cost around $500,000 each—to monitor shipping traffic in the Taiwan Strait. Any attempt by China to invade or blockade Taiwan would involve large numbers of Chinese warships, but with large numbers of these low-cost drones operating over the Strait, the United States could readily spot those ships on the move.[48] Those small drones could also provide critical reconnaissance, sending targeting information back to aircraft, submarines, and surface vessels that have the weapons needed to sink those warships.

Small drones employed at scale can also create a meshed communication network, extending the communication range. The drones would form a chain of relays, in which one drone relays communication for another, to provide beyond-line-of-sight (BLOS) radio communications. They would also be robust against China's high-powered ground-based jammers, including in a Taiwan contingency, one RAND report concludes, by using high-frequencies, such as those in the tens of gigahertz.[49] Currently the Joint force primarily relies on satellites for BLOS communications, but in the event of a conflict with China or Russia such signals could be blocked by jammers or otherwise disrupted. In that situation, a drone mesh network would still offer a communication link, adding another layer of resiliency to military communications and enabling rapid decision-making.

The US Air Force could also use the air littoral to conduct direct attack, employing numerous small, cheap drones in support of Joint combined arms operations. For much of the Air Force's history, its leaders have argued that airpower is most effective when employed indirectly, whether in strategic bombing of an enemy's population, economy, or leadership or the interdiction of its war production and lines of communication. But the historical record of airpower over the last 70 years suggests otherwise. As one political scientist argues, airpower's "asymmetric advantage is its ability to locate and attack massed and maneuvering armies," because it places enemy ground forces on the "horns of a dilemma."[50]

If these forces concentrate and maneuver, they will face almost certain destruction from lethal air strikes, but if they disperse and hide, they cannot concentrate and maneuver to conduct the large-scale breakthrough and exploitation operations required

48. Andrew Hoehn and Thom Shanker, "Are Cheap Drones the Answer to the Tension in the Taiwan Strait?," *Defense News*, June 29, 2023, https://www.defensenews.com/.

49. Thomas Hamilton and David Ochmanek, *Operating Low-Cost, Reusable Unmanned Aerial Vehicles in Contested Environments* (Santa Monica, CA: RAND Corporation, 2020), https://doi.org/.

50. Phil Haun, *Tactical Air Power and the Vietnam War: Explaining Effectiveness in Modern Air Warfare* (New York: Cambridge University Press, 2024), 9, 14.

to seize territory.[51] In other words, airpower is most effective when it has no need to destroy armies, because it has already denied the enemy its preferred strategy of massing at the decisive point.

Air forces can now leverage this asymmetric airpower advantage by crowding the skies of the air littoral. In Ukraine, for example, the blue skies are mostly empty of warplanes, but the air littoral is congested. Drones in the air littoral are a persistent presence and threat over the front lines, making the movement and massing of troops and vehicles extremely dangerous. A Ukrainian drone operator fighting in the Kharkiv region observed, "Nobody really knows how to advance right now." He concluded it was "almost impossible" to achieve a decisive breakthrough "in an era of cheap and lethally accurate drones."[52]

The area between the opposing lines is known as "the death zone," with another Ukrainian drone operator warning that those who dare to move—whether Ukrainian or Russian—are spotted by the other side's drones and are "dead immediately."[53] This drone-saturated airspace has delivered tactical airpower's main advantage—denying an enemy the ability to concentrate and maneuver. The effect on the enemy army or navy is the same, whether it is achieved from the air littoral or the blue skies.

Similarly, drones cycled fast enough into the airspace could overwhelm China's targeting process and in turn inflict significant losses should its forces attempt to invade Taiwan. Chinese commanders would have to decide how much "clearance" is needed in the air, and for how long, but trying to destroy large numbers of these systems would risk depleting their anti-air missiles in the process. Chinese military planners could opt instead to ignore these small, cheap drones, but they would leave their surface forces vulnerable to attacks in multiple directions, including drones maneuvering over the top of them to conduct vertical envelopment, subjecting attackers to continuous fires.[54]

A single small drone is unlikely to sink or even damage a ship. When used in large numbers, however, they could cooperatively attack from different directions to confuse and overwhelm a ship's defenses and then disable the ship by targeting its critical sensors, communications, and engineering components.[55]

Finally, drones employed in the air littoral can carry cargo, sustaining forces distributed across the battlefield. Because these systems are uncrewed, they can assume greater risks in resupplying these forces than traditional crewed aircraft. The Marine Corps is leading the way in this effort, with its logistics battalions set to receive three to six Tactical Resupply Unmanned Aircraft System drones, which can carry

51. Haun, 13–34.

52. Luke Harding, "Cheap but Lethally Accurate: How Drones Froze Ukraine's Frontlines," *Guardian*, January 25, 2024, https://www.theguardian.com/.

53. Siobhan O'Grady and Kostiantyn Khudov, "Drones Are Crowding Ukraine's Skies, Largely Paralyzing Battlefield," *Washington Post*, April 14, 2024, https://www.washingtonpost.com/.

54. Jules Hurst, "Robotic Swarms in Offensive Maneuver," *Joint Forces Quarterly* 87, 4th Quarter (2017).

55. Tyler Rogoway, "The Compelling Case for Arming US Navy Warships with Drone Swarms," *War Zone*, April 4, 2024, https://www.twz.com/.

150 pounds up to nine miles, with the long-term goal to field cargo drones capable of handling "thousands of pounds."[56]

This combination—a transparent battlefield, precision weapons en masse, and a faster kill web—make it very dangerous to move. That puts the attacker at a significant disadvantage because they must move forward to execute an offensive mission, leaving them exposed to the defender's fire. In contrast, the defender can operate and resupply themselves from a prepared position, where they conceal and protect themselves from an attacker's fire. When leveraged appropriately, these developments favor the United States—and its Allies and partners—in preserving the territorial status quo against Chinese or Russian military aggression.

Conclusion

The US Air Force should develop its strategy and doctrine not based on how it wishes it could fight air wars, or how it might relive past successes against nonpeer adversaries but rather on how it will be most effective in future combat. The challenge of the air littoral calls for a rapid and forceful look at doctrine, organization, training, materiel, leadership and education, personnel, and facilities.

Air Force and Joint doctrine should recognize and develop new tactics, techniques, and procedures for the air littoral and denial-based operations. This doctrinal and tactical innovation is more likely to come from its digitally native Airmen than today's legacy pilot force, as the former are much more capable than senior pilots of understanding the nonlinear and one-to-many interactions of humans and machines. From basic training onward, Airmen should be as familiar with small drones as Marines are with their rifles. Airmen need to be airminded and bring that thinking to the Joint fight.

The changing character of war means that uncrewed systems, especially in the air littoral, are no longer the sole purview of intelligence agencies and special operations forces. Air littoral operations will be critical in all future fights, especially against near-peer adversaries. The Air Force, as the independent air component of the Department of Defense, should provide the organizational and intellectual leadership to develop and field new capabilities and concepts, including creating and incorporating high numbers of low-end, close-in air occupation elements and capability as it restructures for conflicts of the future.

Airmen should have not only the freedom to innovate and adapt but also the tools. China's significant industrial lead in small drone production, combined with the increasing cooperation of Iran and Russia in development of military tactics and integration, means US adversaries now hold advantages in both technology and doctrinal innovation. The US and Allied industrial base will need to start producing at scale. The service's thinking needs to expand beyond countering a threat to using new capabilities with the right facilities, including ranges where these concepts can

56. Sam Skove, "Marines See Progress with Drones, Despite Flat Budgets," Defense One, March 19, 2024, https://www.defenseone.com/.

be tested and refined, and the right Airmen placed in positions to drive that development. Most important, the Air Force needs its leaders to advocate for these changes, so the service, charged with warfare in and control of the air domain, is able to regain its role as the leader of that domain. Æ

ARMING FOR THE AIR LITTORAL

The Defense Industrial Base and Future Air Warfare

Jennifer Kavanagh

To effectively contest the air littoral, the US Air Force will need to meet two requirements: production at scale and continuous innovation. First, operating in this subdomain against a major power adversary will require an incredible mass of small drones, loitering munitions, and counter-unmanned aerial systems that exceeds the limits of the US defense industrial base and commercial market. Second, rapid innovation beyond the current Department of Defense procurement model is needed. This article describes these challenges and their implications for Air Force operations. It recommends the development of a new paradigm with three lines of effort: a new business model focused on capabilities, not programs; investment in scaling cutting-edge technologies; and a workforce that continuously upgrades the subdomain's systems and software.

US Air Force Chief of Staff David W. Allvin recently reminded his service of adapting to the changing character of air warfare: "Do not get trapped in paradigms of the past." Key among these changes is the emergence of the air littoral—the space between the ground and the sky—as a critical new subdomain.[1] But just as operating in the air littoral will require a "paradigm change in American military thinking about verticality," so too arming for the air littoral will require such a shift in how the Department of Defense thinks about innovating, producing, and integrating the systems needed to operate in the new trans-domain.[2]

Russia's war in Ukraine has illustrated vividly both the peril and the promise of the air littoral for modern militaries.[3] Cheap drones operating at low altitudes over battlefields have allowed Ukraine at times to offset Russia's significant advantage in firepower

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1. Maximilian K. Bremer and Kelly A. Grieco, "To Reinvent Itself, the US Air Force Must Go Big on Small Drones," *Defense News*, April 2, 2024, https://www.defensenews.com/.

2. Maximilian K. Bremer and Kelly A. Grieco, "The Air Littoral: Another Look," *Parameters* 51, no. 4 (Winter 2021–22), https://press.armywarcollege.edu/.

3. Dominika Kunertova, "The War in Ukraine Shows the Game-Changing Effect of Drones Depends on the Game," *Bulletin of the Atomic Scientists* 79, no. 2 (2023).

but have complicated its efforts to advance along entrenched front lines.[4] Meanwhile, Russia has relied on large numbers of small drones to overwhelm Ukrainian air defenses but has been vulnerable to Ukraine's use of longer-range drones against oil refineries deep inside Russia.[5]

The war has also driven home the mass and technological requirements of operating in the air littoral. For example, the Ukrainian armed forces report using up to 50,000 "first person view" drones and burning through hundreds of air defense missiles each month.[6] Sustaining high rates of production and continually innovating to outsmart Russian defenses have challenged Ukraine's defense industry and surpassed the capacity of its Western partners, leaving Kyiv to rely on cheaper Chinese-made systems.[7] Russia has similarly struggled to meet its demand for small drones and munitions. In addition to investing in domestic drone manufacturing, Russia has purchased thousands of Shahed drones from Iran.[8] In a future war involving the United States and a major power adversary, the demands of the air littoral would likely be even greater.

The air littoral is best defined geographically as the space between the ground and 10,000 feet above it.[9] As one analysis asserts, going forward, the contest for air control will depend as much on what happens in this in-between space as it will on ground-based air defense or advanced fighter jets operating at high altitudes in the "blue sky."[10] "Air forces can now operate large numbers of small, relatively cheap drones in the air littoral," the analysis notes, arguing that "a single system cannot persist indefinitely in this airspace, but large numbers of them can achieve persistence indirectly, by continually rotating in and out."[11] The air littoral will be strategically and operationally important across theaters, with some variations. Drones and loitering munitions dominate the skies in Ukraine, making the air littoral nearly decisive to battlefield outcomes. In an East Asian contingency, standoff missile strikes, bombers, and fighters are likely to matter a great deal more, but even here

4. Maximilian K. Bremer and Kelly A. Grieco, "In Defense of Denial: Why Deterring China Requires New Airpower Thinking," *War on the Rocks*, April 3, 2023, https://warontherocks.com/.

5. Marcel Plichta, "Russia's Growing Kamikaze Drone Fleet Tests Ukraine's Limited Air Defenses," *Atlantic Council* (blog), May 14, 2024, https://www.atlanticcouncil.org/.

6. David Axe, "As the Ukrainians Fling 50,000 Drones a Month, the Russians Can't Get Their Drone-Jammers to Work," *Forbes*, February 16, 2024, https://www.forbes.com/.

7. Brett Forrest and Heather Somerville, "How American Drones Failed to Turn the Tide in Ukraine," *Wall Street Journal*, April 10, 2024, https://www.wsj.com/.

8. "How Are 'Kamikaze' Drones Being Used by Russia and Ukraine?," BBC News, December 29, 2023, https://www.bbc.com/.

9. *Joint Maritime Operations*, Joint Publication (JP) 3-32 (Washington, DC: Chairman of the Joint Chiefs of Staff, 2023), I-5; and Bremer and Grieco, "Air Littoral."

10. Bremer and Grieco, "Small Drones"; and "Air Littoral."

11. Bremer and Grieco, "Small Drones."

the ability to contest the air littoral—for example with drone swarms—will be a necessary component of tactical offensive and defensive operations.[12]

To successfully contest the air littoral, the Air Force will need to meet two requirements: production at scale and continuous innovation. First, operating in this subdomain against a major power adversary will require an incredible mass of systems, likely surpassing the capacity of current US suppliers. Competing in the air littoral in East Asia against China, for example, would involve possibly hundreds of thousands of small drones, loitering munitions, and counterdrone systems along with man-portable air defense. "The fact of the matter is: we don't have an industrial base to do this," an expert in critical technologies assessed of meeting the demand for small drones in similar scenarios.[13]

Second, successful operations in the air littoral will require a procurement model that supports constant innovation and that is able to rapidly generate new systems able to overcome adversary defenses or disrupt adversary operations. As seen on the battlefields in Ukraine, adversaries can and will adapt quickly in this subdomain, developing defenses that can degrade, disrupt, or destroy small drones and loitering munitions, either kinetically or using electronic warfare and jamming, rendering any advantage only temporary.[14] As Georgii Dubynskyi, Ukraine's deputy minister of digital transformation, described, "What is flying today won't be able to fly tomorrow."[15]

Although the Department of Defense is often on the cutting edge of emerging technologies, the timeline for translating these into military hardware and software can be lengthy, far exceeding the rapid innovation cycles—days or weeks in length—necessary if the United States is to contest the air littoral with drone and counterdrone systems or other technologies in the future.

Taken together, the demands of operating in the air littoral will strain not only the physical capacity of the US defense industrial base (DIB) but also the Department of Defense's ability to innovate, field, and integrate new systems at scale. These challenges are not insurmountable, but a new business model, new technologies, and the right workforce will be required.

Dueling Dilemmas: Scale and Innovation

Arming for the air littoral will require the Department of Defense and the Air Force to find ways to meet two demanding requirements that are often in conflict: massive scale and rapid innovation. The current US DIB can produce large quantities of munitions if given sufficient time frames and simple designs. It can also innovate to

12. Evan Montgomery, Travis Sharp, and Taylor Hacker, "Quality Has a Quality All Its Own: The Virtual Attrition Value of Superior-Performance Weapons," *War on the Rocks*, June 19, 2024, https://warontherocks.com/.

13. Patrick Tucker, "Can Troops with 3D Printers Save the Pentagon's Mass-Drone Vision?," Defense One, November 22, 2023. https://www.defenseone.com/.

14. Forrest and Somerville, "American Drones."

15. Forrest and Somerville.

produce small numbers of advanced systems. But producing at scale and harnessing emerging technologies simultaneously can be difficult.

Production at Scale

To operate effectively in the air littoral, the United States must be able to produce large numbers of small unmanned aerial systems (UAS) and counter (c)-UAS systems quickly to saturate contested airspace and to replace systems lost to attrition.[16] This concept of operations is likely to significantly strain a US defense industrial base that suffers from limited production capacity, constrained access to key input parts and technologies, and workforce shortages that slow delivery of key systems.[17]

These pressures affect platforms of all kinds, from 155mm ammunition to F-35 fighter jets, but they have unique implications for the small-UAS and c-UAS market. Specifically, the large defense primes that have the capacity to ramp up production quickly are relatively less interested in the small drone market and its low profit margins.[18] This forces the Defense Department to turn to the commercial market, including established defense tech companies and smaller start-ups, to meet the scale demands of the air littoral, but the US commercial drone market is not currently up to the task.[19]

The commercial drone market is presently dominated by Chinese companies, both in terms of quality and quantity. Chinese-made drones continue to win out over those manufactured in the United States.[20] Chinese companies hold three of the top five spots in US drone sales, comprising 90 percent of the commercial market, despite rapid growth among US manufacturers.[21] Chinese firms also dominate the markets for drone components and inputs, so even some US-made drones end up including Chinese-made parts. These are off-limits to the Department of Defense, which is prevented from using drones or component parts made in China and forced to depend on a small number of domestic suppliers.[22]

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16. Bremer and Grieco, "Small Drones."

17. Doug Cameron, "Pentagon Plan to Buy Thousands of Drones Faces Looming Snags," *Wall Street Journal*, September 25, 2023. https://www.wsj.com/.

18. Cameron.

19. Jonathan D. Caverley, "Horses, Nails, and Messages: Three Defense Industries of the Ukraine War," *Contemporary Security Policy* 44, no. 4 (2023); and Jacques S. Gansler and William Lucyshyn, *Commercial-Off-the-Shelf (COTS): Doing It Right* (College Park, MD: University of Maryland, School of Public Policy, Center for Public Policy and Private Enterprise, 2008), https://apps.dtic.mil/.

20. Ben Jiang, "China's Drone Industry Crosses US$14-Billion Mark in Annual Output in 2022 amid Local Market Expansion into Low-Altitude Logistics," *South China Morning Post*, June 5, 2023, https://www.scmp.com/; and Dnyaneshwar Dhanawade, "U.S. Commercial Drone Market Size to Reach USD 14.11 Bn by 2033," LinkedIn, March 7, 2024, https://www.linkedin.com/.

21. Stacie Pettyjohn, "The US Can't Let China Dominate the Small-Drone Market," Center for a New American Security, April 1, 2024, https://www.cnas.org/.

22. Juan Plaza, "The Potential Impact of the 2024 National Defense Authorization Act on the Commercial UAV Industry," Commercial UAV News, January 8, 2024, https://www.commercialuavnews.com/.

In addition to being ubiquitous in the United States and across global markets, Chinese drones are also higher quality: they have more endurance and better cameras, can fly at faster speeds, and are less costly than US-made drones, which have been reported to be "glitchy" on the battlefields in Ukraine, easy to break and hard to maintain.[23] These differences in quality and price reflect the comparative robustness of China's domestic industrial base, bolstered by generous government subsidies, its civil-military fusion, and a high-tech workforce.[24] China's domestic drone production, for example, continues to grow at rates above the global curve.[25]

Notably, it is not only in small drone production where weak supply chains and lack of component parts are obstacles. Other systems needed in the air littoral are affected as well, including mobile air defense systems like the Javelin and Stinger. Low quantities of the motors and specialized semiconductors needed for these man-portable systems have kept Javelin production at just about 2,500 per year and Stinger production at a much lower 750 per year—rates that are far below what would be needed to support the air littoral in a future conflict.[26]

Even if a more robust commercial market for these systems and components existed, however, the Department of Defense is currently not well set up to make use of the additional production capacity. Historically, the United States has not been effective at integrating smaller defense contractors and commercial producers into its procurement cycle.[27] There are efforts to change this, led by the Defense Innovation Unit and others in the Pentagon, but the progress has been slow. In fiscal year 2023, for instance, contracts to defense tech start-ups made up only 1 percent of the total $411 billion in DoD procurement.[28] The Defense Innovation Unit's Blue UAS program aims to ease access for makers of small drones by certifying systems as meeting DoD security requirements, but according to suppliers, residual barriers—institutional and cultural—to commercial technologies remain.[29]

Working with many different types of contractors does come with challenges for the Defense Department, however, as each has its own incentive structures and levels

23. Forrest and Somerville, "American Drones."

24. Brad Howard, "Can U.S. Drone Makers Compete with Cheap, High-Quality Chinese Drones?," CNBC, October 11, 2023, https://www.cnbc.com/.

25. "China's Drone Industry Reports Robust Development: Data," State Council, People's Republic of China, March 30, 2024, https://english.www.gov.cn/.

26. "Ramping Up: Lockheed Martin Steadily Increasing Production of High-Demand Systems," Lockheed Martin (website), February 15, 2024, https://www.lockheedmartin.com/.

27. *Vital Signs 2024: The Health and Readiness of the Defense Industrial Base* (Arlington, VA: National Defense Industrial Association, April 2024), https://www.ndia.org/.

28. Heather Somerville, "Investors Are Betting on Defense Startups. The Pentagon Isn't," *Wall Street Journal*, January 25, 2024, https://www.wsj.com/.

29. Courtney Albon, "Defense Innovation Unit Eyes Partnerships for Drone-Vetting Effort," *C4ISRNET*, January 19, 2023, https://www.c4isrnet.com/.

of flexibility.[30] For instance, the Department of Defense will have much less leverage with a company whose sales are dominated by commercial buyers as compared to a defense tech firm that sells only to military clients.[31]

Given defense budgets, cost acts as a final constraint on achieving scale needed in the air littoral. Not just drones, but also c-UAS, air defense missiles, and loitering munitions manufactured in the United States remain far more costly than similar systems built and operated outside the United States. There are many reasons for this, including the US preference for advanced systems with many bespoke requirements and higher US labor costs.

For example, the Switchblade 600, the first recipient of contracts under the new Replicator Program—an initiative to rapidly procure large numbers of multidomain uncrewed systems, some of which would operate in the air littoral—costs $60,000 to $80,000. At this price, even if the entire $1 billion initially allocated to the program were put toward Switchblade drones, it would still amount to only 12,000 to 17,000 systems—out of a possible total required several hundred thousand.[32] Cost is an even greater challenge in the c-UAS market, where the high price of candidate systems has prevented the Pentagon from acquiring anywhere close to the number of systems it needs to defeat adversary threats.[33]

To sustainably achieve the scale needed to meet the demands of the air littoral, the US military must combine incentives aimed at rapidly increasing and harnessing the domestic commercial drone market for military ends with targeted investments in the DIB to relieve key bottlenecks.

Rapid Innovation

Production at scale will be required to arm for the air littoral, but it alone will not be enough. In the air littoral and during a conflict with a well-armed adversary, the Air Force and the Department of Defense will need to innovate rapidly and continuously, evolving their systems, capabilities, and defenses as the adversary adapts—sometimes in just weeks or days.[34] The service and the Department must embrace a continuous innovation model that focuses both on upgrading military hardware and advancing software.[35]

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30. Jonathan Caverley, Ethan Kapstein, and Jennifer Kavanagh, "One Size Fits None: The United States Needs a Grand Defense Industrial Strategy," *War on the Rocks*, November 16, 2023, https://warontherocks.com/.

31. Caverley, Kapstein, and Kavanagh.

32. Marc Selinger, "Stinger Missile Production to Rise 50% by 2025, US Army Says," Janes, January 25, 2023, https://www.janes.com/.

33. John Grady, "Pentagon to Industry: Build Drones Cheaper, Faster; Cost Per Unit Matters," *USNI News*, February 20, 2024, https://news.usni.org/.

34. Noah Robertson, "Replicator: An Inside Look at the Pentagon's Ambitious Drone Programming," *Defense News*, December 19, 2023, https://www.defensenews.com/.

35. Robert P. Bremner and Kathleen M. Eisenhardt, "Organizing Form, Experimentation, and Performance: Innovation in the Nascent Civilian Drone Industry," *Organization Science* 33, no. 4 (2022).

The current DoD innovation process—from idea generation to fielding—tends to be lengthy and onerous. Years typically pass during the research and development (R&D) phase, followed by prototypes, experimentation, and eventually fielding.[36] Initiatives run through the Defense Innovation Unit, including the Rapid Defense Experimentation Reserve (RDER), are intended to operate more quickly. RDER, for instance, employs "agile development methods" to cut two to four years off the typical development timeline for high demand emerging technologies.[37] These efforts may help address the peacetime innovation problem but will be insufficient in a contingency.

The United States does have some successes when it comes to rapid innovation during wartime. The best-known example is the Mine Resistant Ambush Protected (MRAP) vehicle program, which relied on a bespoke acquisition process to meet the urgent need for vehicles better able to protect against the improvised explosive devices killing American Soldiers in Iraq. Within 24 months of the need being identified in February 2005, the first MRAP vehicles began rolling of production lines. A little more than a year later, almost 7,000 vehicles had been delivered to Soldiers in the field.[38]

To achieve this rapid outcome, the Department of Defense relied only on proven technologies and commercially available products, specified minimal requirements, offered "indefinite delivery indefinite quantity" contracts to nine commercial sources, and used a concurrent testing approach. Notably, of the nine original indefinite-delivery-indefinite-quantity recipients, only one—General Dynamics—is among today's major defense primes.[39] Suppliers were encouraged to use nondevelopmental solutions—items already produced for other US government or Allied entities or commercial items in need of only minor modifications—to the extent possible. The program benefited from investment by contractors themselves, access to critical materials made possible when the Defense Department designated the program its "highest priority," and supplemental appropriations from Congress.[40]

Clearly, the Department of Defense can act outside of normal channels to innovate rapidly. The MRAP program had its shortcomings, however. First, while contractors were able to innovate quickly, they were less effective at innovating continuously, meaning that the MRAP did not evolve as conditions and needs of US Soldiers in Iraq and Afghanistan changed. Second, the program produced far more vehicles than the US military could use, an overcapacity problem that was written off as unavoidable

36. Peter Dombrowski and Andrew L. Ross, "The Revolution in Military Affairs, Transformation and the Defence Industry," *Security Challenges* 4, no. 4 (2008).

37. Jon Harper, "Pentagon Wants $450M for RDER Tech Experiments in Fiscal 2025," Defense Scoop, March 11, 2024, https://defensescoop.com/.

38. *Testimony before the House Armed Services Committee, Defense Acquisition Reform Panel, Defense Acquisitions: Rapid Acquisition of MRAP Vehicles, Statement of Michael J. Sullivan, Director Acquisition and Sourcing Management* (Washington, DC: US Government Accountability Office [GAO], October 8, 2009), https://www.gao.gov/.

39. Marine Corps Systems Command, "Marine Corps Announces Mine Resistant Ambush Protected Vehicle Contracts," US Marines (website), January 26, 2007, https://www.marcorsyscom.marines.mil/.

40. *Statement of Michael J. Sullivan*.

but that represented wasted resources.[41] Third, small defense suppliers were the winners in the initial round of contracts, but soon the larger defense primes swept up much of the MRAP production, crowding out the original innovators.[42]

This example provides positive and negative lessons when applied to the air littoral. Using many contractors simultaneously, relying on proven technologies and existing systems, and employing a concurrent testing approach were integral to the program's success and should be replicated in efforts to ramp up the production of small-UAS, c-UAS, and other air littoral capabilities. But multiyear contracts that did not incentivize continued innovation, together with inflated production targets, resulted in unnecessary expense, privileged large defense contractors, and ultimately left US military personnel vulnerable in the longer run.

To avoid these mistakes in the future, the Department of Defense will need to balance processes built to encourage rapid innovation and production at scale with contract mechanisms that favor caution, incrementalism, and risk aversion. Further, contract mechanisms must guarantee the ability to quickly surge, decrease, or reallocate production of specific systems as battlefield demand signals change.[43]

The MRAP example also provides several warnings about current Air Force and DoD approaches to arming for the air littoral. First, the success of the MRAP program relied fundamentally on the existence of a robust commercial market able to rapidly develop a new product and scale efficiently. This does not exist in the case of small drones—or other air littoral technologies such as c-UAS or loitering munitions.

Second, the MRAP program relied on special access to critical materials and supplemental funding. Thus far, efforts to arm for the air littoral have not had either but have instead faced supply constraints and relied on funding taken from elsewhere in the DoD budget.[44] Third, while the MRAP's timeline is impressive compared to other similar programs, the innovation cycle for drones and loitering munitions intended for the air littoral would need to be substantially faster and the Defense Department would need to field more systems—on the order of 10 times as many—and more diverse systems, for an extended period of time.

Finally, even with rapid innovation of new military hardware like that accomplished by the MRAP, air littoral operations can only be sustained if the lifespan of existing platforms can be extended with software updates, system upgrades, and rapid remote repairs to overcome adversary adaptation. Right now, this is not possible.[45]

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41. Chris Rohlfs and Ryan Sullivan, "The MRAP Boondoggle," *Foreign Affairs*, July 26, 2012, https://www.foreignaffairs.com/.

42. *FY2010 Annual Report* (Washington, DC: Office of the Director, Operational Test and Evaluation, December 2010), "Mine Resistant Ambush Protected (MRAP) Family of Vehicles," 29–30, https://www.dote.osd.mil/.

43. Jerry McGinn, "How to Use the 'MRAP Mindset' to Get US Industrial Base on a Wartime Footing," Breaking Defense, January 3, 2024, https://breakingdefense.com/.

44. Matt Berg, " 'Disorganized and Confusing': Lawmakers, Industry, Rip Pentagon Plans for Drones," *Politico*, December 17, 2023, https://www.politico.com/.

45. Forrest and Somerville, "American Drones."

US drone manufacturers report that while they have the technical ability to update drone software to overcome Global Positioning System jamming and electronic warfare challenges, they are prevented from easily doing so by long DoD review processes, rendering US drones obsolete in Ukraine.[46] Delays are caused largely by institutional and workforce issues. Specifically, the software systems running small drones and other air littoral systems are managed by contractors, not in-house military personnel. This is largely a function of the limited number of skilled coders in uniform across the military services.

Some sort of safety review is required to guard against cyber threats and sabotage, but the current process can take weeks or months—far too long on an active battlefield. While the Defense Innovation Unit is working to reduce the timeline to a few days, even this may be too long in contested environments where the goal is persistent presence.[47]

While the Department of Defense tends to think of innovation as episodic, the air littoral will necessitate that the process is continuous. Achieving this end will require an evolution not just in military hardware but also, crucially, the software on which that hardware runs. Like efforts to achieve production at scale, this type of innovation will also lean heavily on the commercial sector, which has been on the cutting edge of drones and emerging technologies.

A New Paradigm

Meeting the dual challenges of achieving production at scale and maintaining continuous innovation to arm for the air littoral necessitates a change in paradigm. Neither spending more to expand production capacity nor leaning into new emerging technologies alone will suffice. Instead, the Department of Defense and Air Force will need a new approach: (1) Commercial suppliers must be the center of product development and procurement; (2) the Department and service must shift from a reliance on advanced technologies to commercially available and proven capabilities that can be scaled more rapidly; and (3) the Department and service must prioritize utility and versatility over complexity, seeking the good-enough rather than the perfect solution.

Three changes will jumpstart this transformation, namely, a new business model, new technologies, and a new workforce.

A New Business Model

The Defense Department and the Air Force will need to develop a new business model that can mobilize not just the defense industrial base but the broader US industrial base, to support rapid production at scale while supporting continuous innovation.

The elements of a new business model for the DIB to support the air littoral can be pulled from past rapid manufacturing and innovation successes. The MRAP program offers one model, best suited for areas where there are already commercially available

46. Forrest and Somerville.
47. Forrest and Somerville.

technologies and many available suppliers. Operation Warp Speed (OWS), used to rapidly develop and manufacture COVID-19 vaccines across the United States during the global pandemic, offers another case when there are no existing commercial solutions and where rapid innovation requires more significant R&D dollars.

Operation Warp Speed, a public-private partnership, allocated substantial government funds to support first the research and development of multiple different vaccine candidates and then to rapidly manufacture the most promising technologies while testing was still ongoing. By allocating funding across many candidate technologies and vaccines, the US government was able to reduce risk while also benefitting from competition between candidate pharmaceutical firms. Upfront government funding and use of simultaneous testing sped manufacturing processes while ensuring the efficacy and safety of vaccines. Even as first rounds of doses were still being delivered, pharmaceutical firms were already hard at work on new vaccines tuned to the latest virus variants.[48]

A new business model to support the production of the UAS, c-UAS, air defense, and loitering munitions needed for the air littoral could draw from both the MRAP and the OWS examples. The Department of Defense would offer upfront R&D dollars to a consortium of contractors, including primes, smaller defense tech suppliers, and commercial entities, to support the development of prototypes. It would offer indefinite-delivery-indefinite-quantity contracts to the most promising prototypes, as was done with the MRAP, prioritizing—at least at first—commercial suppliers with proven capacity and mature technologies that can be scaled quickly. Prototypes would then enter experimentation and initial manufacturing simultaneously. Subsequent rounds of contracting could allocate a portion of available funds to big bets on new emerging technologies or to new products from nontraditional defense suppliers more akin to the OWS model.

By continuing to incentivize new product lines and technological breakthroughs, even as it funds longer-term programs, the Department of Defense can avoid some of the rigidity and calcification that affected the MRAP in its later phases. Key to the success of this approach would be ensuring rapid growth in the commercial drone market even outside of DoD initiatives. The Defense Department and Air Force might encourage joint ventures to take advantage of economies of scale and fully utilize production capacity. Working more closely with Allies and partners in the commercial drone market, much as the United States has started to do with shipbuilding and repair with Allies such as South Korea and Japan, is another avenue to pursue.[49]

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48. *Report to Congressional Addresses, Operation Warp Speed: Accelerated COVID-19 Vaccine Development Status and Efforts to Address Manufacturing Challenges* (Washington, DC: GAO, February 11, 2021), https://www.gao.gov/.

49. John Geddie and Tim Kelly, "U.S. Wants Japanese Shipyards to Help Keep Warships Ready to Fight in Asia," Reuters, January 19, 2024, https://www.reuters.com/; and Choi Kang and Peter K. Lee, "Why U.S. Naval Power Needs Asian Allies," *War on the Rocks*, January 12, 2024, https://warontherocks.com/.

Such a model would require Congress to fund UAS and c-UAS development in a more open-ended way than is done currently, attaching money to a capability rather than specific programs.[50] With money attached to air littoral capabilities like UAS or c-UAS, for example, it would be up to the Department of Defense to allocate funding across relevant lines of effort, adapting the set of funded programs as the threat on the battlefield evolves to ensure a steady stream of new technologies even as it worked to accumulate the required mass of systems.

In addition, although multiyear funding has typically been reserved for large platforms such as planes and ships and more recently munitions, there is an argument to be made that the development and manufacturing of UAS and c-UAS capabilities would be most effective and responsive if multiyear funding streams were attached to these capabilities—though not necessarily to specific systems—to allow for long-term acquisition strategies.[51]

Beyond a new funding model, some additional money will likely be required to meet the needs of the air littoral. Both OWS and the MRAP program required large amounts of supplemental funding that is not currently available for efforts to arm for the air littoral.[52] Subsidies of some kind will likely be required to push the commercial drone market forward, just as the Biden administration has done for other key tech sectors central to US national security.[53] Given tight defense budgets, increases in funding for the air littoral will also likely require cuts elsewhere, creating hard choices for Air Force leaders between advanced fighters, long-range drones, and smaller attritable systems.[54]

New Technologies

Adopting this new business model would support efforts to achieve production at scale without simply falling back on larger defense budgets, but this may not be enough on its own to overcome physical limitations. Leveraging cutting-edge technological advances could also help address these constraints and speed innovation, potentially at lower cost in the long run. A few areas warrant particular mention, though in all cases the challenge will be producing the new technology at scale.

First, 3D printing and other additive manufacturing techniques can speed up production and innovation cycles and reduce costs. For example, 3D printing can be employed to produce component and replacement parts—especially useful where there are currently few secondary suppliers—or to rapidly create prototypes to test the

50. Lauren C. Williams, "Don't Call It a Slush Fund: Pentagon's Top Buyer Says Looser Pursestrings Will Foster Innovation," Defense One, February 12, 2024, https://www.defenseone.com/.

51. Ronald O'Rourke, *Multiyear Procurement (MYP) and Block Buy Contracting in Defense Acquisition: Background and Issues for Congress*, R41909 (Washington, DC: Congressional Research Service [CRS], April 29, 2024), https://sgp.fas.org/

52. *Operation Warp Speed*.

53. "FACT SHEET: CHIPS and Science Act Will Lower Costs, Create Jobs, Strengthen Supply Chains, and Counter China" (Washington, DC: White House, August 9, 2022), https://www.whitehouse.gov/.

54. Bremer and Grieco, "In Defense of Denial."

viability of new design ideas. Small drones have also been successfully manufactured using 3D printing, and some hope the technology could serve as another way to increase production capacity.[55]

Ukrainian forces have relied on 3D printed drones to help overcome their limited munitions stockpiles, and US forces in the Middle East are also experimenting with 3D printed drones that could be armed with explosives or electronic jammers to serve in a c-UAS capacity.[56] Currently, however, when it comes to military applications, the technology is still in the "interim phase" and cannot produce systems at scale.[57]

A second area, nanotechnology, can support the development of lighter, smaller drones, munitions, and c-UAS systems that can fly farther and faster.[58] This is especially important for East Asia scenarios where occupying the air littoral will mean covering longer distances. Nano-drones can be used for gaining intelligence and conducting surveillance of adversary defenses, as they have done in Ukraine. Production of nano-drones at scale can also open new delivery options for systems into the air littoral, including a mothership drone that releases large numbers of miniature systems or uncrewed underwater systems that release aerial drones.

Advances in areas such as robotics and quantum mechanics will also be essential to effective operations in the air littoral. Quantum technologies will allow for more secure encrypted communications and coordination between UAS and c-UAS of different types and from different suppliers.[59] Robotics and artificial intelligence (AI) can create UAS and c-UAS systems that will respond to their environment, adapt, and learn, potentially without manual system upgrades.[60]

In the c-UAS space, the US military is currently experimenting with several technologies, including nonkinetic capabilities—such as directed and microwave energy and jamming—and kinetic effects.[61] Although some systems have been fielded in small numbers, the big challenge remains achieving production at sufficient scale and low unit cost. Scaling systems that rely on directed and microwave energy has proven difficult thus far due to technical complexity and because these weapons require scarce inputs.

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55. Tucker, "Troops with 3D Printers."

56. J. P. Lawrence, "Air Force Tech Squad in Middle East Expands Mission into 3D-Printed Drones," Aviation Pros, October 25, 2023, https://www.aviationpros.com/.

57. Noah Robertson and Megan Eckstein, "Why the Pentagon's Use Of 3D Printing Is 'Not Quite There Yet,' " *Defense News*, April 10, 2024, https://www.defensenews.com/.

58. Rory Jackson, "Small Is Beautiful: Nano Drone Tech Is Advancing," Defence IQ, July 20, 2017, https://www.defenceiq.com/.

59. Ishveena Singh, "US is Developing Drones with 'Unhackable' Quantum Communication Technology," DroneDJ, May 26, 2022, https://dronedj.com/.

60. Noah Bressner, "Pentagon Stares Down 'Drone Swarm' Threat," Axios, March 15, 2024, https://www.axios.com/.

61. Ashley Roque, "Spurred by Ukraine Conflict, US Army Conducts New Tests of Kinetic, Microwave Counter-UAS Systems," Breaking Defense, July 13, 2023, https://breakingdefense.com/.

Current systems using these technologies have a unit cost of $100,000 or more, 10 times what the Pentagon says would be needed to acquire systems in sufficient numbers.[62]

Achieving the necessary breakthroughs in these technologies to speed production, increase capacity, and accelerate integration and innovation in a cost-effective way is not guaranteed. In addition to investing in research and development, the Air Force should further expand partnerships with science, technology, engineering, and mathematics (STEM) programs at research universities much as the Department of Defense has already done in the area of AI.[63] Incentives provided to commercial manufacturers could speed development of these technologies as well, and hiring authorities that bring in highly qualified experts can jumpstart new lines of research within the Department of Defense and aid in the integration of new capabilities.

Finally, the United States should also make technologies relevant to the air littoral a central part of defense industrial cooperation with Allies and partners. Some emerging technologies—autonomy and quantum—are included in Pillar 2 of the Australia-United Kingdom-United States (AUKUS) agreement, for example, but the United States should seek to collaborate more with NATO and other Allies such as Japan and South Korea.[64] New technologies will not be a cure-all for speed, mass, innovation, or obsolescence challenges, but they can serve as multipliers.

A New Workforce

Arming for the air littoral will also require a new military and civilian defense tech workforce. All the advanced technology in the world cannot alter the outcomes on the battlefield without the right personnel to build, repair, and manage that technology.[65] The current DIB workforce is insufficient for the air littoral for two reasons. First, it lacks enough skilled workers across key supply chains to produce necessary input components and for later stage manufacturing of relevant military hardware.[66]

This is a problem across the DIB, not one specific to the drones, munitions, and c-UAS systems needed in the air littoral. Investments in technical training programs and colleges, apprenticeship programs, and efforts to make better use of AI and robotics in manufacturing are just some of the promising strategies to build the necessary capacity. Workforce also receives attention in the DoD's *National Defense Industrial Strategy*.[67]

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62. Colin Demarest, "Drone-Killing Costs Must Come Down, Says Pentagon's Chief Weapons Buyer," *C4ISRNET*, April 25, 2024, https://www.c4isrnet.com/.

63. "AI Collaboration Supports U.S. Army Operations," Carnegie Mellon University, 2020, https://www.sei.cmu.edu/.

64. Patrick Parrish and Luke A. Nicastro, *AUKUS Pillar 2: Background and Issues for Congress*, R47599 (Washington, DC: CRS, June 20, 2023), https://crsreports.congress.gov/.

65. Antonio Calcara et al., "Why Drones Have Not Revolutionized War: The Enduring Hider-Finder Competition in Air Warfare," *International Security* 46, no. 4 (2022).

66. John A. Tirpak, "New Report: Defense Industrial Readiness 'Going in the Wrong Direction,' " *Air & Space Forces Magazine*, February 9, 2023, https://www.airandspaceforces.com/.

67. *The National Defense Industrial Strategy (NDIS)* (Washington, DC: Department of Defense, 2022), https://www.businessdefense.gov/.

The second workforce challenge—more specific to the air littoral—is what some have called the need for an "army of coders." The United States must build a cadre of skilled technologists in and out of uniform able to program, integrate, update, command, and protect the small drones and c-UAS systems, loitering munitions, and man-portable air defense that will occupy or operate in the air littoral.[68] These workers will be essential to achieving the continuous innovation required by operations in the air littoral, especially when it comes to the crucial software that will power and protect UAS and c-UAS systems.

Building a corps of computer scientists and AI professionals will be a joint effort between the Air Force and other services and the civilian sector. Efforts on the civilian side are well underway, though there are still shortages. Initiatives to grow university and high school STEM programs and to fund internship programs, on-the-job training, and hiring incentives can work to expand this career field, like others.

Building a military counterpart to this civilian tech workforce will be more challenging. While it makes little sense for it to duplicate civilian capabilities exactly, the Air Force will need a group of uniformed professionals able to lead and manage future battles in the air littoral. To operate with agility and speed, the Air Force will need experienced coders integrated into forward-deployed units, reprogramming drones and munitions in real-time, and generating new ideas and operational concepts as fighting continues. Uniformed personnel will need to be able to directly manipulate the software on which their air littoral's UAS and c-UAS systems run, both for faster upgrades and troubleshooting and to stimulate bottom-up innovation.[69]

The Air Force should make use of the advantages provided by its large pool of trainable workers and an effective career-spanning training system. It could incorporate coding into all levels of training and education while also cycling high performers through specialized software development and coding courses. Creating data science career fields and offering retraining or cross-training incentives could also be beneficial. Retaining highly trained computer and data scientists against a private sector that will be able to offer higher salaries and more stability may be difficult. Sending military personnel to outside training programs, use of retention bonuses, and greater use of lateral hires can help overcome these obstacles.

Conclusion

While some military analysts argue future wars will be shaped primarily by breakthrough technologies that give the United States a decisive military advantage—hypersonics, for example—others argue that wars will only be won by mass and attrition

68. John Ferrari and Charles Rahr, "Army of Coders Needed to Make Replicator Drone Initiative a Success," *C4ISRNET*, September 14, 2023, https://www.c4isrnet.com/; and Jon Lindsay, " 'War upon the Map': User Innovation in American Military Software," *Technology and Culture* 51, no. 3 (2010).

69. Nina Kollars, "Military Innovation's Dialectic: Gun Trucks and Rapid Acquisition," *Security Studies* 23, no. 4 (2014).

as seen in Ukraine.[70] Future battles in the air littoral will require both. Arming for the air littoral requires leveraging and integrating new technologies at scale and producing and employing large numbers of systems. In addition to necessary investments in manufacturing capacity and technology, the Department of Defense and the Air Force will need a fundamentally new paradigm that aims to build a suite of capabilities that is constantly evolving and adapting to the threat environment.

A new business model is needed, one that focuses on capabilities, not programs. This model would incentivize rapid innovation and production, cutting-edge technologies, and a workforce able to continually transform systems for the air littoral in response to changes in threats and operational concepts. This will require developing new procedures and processes, working with Congress to develop new funding models, building new public-private partnerships, investing in STEM education and training, and leveraging the complementary expertise of key Allies and partners.

The changes recommended here will also have spillover benefits across the defense industrial base. The need for a new DIB paradigm likely extends across domains and platforms, and efforts to arm for the air littoral can lead the way to a more resilient US DIB with more production and innovation capacity and a more robust workforce. The Air Force should start what could be a lengthy transition now with an eye toward creating future leaders primed to arm and operate in the air littoral. Æ

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70. Paul Lushenko, "AI and the Future of Warfare: US Military Officers Can Approve the Use of AI-Enhanced Military Technologies That They Don't Trust. That's a Serious Problem," *Bulletin of the Atomic Scientists*, November 29, 2023, https://thebulletin.org/; and *Testimony from Outside Experts on Recommendations for a Future National Defense Strategy: Hearing before the Committee on Armed Services, US Senate, Day 1*, 115th Cong. 231 (2002), https://www.govinfo.gov/.

BEYOND AIR SUPERIORITY

The Growing Air Littoral and Twenty-First-Century Airpower

Michael P. Kreuzer

This article proposes a fundamental reexamination of the nature of airpower in the twenty-first century. The development and diffusion of technology democratizing airspace and increasing both offensive and defensive capabilities have served to significantly expand the air littoral in the past 20 years, upending decades of assumptions about airpower. Airmen today must see airpower as bigger than manned flight, neither inherently offensive nor defensive, not contingent on first gaining air superiority to exploit airpower effects, and neither a necessary nor sufficient condition for success in modern military operations.

January 28, 2024, marked a particularly somber day for the US Air Force. Beyond the loss of three comrades to terrorists in the Middle East, the uncrewed aerial system attack against US service members at a military base near Jordan marked a dark but long-anticipated epoch for airpower: the first time in nearly 70 years that the US military lost ground combatants to an adversary airstrike, excluding missile attacks and attacks of the nature of 9/11.[1] As the US Air Force looks to a future sixth-generation of fighter aircraft and advanced bombers with the Next Generation Air Dominance plan aimed at establishing "continued air dominance," Russia's ongoing war in Ukraine, and recent experiences in the Middle East and Central Asia, it remains evident that tactical and operational air dominance is fleeting and in danger of being lost in the air littoral.[2]

Given these experiences and lessons, it is time to fundamentally re-evaluate some of the stale assumptions that serve as the foundation of airpower theory. Italian army general and airpower theorist Giulio Douhet's argument that strategic bombardment is a morale killer rather than an operational capability to degrade adversaries is weak

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1. C. Todd Lopez, "3 U.S. Service Members Killed, Others Injured in Jordan following Drone Attack," US Department of Defense (DoD), press release, January 29, 2024, https://www.defense.gov/.

2. IDGA Editor, "Flying into the Future: The NGAD Program Explained," Institute for Defense and Government Advancement, February 7, 2024, https://www.idga.org/.

at best.[3] Most importantly, the US military's experience since the First Gulf War makes clear that local and expeditionary limited wars, not direct great power conflict, will likely remain the key operational challenge of all-domain forces under great power competition.[4]

This article proposes rethinking the role of air forces in great power competition, using the lessons of 20 years of US experiences in the war on terror, recent air operations in Ukraine and related conflicts, and the backdrop of airpower in the Cold War as cause to rethink fundamental assumptions. The development and diffusion of technology democratizing airspace and increasing both offensive and defensive capabilities have served to significantly expand the air littoral in the past two decades, complicating battlespace geometry, threatening command-and-control relationships, and ultimately minimizing the vision of airpower within the US Air Force to the high-end fight for air superiority against a near peer.

Air superiority is defined in this article according to US Air Force doctrine; it is "that degree of control of the air by one force that permits the conduct of its operations at a given time and place without prohibitive interference from air and missile threats."[5] This definition is somewhat elusive, as "prohibitive interference" is ill-defined, so this article further interprets air superiority to be an air domain situation more in favor of US and Allied forces than "parity" or "contested" airspace, but not to the level of control as defined by *air supremacy*, "that degree of control of the air wherein the opposing force is incapable of effective interference within the operational area using air and missile threats."[6]

The ability to exploit the air domain in order to coerce adversaries is significantly more complex than manned fighters and bombers, and absent an active Air Force voice in shaping doctrine and ideas within the air littoral, skeptics are likely to grow louder in their critique both of the need for advanced airpower weapons and the need for an independent air service.[7]

Challenges of the Classic Airpower Paradigm

The US Air Force has from its inception relied largely on the core assumptions of Douhet, who stated in the interwar years, "Nothing man can do on the surface of the

3. See Mitt Regan, "Drone Strikes and Evidence-Based Counterterrorism," *Lawfare*, June 2, 2022, https://www.lawfaremedia.org/; and Robert A. Pape, *Bombing to Win: Air Power and Coercion in War* (Ithaca, NY: Cornell University Press, 2014), https://doi.org/.

4. "Eight 'Hot' Wars during the Cold War," Council on Foreign Relations, CFR Education, last updated May 25, 2023, https://education.cfr.org/.

5. See "Air Force Doctrine Advisory: Control of the Air" (Maxwell AFB, AL: Curtis LeMay Center for Doctrine Development and Education [LeMay Center], July 31, 2017), https://www.doctrine.af.mil/; and *Counterair Operations*, Air Force Doctrine Publication (AFDP) 3-01 (Maxwell AFB, AL: LeMay Center, June 15, 2023), 2, https://www.doctrine.af.mil/.

6. AFDP 3-01, 2.

7. See David Barno and Nora Bensahel, "Drones, the Air Littoral, and the Looming Irrelevance of the US Air Force," *War on the Rocks*, March 7, 2024, https://warontherocks.com/.

earth can interfere with a plane in flight, moving freely in the third dimension" and "[c]onquering the command of the air implies positive action—that is, offensive and not defensive action, the very action best suited to airpower."[8] This sentiment was expanded upon by Army Brigadier General Billy Mitchell, who in his magnum opus *Winged Defense* stated, "No missile-throwing weapons or any other devices have yet been created or thought of which can actually stop an air attack, so that the only defense against aircraft are other aircraft which will contest the supremacy of the air by air-to-air battles."[9]

This perspective manifests itself today in the foundational documents of the US Air Force. Air Force Doctrine Publication (AFDP) 1 notes the evolution of airpower "stems from the Airman's original vision of combat from a distance, bypassing the force-on-force clash of surface combat."[10] This vision lays out a system of airpower where command of the air is a prerequisite for control of the surface beneath the air—that the air domain must be controlled before it can be exploited, and therefore the initial and potentially decisive campaign of any conflict is the initial air war. Indeed, AFDP-1 lists the first "truth" of the Airman's perspective as "control of the air is a necessary precondition for control of the surface." It notes that "the "first mission of an air force is to defeat or neutralize the enemy airpower so friendly operations in all domains can proceed."[11]

Since the initial articulations of Douhet, Mitchell, and others, the majority of airpower scholarship has focused on how command of the air should be exploited. For Douhet, the command of the air meant "to be in a position to wield offensive power so great it defies human imagination," which included not just the ability to destroy the efficient operations of the army and the navy, but to take the war directly to the civilian population through conventional and gas bombing, as "all of their citizens will become combatants, since all of them will be exposed to the aerial offensives of the enemy."[12]

In contrast to this position, the bulk of American conventional doctrine to date is ultimately derived from the interwar Air Corps Tactical School and follows through modern theorists John Warden and David Deptula, emphasizing parallel warfare against the adversary's "vital centers," including leadership, industrial production, infrastructure, and then ultimately populations and fielded forces.[13]

The specifics have evolved through multiple iterations over recent decades, but the core principles of precision engagement of critical nodes beyond the battlefield remain the essence of airpower discussion. That said, echoes of Douhet remain, in both

8. Giulio Douhet, *The Command of the Air*, trans. Dino Ferrari (Maxwell AFB, AL: Air University Press [AUP], 2019), 9, 17, https://www.airuniversity.af.edu/.

9. William Mitchell, *Winged Defense* (Tuscaloosa: University of Alabama Press, 2010), 8–9.

10. Charles Q. Brown Jr., *The Air Force*, AFDP 1 (Maxwell AFB, AL: LeMay Center, March, 10, 2021), 7, https://www.doctrine.af.mil/.

11. AFDP 3-01, 8.

12. Douhet, *Command of the Air*, 20, 9.

13. Michael P. Kreuzer, *Drones and the Future of Air Warfare: The Evolution of Remotely Piloted Aircraft* (New York: Routledge, 2016).

the nuclear deterrence strategy of theorist Bernard Brodie and even modern airpower leaders who see enemy morale as the most critical vital center. In the words of one recently retired Air Force general, "There's nothing like the morale-killing nature of air-delivered weapons to destroy an enemy's will to fight."[14]

The assumptions of early airpower theorists were logical given the technology and strategic culture at the dawn of the age of airpower. Absent the invention of radar, which would not be operationalized for air threats until the years immediately preceding World War II, the ability to exploit the third dimension of airspace and the vastness of the air simply offered opportunities for early theorists to hypothesize how the air domain could be exploited to avoid the stalemate of the trenches of World War I. Speed, maneuver, and the lack of a capability to intercept incoming aircraft meant that "the bomber would always get through," and that "the only defence is in offence, which means that you have got to kill more women and children more quickly than the enemy if you want to save yourselves."[15]

Rockets and missiles did not appear until World War II, and though drones existed in small numbers for limited missions dating to the interwar years they would not be a factor in most combat situations until the late twentieth century. Airpower meant relatively limited manned aviation in an environment absent significant warning capabilities.

A century of air and combined arms warfare demonstrated flaws in this perspective. The first major case of strategic bombing theory, the Combined Bomber Offensive of World War II, produced mixed results that remain highly contested today. From a material perspective, one World War II historian argued strategic bombing absorbed significant resources that could otherwise have been used on the Eastern Front, while the *US Strategic Bomber Survey (Europe War)* considered attacks on railways and waterways "the decisive blow that completely disorganized the German economy."[16] This perspective has its share of critics, however—notably one critique that the conventional wisdom oversimplified the relationship between a state's economic output and military power, likely owing to the nature of the capitalism versus communism rivalry at the core of post–World War II international relations.[17]

From an "offense is the essence of airpower" perspective, both the United Kingdom and Luftwaffe demonstrated key nodes could be effectively defended by aircraft, rendering the Combined Bomber Offensive an aerial frontal assault against a fortified adversary position in a number of ways. High losses for the Eighth Air Force in particular challenged the myth that the bomber would get through. Even though it was thought

14. Bruce Wright, "Airpower Is the Key to Victory in Ukraine," *Air & Space Forces Magazine*, February 28, 2023, https://www.airandspaceforces.com/.

15. Stanley Baldwin, "A Fear for the Future: Speech before the House of Commons of the United Kingdom, November 10, 1932" (reproduced online by Center for Strategic & International Studies [CSIS]), Missile Threat, accessed October 17, 2023, https://missilethreat.csis.org/.

16. Richard Overy, *The Bombers and the Bombed: Allied Air War over Europe, 1940–1945* (New York: Viking, 2013); and *The United States Strategic Bombing Survey: Summary Report* (1945; repr., Maxwell AFB, AL: AUP, October 1987), 30, https://www.airuniversity.af.edu/.

17. John Kenneth Galbraith, *The Affluent Society* (New York: Houghton Mifflin, 1958).

that at least some bombers out of many would pass through the defenses, the works of Douhet and other interwar contemporaries paired with this observation led to a common belief in the run-up to World War II that bombers would be nearly invulnerable.

From a morale perspective, most observers—to include both the US and UK bomber surveys—found that contrary to prewar expectations, morale was not significantly impacted by vulnerability to strategic bombing, with the minority of more recent scholarship holding that surveys in Germany late in the war suggested bombing was effective in convincing the German population that the war was lost.[18] The Battle of Britain meanwhile proved the value of defense and denial against the Luftwaffe while further undercutting the preposition that strategic bombing weakens, rather than hardens, civilian morale.

The US Air Force spent much of the 1950s building a force prepared to rapidly intercept Soviet bombers over the North Pole while expanding its own nuclear delivery capabilities. Instead of fighting and winning that planned air war over the pole, the result was a stream of proxy wars and airpower frustrated in limited conflicts in Vietnam, Afghanistan, and Iraq, where forces had to rapidly adapt to adversaries lacking fixed industrial infrastructure that were thus able to evade the industrial targeting models.[19]

At the same time, wars fought between conventional air forces against traditional military targets ran into significant roadblocks as air defenses rapidly grew. Egypt, with Soviet integrated defense systems, left Israel unable to replicate its decisive Six Day War air campaign successes in the 1973 Yom Kippur War.[20]

The threats of anti-access/area denial continue to menace US Air Force strategy in both Europe and the Pacific well into the third decade of the twenty-first century.[21] While airpower arguably was the decisive factor in conflicts in Yugoslavia during the 1990s, air supremacy did not guarantee success in Afghanistan or Iraq, and the "shock and awe" campaign was of limited utility against Saddam Hussein in 2003. The current Air Force desire to template the Desert Storm strategy ignores both the contested legacy of the Gulf War's success and the fact that America's adversaries learn and adapt their strategy accordingly.[22]

Despite the historical record showing numerous challenges to the premise that command of the air will ensure victory in future conflicts, the underlying appeal of offensive

18. John Buckley, *Air Power in the Age of Total War* (London: UCL Press, 1998).

19. Shane P. Hamilton and Michael P. Kreuzer, "The Big Data Imperative: Air Force Intelligence for the Information Age," *Air & Space Power Journal* 30, no. 2 (January 2018), https://www.airuniversity.af.edu/.

20. Robert P. Givens, "Chapter 3: 1973 Yom Kippur War," in *Turning the Vertical Flank: Airpower as a Maneuver Force in the Theater Campaign*, Cadre Paper (Maxwell AFB, AL: AUP, 2022), https://www.jstor.org/.

21. Andrew Krepinevitch, Barry Watts, and Robert Work, *Meeting the Anti-Access and Area-Denial Challenge* (Washington, DC: Center for Strategic and Budgetary Assessments, 2003), https://csbaonline.org/; and Luis Simón and Alexander Lanoszka, "The Post-INF European Missile Balance: Thinking about NATO's Deterrence Strategy," *Texas National Security Review* 3, no. 3 (2020), http://dx.doi.org/.

22. Mike Fowler, "The Rise of the Present Unconventional Character of Warfare," Strategy Bridge, November 4, 2019, https://thestrategybridge.org/.

airpower's potential to bypass land operations for decisive air campaigns remains the elusive goal of air forces. The AFDP-1 pronouncement of the vital need first to gain control of the air, echoing Douhet and Mitchell, may hold true under limited conditions. It is likely true that air superiority, achieved through neutralizing enemy airpower, is necessary for conventional offensive military operations. For all other operations, including defensive operations and irregular warfare, the pursuit of control of the air may not just be unnecessary, but counterproductive.

The Expanding Air Littoral

Scholarly analysis has highlighted the immediate challenge to US airpower theory, defining the air littoral generally as the area from the coordinating altitude to the Earth's surface, which must be controlled to support land and maritime operations and can be supported and defended from the air and/or the surface.[23] The air littoral in this construct represents a transdomain region similar to the maritime littoral, where there is overlap in mission and projection capabilities between two or more domains.

Though the terminology is new, the challenges of the air littoral have existed for decades. US doctrine defines the land domain as "[t]he area of the Earth's surface ending at the high-water mark and overlapping with the maritime domain in the landward segment of the littorals," and the air domain as "[t]he atmosphere, beginning at the Earth's surface, extending to the altitude where its effects upon operations become negligible."[24]

Though the land domain speaks only to surface territory, analysts readily observe the US Army has nearly as many aircraft as the US Air Force, with approximately 4,400 and 5,200 total aircraft, respectively.[25] The Air Force's focus on air superiority and targeting beyond the battlefield had the effect of leaving much of tactical aviation—particularly rotary wing and tactical surveillance and reconnaissance—to Army aviation, and with it significant operational and doctrinal challenges.

Figure 1 illustrates the historically narrow air littoral, noting the traditional fire support coordination line (FSCL), forward edge of battle area (FEBA), and forward line of troops (FLOT), defining battlespace geometry for operational coordination and deconfliction.

23. Maximilian K. Bremer and Kelly A. Grieco, "The Air Littoral: Another Look," *Parameters* 51, no. 4 (Winter 2021–22), https://press.armywarcollege.edu/.

24. Michael P. Kreuzer, "Cyberspace Is an Analogy, Not a Domain," Strategy Bridge, July 8 2021, https://thestrategybridge.org/.

25. *World Air Forces 2021* (London UK: FlightGlobal, 2020), https://www.flightglobal.com/.

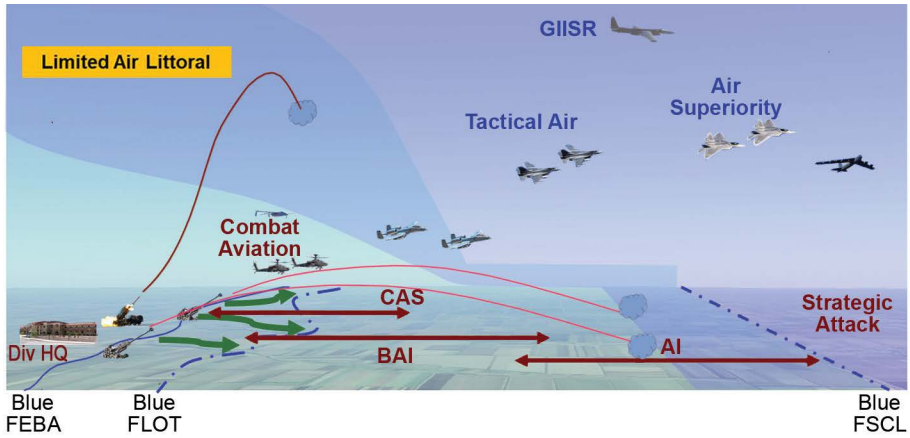

Figure 1. Limited overlap in air domain and land domain air operations, deconflicted through control mechanisms

The challenge of deconflicting air roles and missions is a struggle that predates the US Air Force's service independence in 1947, raged throughout the Cold War, reached a tenuous consensus in the aftermath of Desert Storm, and only to a degree lay dormant through much of the war on terrorism as the absence in most cases of a deep fight left many of the debates seem antiquated.

The Joint Chiefs of Staff have issued multiple memoranda to deconflict modern allocation of roles and missions—from the 1948 Key West Agreement to the Pace-Finletter Memorandum of Understanding and McConnell-Johnson Agreement—but no formal codification of a boundary exists.[26] Generally, the Air Force owned fixed-wing combat roles and intercontinental ballistic missiles, while the Army retained rotary-wing combat roles, air defense, and rockets/missiles of intermediate range or closer.

The lack of a formal division of roles, mission, and battlespace geometry presented challenges to operators historically, with most having to be resolved in the commands executing operations. From the Army's perspective, the Air Force has explicitly delineated the close air support (CAS) function as one of its most vital with respect to Army operations.[27] But there have been multiple reports for years that the Air Force would rather not perform CAS and has only acquiesced to holding onto the A-10 and other CAS assets to prevent that mission from reverting to the US Army.[28] This has led the Army to hedge in recent years with armed drones, expanded rotary-wing capabilities, and longer-range missiles to interdict operations.

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26 Mike Pietrucha, "Slaying the Unicorn: The Army and Fixed-Wing Attack," *War on the Rocks*, December 9, 2019, https://warontherocks.com/.

27. John Matsumura, John Gordon IV, and Randall Steeb, *Defining an Approach for Future Close Air Support Capability* (Santa Monica, CA: RAND Corporation, 2017), https://www.rand.org/.

28. See Tom Temin, "Is the Air Force Abandoning Its Close Air Support Mission?," Federal News Network, February 2, 2023, https://federalnewsnetwork.com/; and Stephen Bryen, "US Air Force in a Big Lie about the A-10," *Asia Times*, May 2, 2023, https://asiatimes.com/.

Russia's war in Ukraine is teaching militaries around the world many lessons in modern warfare, which may or may not all be relevant for future conflicts, particularly the prospect of naval and island warfare in the Pacific. But one clear lesson that airpower theorists and advocates must take from recent conflicts is that war within the air domain has profoundly changed, owing to the development of modern drones, loitering munitions, and longer-range land force fires.

These innovations and their successful demonstration in combat portends the dramatic widening of the air littoral and an end to the day where ambiguous doctrine and ad hoc deconfliction at the operational level will be effective in Joint campaign planning. Figure 2 illustrates the new challenges of the expanded air littoral, from crowded tactical airspace and new threats to a more distant, or even potentially nonexistent, fire support coordination line.

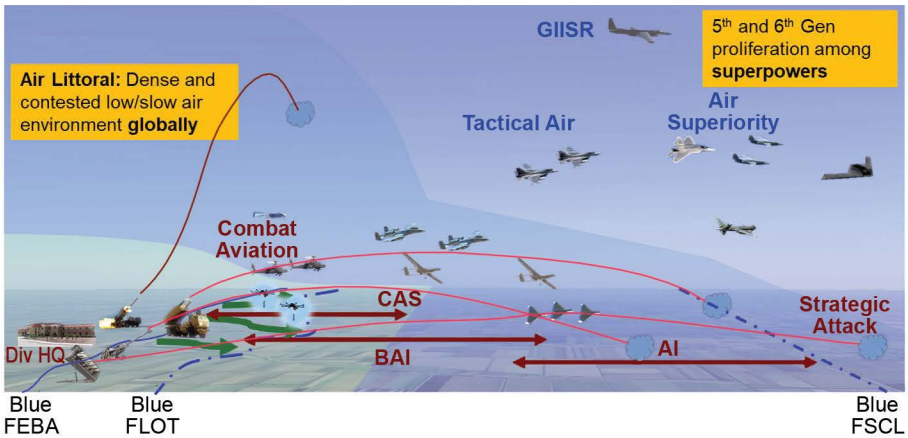

Figure 2. Significant overlap in airspace and potential land targets, leading to heavily congested tactical airspace and significant overlap of potential ground targeting

As noted previously, US Soldiers and Airmen faced sharp divisions throughout the Cold War and to the 1991 Gulf War over the meaning and interpretation of the FSCL.[29] For Airmen it was a demarcation line dividing areas of operations between Air Force targeting and Army artillery targeting. For Soldiers it represented the range of artillery and the limit of their internal fires.

These doctrinal disagreements reached a temporary truce in the 1990s, with the Army recognizing that "deep battle" is not simply support for the close fight and the Air Force increasing its focus on air interdiction and CAS, but Soldiers and Airmen retained different attitudes about this shift. Airmen saw the Army yielding to the Air Force vision when the Air Force only conceded the line did not explicitly serve as an area of operations boundary, but rather a measure to "facilitate the expeditious engagement of targets

29. David E. Zook III, "The Fire Support Coordination Line: Is it Time to Reconsider Our Doctrine?" (master's thesis, US Army Command and General Staff College, Fort Leavenworth, KS, 1992), https://apps.dtic.mil/.

of opportunity beyond the coordinating measure."[30] This truce has likely only survived to date as the character of US operations since then have rendered the FSCL largely moot, with Joint Task Force fire control elements managing virtually all targeting in a close environment.[31] Of note, the updated version of Joint Publication 3-09 eliminated the FSCL term.

The modern close air environment, characterized by a significant uptick in drone, missile, loitering drone-powered munitions, and rocket-propelled artillery is likely to reinvigorate the debate over the status and nature of the FSCL. Add to that pressure from ground commanders to extend the FSCL based on their increased land asset ranges and the situation is ripe for a breakdown in targeting and mission coordination between close air assets and targeting, from deep interdiction to strategic attack. The further prospect of a greater role for land domain munitions to reach strategic targets has the potential to strike at the core argument for US Air Force independence, namely that the Air Force can more efficiently and economically execute long-range precision-strike missions than other components of the US military.[32]

Reconceptualizing Airpower for Twenty-First Century Operations

Although to date the US Air Force has been perceived as reluctant to play a greater role in CAS and light attack and still yields air defense to the Army, the expanding air littoral is an opportunity for the Air Force to ask some tough questions of itself about the real meaning of airpower and what air domain operations mean in the twenty-first century. This article's argument is not that Mitchell was outrightly wrong but that his ideas and the models that stem from his works are based on assumptions that have been overtaken by events. To this end, this article proposes a new set of fundamental premises for the study of airpower in the twenty-first century.

Airpower is the ability to make others do what the Air Force wills through the exploitation of the air domain. Strength or capability—measured in number of aircraft, sortie generation, and other quantifiable metrics—is a common means of measuring military power and has strong applications when a western nation-state-centric conventional/Jominian conflict defines the war.

But strength alone is not power. Power is the ability to make another do one's will. Strength is a critical component, but it must be leveraged in time and space against an adversary's pressure points sufficient to change their behavior. The adversary's fielded

30. R. Kent Laughbaum, *Synchronizing Airpower and Firepower in the Deep Battle*, Cadre Paper (Maxwell AFB, AL: AUP, January 1999), https://media.defense.gov/; and *Joint Fire Support*, Joint Publication 3-09 (Washington, DC: Chairman of the Joint Chiefs of Staff [CJCS], 2010), A-2, https://api.army.mil/.

31. Mike Benitez, "How Afghanistan Distorted Close Air Support and Why It Matters," *War on the Rocks*, June 29, 2016, https://warontherocks.com/.

32. Mark Gunzinger and Lukas Autenried, *Building a Force That Wins: Recommendations for the 2022 National Defense Strategy* (Arlington, VA: Mitchell Institute for Aerospace Studies, June 2021), https://mitchellaerospacepower.org/.

forces, industrial production, or fixed government locations may not be critical targets for many adversaries as recent conflicts have shown time and again. Airpower strategy must see beyond industrial webs, Five Rings, and quantitative network-centric analysis to determine how the air domain can bring a diverse set of adversaries to a culminating point, which may be independent of state status or temporary capability to resist.[33]

The effectiveness of airpower is best judged from its ability to achieve effects on the surface. As Royal Air Force Marshal John Cotesworth Slessor observed, the air situation has no importance in war except in how it affects the situation on the ground.[34] This includes land forces, naval forces, and the political calculus of war termination. This can be through direct action via weapons employment or indirect effects via intelligence and supply among other means. Balance of power in the air for purposes of determining the status of air superiority is one means to the ends of airpower—a measure of performance—but is not a measure of airpower effectiveness.

In some cases, excessive strength may even be counterproductive to favorable war termination. It matters little that multiple conflicts between strong state actors and weak nonstate actors have demonstrated the ability to hit the adversary increasingly harder when escalation of violence, and of collateral damages, may in practice be the adversary's strategy.

Air superiority is highly desirable but is neither a necessary nor sufficient condition for victory. Air superiority is a condition that makes it easier to exploit the air domain, but relative capability to exploit the air domain does not guarantee victory. Strength in the air domain does not automatically equate to power over adversaries. In some cases, airpower effects will need to be delivered well before even localized air superiority can be attained. In other cases, mutual denial of airspace may be sufficient to deter aggression. Airpower theory and strategy must address these scenarios rather than focus all efforts on attaining air superiority as a prerequisite for further action.

Airpower exists at all levels of war and produces effects at all levels of war. Large fixed-wing airpower assets, owing to speed, endurance, airframe-specific maintenance requirements, and exploitation of the third dimension of the operating environment, largely exist at the level of the theater commander or of global strategy. Rotary-wing aircraft, tactical drones, and light-attack assets exist at the tactical level of war. All assets can hold an enemy's strategic, operational, and center of gravity and critical vulnerabilities at risk immediately but can also produce negative effects when strength is not directly tied to fulfilling an operational/strategic objective or is otherwise misused.

Airpower is neither inherently offensive nor defensive. To early airpower scholars, airpower was inherently offensive as air attack was seen as impossible to guard against on the one hand, and airfields were vulnerable to attack on the other. The basing vulnerability may remain true for manned operational aircraft, but improved air defenses, the

33. John Warden, "The Enemy as a System," *Airpower Journal* 9, no. 1 (Spring 1995), https://www.airuniversity.af.edu/; Jon R. Lindsay, *Information Technology and Military Power* (Ithaca, NY: Cornell University Press, 2020); and Kreuzer, *Drones*.

34. John Cotesworth Slessor, *Air Power and Armies* (Tuscaloosa: University of Alabama Press, 2010).

prospect of drone walls in future airspace, and the limited basing needs of many tactical aircraft make air denial as important an air domain mission as offensive attack.

Beyond "Great Contests for Control of the Air"

For the Air Force, the prospect of abandoning the air littoral in favor of a focus on air superiority operations yields critical battlespace to Allies and other domains to cover, decreases its priority and overall probability of success, and plays into the hands of critics of the independent Air Force who see it as operationally irrelevant despite its strategic deterrent success.[35]

Successful modern air forces must be shaped to both deter conventional war through fifth- and sixth-generation air superiority operations and readily flex to expeditionary combined arms air littoral operations. This means not a return to full-spectrum dominance as cost-prohibitive over-extension but shaping doctrine, organizations, and equipment to flex to small wars under mutually deterred great power competition. "Full-spectrum dominance" was a prominent feature of the US military's *Joint Vision 2020*, published in 2000.[36]

"Contesting airspace" in the modern operating environment is only partially through air-to-air engagement for air superiority. More often, it is through evasion and denial of air supremacy assets. Small drones have successfully contested Russia's formidable air defense network in Ukraine not by defeating their adversaries in the air but by shifting the cost curve away from theater missile defenses and manned fighter aircraft with smaller weapons platforms in higher volume.[37] Launching an S-300 or S-400 against a small drone may not be the equivalent of using a $2-million-missile to hit a camel in the butt, but it does make an elaborate integrated air defense system cost prohibitive against smaller threats in greater numbers.[38]

Air superiority may be necessary for successful conventional offensive operations, but the experience since 1991 has readily demonstrated that America's adversaries have learned to bypass that prospective course of action, with mixed results for airpower even in the best cases. This hider-finder competition as the dominant feature in modern air warfare should be the essential lesson of 30 years of air combat post–Desert Storm.[39]

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35. Diane Tedeschi, "Is it Time to Abolish the US Air Force? A Political Scientist Says Yes," *Smithsonian Magazine*, October 2015, https://www.smithsonianmag.com/.

36. See Scott N. Romaniuk and Tobias J. Burgers, " 'Full Spectrum Dominance': US National Security Doctrine in the New Global Security Environment," in *The Future of U.S. Warfare*, ed. Scott N. Romaniuk and Francis Grice, 1st ed. (New York: Routledge, 2017); and *Joint Vision 2020* (Washington, DC: CJCS, June 2000), https://apps.dtic.mil/.

37. John Grady, "Russian Forces Unprepared to Protect against Drones, Lack Adequate Command and Control, Panel Says," *USNI News*, November 1, 2022, https://news.usni.org/.

38. *Wired* Staff, "Blasted Camel!," *Wired*, December 7, 2001, https://www.wired.com/.

39. Antonio Calcera et al., "Why Drones Have Not Revolutionized War: The Enduring Hider-Finder Competition in Air Warfare," *International Security* 46, no. 4 (Spring 2022), https://doi.org/.

The Ukraine conflict has clarified the implications of new technology and the democratization of violence that has come with many of these innovations.[40] These technologies were untested and never held out as a viable deterrent threat prewar, with US and NATO Allies relying predominantly on conventional, economic, and information forms of extended deterrence to dissuade conflict before Russia's most recent invasion of Ukraine. Though extended deterrence failed in 2022, the lessons from this failure have in turn shown significant future deterrence benefits.[41]

China has watched the events unfold in Ukraine with great interest and is taking the lessons of the new calculus to heart. Space infrastructure, to include the civilian Starlink network, and land combined arms threats like Javelin, small drones, high-mobility artillery rocket systems, and other threats to China's military equipment will play a greater role in a Taiwan invasion than previously believed, likely driving up the costs for China of invasion and forcing it to make key force structure changes.

To some researchers, the integrated military application of US, Allied, and civilian partnerships creates a combined-arms challenge that China is unable in the near term to match. Despite the battlefield in Ukraine today largely existing in what Thomas Schelling dubbed a "brute force world," where no current negotiating ground exists between the factions, the costs being imposed through drone activity are readily causing other powers, notably China, to reconsider the probability of success through lower intensity conflicts.[42]

In the twenty-first century, airpower strategists and theorists must see the entirety of the air operating picture, and they must see conflict in the air as a contested operating environment, particularly at the tactical and operational levels. While air superiority is desirable for air operations, as superiority is desirable in any military domain, airpower strategy and theory must move beyond gaining control of the air/air superiority as a starting prescription and work to build a new picture for exploiting and projecting air domain effects from within the contested environment. This will mean more Joint collaboration and embedded Airmen with surface combatants, more reliance on Joint fires, a greater understanding of the defensive and denial applications of airpower, and a greater emphasis on the importance of the air littoral for future conflict.

Conclusion

After 80 years, the ghosts of Douhet and Mitchell continue to haunt the US Air Force. Seventy years of conflict post–World War II should demonstrate that winning command of the air is neither a necessary nor sufficient condition for victory in war. It

40. See Olafimihan Oshin, "NATO Chief: China Is 'Learning Lessons' from Putin's Invasion of Ukraine," *Hill*, January 31, 2023, https://thehill.com/; and Ben Blanchard, "Taiwan Sees China Taking Lessons from Russia's Ukraine Invasion," Reuters, February 23, 2023, https://www.reuters.com/.

41. Benjamin Jensen, "The Two Sides of Deterrence in Ukraine," CSIS, March 30, 2022, https://www.csis.org/.

42. Thomas C. Schelling, *Arms and Influence* (1966; repr., New Haven, CT: Yale University Press, 2008).

is vital to the American way of war to gain air superiority as rapidly as possible to facilitate military operations, but adaptive adversaries playing against US strengths have readily shown the ability to neutralize the inherent advantages afforded by command of the air in ways that Douhet, Mitchell, and others did not foresee.

As the operating environment expands and air assets have shrunk in both physical size and detectability, the flexibility to deny the adversary localized freedom of movement through the air in some cases must trump the desire to gain theater air superiority through long-range fast movers alone. The first step to air superiority, and with it control and exploitation of the air domain, must be the ability to deny access to the adversary, at all levels of conflict. Even as the US Air Force must plan to defeat threats to the United States and its Allies, it must simultaneously plan to lead in air operations inside the growing air littoral. Æ

THE AIR-GROUND LITTORAL AND GREAT POWER CONFLICT

David M. Giffen

The air-ground littoral has emerged as key terrain and may prove decisive in the wars the Joint force is likely to fight in the near future. The democratization of airpower—typified by inexpensive unmanned systems—has enabled this emergence, and the complexity of the problem has been compounded by an erosion of Jointness within the force. The air-ground littoral affects the land component most acutely. While this is a Joint problem which demands a Joint solution, the Army should take the lead in comprehensively framing the problem for the Joint force and establishing what multidomain contributions will be needed from the other components.

In the year prior to Russia's conventional invasion of Ukraine, an unconventional analysis identified the so-called air littoral, making remarkably accurate predictions of the contest in the upper tier of the ground domain.[1] The analysis determined that rapidly changing technologies—specifically, low-cost uncrewed aerial vehicles—enabled virtually anyone with the wherewithal to take advantage of airpower in combat. The profusion of these technologies offers a direct challenge to American concepts of warfare and the military's ability to characterize and understand the operating environment. As predicted, the battlespace of today is witnessing the emergence of a new asymmetric seam between the air and ground domains, the air-ground littoral.

The proffered potential solutions to many of the challenges and consequences that this new asymmetry has had on warfare in the modern era are important.[2] Yet despite the conflict in Ukraine validating many of these assumptions, the combat services have largely ignored recommendations to change their perception of combat within the air-ground littoral, codify this changed understanding via renewed interservice agreements, and pursue conceptual rather than exclusively technological solutions to the problem.

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1. Matthew Beinart, "Army Brings out New Tech to Use Lower-Tier of Air Domain to Close Joint Kill Chain at EDGE21 Demo," Defense Daily, May 17, 2021, https://www.defensedaily.com/.

2. Maximilian K. Bremer and Kelly A. Grieco, "The Air Littoral: Another Look," *Parameters* 51, no. 4 (Winter 2021–22), https://doi.org/.

As predicted, these inexpensive technologies have transformed the "coastline of the air" into a contested zone, and belligerents now "vie for control of the air littoral."[3] The compressed size of the air-ground littoral, a relatively narrow area bounded by the Earth's surface and vertical obstructions, complicates reaction times and responsive maneuvers for manned, fixed-wing flight operations within this volume. As forecasted, Russia would exploit this region to enable offensive operations and deny its use by Ukraine. The compressed size of the littoral confers a "home-court advantage" to potential defenders, amplifying the idea that the defense enjoys some inherent advantages over offense in this domain. This is also exemplified in Israel's recent denial of a massed air attack by Iran.[4] Essentially, it was theorized that the speed of conflict enabled by exploitation of the air-ground littoral would be too fast to be addressed by the 72-hour air tasking model used by the Joint force.[5] Combat operations in Ukraine bear out this hypothesis, with constant demonstrations of rapid, tactical targeting enabled by persistence in the air-ground littoral.[6]

Other analyses have addressed the emerging relevance of the air-ground littoral as well.[7] For instance, a 2023 assessment supports many of the same conclusions but offers a differing perspective on the characteristics of the region, stating that it is "easier to attack through the air-ground littoral than to defend against attack from it."[8]

This article echoes and amplifies the concepts articulated by these military theorists to promote the idea that the liminal space between the air and ground is key terrain. This article will also make interim recommendations and suggest long-term changes to law, policy, and procedures to address this and other emerging asymmetries. Confronting the dangers inherent within the air-ground littoral will require a reconceptualization of how the Department of Defense conceives of Joint and multidomain combined arms maneuver and will challenge its understanding of the "utility of force" within the air domain.[9] The impact of the air-ground littoral will be felt most acutely in the ground domain, where land force commanders will contend with threats in

3. Bremer and Grieco, 72, 71.

4. Bremer and Grieco, 73; and C. Todd Lopez, "Israel, U.S., Partners Neutralize Iranian Airborne Attacks," US Department of Defense (DoD), April 16, 2024, https://www.defense.gov/.

5. Bremer and Grieco.

6. Todd A. Schmidt, "The Russia-Ukraine Conflict Laboratory Observations Informing IAMD," *Military Review* 22 (March 2024), https://www.armyupress.army.mil/.

7. T. X. Hammes, "The Future of Warfare: Small, Many, Smart vs. Few & Exquisite?," *War on the Rocks*, July 16, 2014), https://warontherocks.com/; and Clay Bartels, Tim Tormey, and Jon Hendrickson, "Multidomain Operations and Close Air Support," *Military Review* (March–April 2017), https://www.armyupress.army.mil/.

8. Jim E. Rainey and James K. Greer, "This is Your Army: Land Warfare and the Air-Ground Littoral," *Army Aviation 71*, no. 12 (December 31, 2023): 16.

9. Rupert Smith, *The Utility of Force: The Art of War in the Modern World* (London: Penguin Books, 2005).

both the horizontal and vertical planes. This "spherical challenge" presents an asymmetric problem that the Joint force has thus far left to the services to resolve.[10]

The Air-Ground Littoral and Erosion of Jointness

There is no term of reference in Joint doctrine for the *air littoral*, the *atmospheric littoral*, or the *air-ground littoral*; each of these terms has been used interchangeably and generally aligns with the perspective of the originator's component. The seminal definition of the air littoral, offered by scholars affiliated with the Air Force, was extrapolated from Joint terminology that describes the more familiar maritime littoral. The vertical limit of this region is 10,000 feet; the volume below this altitude to the Earth's surface, "which must be controlled to support land and maritime operations and can defended from the air or the surface," is the air-ground littoral.[11]

The Army has unofficially used "lower tier of the air domain" and "upper tier of the ground domain," but it has finally settled on the phrase "air-ground littoral" to describe this region; while a doctrinal definition remains elusive, one study suggests that the Army would generally consider the air-ground littoral service ceiling to be lower, probably closer to 5,000 feet.[12] This is an example of Miles' Law—"*Where you stand depends on where you sit*"—and demonstrates why the air-ground littoral is a Joint problem; it exists on a seam between force component regions of responsibility.[13] This article prefers to use the term air-ground littoral to identify this space.

No service has direct responsibility for the air-ground littoral; it is a shared problem of the Joint force. This is a consequence of decisions made 75 years ago in southern Florida. The Key West agreement, a colloquialism applied to the more ponderously titled "Functions of the Armed Forces and the Joint Chiefs of Staff" paper, outlined each service's mutual responsibilities within the air domain. This agreement improved the Joint force by codifying roles and responsibilities between the services and reduced service friction. This reduced friction meant less competition for relevancy and resourcing.[14] A relevant feature of this agreement regarding the air-ground littoral is the apportionment of responsibilities between the Army and Air Force for air defense.

10. Kobi Barak, "The Sky Is No Longer the Limit: The Need for a Ground Forces UAV Fleet and Multidimensional Warfare Capabilities," *Dado Center Journal* 11–12 (2017): 40, qtd. in Bremer and Grieco, "Air Littoral," 75.

11. Bremer and Grieco, 68.

12. Beinart, "Army Brings out New Tech"; Kerensa Crum, "CCDC Aviation, Missile Center Highlights Forward-Launched UAS Technology," US Army (website), March 30, 2020, https://www.army.mil/; and Jules Hurst, "Small Unmanned Aerial Systems and Tactical Air Control," *Air & Space Power Journal* 33, no. 1 (2019), https://www.airuniversity.af.edu/.

13. Rufus E. Miles, "The Origin and Meaning of Miles' Law," *Public Administration Review* 38, no. 5 (1978): 399, https://doi.org/; and Rainey and Greer, "This is Your Army."

14. John T. Correll, "A New Look at Roles and Missions," *Air & Space Forces Magazine*, November 1, 2008, https://www.airandspaceforces.com/.

Inconveniently, this new competitive arena—the air littoral or air-ground littoral—emerged just as the dissolution of Joint Forces Command and politically induced resource constraints drove insularity between the services. This pivot toward insularity followed a peak period of Jointness, which reached its apogee in 2011, coinciding roughly with the death of Osama bin Laden. An Army analysis elaborating on the dissolution of Joint Forces Command argues that circumstance alone drove the erosion of Jointness.[15] This insularity, driven by resource scarcity that compounded service paranoias centered on "relevance," drove the services to prioritize the requirements of their domain over those of the Joint force.[16]

The Joint force fights in all domains but wins war on land. The Air Force tends to ignore this reality and has continued to prioritize every function of airpower except those most essential to fight and win wars on land: close air support and interdiction.[17] The Navy and Marine Corps have not avoided parochialism, insularity, and a fight for relevancy in the years since 2011 either. The commandant of the Marine Corps recently provoked controversy by task organizing primarily against a single threat actor.[18] The Navy has chased seemingly service-centered concerns as well, a prominent example being the struggling littoral combat ship.[19]

The loss of Jointness compounds the problem of service responsibility. In 1991, Operation Desert Storm validated the shared doctrinal approach of AirLand Battle and the intent of the Goldwater-Nichols Act.[20] The act granted necessary authorities to enable Joint force commanders while placing statutory constraints on the services to limit the worst aspects of these rivalries. The doctrine oriented and aligned the Joint force to the war it expected to fight. The guidance of these interrelated concepts informed the force design of the post–Cold War Joint force, which emphasized crisis response and global reach, tasks for which a Joint theater commander would command an integrated force task organized against a specific problem.

The Joint force was well-postured for a tailored response after the 9/11 attacks. Drawing upon the strengths of the individual services, it was committed to action with spectacular success in Afghanistan. Two years later, a considerably larger and

15. Mark Hirschinger, "The Disestablishment of U.S. Joint Force Command: A Step Backward in 'Jointness'" (master's thesis, Joint Advanced Warfighting School, Joint Forces Staff College, Norfolk, VA, 2021).

16. Dan Grazier, "Documents Show Air Force Leaders Shirking Their Close Air Support Responsibilities," POGO: Project on Government Oversight, February 1, 2023, https://www.pogo.org/.

17. Chris Gordon, "Air Force Must Rethink How to Achieve Air Superiority, Chief Says," *Air & Space Forces Magazine*, February 29, 2024, https://www.airandspaceforces.com/; and Mike Pietrucha, "The Five-Ring Circus: How Airpower Enthusiasts Forgot about Interdiction," *War on the Rocks*, September 29, 2015, https://warontherocks.com/.

18. David Vergun, "Marine Corps' Force Design Is Focused on Pacing Challenge from China," DoD, July 2, 2024, https://www.defense.gov/.

19. Joaquin Sapien, "The Inside Story of How the Navy Spent Billions on the 'Little Crappy Ship,'" ProPublica, September 7, 2023, https://www.propublica.org/.

20. David E. Johnson, "Shared Problems: The Lessons of AirLand Battle and the 31 Initiatives for Multi-Domain Battle," RAND Corporation *Perspective* (April 2018), https://www.rand.org/.

more conventional force package was assembled to achieve the same form of nearly instantaneous success against the Baathist regime of Iraq. For almost a decade, the Joint force enabled active combat in both theaters, all while committing force and action to various minor global conflicts. It did this while simultaneously delivering humanitarian aid, maintaining freedom of navigation of the ocean, defending the neutrality of space, disrupting Somali pirates, and deterring adversaries in Europe, Asia, and the Middle East.

Nevertheless, the military reached the peak of this integration, Jointness, after the success of the May 2011 Operation Neptune Spear and the death of bin Laden, the primary object of the Afghan campaign. As key mission objectives in the war on terror were achieved, formerly meek adversaries—Russia and China—were asserting themselves once again in a manner contrary to American interests. This relative normalization of force requirements coincided with the initial stages of the return to great power competition, and each service renewed consideration of its inequities in a service-specific light rather than with a focus on the future needs of the Joint force. The reemergence of interservice rivalry has chipped away at gains made in Jointness and how the services conceive of their specific contributions to the Joint force's needs.

An example of service parochialism is the Air Force's continued embrace of airpower theory despite ample evidence that it has failed in its promises.[21] Strategic airpower, enabled by blue sky dominance, has not lived up to its promise of victory through airpower alone. Airpower theory has long been enculturated despite its failure, driving the Air Force's priorities and operating concepts. Retired Air Force Colonel Phillip Meilinger's *Ten Propositions regarding Airpower* is an essential reading for those seeking to understand the cultural drivers of this phenomenon.[22]

Unfortunately for airpower purists, several of Meilinger's assumptions have been disproved, or at least challenged, in the modern era.[23] This is not the first-time organizational culture and a focus on outdated theories have prompted a service to move in a strategic direction contrary to the needs of the Joint force.[24] The essential point is not that domain-specific theories are invalid. It is that they should be continuously tested and revalidated and should focus on Joint outcomes rather than a given service's contributions to the Joint fight.

Military services also tend to conceive of tasks and problems in the context of "worst case" and "most likely." Yet this methodology fails in a multipolar world with democratized airpower. Rather than be hobbled by the worst-case/most-likely binary,

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21. T. X. Hammes, "Independent Long-Range Strike: A Failed Theory," *War on the Rocks*, June 8, 2015, https://warontherocks.com/; and Chris Gordon, "Allvin: Drones, New Technology Driving 'Reinvention' of Airpower and USAF," *Air & Space Forces Magazine*, February 14, 2024, https://www.airandspaceforces.com/.

22. Phillip S. Meilinger, *10 Propositions regarding Air Power* (Maxwell AFB, AL: Air University Press, 2015), https://www.airuniversity.af.edu/.

23. Maximilian K. Bremer and Kelly A. Grieco, "Assumption Testing: Airpower Is Inherently Offensive, Assumption #5," Stimson Center, January 25, 2023, https://www.stimson.org/.

24. Harlan Ullman, "Mahan's Illusory Command of the Seas," *Proceedings* 147, no. 6 (June 2021), https://www.usni.org/.

the services should focus on Joint outcomes through a realistic versus unrealistic lens. It is realistic to believe the United States will have an armed conventional confrontation with China; it is unrealistic to think America would seek unlimited ends in such a conflict. Demonstrating the will and ability to seek unlimited ends provided an acceptable level of deterrence during the Cold War against a single adversary. The complexity of the modern operating environment with multipolar threats has rendered old ideas on deterrence moot. Planning for unrealistic ends promotes insularity in developing ways, the result of which are service-oriented means that do not serve the needs of the Joint force.

The Army's Role in the Joint Force

Culturally, the Army does not conceive of itself as an enabler of the Joint force. It conceives of itself as the Joint force. The conception is rational as the Army is enormous and has capabilities in all the warfighting domains. The Army controls the second-largest air force in the world and almost half as many watercraft as the US Navy. The Army's Reserve component is larger than the Marine Corps. The Total Army dwarfs the second and third largest services, larger than the combined end strengths of the Air Force and the Navy. The immense size of the force corresponds with an equally large mission set; after all, it is the service responsible for the domain in which the Joint force fights and wins war.

Yet as with the Air Force, the Army has made decisions seemingly out of step with the Joint force's needs. Commander of US Southern Command General Laura Richardson's assessment of the Army's decision to cancel its Future Attack Reconnaissance Aircraft program is an excellent example.[25] As a combatant commander, Richardson determined that the program's cancellation would result in operational opportunity costs either unperceived or unanticipated by the Army. For this matter, the Army determined that what it has learned "from the battlefield—especially Ukraine—that aerial reconnaissance has fundamentally changed."[26] It was the opinion of Army senior leaders that the ubiquitousness and apparent utility of small and inexpensive unmanned systems had changed the very nature of modern warfare, analogous to the disruptions caused by the introduction of the machine gun just before World War I.

Two key ideas should be learned from this interchange of concepts and requirements. First, at least one combatant commander perceived a requirement that Army Aviation be capable of "expanded maneuver from sanctuary, including strategic self-deployment," the ability to "operate in contested logistics environments," and "pierce

25. Laura Heckmann, "FARA Cancellation Leaves Unfilled Gaps," *National Defense Magazine*, April 25, 2024, https://www.nationaldefensemagazine.org/.

26. US Army Public Affairs, "Army Announces Aviation Investment Rebalance," US Army, February 8, 2024, https://www.army.mil/; and see also David Barno and Nora Bensahel, "Drones, the Air Littoral, and the Looming Irrelevance of the U.S. Air Force," *War on the Rocks*, March 7, 2024, https://warontherocks.com/.

the [anti-access/area denial] bubbles."[27] Whether or not the Army erred in its decision to cancel its Future Attack Reconnaissance Aircraft program is outside the scope of this analysis, but what is within its scope is that the Army did not have the full endorsement of Joint force commanders, with potentially imminent operational requirements, when it made this decision. This friction between the services and operational components will likely increase as requirements outpace resources.

Despite the breadth of mission and scale of its force, the Army is concerned about its relevancy as are the other services. General Eric Shinseki, former Army chief of staff, famously admonished his commanders, "If you don't like change, you are going to like irrelevance even less."[28] Given the pivot to the Indo-Pacific, the Army's concern for its relevance reinforced the development of operational concepts that would make the Army more relevant in a theater whose primary feature is water. These concepts presume that the Joint force will most likely be called upon to prevent a fait accompli—in other words, to thwart a People's Liberation Army invasion of the island of Taiwan. The Army views long-range weapons as its primary plausible contribution to this fight.

Great Power Conflict in the Near Future

The lack of Joint focus and devolution to overt parochialism create an opportunity for the services to focus inwardly on the requirements of their specific domain. The services tend to concentrate on the most dangerous possibility and look to acquire the tools and capabilities to fight and win within their domain against the most dangerous threat. In today's era, this is decidedly the pacing threat—the People's Republic of China. China has rapidly increased its capabilities in all warfighting domains and presents a formidable adversary in a conventional, regional conflict.

China understands the American method of warfare is expeditionary and has tailored its regional defenses to blunt this methodology. Colloquially referred to as anti-access/area denial, this is the "bubble" that Richardson perceives she will need to pierce in future wars.[29] The general rightly suggests the Joint force must be capable of operating within the envelope of threat systems, as the military is likely to fight wars in the future where these systems—like al-Qaida terrorists—enjoy relative sanctuary and operational security in an area the military is either unable or unwilling to molest. Air superiority is a preferable condition in any conflict, but it may not be achievable. Even if air superiority was feasible, the cost to achieve it may exceed the operational value it would create.

The cost of air superiority against a great power peer would be high, particularly if the United States is engaged in conventional action against said adversary in their own

27. Heckmann, "FARA Cancellation."
28. Barno and Bensahel, "Drones."
29. Heckmann, "FARA Cancellation."

territory. It is also unlikely the Joint force will find itself in a conventional war, pursuing unlimited ends against a nuclear-enabled peer threat.[30]

"Unlimited ends" is a military euphemism for seeking the overthrow of the enemy government and broadly infers both military conquest and long-term occupation. While pursuing these ends is not altogether impossible, then, it is more likely that the political ends sought by the Joint force would be limited. The US military can and should pursue air superiority capabilities against near-peer and weaker adversaries. Still, there should be careful consideration of the wars the United States is likely to fight as the military considers what capabilities would be essential to dominate conventional warfare with a peer adversary.

The enemy informs the types of wars the military is likely to fight. The United States and the collective West recognize peace as the normal state of existence, whereas Russia views warfare as a continuous spectrum. Russia, for instance, has stated it is in a state of "war with the West." This rhetoric is not anecdotal and provides insight into the means Russia would use to achieve its goals.[31] Senior decisionmakers should recognize that just as the ends the United States is willing to fight for are shifting, so are those of its adversaries, and as ends shift, so do the means. For instance, Russia's attack on Ukraine has as much to do with demography as it does territory—the people are the primary objects of war.[32] Shifting ends result in shifting means, influencing the wars the United States is likely to fight.

The persistent threat to use tactical nuclear weapons is an example of the shifting means observed in modern great power competitions. Russia's rhetoric regarding the use of tactical nuclear weapons has effectively deterred the United States from providing certain weapons or authorizing their use against strategic targets. If the United States were to engage in direct conflict with Russia, a primary aim would be to manage the conflict below the nuclear threshold. America's adversaries' competing and interrelated aim is to keep the United States below the conventional level of armed conflict. Russia, for years, exercised a strategy of patiently eroding American, Ally, and partner will before its full invasion of Ukraine; there are observable similarities in China's approach to Taiwan and the South China Sea as well.

The services and the Joint force need to be realistic about the types of wars the military will fight. Against peer adversaries, the Joint force is just as likely to be committed to defensive action as offensive action. Offensive action, when required, will be politically and operationally hindered and limited to conventional means. These strategic restraints demand operational concepts intended to deny the enemy's strategy.[33] In a Ukraine-like scenario this means the Joint force must destroy the enemy army in the

30. Julian S. Corbett, *Some Principles of Maritime Strategy* (Annapolis, MD: Naval Institute Press, 1988).

31. Arsalan Bilal, "Hybrid Warfare – New Threats, Complexity, and 'Trust' as the Antidote," NATO Review, November 30, 2021, https://www.nato.int/.

32. Brian M. Jenkins, "Consequences of the War in Ukraine: A Bleak Outlook for Russia," *RAND* (blog), February 28, 2023, https://www.rand.org/.

33. Sun Tzu, *The Art of War*, trans. Yuan Shibing (Hertfordshire, UK: Wordsworth Editions, 1993).

field.[34] In a Taiwan scenario, the Joint force would need to integrate a comprehensive air denial strategy, to include denial in the air-ground littoral, to complement action in the maritime domain intended to blunt and deny China sea control. In both scenarios, the wars will be fought in all domains but won in the land domain.

The air-ground littoral will likely prove decisive in these types of conflicts. In a European scenario, the United States will enjoy critical advantages in the air domain over friendly territory. These advantages erode as one approaches the Russian border. The aerial borders of the Russian state are well-monitored and defended in depth by a complex, interlocking system of defenses described as the "Snow Dome."[35] This strategic system, perhaps existing more in concept than function, integrates early warning with advanced ground-based air defenses and ground-control intercept coordinated fighter aircraft.[36]

In an ideal conflict, the Joint force would generate sufficient combat power to disaggregate and suppress this integrated air defense system (IADS) before committing to ground maneuver; but in the wars the military is likely to fight, vital system elements will operate from relative sanctuary. The strategic IADS can integrate with the tactical IADS, supporting the tactical defenses of the Russian fires complex and fielded forces. This enables comprehensive air defense overwatch from the position of relative sanctuary for Russian forces engaged in combat operations near their border. This threat-in-being will likely result in continuous disruption to friendly air supremacy in the blue skies; it will also provide sufficient opportunity to exploit the air-ground littoral.

A rough approximation of these conditions can be visualized in the contemporary Ukrainian environment by inversing the actors' perspectives. Ukraine rapidly integrated Western and former Soviet air defense technology. It enabled it with a national, smartphone-powered network of visual observers to form a highly effective air denial force operating primarily in the air-ground littoral. This force effectively denied Russian Air Force (VKS) operations over most of Ukraine until the development of glide bomb tactics. This mobile force obliged the aggressor to operate from sanctuary, severely limiting the effectiveness of VKS operations.

Russia could have similar successes in denying the full utility of the air domain to Western air forces as it has capabilities analogous to the Ukrainians, with better integration methods.[37] Given the ability to operate strategic and long-range tactical systems from sanctuary, the Russians would have the most significant impact on the

34. Carl von Clausewitz, *On War*, ed. and trans. Michael Howard and Peter Paret (1989; repr., Princeton: Princeton University Press, 2008).

35. *Russian Tactics*, Army Techniques Publication 7-100.1 (Washington, DC: Headquarters, Department of the Army, 2024), https://armypubs.army.mil/.

36. Tom Balmforth and Max Hunder, "Small Uncrewed Ukrainian Plane Likely Used in Attack Deep inside Russia - Experts," Reuters, April 4, 2024, https://www.reuters.com/.

37. Maximilian K. Bremer and Kelly A. Grieco, "In Denial about Denial: Why Ukraine's Air Success Should Worry the West," *War on the Rocks*, June 15, 2022, https://warontherocks.com/.

middle and upper echelons of the air domain, drawing airpower away to conduct counter-air and suppression activities.

The air-ground littoral is open for exploitation if fighter aircraft are encumbered with air superiority tasks. Rotary-wing aviation is essential in this domain as its mission profiles largely mitigate the maneuverability concerns fighter aircraft face in the air-ground littoral's compressed space. Drones are an indispensable exponent of persistence and presence, two of the critical capabilities enabled through the dominance of this domain.

For the Russians, drone operations are secondary only to their artillery operations, which mutually reinforce one another. The Russian system of warfare tolerates conditions of relative parity to exploit the air-ground littoral. Conditions have allowed for a return of VKS operations, but these are shaping operations using standoff and are not a demonstration of blue-sky dominance. Ukraine proved that a relatively weak power can disrupt a blue-sky force with a highly mobile threat, particularly if it opposes a qualitatively challenged or risk-averse air force like the VKS. This conflict also proves that blue sky dominance is not an essential condition before exploiting the air-ground littoral for tactical advantage.

Parity in the air-ground littoral is advantageous for Russia's concept of operation. It will be fighting from well-defended positions, making it harder to target successfully. The Joint force must assemble; Russia will exploit the air-ground littoral to find the US military's assembly areas. Expeditionary forces are more subject to interdiction than will be the Russian army, operating on interior lines. The Russians will try to use their well-honed integration of unmanned spotters into their fires complex to interdict logistics. They will hunt exquisite capabilities, which the US military will struggle to hide.

The land component needs to be relatively close in order to use attack aviation and most artillery effectively; closing is the only way to destroy Russia's offensive warfighting capabilities. The land component lacks long-range surface-to-air missile systems that can successfully challenge Russian air-ground littoral operations at range, and Russian strategic air defenses will also make disrupting airborne standoff attacks a challenge. A potential counterargument to this analysis is that Russia, in a war with NATO, would be on the offensive rather than on defense and therefore be more exposed and subject to attack and not retain these advantages in the littoral seam. It is more likely, however, that Russia would seize a limited objective and quickly consolidate gains and transition to the defense.[38]

The Decisive Nature of Land Warfare

The Joint force needs to be realistic about the types of wars it is likely to fight. Particularly against a peer adversary, the Joint force will "fight tonight"—with resources already nearby or rapidly delivered to the battlefield. The Joint force will fight while

38. Michael Kofman, "Getting the Fait Accompli Problem Right in U.S. Strategy," *War on the Rocks*, November 3, 2020, https://warontherocks.com/.

underway as it builds combat power rather than deploying, consolidating, and then employing as it has in wars past. In such scenarios, the destruction of the enemy's army—its ability to prosecute offensive warfare—should be the priority of the Joint force for the foreseeable future. Great power competition and multipolarity have changed the ends for which the United States is willing to fight; it is not likely to seek unlimited ends in a confrontation with a peer. Similarly, how the military fights would be constrained by geopolitical and operational realities.

One likely end for which the military would fight a great power would be to restore the status quo ante bellum by removing a well-defended force from friendly or Allied territory. Another likely war of the near future is a fight to prevent a change to the status quo. For analogy, the conditions in contemporary Ukraine describe the former, and Taiwan is exampled in the latter. In both types of conflict, decisionmakers should assume that the great power aggressor will retain critical operational advantages.

Adversary air defense and surveillance systems will be able to operate from relative sanctuary due to constraints on war escalation placed against the Joint force. These adversarial forces will enjoy interior lines of communication for resupply, and their industrial bases will remain largely intact throughout the conflict. Simultaneously, friendly forces will operate under conditions of persistent threat on a transparent battlefield, which will impose unanticipated operational dilemmas on the Joint force's ability to generate mass and conduct maneuver warfare in the offense or defense.

Control of the air-ground littoral is essential for maneuver warfare in modern conditions. It is preferable, but optional, however, to have blue-sky air superiority to conduct maneuver operations. The ability to provide air superiority was already in doubt, challenged by advanced air defense systems and aerospace forces designed to present a symmetrical challenge within this domain.[39] Despite acknowledgements to the contrary in modern doctrine, the United States has had "big blue sky" dominance for so long that it is likely hard for Joint force commanders to even conceive of operating without these conditions. In any regard, the United States has not fought without air dominance since the Korean War.[40]

Land commanders commit tactical actions and seek to converge combined arms effects from multiple domains to achieve operational objectives. Every action the land component makes furthers this concept. Land force commanders at the division level and below view aerospace force contributions to land warfare through a somewhat simplified lens: interdiction and close air support.[41] The first disrupts the enemy army's ability to mobilize, maneuver, and sustain itself. The second either disrupts the enemy's operational maneuver or enables friendly offensive maneuver. Astute commanders will realize that aerospace forces are essential for Joint airspace management, intelligence

39. Chris Gordon, "Air Force."

40. Walker Mills, Dylan Phillips-Levine, and Trevor Phillips-Levine, "Air Supremacy Lost: An Imminent Danger for Ground Troops," *Proceedings* 146, no. 12 (December 2020), https://www.usni.org/.

41. John Q. Bolton, "Precedent and Rationale for an Army Fixed-Wing Ground Attack Aircraft," *Military Review* 96, no. 3 (May 1, 2016).

gathering, and electronic warfare, but the priority will always be interdiction and close air support.

When fighting on the offense, land component commanders need to find, fix, and finish the opposing military force; this commander has key expectations of the air component. The first is to suppress the tactical IADS and deny the enemy an opportunity to understand the air situation comprehensively. These tactical actions create the noise and clutter that provide a protective umbrella for land component aviation force employment in the lowest reaches of the air domain. The land commander also needs the aerospace forces to interdict enemy sustainment in its rear area and mass fires against the enemy artillery complex. Aerospace forces provide critical functions to the Joint force's concept of maneuver, particularly against an adversary adept at fighting from prepared positional defenses.

Land component requirements for the defense are harder to contemplate. American warfighting strategy hinges on the superiority of the offense, and defensive-oriented systems like ground-based air defenses are secondary considerations to Army force designers. One analysis predicts what was observed during Iran's recent failed attack on Israel: aerospace forces can be an essential component for defensive action.[42] Aerospace forces on defense provide a valuable augmentation to ground-based air defenses and enable flexibility in providing defense in depth and volume.[43] On defense, aerospace forces are force multipliers that can rapidly move force and sustainment to the points of need on the battlefield and disrupt the enemy attempts to mass and blunt enemy attacks.

Land commanders should consider the potential of the air component as part of an integrated counterstrategy to enemy loitering munition and drone operations in the air-ground littoral, whether on the offense or the defense. The compressed battlespace and sheer volume of air vehicles within the air-ground littoral suggest an emerging requirement for "total domain awareness," or air-ground battle management, to center understanding and integrate effects from all domains at the echelon of action.

Warfare in this domain, under conditions in which the US military is likely to fight, requires a new way of conceptualizing the direct support activities of aerospace forces. Operational commanders prioritize air interdiction, but tactical commanders are most concerned with close air support. Close air support, primarily considered a fixed-wing mission, provides fire superiority to tactical operations in deliberate or hasty contexts. This is closely linked with close air attack, a rotary-wing mission requiring less direct coordination with the supported element.[44]

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42. *Israel-Iran April 2024: UK and International Response* (London, UK: Commons Library, 2024), https://commonslibrary.parliament.uk/; and James Gregory and Adam Durbin, "RAF Fighter Jets Shot Down Iran Drones, Rishi Sunak Says," BBC, April 14, 2024, https://www.bbc.com/.

43. Bremer and Grieco, "Air Littoral."

44. Bartels, Tormey, and Hendrickson, "Multidomain Operations."

Recommendations

The US military will likely fight wars against a peer- or near-peer threat for limited ends. The return of great power competition will likely deter further neoliberal adventurism or wars of choice, which essentially characterized the post–Cold War era. The ends of a peer conflict are likely to be focused on a return to the status quo ante bellum or fought defensively to prevent a fait accompli. Wars to restore the status quo will ideally be short, but they will assuredly be intense.[45] These wars will involve combat and defensive operations in all domains but will be won in the land domain. The traditional theater of combat operations will extend globally as the Joint force's logistics, communications, and communication lines are at risk. America's adversaries will retain critical advantages such as interior lines of communication and combat operations generated from relative sanctuary.

The air-ground littoral is a Joint problem but affects the land domain most acutely. For this reason, the Army has de facto ownership of the problem of the air-ground littoral. As the land component, the Army needs to articulate this domain's impact on combined arms operations and how these effects will challenge Joint force priorities. The Army should take the lead in comprehensively framing the problem, setting the terms of reference and terminology used to conduct operations within this environment, and establishing what multidomain contributions will be needed from the other services. The Army should articulate its requirements in this arena to the Joint force and seek to convince the Air Force, as the component responsible for the air domain, to live up to its requirement to provide area defense as initially envisioned during the negotiations that culminated in Key West almost a century ago.

The Army's concerns regarding the air-ground littoral need to be framed against realistic problems, the types of wars the military is likely to fight, and the necessary force structure developed within the Joint force to address these concerns. To be successful, the Army will need to change the way it conceives of its warfighting domain; the service will need to inculcate the concept of visualizing the battlespace with "a third dimension, that of vertical space, to conceive of both the air and land domains as volumes" and convert to a "concept of air control that accounts for time, planar distance, and altitude."[46] Alternatively, the Army could adopt and adapt the concept of tactical air control proposed in 2019 by one Army strategist who recommends differentiated air superiority responsibilities below and above 5,000 feet.[47]

These interim solutions, focused on the immediate needs of the land component, tailored to the wars the Joint force is likely to fight, and led by the Army, should not be the end of this discussion. As a host of theorists have noted, the emergence of new zones of competition in warfare often provides asymmetric advantages to US

45. David Barno and Nora Bensahel, "Learning from Real Wars: Gaza and Ukraine," *War on the Rocks*, December 6, 2023, https://warontherocks.com/.

46. Bremer and Grieco, "Air Littoral," 68.

47. Hurst, "Small Unmanned Aerial Systems."

adversaries, who more rapidly adapt to these new domains to exploit positions of relative parity or advantage against the United States. The exploitability of this domain by adversaries ranging from nuclear-armed peer threats to stateless terrorists brings new risk to the American concept of Joint warfare. The time has come for a renewed Key West agreement to frame this issue, identify other liminal or emergent domains of concern, and levy service-specific responsibilities as appropriate. A new deal, however, should not be the sole end state.

Beyond service-level agreements within the Joint community, there is also the need for executive and congressional action. Former President Donald Trump's creation of the Space Force in 2019 further compressed the Air Force's operating domain. The service's focus on blue-sky air superiority and strategic attack capabilities has ceded responsibility for the air-ground littoral to the Army.[48] Does the Joint force require an air component that only owns some of the domain, some of the time? Does the land component need its own air branch, or can the Joint force be better designed and integrated?

The first hypothetical question amplifies the suggestions of retired Army General David Barno, who recently observed that this salami-slicing of domain responsibilities has made the Air Force irrelevant as a service.[49] The second stems from a conversation with an uncredited senior adviser for this article, who believes "Army Aviation is a failed state" and should be absorbed into the Air Force. All options should be considered as law, and policymakers should consider the future structure and functions of tomorrow's fighting force.[50]

The air-ground littoral is potentially decisive terrain that rests on a seam of capability and responsibility within the service components. Dominance of this key terrain will be critical in the wars of the near future, and it will require comprehensive input and effort from the Joint force. In the short term, the Army should take the lead and proactively frame this problem, advocate for the necessary resources, develop applicable concepts, and identify and address capability gaps within this region. Æ

48. Rachel Cohen, "Air Force Looks to Cut Nearly 50% of Tactical Air Control Party Jobs," *Air Force Times*, April 14, 2023, https://www.airforcetimes.com/; and Victoria Leoni and Kyle Rempfer, "A-10 vs. F-35 Close-Air Support 'Fly Off' Shrouded in Secrecy," *Air Force Times*, July 17, 2018, https://www.airforcetimes.com/.

49. Barno and Bensahel, "Drones."

50. Bolton, "Precedent and Rationale."

LIMINALITY

Opportunities in the Transition Space of the Air Littoral

Branden W. Gulick

Through a multidisciplinary approach using folklore and anthropology, psychology, and war theory, this article defines the air littoral as a liminal space—a threshold and transition between air and space—that is more cognitive than physical. This not only creates challenges but also offers opportunities for exploitation and power projection. Irregular warfare theory and systems thinking around design for complexity connect the disparate fields to demonstrate how to operate in this space and outmaneuver adversaries, building a framework for the US Air Force to exploit the problems inherent in the air littoral. In this way, operators will gain advantage in what is ultimately a cognitive fight.

The air littoral is emerging as a contested environment as the parallel technologies of small-unmanned aircraft systems (sUAS) and artificial intelligence (AI) converge. The US Army is beginning to stake its claim in the air littoral due to its closer proximity to the land domain, the historical precedence of smaller, airborne weapon systems, and the reluctance of the US Air Force to engage in spaces with less defined roles for traditional airpower. The air littoral is liminal in nature: it is both a threshold and a transition space between traditional, ground-based assets and dedicated air assets for which the Air Force is responsible. As such, the air littoral—characterized by nebulous borders—carries with it feelings of unease and a lack of definition that make operating within it difficult under the best of circumstances.

Research from folklore and anthropology provides the contours and understanding of the enduring qualities of liminal spaces. The field of psychology offers further detail on why liminality is so disturbing to rational thought. War theory, including principles of war, then illustrate the context of the air littoral's liminal space. This framing of the air littoral is less about the physical domain in which it exists, nestled between the land and the air, and more about the cognitive space in which it resides, which is the linkage between liminality and exploitation.

Finally, irregular warfare theory and systems thinking around design for complexity connect these disparate fields together to provide the tools not only to operate in

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this space but also to outmaneuver adversaries. This article argues this multidisciplinary approach across such disparate fields builds a framework for understanding the problems and exploiting the gaps inherent in the liminal spaces of the air littoral to gain advantage in what is ultimately a cognitive fight.

Defining Liminality and its Psychology

Before delving into the air littoral and its practical implications, a discussion on liminality helps explore the themes of this space to understand the true nature of the air littoral more fully. Anthropologists and folklorists examine the realm of liminality due to its pervasive role in rituals and mythology. As Joseph Campbell opined in his study of the hero's journey in mythic narratives, the world is "bound . . . in the four directions . . . standing for the limits of the hero's present sphere, or life horizon," stating that "beyond them is darkness, the unknown, and danger . . . beyond the protection of his society is danger to the member of the tribe."[1] Campbell described this liminal space as a threshold that a hero must cross to emerge changed and ready for the trials to come. Liminality itself refers to "a very long threshold, a corridor almost," where objects and people are "betwixt-and-between established states of politico-jural structure."[2]

Most striking for the purpose of this article is how one anthropologist describes liminal spaces as "evad[ing] ordinary cognitive classification, too, for they are neither-this-nor-that, here-nor-there, one-thing-not-the-other."[3] The disconcerting nature of liminality comes from this lack of definition, representing a deeply unsettling state of change. And yet, it is an experience of every human being. Teenage years are a liminality, marking one's transition between child and adult, having resonances and characteristics of both but never quite being either. The purpose of rituals of adulthood is to define the transition from childhood, complete with a change in responsibilities and expectations, all of which can be scary for those preparing to cross the proverbial threshold.

Above all, the liminal space is a transition, and it carries deep emotional resonance most often characterized by uncertainty, anxiety, and fear. These emotions, which challenge human cognition, are key to tying together the notion of liminality to the air littoral. Moreover, the resulting interplay of chaos and sensemaking is essentially what comprises consciousness.[4] Humans learn by interacting with a chaotic environment and making sense of what they see, processing the result as memory to create pathways of understanding that can be referenced when faced with future experiences.

As is seen in coming-of-age stories and experiences across cultures, when these interactions are especially powerful or overwhelming, they generate a trauma, through which

1. Joseph Campbell, *The Hero with a Thousand Faces*, 3rd ed., Bollingen Series XVII (Novato, CA: New World Library, 2008), 64.

2. Victor Turner, "Chapter III: Variations on a Theme of Liminality," in *Secular Ritual*, ed. Sally F. Moore and Barbara Myerhoff (Assen, Netherlands: Van Gorcum, 1977), 37, https://sites.tufts.edu/.

3. Turner, 37.

4. Robert Berezin, "Consciousness Encompasses and Reflects Chaos and Order," *Psychology Today* [blog], July 15, 2024, https://www.psychologytoday.com/.

a new pathway eventually opens to process and handle this new experience.[5] These traumatic lived experiences can, in some cases, help individuals grow and develop within the context and understanding of the broader culture and society. Liminality creates trauma by being unsettling, forcing one to either choose to embrace the space or reject it entirely. There are consequences for both actions, but this forcible choice—this coercive experience—can be a means of exploitation given the right framing because of the role it plays in human cognition and how it undermines logical or rational responses. For that framing, it is prudent to turn to more traditional war theory.

Liminality in War Theory

The Army has made the initial claim to the air littoral, creating educational and training courses, developing platforms, and integrating the capability into planning, perhaps sensing a more traditional-minded Air Force's trepidation toward and resistance to unmanned systems, that sees only tenuous associations to long-standing notions of airpower.[6] Yet, this is a land-based mentality, focused (as it should be) on occupying space—owning the territory while protecting land-based assets from air attack.

The ethereal nature of the air precludes long-term ownership; one cannot occupy the air definitively or in any enduring fashion. The air is itself a liminal space, marking the boundary and transition of the terrestrial habitat of humanity from the greater cosmos that has figured into human desire and oral tradition since prehistory. Technology advances opened further vistas in the skies, providing greater reach and distance, all while normalizing flight as an almost mundane experience. The Wright Flyer appears as a flimsy contraption next to the SR-71 Blackbird, and they are only separated by six decades. Yet, each milestone along this technological advancement increased the ceiling, distance, and speed that aircraft could traverse, further changing humanity's conception of what "flight" meant.

The rise of drones is unique in that it has not opened new territory. Instead, this technology has thinly sliced the greater sky into much smaller segments, the air littoral, where traditional airpower has moved away in the name of higher, faster, and longer. The air littoral is both an emergent aspect of the fusion of technology and the ecosystem of the air domain and an enduring quality of the air itself as a liminal space.

This thin slicing of the air into the air littoral exacerbates air's liminality, confusing the traditional roles of airpower and landpower and blurring the lines of responsibility between them. This is the epitome of liminality, being both familiar in terms of airpower and generating feelings of uncertainty because of the novel approaches sUAS present to the Joint force. Airpower theory, for all its faults, has traditionally understood the inherent flexibility of the domain, embracing the way it flips the narrative by

5. Berezin.

6. See, for example, Maximilian K. Bremer and Kelly A. Grieco, "The Air Littoral: Another Look," *Parameters* 51, no. 4 (Winter 2021–22); and David Barno and Nora Bensahel, "Drones, the Air Littoral, and the Looming Irrelevance of the U.S. Air Force," *War on the Rocks*, March 7, 2024, https://warontherocks.com/.

ignoring distance and thinking in terms of time and increasing the scale of operations.[7] This theme of a shift in thinking is key to discovering the means of framing how the air littoral can be exploited, which can be ascertained using traditional war theory.

Maneuver and Tempo

War, like all human activity, is an enduring characteristic of human interaction and a means for executing conflict. Traditionally, principles of war evolved from experiential learning by commanders and generals sensing patterns or means of fighting. One of the most basic principles is that of maneuver, defined as the "place[ment] of the enemy in a position of disadvantage through the flexible application of combat power."[8] It must be pointed out that maneuver, thought of in traditional movement of forces, is in fact a play to outmaneuver an opponent not only in the field, but also in the mind.

Military historian and strategist Martin van Creveld took this notion of maneuver and explicitly applied it to airpower. Of the six elements he defined that comprised maneuver—tempo, *Schwerpunkt* ("focal effort at the center of gravity"), surprise, flexibility, combined arms, and decentralized command—the most applicable to the air littoral and liminality is tempo.[9] Tempo, as he indicated, is at the heart of John Boyd's orient, observe, decide, act (OODA) loop, which focuses on creating, exploiting, and magnifying flaws in the enemy's activity or, more crucially, in their thought process.[10] Unlike speed, tempo involves pace, and controlling it focuses on accelerating or slowing down engagements by working inside of decision-making processes to increasingly break down cohesion until one can paralyze the enemy.[11]

Maneuver through the control of tempo is focused on the adversary, the fight taking place in the mind as much as in the physical battlespace. As Boyd argued, "Terrain does not fight wars. Machines do not fight wars. People fight wars. It is in the minds of men that war must be fought."[12] Even if sUAS in the air littoral will eventually be guided by AI systems, the ultimate arbiter of the engagement is still a human adversary. The fight must be won in the cognitive space of the adversary. This understanding establishes the framework of liminality that enables the exploitation of the air littoral via tempo control, making it the perfect place to exploit an adversary. For this reason, the previous argument concerning liminality is vital to dominating in the space.

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7. Phillip S. Meilinger, *10 Propositions regarding Air Power* (Maxwell AFB, AL: Air Force History and Museum Program, 1995), https://media.defense.gov/.

8. *The Air Force*, Air Force Doctrine Publication 1 (AFDP-1) (Maxwell AFB, AL: Curtis LeMay Center for Doctrine Development and Education [LeMay Center], 2021), https://www.doctrine.af.mil/.

9. Martin van Creveld, *Air Power and Maneuver Warfare*, 7th ed. (Maxwell AFB, AL: Air University Press, 1994), 3–7.

10. Van Creveld, 3; and John Boyd, *Patterns of Conflict: A Discourse on Winning and Losing*, ed. Grant T. Hammond (Maxwell AFB, AL: LeMay Center, 2018), 135.

11. Van Creveld, 3.

12. Boyd, *Patterns*, 9.

Trauma

The liminal space that is the air littoral increases complexity as it is home to nebulous points of interaction that lead to emergent, dynamic environmental conditions. It is a deeply uncomfortable place for humans to operate within and can create the conditions for generating trauma. In Russia's war with Ukraine, this trauma is apparent in the ubiquitous nature of quadcopters raining down grenades on hapless troops in the trenches or suicide first-person view drones chasing infantry around support vehicles.

Humans are not accustomed to being prey, especially from the sky; this only exacerbates the trauma and is reminiscent of the advent of industrial artillery and machine guns and the rise of shell shock, now known as post-traumatic stress disorder, during World War I. Further evidence of this trauma can be seen in Iraqi troops during the First Gulf War and today in the videos of troops killing themselves or requesting their fellow troops kill them when they are injured and being stalked by drones in the fields of Ukraine.[13]

The prevailing assumption that placing autonomous systems to fight within the air littoral obviates or mitigates such trauma ignores that a human will be fighting on the ground or in the air as well as conducting the campaign through some means of command and control. Humans will have to engage with a complex cognitive space that will seem chaotic and may induce the types of traumas that trigger poor decision-making.[14] The use of mental schema, patterns of behavior that help create order and predictability, increases humanity's susceptibility to these occurrences.[15] Contradicting mental schema, such as the realities of a liminal space, make it far more likely that a person will disregard the information at hand, as in the case of some intelligence failures.[16]

This situation creates the perfect environment for cognitive dissonance, whereby a person must confront contradictory beliefs or choices, which is all but guaranteed in liminal spaces. Further complicating this process is the tendency for people to seek justification for choices, an unfortunate byproduct being the subsequent dismissal of

13. Tracy Wilkinson, "Iraqi POWs Tell of War's Terror and Fear of Future: Military: They Are Gradually Going Home, but What Awaits Them Is Potentially as Deadly as the Conflict," *Los Angeles Times*, April 8, 1991, https://www.latimes.com/; and Systema, Current Time, and Yelizaveta Surnacheva, "Drone Footage Shows Russian Soldier Killing Wounded Comrade, Investigation Finds," RadioFreeEurope/RadioLiberty, July 18, 2024, https://www.rferl.org/.

14. Elliot Atkins and Evan R. Seamone, "Remote Combat Exposure and Moral Injury from Drone Operations: The Cost of a New Form of Warfare," in *Preventing and Treating the Invisible Wounds of War: Combat Trauma, Moral Injury, and Psychological Health*, ed. Justin T. McDaniel et al. (Oxford, UK: Oxford University Press, 2023), https://doi.org/; and Rajiv Kumar Saini, M. S. V. K. Raju, and Amit Chail, "Cry in the Sky: Psychological Impact on Drone Operators," *Industrial Psychology Journal* 30, suppl. 1 (October 2021), https://www.ncbi.nlm.nih.gov/.

15. Yuen Foong Khong, *Analogies at War: Korea, Munich, Dien Bien Phu, and the Vietnam Decisions of 1965* (Princeton: Princeton University Press, 1992).

16. Khong, 257.

new information that would promote better understanding or even overturning the previous decision or convictions.[17]

Given these realities, the difficulties of operating in the liminal space become apparent, proving daunting even for those willing to embrace the opportunity for exploitation. Fortuitously, there is a branch of warfare that is far more comfortable dealing with ambiguous spaces filled with ill-defined enemies dispersed in complex environments: irregular warfare. Irregular warfare is defined as "a struggle among state and non-state actors to influence populations and affect legitimacy."[18] This type of warfare, as it relates to the difficulties of the liminal spaces in warfare, provides further guidance for building out the framework for understanding the air littoral.

Irregular Warfare, the Liminal Space between War and Peace

Irregular warfare's approach in dealing with ambiguity among combatants, the populace, and the environment provides the means of exploiting the liminality of the air littoral. Irregular warfare, called the "graduate level of war" by its practitioners, is conducted in conflicts featuring combatants with varying degrees of support living among a larger civilian populace and fighting against a superior, traditional military force, typically belonging to a state.[19]

Because the combatants rarely form large fighting forces, strike from the shadows, and hide among populations, defeating them is challenging. Not only does combat require consummate martial skill, but it also requires a deft understanding of politics and cultural sensitivities. Irregular warfare requires a different mindset, a shift from the conventional means of conducting war to an altogether dissimilar paradigm.

Irregular warfare is itself a liminal space, a nebulous transition between war and peace. As such, irregular war practitioners have developed principles such as complexity and context-dependent operations and tools focusing on mental agility and empowerment that are critical for dealing with this liminality.[20] These approaches to navigating irregular warfare provide useful frameworks for understanding the battlespace, operating within it, and ultimately for exploiting advantages it can provide to operators.

Irregular warfare requires embracing ambiguities in a way that complicates traditional displays of power and state-sponsored violence, providing a guide for how to negotiate the liminal space of the air littoral. Participants in irregular warfare have a distinct advantage in that time is almost always on their side; this, coupled with the

17. Robert Jervis, *Perception and Misperception in International Politics*, New ed. (Princeton: Princeton University Press, 2017).

18. *Joint Warfighting*, Joint Publication 1 (Washington, DC: Chairman of the Joint Chiefs of Staff, 2020), GL-4.

19. David S. Maxwell, "Is Counterinsurgency the Graduate Level of War?: Some Random Thoughts on COIN Today," *Small Wars Journal* (blog), July 20, 2008, https://smallwarsjournal.com/.

20. James D. Kiras, "Irregular Warfare," in *Understanding Modern Warfare*, by David Jordan et al. (Cambridge, UK: Cambridge University Press, 2016).

fact that they simply avoid losing as opposed to trying to achieve a decisive win, provides greater strategic flexibility against superior forces.

Irregular warfare's liminality lies in the space between nation-states conducting overt war and subgroups seeking political change, revolution, or opposing a foreign power. Because the fight is not dictated by states owning a monopoly on violence, a new set of rules comes into play, often at the behest of the irregular forces. As one irregular warfare expert points out, these forces have the distinct advantage of fighting in their own way, with their own rules, and within the context of their fight.[21] In other words, they force their enemies to adapt to them, often gaining the initiative and exponentially increasing the difficulty of the fight.

This requires a mind shift for traditional forces seeking to engage irregular fighters on their home turf, which is why traditional forces often lose—as seen with the recent struggles of the US military during the Global War on Terror and the recent French experiences in Mali, Chad, and other former colonies. Being in this ambiguity is deeply uncomfortable and, as stated previously, creates the space cognitively for problems to occur. This is where irregular warfare specialists shine in terms of theory and where planners for the air littoral must explore to find the means for exploitation of the liminal space.

By understanding the context of fighting in ambiguous spaces, one can better understand the universal characteristics that apply to the air littoral. On the surface, irregulars seem to have the advantage of initiative and an air of mystique as they routinely rout and confound superior, state-organized traditional forces. Yet, this frame ignores the underlying logic of irregular warfare. Adversaries that employ irregular warfare do not do so by choice; they are forced to adapt due to a lack of resources.[22] They adapt to the conditions of the engagement. When superior forces do not adjust similarly or attempt to apply straight doctrine as if they were hard-set rules, they often fail.[23]

Oversimplifying problems and ignoring the realities and their nuances are at the heart of failure for conventional forces. As one military strategist argues, approaches to fighting should be seen as tools, reliant on the context and place in which they were and could be used, and that "confusion stems from the belief that operational approaches . . . are comprehensive solutions rather than tools."[24]

This is the danger for operators in the air littoral. They must understand the type of war they are fighting, including the context in which it takes place, to ensure that whatever means can and should be utilized to achieve their desired ends.[25] The air littoral is its own physical and cognitive space, couched in the ambiguities of liminality that require their own means of approach and operation. The conditions of the air littoral—a

21. Kiras.

22. Kiras.

23. Kiras, 261.

24. Emile Simpson, *War from the Ground Up: Twenty-First Century Combat as Politics* (New York: Oxford University Press, 2018), 153.

25. Kiras, "Irregular Warfare," 268.

dynamic, ill-defined environment—will rapidly evolve through time, demanding that operators adjust with these conditions and the concomitant problems of emergence and chaos. This approach may require recognizing intertwined threads precluding set formulas or defined rules.[26]

Instead of "working around" the air littoral, operators should embed themselves within it, using the terrain to their advantage.[27] Adversaries will also face these difficulties, providing opportunities for operators willing to embrace the essence of the liminal space, adapt to its changing conditions, and evolve in tandem with its emergent properties.[28] This final piece, handling complexity, helps resolve the air littoral puzzle before bringing it all together.

Complexity and Systems Thinking

The human mind struggles with adapting to the complexity of a dynamic world. According to systems theory, to compensate, humans rely on mental models that simplify reality, which can lead to problems in some cases. In the quest for sensemaking, humans tend to resolve phenomena into internal narratives, schema upon which consciousness is built.[29] One of the byproducts of this is the tendency toward apophenia, or the making of connections between random occurrences.[30]

While rationality is something to be prized, it was never meant to be the sole arbiter of judgment. Intuition is instinctual for a reason. As one systems thinker points out, "Working with systems, on the computer, in nature, among people, in organizations, constantly reminds me of how incomplete my mental models are, how complex the world is, and how much I don't know."[31] In a world filled with this measure of complexity, the smart thing to do is to take one's time, probe with small experiments, and employ "constant monitoring, and a willingness to change course as you find out more about where it's leading."[32] This observation is nothing new.

Carl von Clausewitz recognized this phenomenon when he proposed his ideas concerning fog and friction. In his mind, the two concepts encapsulated the random phenomena that distinguished war in the abstract from actual combat, which led to making even the simple things about war difficult.[33] More troubling is the realization

26. Kiras, 270.

27. Simpson, *War from the Ground Up*, 169, 175.

28. Valérie Gauriat, "Two Years On: How Is Ukraine Adapting to a Long-Term War?," Euronews, March 22, 2024, https://www.euronews.com/; and Vikram Mittal, "Russia and Ukraine Are Adapting for the Next Phase of the War," *Forbes*, April 20, 2024, https://www.forbes.com/.

29. Khong, *Analogies at War*.

30. "Apophenia," *Psychology Today*, undated, accessed August 8, 2024, https://www.psychologytoday.com/.

31. Donella H. Meadows and Diana Wright, *Thinking in Systems: A Primer* (White River Junction, VT: Chelsea Green, 2011), 180.

32. Meadows and Wright, 180.

33. Carl von Clausewitz, *On War*, ed. and trans. Michael Eliot Howard and Peter Paret, rev. ed. (Princeton: Princeton University Press, 1989).

that these limitations are inescapable and humans are hardwired to simplify thought to the point of error. One psychologist suggests "this need to economize—to save time and effort—underlies any of the failings in our thought processes."[34] Systems thinking, however, requires a different method of approaching this pitfall—indeed, reducing every thought to mental shortcuts and making careless leaps in logic purely on predictive or causal factors does not work in an emergent, dynamic environment. A person must understand that actions have ripple effects, some of which may show up much later in ways that one might not expect.[35]

In systems thinking, grappling with complexity has striking similarities to dealing with irregular warfare. Context is essential, both to understand and from which to frame possible problems. Complexity requires a family or network of capabilities, tools that are adaptable and flexible in application. Rigidity and prescription are the enemy of the design space in dealing with complexity. This is how one must deal with liminality in the air littoral. This article thus brings all these concepts together into one approach, connecting the notion of liminality to the cognitive aspects of maneuver when engaging in the liminal space of the air littoral.

A New Framework

Maneuvering forces to offset the adversary in the air littoral can certainly occur with mass as drone swarms overwhelm this liminal space and complicate airpower and landpower projection. Yet, regardless of how much AI is used to control drone swarms or any other forces on the battlefield, such physical forms of maneuver neglect the ever-present cognitive aspects of fighting that are ever present. Command and control in the air littoral will continue to involve humans in addition to the more conventional forces operating aircraft or pushing forward on the ground.

Maneuver in this case then refers to psychologically positioning the adversary, which is where the previous discussion of tempo comes into play. If the adversary is placed off balance by being forced to contend with the liminality of the air littoral, then psychological mistakes—driven by mental schema, cognitive dissonance, and other biases—become the dominant factor for success. Accelerating this tendency is the possibility of pushing adversaries further into the depths of the air littoral and liminal space to compete, especially if they are using AI decision systems that do not handle the complex boundary conditions particularly well.

One means of manipulating this sense of unease is through exploiting mass within the air littoral, overloading sensory information and data collection efforts as the mass projects apparent chaos across the operating area with interdependencies, ripple effects, and emergent behaviors of the system. Then, the operator can dictate tempo by

34. Dietrich Dörner, *The Logic of Failure: Recognizing and Avoiding Error in Complex Situations*, rev. ed. (Reading, MA: Basic Books, 1997), 186.

35. Dörner, 198.

speeding up or slowing down operations, operating within the adversary OODA loop until the adversary experiences decisional paralysis.

The critical factor for the operator is being able to engage in this cognitive liminal space just as the practitioners of irregular warfare do without succumbing to the same cognitive impairments of their opponents. This requires embracing the complexities of the environment, understanding the tools available without having to deploy them in an overly prescriptive manner, and being able to adapt as the circumstances and context shift. This is fundamentally a systems approach to a dynamic, evolving ecosystem of players, weapons platforms, and the environment.

Challenges remain. Each element on its own is extremely difficult to manage and takes time to master. Moreover, these elements require intensive study, training, and consideration to produce the types of operators capable of dealing with rapidly fluctuating conditions. This is why the air littoral will be difficult to operate within, but embracing that difficulty also provides an opportunity for exploitation and dominance, all of which rests on comprehending the air littoral as the liminal space it occupies, utilizing cross-discipline methodologies to build a strategic framework for approaching this space. This completed framework provides the practical elements for preparing operators for the air littoral.

Develop sUAS Drone Capabilities

To reduce the feelings of unease in liminal spaces, people must expose themselves to the condition. At one point, most bases across the Air Force had an aero club, which not only helped encourage an air-centric mentality, but also improved the basic flight skills of many on base.[36] While expenses and other issues sunset the aero clubs, there is an heir apparent—drone clubs.

Far less expensive, drone clubs involve lower operating costs than the maintenance costs and upkeep for an aero club. Combined with the nearly ubiquitous Spark Cells—sectors on Air Force bases that foster innovation and problem solving—that have significant 3D printing capability, the possibilities are endless.[37] Ukrainian operators can provide plenty of tips, blueprints, and ideas that can be rapidly tested in bases across the country and the world.

These refashioned aero clubs would not only familiarize individuals with drones, thus reducing the cognitive problems from encountering the liminal air littoral, but would also develop operators. Airmen in many ways have become divorced from the core mission of the Air Force, projecting airpower.[38] These aero clubs can reconnect Airmen to the purpose of the service while reinforcing the airmindedness that has been lost during the years of the Global War on Terror. Unfortunately, drone swarms

36. Mh53eflyguy, "Where Have All the Aero Clubs Gone?," thread post, AirWarriors, Naval Aviator's Forum, "Navy/Air Force Aero Clubs," November 8, 2007, https://www.airwarriors.com/.

37. "Spark Cells," AFWERX, undated, accessed August 8, 2024, https://afwerx.com/.

38. Shawn Cochran et al., *The Forces We Need: Building Multi-Capable Airmen to Enable Agile Combat Employment*, RR A1746-1 (Santa Monica, CA: RAND Corporation, 2023), https://www.rand.org/.

are coming, and the Air Force must create individuals knowledgeable in the operation, construction, and capability of drones. A more positive aspect would be the establishment of a strong community, which can be protective for the effects of moral injury and combat exposure experienced by drone operators.[39]

Wargaming and Emerging AI

Wargames powered by AI systems acting as adversaries will further expose operators to the complex environment of the air littoral. One of the hallmarks of systems thinking as it concerns complexity is the idea of probing and experimentation. As noted above, actions taken in complex environments cause ripple effects, many of which are unpredictable.[40] Probing, sensing, and experimenting are vital elements of maneuvering in this complexity.

Operational planners and individuals manning whatever evolves from the current air operations center futurization efforts will need to have experience contending with these complexities, which will only worsen as drone swarms begin to enter the battlespace. AI can act as adversaries, exposing operators to complex conditions that evolve as the operator makes decisions and takes actions. Along the way, operators will learn how they manage such conditions, receiving feedback and tools for dealing with them as well as providing opportunities for experimentation.

Further, operators may reveal synergistic learning between the machine and the operator as they develop novel strategies for employing capabilities in the air littoral. All the while, operators will focus on understanding the environment and learning the limitations of capabilities in the air littoral, providing areas of exploitation against adversaries who may not have the same level of training or ability.

Training and Exercises

The Air Force must integrate drones into basic training and exercises to enable full exploitation of the air littoral. Whether officer or enlisted, every Airmen should have some exposure to the different aspects of drones at every level of accessions and education. While the Air Force has focused on improving the use of M4 shooting across the service, getting drones in the hands of at least some individuals may be more important. Exercises should fundamentally incorporate drones to prepare the service to integrate and defend against these capabilities.

Moreover, rather than focus only on defenses such as electronic warfare spectrum jamming or laser weapons, the Air Force should work on developing offensive drone capabilities that can meet everything from quadcopters to suicide drones, manned and unmanned.[41] Flooding the service with a drone mentality would decrease the

39. Atkins and Seamone, "Remote Combat Exposure"; and Saini, Raju, and Chail, "Cry in the Sky."

40. Dörner, *Logic of Failure*, 198.

41. John Knowles, "Air Mobility Command Ponders 'On Aircraft' Counter Drone Capability," *Journal of Electromagnetic Dominance*, July 16, 2024, https://www.jedonline.com/.

likelihood of the Air Force falling prey to the cognitive problems inherent in the air littoral, as familiarity can help to eliminate or at least reduce the ambiguity that causes anxiety and indecision in this liminal space.

Power of People

As China is one of the primary focuses of great power competition, the air littoral is the perfect place to find advantages against it. The American military largely succeeds not only due to its incredible assets but arguably more so due to its talented, empowered people. Fighting against the People's Liberation Army (PLA) will require every ounce of this strength that begins and ends with people. As stated previously, the war in the air littoral will be fought primarily in the mind. The PLA, with explicit loyalty to the People's Republic of China (PRC), will not have the same flexibility of thought necessary to fight in a complex, dynamic space. Political commissars and other mechanisms for controlling decision-making slow down the ability of operators to engage, assess, and take initiative on their own. This violates the best practices of mission command, which require decentralizing decision-making and empowering lower levels of execution authority to the point of being uncomfortable.[42]

A lack of a competent noncommissioned officer corps is another key weakness. Pushing the PLA into the liminal space of the air littoral aggravates these problems while playing into the fundamental strengths of the United States. Even with the use of AI, China will struggle when the air littoral expands into boundary conditions that have no defined solutions or predetermined, predictive outcomes.[43] This will sow seeds of doubt and hesitancy, making the deep cognitive responses of being in liminal spaces nearly overwhelming. The United States can push decision-making to higher levels by openly questioning the PRC's control of the PLA, impairing its initiative. Yet, this will only be possible if the United States and specifically the Air Force embrace the air littoral, build on the framework described in this article, and inculcate an air-mindedness focused on drones.

Conclusion

The air littoral will continue to advance as sUAS and AI merge to create a truly formidable capability that is rapidly changing the character of war for both the air and land domains. The liminality of the air littoral is as intimidating as it is complex, requiring a restructuring of the way operators approach the battlespace. In reframing the engagement with a cognitive focus, operators embrace the complexity of liminality that includes the physical and the mental.

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42. "Mission Command," Insights and Best Practices Focus Paper, 2nd ed. (Washington, DC: Joint Staff J7, January 2020), https://www.jcs.mil/.

43. Amit Ranjan Alok, "Turmoil and Transformation: The Reconfiguration of China's Military under Xi Jinping," *Australian Outlook*, Australian Institute of International Affairs, August 6, 2024, https://www.internationalaffairs.org.au/.

Further, recognizing this reality provides the opportunity for exploitation through pushing opponents into the boundary conditions that challenge human cognition—let alone AI decision-making programs that may be assisting them. Operators must be ready and willing to adapt to a dynamic system, exposing the emergent qualities of the environment. Controlling tempo and utilizing maneuver is but one means of accomplishing this task, but it is certainly not the only means of doing so.

Operators should see liminality itself as a condition of existence and enter the proverbial threshold, ready to change and grow to succeed. As Campbell notes, "The hero is the champion of things becoming, not of things become, because he is." He goes on to quote Ovid's *Metamorphoses*, "Nothing retains its own form; but Nature, the greater renewer, ever makes up forms from forms. Be sure that nothing perishes in the whole universe; it does but vary and renew its form."[44] The critical aspect is being able and willing to master the liminal space, something the Air Force and its operators should consider as they ponder the future of airpower in the air littoral. *Æ*

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44. Campbell, *Hero*, 209; and Ovid, *Metamorphoses Book XV* (Loeb Classical Library, Public Domain), 383, as qtd. in Campbell.

The New Makers of Modern Strategy: From the Ancient World to the Digital Age

Edited by Hal Brands. Princeton University Press, 2023, 1,158 pp.

The New Makers of Modern Strategy is the latest update to the classic compendium first edited by Edward Mead Earle in 1942 and last updated in 1986 by Peter Paret. Unlike Earle or Paret, who were historians, the editor of this most recent volume, Hal Brands, is a political scientist. Brands is the Henry A. Kissinger distinguished professor of global affairs at the Johns Hopkins University School of Advanced International Studies and a resident scholar at the American Enterprise Institute. The latest version of this anthology consists of 45 essays from a veritable *Who's Who* in contemporary strategic studies, with two contributors—Williamson Murray and S. C. M. Paine—contributing two essays. Eight essays from the previous volume have received a fresh treatment in *The New Makers*.

The New Makers has twice as many contributions as the original *Makers of Modern Strategy* and slightly more than one and a half as many as the Paret edition.[1] This reflects an attempt to cast a wider net than its predecessors in terms of both the periods and material covered, such as the inclusion of new domains and a shift from the bipolarity of the Cold War to a multipolar world. In this, it achieves mixed results. Despite its subtitle, the ancient world is an afterthought. Only two entries cover strategy in the period prior to Machiavelli—the earliest strategist discussed in the prior editions—in contrast to four that touch on the First World War.

The book does a better job when expanding the range of the *Makers* series. It does this through the inclusion of essays on strategy in non-Western contexts and on the economic aspects of strategy. Among the first, Paine's and Elizabeth Economy's essays are especially noteworthy, and serve as valuable introductions to Chinese thinkers such as Sun Yat-Sen, whom Western strategists would be well advised to become familiar with.The contributions by James Lacey and by Eric Helleiner and Jonathan Kirshner on the relationship between economics and strategy are some of the best contributions to the volume.

Yet Brands' attempt to broaden the *Makers* perspective is not always successful. Kori Schanke's essay on "Strategic Excellence: Tecumseh and the Shawnee Confederacy" and Priya Satia's "Strategies of Anti-Imperial Resistance" are among the weakest contributions to this volume. Both pieces could have been sacrificed in favor of addressing some of the omissions in the earlier editions and in this specific volume. Carter Malkasian's essay "Strategies of Counterinsurgency and Counter-Terrorism after 9/11" is one of several contributions that are of uneven quality. The portion on counterterrorism is valuable and highlights how domestic politics and fiscal realities impact strategy, key factors that are often overlooked by military leaders. Yet the section on counterinsurgency borders on hagiography and would have been better served by a more skeptical voice like

1. Edward Meade Earle, ed., *Makers of Modern Strategy: Military Thought from Machiavelli to Hitler* (Princeton: Princeton University Press, 1943); and Peter Paret, ed., *The Makers of Modern Strategy from Machiavelli to the Nuclear Age* (Princeton: Princeton University Press, 1986).

that provided by Gian Gentile.[2] Overall, the uneven nature of the essays in this collection leaves one with the feeling that a third of them could have been omitted entirely.

Despite the greatly expanded nature of *The New Makers*, once again there is no essay on Julian Corbett. Airpower theorist John Warden and the ever controversial but often-cited John Boyd are both deserving of coverage but also go unmentioned. As in the previous edition, geopolitics is overlooked. An essay on Halford J. Mackinder and Nicholas J. Spykman would have been valuable and would have served to complement Derwent Whittlesey's on Karl Haushofer in the original edition. Despite the ubiquity with which terms like hybrid, gray zone, and irregular warfare are thrown around, the debate about their usefulness as intellectual constructs is far from settled, and an essay by Donald Stoker on the topic would have been a welcome addition.

The inclusion of new domains is discussed in Joshua Rovner's "Strategy and Grand Strategy in New Domains" and is one of the more useful essays in the volume. He reminds us that there is no magic technological solution that leads to cheap victory. By successfully tying the new domains of cyberspace and space to the past, Rovner illustrates how logistical, organizational, and fiscal realities will define the realm of the possible. Ultimately, strategic success requires integrating capabilities from both new and existing domains. One can see a future edition of *Makers* including a more expansive examination of strategy as it relates to space and cyberspace.

Lawrence Freedman's opening essay on the idea of strategy is, like all his work, insightful. Yet it is essentially a reworking of two pieces that were previously published in the *Texas National Security Review*.[3] In addition to those contributions already singled out for praise, among the most valuable essays in the book are Walter Russell Mead's on the strategic legacy of ancient Greece and Rome, Michael Leggiere's on "Napoleon and the Strategy of the Single Point," and Iskander Rehman's discussion of French strategy in the seventeenth century.

Hew Strachan's treatment of Carl von Clausewitz is an example of how fresh insights can be found in oft-studied material. At the same time, Dimitry Adamsky's discussion of the revolution in military affairs and Thomas Rid's examination of the intelligence revolution are thoughtful pieces that bring the *Makers* series into recent history. The volume concludes with an excellent essay by John Lewis Gaddis that neatly summarizes and ties together the work by the preceding authors.

The New Makers embraces a broader conception of strategy than the 1986 version, which was firmly focused on war. This reflects not so much an evolution of the term strategy but a return to its use in the original Earle edition. Yet, in doing so it unwittingly raises questions of who makes strategy and at what level it is made. Because of the nature of the volume—a collection of essays that examine practically the entire span of

2. See, for example, Gian Gentile, *Wrong Turn: America's Deadly Embrace of Counterinsurgency* (New York: New Press, 2013).

3. See Lawrence Freedman, "The Meaning of Strategy, Part I: The Origin Story," *Texas National Security Review* 1, no. 1 (December 2017); and Freedman, "The Meaning of Strategy, Part II: The Objectives," *Texas National Security Review* 1, no. 2 (2018).

recorded history across the globe—this book is ill-suited to answer this question or to untangle the nuances between policy, grand strategy, and strategy.

Despite this, *The New Makers of Modern Strategy* is essential reading for courses on strategy. It does not replace the previous two volumes but serves as a useful addition and update by expanding the historical periods, topics, and cultural backgrounds addressed in the *Makers* series. The uneven nature of this work, however, means that it is best dipped into selectively.

Lieutenant Colonel Wilson C. Blythe Jr., USA, PhD

Fight for the Final Frontier: Irregular Warfare in Space

John J. Klein. Naval Institute Press, 2023, 264 pp.

Fight for the Final Frontier plots irregular warfare strategic theories from traditional warfighting domains to space, arguing that established military strategic thought on limited warfare is valid in this newly recognized domain. John Klein, a retired US Navy commander with 22 years of service as a naval flight officer, has written extensively on space strategy and deterrence and is currently an adjunct professor at George Washington University's Space Policy Institute and Georgetown University's Strategic Studies Program. A clearly established academic in the field, Klein builds on his previous work on space strategy to demonstrate how irregular strategies might influence the execution of space warfare by the United States, its Allies, and its partners. The book considers a range of strategic theories applied to historical vignettes, and while not exclusively devoted to lessons from the maritime domain, it does follow the general trend of military space literature by focusing on maritime synergies.

Klein corrals a variety of strategic concepts across eight chapters. Throughout, the key tenets of multidomain strategic theory commonality, opportunity presented by asymmetric tactics, primacy of technology, and inevitability of third parties in play shine through as consistent themes. He first introduces irregular warfare itself, comparing it with limited war, hybrid war, gray-zone conflict, gunboat diplomacy, and other similar, perhaps popularized terms that fulfill his fundamental criteria for *irregular*. For Klein, irregular warfare amounts to any multidomain strategy that does not involve conventional warfare, where the end result is won by more than military force alone. This point is important and one of a few golden threads through the work; the lessons from recent history regarding counterinsurgency, maintaining political will, guerrilla wars, and great power competition all apply in irregular warfare and in the space domain. It is in these early chapters that Klein's key argument that "space is not special" starts to become clear. Although space is not a new domain, theory can be applied to it as well as any other domain. This makes the work accessible to students of military strategy who find themselves attempting to navigate the application of operational art to the space domain.

Klein makes the assertion that a state's space strategy will probably align with its other multidomain strategies, which are fed by the state's politics and culture. Actions in space are unlikely to be strategically decisive on their own, but their impact may have

strategic consequences. This is one area where Klein is able to describe the application of indirect warfare theory to the space domain, and he does so convincingly. Irregular warfare in space lends itself to cumulative strategies of small, non-decisive action, which prevents an overall victory. This highlights the asymmetric opportunity of a small space force and also the intractable nature and impact of time on irregular strategy, both of which are compounded in space domain conflict.

Chapter 3, arguably one of two key sections for space operations practitioners, discusses small space wars and the operational art of conducting irregular space warfare. Klein asserts that command of space—analogous to both command of the sea and control of the air—cannot be absolute but will be bounded temporally and spatially as well as often disputed. Key terrain across space, link, and ground segments are discussed. Klein also takes the opportunity to reintroduce celestial lines of communication—"those lines of communication in, through, and from space associated with trade, materiel, supplies, personnel, spacecraft, electromagnetic transmissions, and some military effects"—from his earlier work as a way to describe key terrain in space to be contested.[1] It is a fair argument that certain frequencies for communication or certain orbital regimes or planes are more valuable than others and that they will be contested. Klein discusses space control in terms of general versus local and persistent versus temporary—a valuable discussion, but one that left me wishing for a quadrant matrix as an accompanying figure to illustrate a space vignette fully.

In chapter 4, Klein also delineates how limited warfare or assertive activity short of conflict can still present challenges to space actors. Analogies with gunboat diplomacy are again well made and should give strategists thought when considering how to either assure access to space or coerce an outcome. A key argument introduced here and continued later is how space domain awareness—and its attribution of space action—is needed to reduce the gray zone that adversaries operate within during limited war. This argument offers one of the book's more immediately and practically applicable ideas, reinforced in chapter 8 with Klein's framework that recognizes space attribution as a process; however, it deserves even further exploration than this book provides.

Chapters 5 and 6 introduce lawfare—"the intentional distortion and misuse of legal regimes for competitive advantage"—and commercial risks and opportunities (91). Klein demonstrates how adversaries already have lawfare within their arsenal and how it is likely to also be employed in space. Borrowing from naval irregular warfare, he discusses space privateering and piracy, where the probability of the former—the pillaging and taking of "prizes" such as space capabilities or services with the authority of the government or other licensor—is well argued. Yet, the possibility of space pirates—who act outside of the law—seizing such prizes is perhaps a step too far outside the cone of plausibility. Setting the conditions for lawfare to be employed, he argues that commercial actors in space will drive the maturity of the space domain more than government actors. It is therefore incumbent on states to integrate key commercial elements into a hybrid space architecture, both to establish norms

1. John J. Klein, *Space Warfare: Strategy, Principles and Policy* (Abingdon, UK: Routledge, 2006), 51.

for space behavior in order to defend against lawfare and to exploit the opportunities and redundancies found within dual-use capability.

This latter opportunity from the commercial sector is further discussed in the context of space technologies in chapter 7. Klein offers that technology can provide deterrence by denial; any definitive action against a capability in space that can be mitigated through a hybrid redundancy potentially reduces the chance of the action at all, protecting sovereign capability. Klein then contends that, largely owing to the technologically driven context of space operations, the domain is inherently both offensive and predictable. A valid example is seen in the ways costs of launch forces prioritize ensuring payload capability over including defensive suites, while technology makes obfuscation difficult.

The book's second key element for the practitioner is the proffered 10 counterstrategies for irregular warfare in space. Here, Klein argues for education in irregular space warfare and then the criticality of maintaining political support and patience when in a prolonged, irregular conflict. He restates the importance of attribution through his space attribution framework, which creates a triad between space domain awareness, intelligence, and commercial elements. He argues the case for defensive measures and resilience in space and notes the need for a nonmilitary solution to irregular warfare, stating the importance of dispersal and concentration—that is, maneuverability—before work with commercial partners and allies. Klein's final point is to tie off a key thread that runs throughout his work: space is not special. There is no all-encompassing answer or rules to space strategy; there are just strategic guidelines for current strategists to contend with and apply.

Klein has made convincing arguments throughout. In what is a nascent but growing pool of academic literature, *Fight for the Final Frontier* is accessible to current military strategists and will help place space warfare thinking in the minds of multidomain planners. Yet while some of Klein's key strategic theories are well illustrated at a level accessible to the generalist, one or two clear and realistic space vignettes with more depth would help seat the book's offerings in the generalist strategy student's mind and therefore neatly into multidomain strategic education. Overall, *Fight for the Final Frontier* presents a good thesis. It deserves a place as essential reading for any military member engaged in professional military education or indeed any staff charged with operations, strategy, or capability development.

Squadron Leader Mike Lambert, Royal Air Force

Warrior Diplomats: Civil Affairs Forces on the Front Lines

Edited by Arnel P. David, Sean Acosta, and Nicholas Krohley. Cambria Press, 2023, 280 pp.

As the Department of Defense shifts its focus toward strategic competition, its temptation to simply leverage technological overmatch is real. In *Warrior Diplomats*, Arnel David, Sean Acosta, and Nicholas Krohley offer an anthology of nine chapters regarding the value proposition of military civil affairs forces within this new environment and how, at scale, the activities of these specialized service members inform military com-

manders—particularly in the human domain—at a fraction of the cost of the forecasted hardware procured for the joint force.

Despite published Joint, Army, and Marine Corps doctrine, there currently exists no unified theory of civil-military operations, but instead an interdisciplinary—and messy—body of work from sociologists, historians, political scientists, and strategists. The editors and authors of *Warrior Diplomats*, however, are largely operators, seasoned and exposed to the value of civil reconnaissance. David is a colonel in the US Army, Acosta a senior noncommissioned officer, and Krohley a US government adviser, all of them holding experience operating within and publishing about the human domain. The authors of the chapters include civil affairs professionals from the active and reserve components, US Army, US Marine Corps, and British Army. Throughout the book, the authors challenge their field to know their worth and do better.

The term *warrior diplomat* used throughout the book stems from the civil affairs tradition of many of the authors and speaks to the military's role in engaging and influencing people as well as battlefields. The warrior, exposed to contested terrain, must take acceptable risk in pursuit of operational outcomes, while the diplomat must act prudently and discreetly with foreign counterparts. The Joint force is asked to appreciate the nuance of geopolitics for the coming struggles, but it is important to remember that all politics—even geopolitics—is local. To that end, warrior diplomats, through civil reconnaissance, provide the commander a more granular understanding of the human networks and communities which the United States seeks to influence.

Over nine chapters, the authors lament the ad hoc structures built over the previous decades to address commanders' demands in that moment but hold that the wrong lessons may be learned from strategic failures by focusing only on technology as the remedy. While the authors do not challenge the Joint force's need to adapt and modernize, they posit a critical weakness is the inability to understand ground truth in areas of geopolitical importance borne of a lack of investment engaging at lower levels. Further, the Joint force must address this vulnerability through systemic change.

In recent years, the services have been divested of many of their civil affairs forces. Whether this divestment is due to policymakers shifting the focus of resources toward technological change or to their fundamental misunderstanding of civil affairs' value proposition, the authors do not claim civil affairs is without room for improvement. Instead, the book begins by communicating the value of civil affairs forces using historical and recent examples then suggesting ways to optimize civil affairs and evolve beyond the current structure.

The book first offers a discussion of the strategic environment and the new great game, resulting from a world disaggregating beyond even the bipolarity of the Cold War. This disaggregation makes the application of standard geometric models of the international state of play difficult if not irrelevant, specifically because these models do not adequately account for localized details. This leads directly to a discussion of operating in the gray zone below the state of open conflict and the opportunities available to the state able to leverage information about the populations in question. In the gray zone, presence matters, relationships shift, and optimization is difficult.

Warrior diplomats play a role as persistent partners, mapping local networks and providing continuous feedback to operations.

The discussion of the human domain balances cognitive and emotional models with historical context and strategic documents. Through this chapter, the authors remind the reader that influence over the population, the often-disregarded point of Clausewitz's trinity, requires an appreciation of both how people think and feel. The described relationship of network science is similarly academic as it relates to the discipline of civil reconnaissance cultivated in civil affairs manuals. Expanding on these models, Acosta challenges readers to elevate their staff work by "cancelling the crosswalk" matrices (the example given is the PMESII/ASCOPE matrix—political, military, economic, social, information, and infrastructure domains interwoven with areas, structures, capabilities, organization, people, and events) that equate to checking boxes rather than engaging in deep, meaningful analysis of populations relevant to commanders' decisions.

The messiness of these theories, however, is made salient with a relevant case study from central Africa's Lake Chad Basin, wherein forces managed to integrate multilateral humanitarian assistance and counterterrorism operations. The simultaneity of these activities, given the nature of influencing populations in under-governed spaces, may seem as necessary as it is novel to the staffer negotiating military authorities with higher headquarters. The authors then illuminate opportunities to optimize and improve with chapters on integrating civil affairs forces across the US Army (active and reserve components, conventional and special operations forces), across the Joint force (US Army and US Marine Corps), and across US Allies and partners—specifically discussing civil-military cooperation in the NATO Alliance—to build a global civil-military network.

Warrior Diplomats: Civil Affairs Forces on the Front Lines is, then, not a collection of war stories but a compilation that presents another paradigm for strategic competition beyond and complementing technological overmatch through its discussion of the value proposition of civil affairs forces moving forward. It leverages relevant examples of civil affairs actions during Operation Enduring Freedom–Philippines and the operation of the Danab Brigade in Somalia, but these inform the theories presented. Given the lack of exposure to civil affairs experienced by so many in the Joint force—neither the Air Force nor the Navy have designated civil affairs forces—*Warrior Diplomats* provides insight beyond what the practitioner might glean by simply reading doctrine. Current civil affairs forces may parochially appreciate the book insofar as it validates any thoughts they may have around organization and optimization. Even so, the layperson likely benefits more so with a broadened understanding of the tools available to the Joint force as it navigates the changing strategic environment.

Lieutenant Colonel Robert Newton, USAF, PhD

Deter, Disrupt, or Deceive: Assessing Cyber Conflict as an Intelligence Contest

Edited by Robert Chesney and Max Smeets. Georgetown University Press, 2023, 301 pp.

There is an old parable about a group of blind men encountering an elephant for the first time. They try to determine what the animal is through touch but are each able to touch only part of the elephant—its trunk, its ear, and its side. From their limited perspective, they determine what they have encountered—one thinks the elephant is a snake, another a fan, and the third, a wall. This same theme applies to the analysis of cyber in *Deter, Disrupt, or Deceive*, edited by Robert Chesney and Max Smeets. In examining offensive cyber operations, each editor finds comparisons based on their own understanding and offers solutions. The articles are well-researched and documented but lack any broad connection to an overall cyber operations thesis.

The editors ask contributors to align cyber conflict as an intelligence contest—or "statecraft pursued through the means and methods traditionally associated with intelligence agencies"—before examining state and nonstate actor policies (5). Integrating all cyber conflict possibilities with such a narrow scope is a difficult task, even for someone like me, despite my career in intelligence. Still, the book provides interesting reading for anyone involved in cyber or intelligence operations.

In the first section, contributors analyze the theory and concept of intelligence contests and cyber operations. The underlying insight suggests that some cyber operations fit into this framework, but the perspective is focused on strategic contests, which support the ends of national policy, rather than intelligence missions, which are the means to achieve the ends. In the first chapter, Joshua Rovner outlines the book's central thesis, which demonstrates the five elements of intelligence contests: collect more information than an adversary; exploit information for practical gain; undermine adversaries' morale, institutions, and alliances; disable opponent intelligence capabilities; and pre-position collection assets for the future. Rovner's analysis of historical precedents spanning England and Spain in the late 1500s to the Cold War yield additional thoughts referencing the difficulty in using intelligence gains and a demand for secrecy in intelligence. The various authors discuss how these elements apply, but like the blind men, they are limited in their perspective to provide broader insights by viewing cyber operations through the lens of an intelligence contest.

The first six articles build a United States cyber operations perspective using the published national cyber strategy. Michael Warner starts the arguments by stating intelligence functions as a secretive support activity rather than a cyber end. The articles then address challenges between US Code Title 10 detailing military operations guidelines, and Title 50, which addresses intelligence collection difficulties in conducting covert cyber operations; and the United States' management of past cyberattacks.

Each article varies the approach slightly, but the common theme suggests cyber operations that focus on intelligence collection as operations are too difficult to manage and execute. The difference between intelligence collection and operations is that the former prepares for future conflict while the latter generates current or future effects. Cyber difficulties emerge as large operation secrecy, the technical scope needed to cre-

ate effects, and deterrence model vagueness. Overall, the first section is interesting, but it highlights the need to further examine challenges in the US cyber model.

The next section addresses cyber internationally through China, Russia, and the United Kingdom. A retired People's Liberation Army officer submits the Chinese perspective on cyber operations as the defense of China's ideology. The author, Lyu Jinghua, suggests China's cyber aims to grow the country without physically destroying adversary assets constitutes legitimate cyber usage. This varies greatly from the international stance that economic cyberattacks such as stealing corporate intellectual property are as harmful as physical attacks.

Valeriy Akimenko and Keir Giles' article on Russia's approach to cyber activity contends that its current cyber operations mindset is an extension of Russia's long-term information operations. The case of Vasili Mitrokhin, a KGB defector who provided the UK's intelligence agency MI6 with intelligence files that exposed Soviet agents, is referenced as demonstrating how Russia has always defended its ideology against Western influences by any means necessary. Russian operations based in the GRU, an intelligence directorate, and the FSB, a state security agency that emerged from the KGB, show the national emphasis on continuing information warfare approaches.

Moving from adversarial nations to the UK, the philosophy shifts to protection rather than exploitation. Unlike adversarial nations but similar to the United States, the UK publicly acknowledges its cyber efforts center on the Government Communications Headquarters (GCHQ) intelligence hub. The section shows how other nations link intelligence contests and operations without losing the capacity to generate cyber effects.

The book concludes with nonstate actors. Nonstate actors typically imply terrorist organizations, but in the book, it refers to contractual parties working for the government in an intelligence capacity and other parties operating within the cyber environment. These parties have emerged due to the US government's general lack of cyber expertise. One key example, referenced in Lyu Jinghua's article, was American cybersecurity firm Mandiant's government-funded Chinese research. This government funding led China to conclude the Mandiant report constituted an ideological attack even when presented as pure research. The article demonstrates how government-funded cyber actors and government cyber action gaps will become inseparable in managing accountability. Thus, any action a private actor takes may be attributable to the US government. These discussions carry over to other state actions, such as use of social media by the Internet Research Agency (IRA) in St. Petersburg, Russia, to influence the 2016 presidential elections. The remaining discussion then addresses when contracted intelligence assets become official government action and whether those lines can be drawn effectively.

One clear gap in the book's analysis was in its technical knowledge concerning current cyber operational capabilities. The comment appears multiple times that cyber is more appropriate for intelligence as technical access lacks connections to physical effects. The 2008 Turkish pipeline explosion, Stuxnet, and multiple Ukrainian power outages are the most common physical examples of cyber effects. The 2014 Target hack shows where an infiltration via network access given to a vendor in charge of a physical system—the refrigeration, air conditioning, and heating system—led to financial results. Growing trends

in smart houses, integrated grids, and Wi-Fi everywhere show where initial cyber effects could drive or support integrated actions. Those integrated actions currently match Russia's information warfare plans, whereas China remains focused on economic growth. Failing to address these points means authors may not have fully considered the operational effects possible through cyber.

Overall, *Deter, Disrupt, or Deceive* summarizes some old arguments in a new format, updates the packaging, and presents the same solutions. The various authors do not reach an agreement on whether cyber should be considered merely an intelligence resource or a strategic policy tool. Lacking a conclusion is emblematic of the cyber field as a whole: the areas reachable through cyber grow daily, and no one agrees on the perfect approach. The central thoughts examined were scaling operations, maintaining secrecy, analyzing other nation's strategies and civilianizing cyber functions. The answer likely lies somewhere in between; however, continuing to analyze the issue from only one perspective—identifying one part of the elephant, so to speak—will likely not move the debate forward. Still, I would recommend *Deter, Disrupt, or Deceive* to anyone who has been exclusively on either the intelligence or operations side of cyber for ideas in eventually bridging the gap with solid strategies supported by policy.

Dr. Mark T. Peters II, Lieutenant Colonel, USAF, Retired

Outsourcing National Defense: Why and How Contractors Are Providing Public Services

Thomas C. Bruneau. Lynne Rienner Publishers, 2023, 167 pp.

Thomas Bruneau's *Outsourcing National Defense* wants to set the record straight on DoD contracting. Bruneau, professor emeritus at the Naval Postgraduate School, oversaw contractors as chairman of its national security affairs department and director of its Center for Civil-Military Relations, eventually becoming a contractor himself. Early in the book he highlights that contracting makes up an enormous part of the DoD budget but is an understudied topic among scholars. Several studies dealing specifically with private military and security contractors exist, but such contractors are just one part of a multibillion-dollar industry. The book is therefore both an initial study of DoD contracting and a call for more academic scrutiny on the topic.

Bruneau modifies an existing civil-military relations framework to understand the degree to which the Defense Department successfully uses contracting to get results. The factors he examines include the coherence of the DoD's strategy overall, the level of education and training of those who award and monitor the contracts, the implementation of the contracts, the level of oversight by Congress, and the usefulness of the Federal Acquisition Regulation (FAR)—the set of regulations and authorities most often used for DoD contracting.

Bruneau broadly applies the framework to two security challenges—or what he calls "strategies"—that the United States has faced in the past 25 years: the Global War on Terror, specifically Iraq and Afghanistan, and great power competition with China. He argues that each demanded different requirements from contractors. While the war on terror drove demand for expeditionary contracting that supported the war effort

abroad, great power competition requires contractors to provide cutting-edge technology. As the timelines of these two strategies overlap, the large number of contracts involved are often not always clearly demarcated as falling under one or the other. Yet Bruneau makes a compelling enough case that these strategies should be treated separately in terms of contracting, and his analysis benefits from isolating two different lines of effort at least in theory, even if in practice such a distinction is less clear.

Bruneau reaches several broad conclusions in his book. The first is that a lack of overall strategy in the war on terror drove an increased dependence on contracting to support the military's operations abroad. Simultaneously, the Defense Department did not know how to use contractors in the most efficient way. For instance, the DoD staff in charge of monitoring contracts to combat waste, fraud, and abuse were often unable to travel to the area of operations to personally monitor the contracts' implementation for logistical and administrative reasons, including the overwhelming amount of paperwork involved along with the security risk. Consequently, as contracting abroad expanded, the Department was increasingly unable to oversee it efficiently. While the withdrawal from Afghanistan and reduced presence in Iraq lessened the number of contracts, the issue was never fully addressed. Bruneau cautions that another expeditionary conflict could easily replicate those dynamics of inefficiency.

Bruneau's other conclusions focus on defense contracting more broadly. He asserts that policymakers should develop strategies that include contracting since it makes up such a large part of the DoD budget and underpins military operations and the delivery of new technologies. For the latter case, he contends that FAR is not ideal for acquiring new technologies compared to another contracting framework, Other Transaction Authorities (OTA), due to the latter's flexibility. OTAs have delivered significant results for the Defense Department, such as helping develop the COVID-19 vaccine. Still, very few contracts use OTAs compared to the FAR, so there are lost opportunities for the Department to acquire new technologies and compete successfully in great power competition. How the Department of Defense treats the staff that manage contracts also matters.

Bruneau points out that the Department does not use OTAs as much as it should because the staff who award and oversee contracts are poorly compensated and have limited prospects for career advancement. The existing structure offers few rewards for eschewing the FAR in favor of OTAs and presents potential consequences for one's career if they take a risk by not using FAR and do not succeed. He therefore argues that DoD personnel need a more effective incentive structure to pursue contracts that deliver new and better technologies.

The necessity for strong oversight, especially by Congress, is a major theme in Bruneau's book. He argues that the Defense Department often struggles to change without external pressure. In the war on terror, the Department resisted congressional oversight over contracting, even as lawmakers documented waste and recommended meaningful improvements. The most significant improvements to contracting for both the Defense Department and the Intelligence Community (IC) came after intense congressional monitoring and recommendations.

Bruneau's arguments and policy recommendations are compelling, but he is often limited by his sources and his access to information. This is not the fault of the author: few academic sources deal with the topic of contracting, and information about contracting from the Defense Department and Intelligence Community are frequently classified on the government side and proprietary on the industry side. Objective reports from the government, including the Congressional Research Service and Government Accountability Office, are in short supply. Bruneau conducted interviews with government officials and contractors to help fill in the gaps, but because contracting is ultimately such a complex and occasionally opaque subject and available information limited, he must resort to roundabout methods to reach his conclusions. For instance, he indicates that many problems in contracting by the IC were addressed because of a lack of reports and scrutiny after 2014. Yet these shortcomings reflect more on the quality of information currently available to researchers than on that of Bruneau's analysis itself.

As *Outsourcing National Defense* offers one of the first academic studies to tackle a topic as broad and complex as DoD contracting, there is much to build on. For instance, discussions on OTAs, contracting in Afghanistan and Iraq, and congressional oversight of contracting could easily fill books in their own right. Contracting in Intelligence almost certainly deserves its own study, as Bruneau's main focus is the Department of Defense as a whole rather than the IC, which spans multiple parts of the government. Bruneau and subsequent scholars should also seek to develop frameworks of analysis that are suited to the peculiarities of contracting, as the adapted framework he uses here may not be suitable for future studies.

This book is recommended not only for practitioners and scholars working on most elements of US national security but also for those interested in contracting. Bruneau makes the point that contracting is so fundamental to how the Defense Department operates that a reasonable understanding of how it works is key to recognizing how the military approaches everything from counterterrorism abroad to technological advancement at home. Because the Department is especially reliant on contracting, scholars and policymakers focused on other parts of the US government or foreign governments may not find that all the conclusions apply to their context.

In all, *Outsourcing National Defense* is not without its shortcomings due to limited access to information, but it addresses an enormous gap in the scholarly understanding of US national defense and lays a foundation for future work on defense and intelligence contracting.

Marcel Plichta

Blown to Hell: America's Deadly Betrayal of the Marshall Islanders

Walter Pincus. Diversion Books, 2021, 416 pp.

Popular histories of American nuclear weapons testing commonly tend toward the Manichaean, neatly dividing that period of Cold War history between perpetrators and victims. In *Blown to Hell: America's Deadly Betrayal of the Marshall Islanders*, Walter Pincus rejects such a simplistic narrative, instead weaving a more intricate tale of the

complex moral and technological decisions made by the United States during the early atomic age. The resulting work justifiably casts the people of the Marshall Islands, that small island nation in the Western Pacific, as victims of atmospheric nuclear weapons testing's literal and metaphorical fallout. Yet it simultaneously paints a very human picture of those who participated in nuclear weapons testing, from the scientists who underestimated the yields of prototype weapons, to the medical doctors who devoted their lives to the health of those affected.

Though not a credentialed historian, Pincus comes with his own pedigree, having been among *The Washington Post* staff who won the 2002 Pulitzer Prize for national reporting for its coverage of the war on terrorism.[1] Moreover, he has deep experience as a national security journalist, having reported for the *Post* from 1966 until 2015. Indeed, he traces his own interest in nuclear weapons testing's effects upon Pacific Islanders to his earliest days as a journalist, reinforced by a 1974 visit to the Marshall Islands. Pincus' professional background manifests itself somewhat jarringly in the more distinctive writing style of *Blown to Hell*'s later chapters, given their more contemporary focus; yet his grasp of the subject matter remains evident throughout the book.

Pincus divides *Blown to Hell* into two halves, each arranged chronologically. The first half, dubbed "The First Tests," traces American nuclear weapons testing from the Manhattan Project to Operation Castle in 1954. The second half, "Long-Term Problems," picks up in the immediate aftermath of the Castle Bravo shot—the March 1, 1954, test of a thermonuclear weapon at the Marshall Islands' Bikini Atoll, which to date remains the highest-yield nuclear weapons test in American history—and recounts the US government's decades-long inconsistent treatment of the Marshallese following the irradiation of their homeland.

Pincus' use of Castle Bravo as the book's narrative focal point is not without reason, given that test's very real consequences for the Marshall Islanders' health and ability to return to their homeland; yet it comes at the cost of eliding discussion of subsequent nuclear weapons tests in the Pacific. Indeed, Operations Redwing (1956) and Hardtack I (1958) pass entirely unmentioned, leaving the reader with the mistaken impression that testing at Enewetak and Bikini Atoll ended with Operation Castle, and forgoing the opportunity to more closely examine the process by which the US government weighed the Marshall Islanders' welfare against the competing demands of national security—itself a major theme of the book.[2]

The greatest strength of *Blown to Hell* is its ability to put a human face on those involved in nuclear weapons testing. Despite his evident sympathy for the Marshallese whose home islands were irradiated to the point of being uninhabitable, Pincus amply demonstrates that the scientists, military personnel, and bureaucrats responsible for

1. "Staff of *The Washington Post*," Pulitzer Prizes (website), 2024, https://www.pulitzer.org/.

2. T. R. Fehner and F.G. Gosling, *Atmospheric Nuclear Weapons Testing, 1951–1963, Battlefield of the Cold War: The Nevada Test Site*, vol. 1 (Washington, DC: Department of Energy, September 2006), https://www.osti.gov/.

conducting atmospheric nuclear weapons tests in the Pacific between 1946 and 1962 were operating at the limits of contemporary scientific comprehension.

For example, much detail is given regarding pioneering efforts to decontaminate target vessels after the second "Baker" shot of Operation Crossroads—the pair of nuclear weapons tests which in 1946 first displaced the Marshall Islanders from their home at Bikini Atoll—bathed its target vessels in irradiated seawater. Similarly, Pincus raises the important point that in 1954, scientists expected that Castle Bravo's yield would be six megatons, not the 15 that occurred, and that both the volume and the geographic dispersion of the resulting fallout were consequently far greater than their plans had accounted for. But in addition to the islanders themselves, the author displays evident sympathy for those Atomic Energy Commission scientists and medical professionals who, like Dr. Robert A. Conard, devoted their professional lives to the Marshall Islanders' well-being notwithstanding their own government's role in the conduct of such tests. *Blown to Hell* thus yields a complex and multifaceted picture of the interactions between the US government and the Marshallese during and after the era of weapons testing.

That said, a significant defect of *Blown to Hell* lies in the inconsistency of its sourcing and argumentation. Although Pincus draws upon a diverse body of evidence, this does not uniformly speak to the US government's treatment of the Marshall Islanders. For example, fully 14 of the book's 41 chapters concern Operation Crossroads. Yet most of the content of those chapters concerns Joint Task Force One's planning and execution of the tests, with the Bikinians' evacuation and subsequent repatriation receiving comparatively short shrift—likely the consequence of the author's heavy reliance upon US government sources. Pincus likewise describes in engaging detail the task force's pioneering decontamination of Operation Crossroads' target vessels but does not examine how or whether the lessons learned from that effort might have informed projections on the probable effects of fallout upon the Marshall Islands during subsequent tests. The result is a narrative that is rich in incidental detail but one which neglects to answer the question as to how the US government failed to predict the long-term consequences of atmospheric nuclear testing.

The problem of argumentation repeats itself, in a different guise, in the second half of the book. Pincus is at his most engaging as a writer when describing the plight of the *Lucky Dragon #5*, the Japanese fishing vessel at the center of international controversy when in 1954 its crew was accidentally exposed to radioactive fallout from the Castle Bravo shot. The author relates a compelling narrative grounded in the historical record, juxtaposing the maximalist positions adopted by the Japanese and American governments against the well-meaning efforts of scientists and medical professionals to ascertain what had happened to the fishermen and how to assist them.

Yet the book notably fails to tie the *Lucky Dragon* incident into the overarching history of the Marshall Islanders' treatment by the US government. For example, it misses the opportunity to examine why the Japanese case received so much more public and international attention than the plight of the Marshall Islanders, beyond the simple fact that the White House exercised greater control over the flow of information in the latter

case. A more comprehensive study of the Castle Bravo test's human toll might account for the political necessity of keeping Japan on-side during the Cold War, or consider whether implicit bias played a role in the disparate treatment accorded to the "modern" Japanese and "primitive" Marshall Islanders. *Blown to Hell*, however, merely tees up such questions for other writers to address more fully.

Pincus' book, though an uneven and incomplete account of American nuclear weapons testing and its consequences, remains an engaging and accessible work of popular history, which generally succeeds on its merits. It convincingly demonstrates the devastating legacy of such weapons testing upon the Marshall Islanders to a degree best suited for readers with an introductory understanding of this chapter of Cold War history. The book has the particular virtue of illustrating the diversity of the US government's responses to unforeseen problems surrounding nuclear fallout, juxtaposing those who sought to preserve secrecy at all costs against those who, like Conard, committed themselves to the task of improving the Marshall Islanders' lives. Most importantly, Pincus effectively demonstrates that for the Marshallese, this chapter of history remains open as they continue to experience the physical and emotional consequences of nuclear weapons testing.

Lieutenant Colonel John William Sutcliffe IV, USAF, PhD

The Military Legacy of Alexander the Great: Lessons for the Information Age

Michael P. Ferguson and Ian Worthington. Routledge, 2024, 370 pp.

British Army Major General J. F. C. Fuller, a veteran of World War I and a profound contributor to the development of armored warfare, wrote extensively on military theory, history, and biography. In particular, Fuller found examples of ancient generalship pertinent to contemporary military affairs and wrote accounts of the lives of two famous ancient generals, Julius Caesar and Alexander the Great—works which demonstrate Fuller's acumen as both historian and military officer.[1]

Ian Worthington, professor of ancient history at Macquarie University in Sydney, and US Army Lieutenant Colonel Michael Ferguson, history doctoral student at the University of North Carolina–Chapel Hill, have combined forces to write a new book attempting to follow Fuller's lead and make the ancient art of war more accessible to a contemporary audience. Their work not only focuses on Alexander the Great's campaigns and leadership but also melds ancient history with contemporary events and concepts. Their goal was not to write another biography or military history of Alexander but to highlight select examples of his career that resonate in the modern era.

Yet while the authors lay out a clear description of key elements of Alexander's life and career and mix in several succinct accounts of modern events, the book's dual approach never really unifies around their central intended theme. They do demonstrate how important studying Alexander's life is for today's military leaders, just not as effectively as

1. See J. F. C. Fuller, *Julius Caesar: Man, Soldier, Tyrant* (London: Eyre & Spottiswoode, 1965); and *Generalship of Alexander the Great* (New Brunswick, NJ: Rutgers University Press, 1960).

could have been done. Their attempt to merge modern military and ancient history into a cohesive narrative misses the mark, primarily due to the bifurcated approach.

After an introduction, the authors begin with some background and biographical information, and then, in order to prepare the reader for appreciating the relevancy of Alexander's context, they discuss contemporary military issues in an effort to "offer the reader a deeper appreciation for, and perhaps connection to, the ancient world by showcasing flawed assumptions surrounding divergent trajectories of modern conflict" (34). After explaining the rise of Macedonia and the development of its army in the aftermath of the classical age of Greek warfare, the book turns to surveying innovation and modernization in the modern military, focusing on the notion of the revolution in military affairs, inaugurated in the post-Vietnam era. Three chapters on key Macedonian campaigns are followed by another on modern issues, then another section on Alexander's more distant campaigns, his leadership legacy, and his performance as a strategist.

The sections covering Alexander's conquest of Persia are excellent, with tactical and operational details, maps, and careful analysis using a mix of modern history and ancient sources. The maps are particularly useful in aiding comprehension. The chapters on more recent military events and concepts are not as effective, partly out of a need for brevity but also in the topical structure in which they are couched. This ancient/modern mix is the chief problem with the book; the attempt to connect the Alexander narrative overtly to contemporary events and ideas is rather strained at times, despite frequent use of the "like Alexander" clause. A better approach would have been to mix the modern and ancient factors topically within the same chapter—that is, by extended applicable contemporary passages interlaced within the Macedonian narrative. For example, when discussing reforms and the innovative organization of the Macedonian army, some of the description of the post-Vietnam revolution in military affairs could have been more directly inserted, followed by a comparative section.

Additionally, although Alexander and the US military both campaigned in the Near East, Mesopotamia, and Afghanistan, little attempt was made at comparing the two, other than their shared challenge of confronting different cultures. A more robust examination of the geographic factors in warfare for both ancient and modern armies would have been fascinating. A stronger editing of the text, seeking to mix the two historical approaches, could have enabled the writing and scholarship to be more cohesive.

The authors' call for the careful study of history by modern military practitioners is eloquently aided by their clear writing styles and carefully measured flow of facts and data. The reader is not drowned in detail, nor do they suffer from confusion due to breadth. A succinct, clever conclusion by former US National Security Adviser Lieutenant General H. R. McMaster, himself a history PhD, was a striking way to finish the work.

A detailed book on Alexander's generalship in and of itself is a rich source of lessons learned, inspirational leadership, and brilliant innovation for a modern commander. What would make Ferguson and Worthington's work resonate better with a contemporary reader is if, rather than forcing snippets of modern campaigns into the narrative, its language, structure, and approach modeled more traditional campaign history—the kind of history written by military officers for military officers, using one voice instead of

two. This is what makes Fuller's *The Generalship of Alexander the Great* (1960) so powerful for a military reader and the *Anabasis of Alexander* by Arrian (c. 86–160 CE)—a general like Fuller—stand the test of time. A Landmark version of Arrian, modeled along the lines of *The Landmark Thucydides*, is now available as a wonderfully accessible account of Alexander for today's readers; it would pair quite nicely with Ferguson and Worthington's work and give it a powerful resonance with the distant past.[2]

Nonetheless, *The Military Legacy of Alexander the Great* would be a useful study for students of history or security studies and would make a good reading for professional military education.

James M. Tucci, PhD

The Coming Wave: Technology, Power, and the 21st Century's Greatest Dilemma

Mustafa Suleyman with Michael Bhaskar. Crown Publishing Group, 2023, 352 pp.

The Coming Wave is a futurist nonfiction science and technology book by Mustafa Suleyman. Suleyman is the cofounder of two artificial intelligence (AI) companies, DeepMind and Inflection AI, and has held multiple AI development and policy positions throughout his career. *The Coming Wave* attempts to stand out among a multitude of emergent technology books written within the past year with its take on how an ensuing technological revolution will result in a far more dramatic impact on humanity than any other in history. Though it offers valuable insights, the book overstates the threat of AI and synthetic biology while proposing containment options that Suleyman admits are unrealistic to implement.

The foundational premise of *The Coming Wave* is that throughout history, there have been "waves" of technological advancement with reverberating effects that altered the course of human history. Suleyman delineates 24 previous general-purpose technologies that have indiscriminately diffused across the globe, with the twenty-fifth currently in progress. He argues that preceding waves ranging from the discovery of fire to the proliferation of the internet have not been as disruptive to human technological evolution as the impending wave, which combines AI and synthetic biology. A convergence of large-scale knowledge systems with genetic modification, as he proposes, will transform the world at an unprecedented pace and with far-reaching, irreversible consequences. Suleyman supports this claim by highlighting the effect economies of scale are having on the increased availability of these technologies. Specifically, he notes the relative ease of acquiring advanced genetic testing equipment that is enabling the establishment of hobbyist biological labs, akin to the early '90s tech sector garage startups. While still a well-intentioned niche market, these homegrown experimentation centers augmented by emergent AI systems could accelerate radical pursuits of human genome modification with potentially disastrous results.

2. *The Landmark Arrian: The Campaigns of Alexander*, ed. James Room and trans. Pamela Mensch (New York: Anchor Books, 2012); and see *The Landmark Thucydides: A Comprehensive Guide to the Peloponnesian War*, ed. Robert B. Strassler and trans. Richard B. Crawley (New York: Free Press, 2008).

In supporting the premise that the world is amid the next large-scale transformation, Suleyman thoroughly covers numerous examples of previous technologies expanding beyond their original intended use and being adapted for other purposes. This is being played out in the current wave through the widespread adoption and adaptation of large language models (LLM) for uses that promote knowledge discovery and application for both good and bad. The author posits that recent advancements in AI will follow an exponential trajectory, leading to a redistribution of wealth and power that could disrupt the existing geopolitical order in favor of small nation-states and nonstate actors. This redistribution would give ambitious actors the ability to not only fund but also rapidly develop and scale capabilities favoring their ideological use cases.

This background effectively establishes the foundation for Suleyman's argument for containing the impending technological wave and limiting its potentially disastrous effects. Yet Suleyman immediately undermines his efforts to rally humanity to his cause by highlighting that previous technological containment has largely failed. One example he provides is the Ottoman Empire's thwarted attempt to restrict the effects of the printing press, specifically to ban Arabic writing.

Acknowledging the complexity of the task at hand, the author primarily focuses on topics that present a worst-case scenario and neglects substantive discussions on the positive aspects of the technology. For example, his proposed vision of deep surveillance states or an "East India Trading Company" consolidation of corporate influence, while plausible, is representative of a superficial omission of incremental adaptation of these technologies as an opportunity for divergent outcomes. Ultimately, Suleyman's attempts to include counterarguments to the overly pessimistic stance are not as impactful as the arguments for a worst-case scenario and, in the end, do not provide enough balance to overcome the alarmist tone. These views also neglect to support a relevant way forward. The author proposes 10 steps to contain the rapid expansion of technology, ranging from technological safeguards and government regulation to cultural changes and large-scale movements. Most, if not all, of these steps are grandiose and largely unattainable because of the bureaucracy and cost associated with implementing them. The author rightly acknowledges the near impossibility of such an effort but admirably persists in his recommendation anyway. While the steps for containment have solid support, they should not be viewed as the ultimate guide. Instead, as he mentions in chapter 13, these steps should serve as a catalyst for further conversation.

As a thought experiment based on the content in the book, I asked Google's latest LLM, Gemini Advanced, if it agreed with the arguments presented in the book. Its output: "It's difficult to give a definitive yes or no to whether I agree fully with *The Coming Wave*." It then explained why it could not fully agree or disagree: "I don't form my own beliefs or opinions in the same way a human does. I process information and provide responses based on patterns and probabilities in the data I've been trained on."[2]

These responses illustrate two concepts from the book. The first is an attempt at technological containment by putting guardrails in place to control the output from

2. Text generated by Gemini, Google, February 4, 2024, https://gemini.google.com/.

LLMs. The second is the drive for corporate-aligned interests and protectionism by preventing copyright material from being used. There is movement in the right direction, as Suleyman states, and his steps to containment are a starting point. Ultimately, the author's assessments, based on research and personal experience, are well-intentioned. But the future is incredibly difficult to predict, and this next wave as he describes it may or may not come to pass.

The book tends to be a bit repetitive throughout and seems to emphasize the main points with excessive reasoning. This over-justification tends to be monotonous and can read as a desperate attempt to support the book's main stance. This does little to help Suleyman overcome the tendency common among leaders to reject narratives seen as negative—what he calls "pessimism aversion"—which he seeks to avoid. Furthermore, as Suleyman comes primarily from an AI background, detailed discussions of synthetic biology are missing from the text, which can at times cause a lack of focus and distraction when the subject is briefly reintroduced.

Still, Suleyman presents solid and extensively researched concepts that provide an ideal starting point for discussing the proper implementation of this new technological frontier. While *The Coming Wave* presents valuable insights, it ultimately tends to be overly alarmist and is unlikely to attract a wide audience outside of technologist communities.

Captain Brad Worley, USAF

NOTES

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