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FROM THE EDITOR

Dear Reader,

Despite a year marked by increasing global turmoil, barbarism, and climate-related challenges, we continue to see important advances in science, technology, and organizational management. Integrating these advances into force modernization, analytical systems, physical infrastructure, and human systems will improve the ability of the United States and its Allies and partners to work together in defense against adversaries who seek to destabilize a democratic world order. Our Fall 2023 issue considers some lessons we are learning from today's conflicts and highlights the benefits of recent scientific and technological research and development.

In our lead article, Matthew Galamison and Michael Petersen delve into Russian aerospace forces' (VKS) technological capabilities, training, doctrine, and operational concepts, revealing significant deficiencies. As NATO nations modernize their air forces, they can and should learn the lessons behind Russia's air campaign failures in Ukraine.

Turning to renewable energy, Nate Olsen argues the best way to ensure energy grid sustainability and readiness at overseas US military bases is to generate power through renewable microgrids. Multiple forms of renewable energy, tailored to specific geographic regions, will provide the United States and its Allies with uninterrupted power to maintain power down range. As the world pays increasing attention to climate change, Lauren McQuone asserts that advances in meteorological analysis can highlight differences between adversary and friend vulnerabilities. An assessment of capabilities, risk, and behavioral norms and anomalies can help our forces determine the marginal advantage in operational planning.

Threats—climate or otherwise—to installations are persistent today. Brandon Dinkins argues a new US Air Force Security Forces framework is needed to modernize the forces and create a comprehensive security posture for our physical installations. This framework will mitigate personnel shortfalls as well as mental and physical health factors that impede the readiness and capabilities of our Defenders.

Adding further context and the view of an Ally to the questions posed by Galamison and Petersen for NATO, our issue concludes with a contribution focused on France's participation in US and Allied air and space operations. David Pappalardo and Andy Hamann remind us of France's key role in the Alliance in providing critical airpower capabilities, and they highlight the importance of interoperability and potential future collaboration in space efforts.

As always, thank you for taking the time to read this issue of *Air & Space Operations Review*. We hope you find it engaging and informative.

~ The Editor

Failures of the Russian Aerospace Forces in Ukraine

Matthew S. Galamison
Michael B. Petersen

Russian thinking on Russian aerospace forces' capabilities prior to the invasion of Ukraine reveals the force faced interconnected and unresolved challenges, including a mistaken strategic priority on defensive over offensive operations, a failure to develop sufficient capacity and capability for large-scale operations, and comparatively undeveloped operational concepts. As European NATO partners modernize their forces in the coming years, these critical shortfalls provide lessons related to acquiring specific technologies and platforms, engaging relevant operational concepts, and committing to extensive, ongoing training.

Since the start of Russia's invasion of Ukraine in February 2022, one of the enduring questions of the conflict has been why Russian airpower has failed to establish air superiority against a seemingly less capable adversary. Failing to establish air superiority—or even air supremacy—over Ukraine, Russia's leadership has limited its Russian aerospace forces (VKS) to conducting long-range cruise missile and drone strikes from within the bastion of its national borders, or worse, to dangerous low-altitude strikes in the heart of man-portable air defense and air defense artillery engagement zones.

> *Starting a war without controlling the electromagnetic spectrum is tantamount to defeat.*
> Anatoly Tsyganok, director of the Center for Military Forecasting, Moscow[1]

Why has Russia not taken advantage of its numerical and technological air advantage over Ukraine? This article examines Russian sources to argue intellectual biases among Russian defense planners have resulted in technical shortcomings, an absence of operational concepts especially in the critical area of suppression of enemy air defenses (SEAD) and destruction of enemy air defenses (DEAD), and a force that is too poorly trained for the combat environment found in Ukraine. Many Russian-language airpower experts under-

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1. Anatoly Tsyganok, "Применение сил и средств РЭБ в войнах и конфликтах XXI века" [The use of forces and means of electronic warfare in wars and conflicts of the XXI century], *Nezavisimaya Gazeta*, last modified September 20, 2019, https://nvo.ng.ru/.

stood these gaps, which at least in the trans-Atlantic community, were papered over by massive military investment and credulous analysis of that investment.

Russia's struggles in the air also offer lessons for NATO's procurement efforts. As European alliance members invest in critical tactical air capabilities, they must consider the observed gaps in Russian airpower capability. One of the most serious is the lack of a tactical-level, dedicated electronic attack aircraft capable of both intelligence, surveillance, and reconnaissance (ISR), and SEAD/DEAD. Current European procurement efforts, even of the F-35 Lighting II, do not completely fill this gap.

In addition, European air forces must be wary of believing that technological innovation equals improved battlefield outcomes. As procurement efforts progress, developing practical operational concepts and practices will be imperative as the number of strike aircraft increases. Failure to do so will place European air forces in the same conundrum Russia currently finds itself. Finally, European NATO partners must commit to sufficient training and aircraft maintenance to enable Alliance air supremacy in a potential conflict with Russia.

Perspectives on Russian Airpower

A number of authors have examined the problem of the so-called "disappearance" of the Russian air force in the Ukraine conflict.[2] Studies that reflect longer-term analyses of the Russian war in Ukraine began emerging in late 2022, less than a year into the conflict. Thus far, the two most thorough examinations of the air war in Ukraine indicate Russia's failures in large part stem from the inability of the VKS to consistently suppress or destroy Ukrainian ground-based air defense systems at the outset of the conflict.[3]

These analyses describe Russia's success in the opening week of the war when Ukrainian surface-to-air-missile (SAM) systems could be well-mapped and few defensive measures were taken to enhance their survivability. But once this initial flurry subsided, the VKS began to stumble. Inadequate Russian SEAD/DEAD and Ukraine's ability to sustain its ground-based air defense denied air superiority to Russia and resulted in a deadlocked air conflict. Both sides became limited to tentative jabs, small-scale tactical innovation (Ukraine), and reliance on long-range precision strikes (Russia) against fixed targets.

Yet these otherwise thorough works offer little in the way of Russian-language evidence to support their case. Further, these perspectives reveal critical flaws in Russian capabilities. As this article will demonstrate, many reliable Russian-language airpower

2. Justin Bronk, "The Mysterious Case of the Missing Russian Air Force," Royal United Services Institute (RUSI), February 28, 2022, https://rusi.org/; Phil Stewart and Idrees Ali, "What Happened to Russia's Air Force? U.S. Officials, Experts Stumped," Reuters, March 2, 2022, https://www.reuters.com/; and Dougal Robertson, "Getting It Wrong: The Missing Russian Air Campaign over the Ukraine," *Australian Defence Business Review*, September 2, 2022, https://adbr.com.au/

3 Justin Bronk, Nick Reynolds, and Jack Watling, *The Russian Air War and Ukrainian Requirements for Air Defence* (London: RUSI, 2022), 1, https://rusi.org/; and Justin Bronk, *Russian Combat Air Strengths and Limitations: Lessons from Ukraine* (Arlington, VA: Center for Naval Analyses [CNA], 2023), https://www.cna.org/.

sources observed before the war that for all of Russia's technological improvements in airborne ISR and electronic attack, it had yet to translate those improvements into effective operational practice.

Piecing together prewar Russian thought on VKS operations reveals a set of interwoven challenges that Russia had not yet solved by the outbreak of the war. This includes a strategic priority on defensive over offensive operations, failure to develop sufficient capacity and capability for operations at this scale, and comparatively immature operational concepts. These lessons have critical implications as NATO partners undergo major force modernization over the next several years.

The Defensive Bias

An analysis of Russian military doctrine reveals the VKS is primarily anchored to Russia's enduring military priority of defending "Mother Russia" from a so-called "aerospace blitzkrieg" by NATO, to the detriment of sustained, strategic offensive air operations.[4] "Russia has no intention to assault anyone," ran one Russian analysis of the Aerospace Defence Forces—the predecessor of the VKS—in 2019.[5] Politically expedient or not, this sentiment has influenced the VKS' strategic emphasis and prioritization of tasks. As a result, Russia's military spending priorities did not accentuate operational concepts such as suppression and destruction of enemy air defenses, a critical requirement for gaining air superiority over a contested area of operations, and thus an essential element of any air campaign.

Most Russian operational planning in the post-Soviet period has focused on defense against NATO aerospace attacks, especially in the "initial period of war . . . the most critical and decisive period of conflict when countries launch strategic operations with already deployed forces."[6] In Russian assessments, the initial period of war for a NATO attack on Russia would consist of what Russia terms a massed missile-aviation strike, now more commonly referred to as an integrated massed air strike.[7] The concept of this massed-aerospace assault has driven much of Russian thinking on air operations. As Russian thinkers have emphasized the need for aerospace defense at the operational level of war, they have commonly landed on these integrated massed air strikes as a primary threat to national security.

This, in turn, has pushed the state's military-technical development, procurement, and training into integrated air defense rather than more offensively oriented air dominance operations. While Russia demonstrated an increase in offensive air operations in recent conflicts such as Georgia in 2008, Crimea in 2014, and Syria in 2015, "the fundamental

4. Thomas Withington, "Defending Mother Russia's Skies," RUSI, July 13, 2022, https://rusi.org/.

5. S. N. Borisko and S. A. Goremykin, "Analyzing the State of Russia's Aerospace Forces, Development Projects," *Military Thought* 28, no. 1 (2019).

6. Michael Kofman et al., *Russian Military Strategy: Core Tenets and Operational Concepts* (Arlington, VA: CNA, 2021), 3.

7. Kofman et al., 21.

orientation and posturing of the Russian military over the years still remains centered on defending its heartland and vital industries and cities, using layered and integrated air defense."[8] Even if Russian military theory posits a mixture of offensive and defensive air actions, as prominent Russian airpower theorists have noted, "it can be assumed that in the general concept of aerospace defense, the main semantic load still falls on the concept of 'defense.'"[9]

Because of this cognitive prioritization on integrated air and missile defense, Russian airpower strategists have spent less intellectual capital on preparation for complex, offensive air superiority and air dominance campaigns. Retired US Air Force Lieutenant General David Deptula has noted "Russia has never fully appreciated the use of airpower beyond support to ground forces," and "as a result, Russia, in all its wars, has never conceived of or run a strategic air campaign."[10]

Russian military strategy has generally prioritized the defense of critical infrastructure and close air support of ground troops rather than power projection in defended airspace. Because of this, the development of operational concepts and doctrine for air dominance operations, including SEAD/DEAD, has suffered. The cognitive defensive bias has led, intentionally or not, to the deprioritization of the planning, practice, and execution of offensive operations to gain air superiority in contested airspace.

Inadequate Procurement

While Russia has conducted a thorough reform of its military since the Georgian War of 2008, it is unclear at this point if the rubles have been spent wisely for a twenty-first-century conflict. One Russian defense analysis points out that while established Russian hardware designs experienced successful growth, only marginal progress was made in producing completely new weapons and platforms such as fifth-generation aircraft.[11] Since 2010, the VKS has received approximately 350 modern strike-fighter aircraft, most of which are upgraded designs of older platforms, including Su-30SM multirole fighters, Su-35S air-superiority fighters, and Su-34 bombers.[12] But this investment in upgraded

8. Diptendu Choudhury, "Russia's Military Understanding of Air Power: Structural and Doctrinal Aspects," Vivekananda International Foundation, May 23, 2022, https://www.vifindia.org/.

9. Valentin Dybov and Yuri Podgornykh, "Всесторонне проработанной теории ВКО пока нет" [There is no comprehensively elaborated theory of WSC yet], VKO, last modified December 2015, http://www.vko.ru/.

10. Phillips Payson O'Brien and Edward Stringer, "The Overlooked Reason Russia's Invasion Is Floundering," *Atlantic*, May 9, 2022, https://www.theatlantic.com/.

11. Richard Connolly and Cecilie Sendstad, "Russian Rearmament: An Assessment of Defense-Industrial Performance," *Problems of Post-Communism* 65, no. 3 (October 19, 2016), https://doi.org/; and Julian Cooper, *Russia's State Armament Programme to 2020: A Quantitative Assessment of Implementation 2011–2015* (Stockholm: FOI [Swedish Defence Research Agency], 2016), 48, https://www.foi.se/.

12. Justin Bronk, "Is the Russian Air Force Actually Incapable of Complex Air Operations?," RUSI, March 4, 2022, https://rusi.org/.

strike platforms has masked the underinvestment and underdevelopment of less flashy but critically essential systems necessary to overcome Ukrainian ground-based air defenses as part of a successful air campaign.

Russia's own military experts may not believe Russia has put its money or focus on the right technology. Airpower observers have noted the defense industry has failed to develop capability and capacity, especially in ISR and electronic attack, for the purpose of SEAD and DEAD. For example, a 2021 article published in *Military Thought*—the English translation of the journal of the Soviet Union's and Russian Federation's Ministry of Defense—made a tacit admission that Russia is still lagging in the development of a wide variety of platforms, including "advanced fixed-wing and rotary, low-altitude and stratospheric, reconnaissance and reconnaissance-strike, fighter and jammer, and relay and radar surveillance and guidance UAV [unmanned aerial vehicle]."[13] This indicates a defense-focused semantic load evident in the doctrine that has resulted in capability gaps in critical offensive air dominance capabilities such as SEAD and DEAD.

Like any kill chain, SEAD and DEAD rely highly on timely, accurate ISR. As of 2022, Russia's most prolific airborne ISR platforms are the Ilyushin Il-20 Coot and the Su-24MR. The Il-20, a Cold War-era turboprop built in the 1970s, is almost entirely unsuited to operations in a contested environment, while the Su-24MR is a modification of the 1980s fighter-bomber. Both aircraft can collect and classify electronic intelligence from ground-based radar systems, but they lack electronic suppression systems. Additionally, the Su-24MR can generate synthetic aperture radar imagery.[14] Yet in the 2008 Georgia War, the Su-24MR was ineffective against Georgian air defense systems, which, like Ukraine's, were Soviet-produced.

Operations there also revealed Russian aircraft could not accurately locate enemy radars with available electronic intelligence technologies. Su-24MR crew training was also considered to be subpar.[15] Currently, it is assessed that Russia has a global inventory of 10 operational Il-20s of various configurations, and 48 Su-24MRs are believed to be still operated by the VKS as of January 2023.[16] It is not clear how many of each aircraft are allocated to Ukraine operations, but given global demand, whatever the number, it is almost certainly too few.

Notably, Russia has recently attempted to modernize its strategic ISR force with the Tu-214R. Russia currently operates only two of these modern ISR aircraft, with a third still in development. Russian sources claim the Tu-214R can detect radar systems out to

13. S. N. Kurilov, A. N. Kiryushin, and Yu. N. Moiseyev, "Current Problems of Air Forces Tactics and Ways to Solve Them," *Military Thought* 30, no. 3 (September 30, 2021): 22.

14. Piotr Butowski, *Russia's Warplanes: Russian-made Military Aircraft and Helicopters Today* (Houston, TX: Harpia Publishing, 2015), 178, 192.

15. Tsyganok, "Применение сил."

16. "An In-Depth Review of Russia's Current ISR Aircraft," Key.Aero (website), May 18, 2022, https://www.key.aero/; and "Su-24 Inventory," Janes, accessed January 21, 2023, https://www.janes.com/.

400 kilometers, but development issues have plagued the platform.[17] Russian military bloggers have been especially critical of the delayed development of the Tu-214R, asserting if Russia had been able to field the Tu-214R on time and in sufficient numbers for the invasion of Ukraine, then the "resistance of the Armed Forces of Ukraine would have been suppressed long ago."[18]

For all its publicly claimed capabilities, it seems the VKS has been disappointed in the performance of the Tu-214R and has canceled further production.[19] This program cancellation leaves the Russian aerospace forces with a few dozen legacy aircraft and three poorly performing modern ISR aircraft. Russian unmanned aerial vehicles such as the Orlan-10 have filled in gaps but are operated by Russian ground forces and do not appear to provide rapid and reliable ISR mapping for SEAD/DEAD missions.[20]

There is also little evidence to show the VKS has fully developed the proper capabilities for electronic attack in support of SEAD/DEAD. First, Russia has no dedicated tactical airborne electronic attack aircraft to nonkinetically suppress adversary SAM systems. The Il-22PP is equipped with a standoff electronic warfare suite, but the airframe is based on an Il-18D airliner.[21] Unsurprisingly, an airframe based on an antiquated airliner makes for a poor tactical SEAD asset in a dynamic SAM environment, where standoff jamming is insufficient, and speed and maneuverability are required to maintain jamming alignment with supported strike aircraft. One Russian military analyst has noted that the use of the Il-22PP for electronic attack is "not the ideal solution."[22]

To compensate, the VKS currently fields the RTU 518-PSM electronic warfare suite on its Flanker family of aircraft.[23] This wing-mounted pod, also known as the Khibiny family of jamming pods, is reported to be highly capable of detecting and defeating adversary SAM radars, utilizing what appears to be digital radio frequency memory technology.[24]

While the Su-34 can be configured with Khibiny pods to act in an escort jamming role, open-source reporting alludes to the fact that the Khibiny pods primarily operate in an

17. Boyoko Nikolov, "Russia is Testing a Tu-214R Reconnaissance Aircraft over Ukraine," Bulgarian-Military.com, last modified September 24, 2022, https://bulgarianmilitary.com/; and "Russian Military Confident in Tu-214R Capabilities after ELINT Missions in Syria," Air Recognition, last modified 2015, https://airrecognition.com/.

18. Andrey Mitrofanov, "Ту-214Р в специальной военной операции на Украине: не прошло и года" [Tu-214R in a special military operation in Ukraine: Less than a year], TopWar, last modified September 27, 2022, https://topwar.ru/.

19. "Tu-214ON/Tu-214R," Janes, last modified August 2, 2022, https://www.janes.com/.

20. Bronk, *Russian Combat*, 17.

21. "In-Depth Review."

22. Nikolai Litovkin, "Russia Receives First Il-22PP Porubschik Electronic Countermeasures Planes," Russia Beyond, November 9, 2016, https://www.rbth.com/.

23. Joseph Trevithick, "Ukraine Just Captured One of Russia's Most Capable Aerial Electronic Warfare Pods," Drive, September 12, 2022, https://www.thedrive.com/.

24. Roman Skomorokhov, "Комплекс РЭБ «Хибины» чудо-оружие армии России?" [Complex EW "Khibiny" miracle weapon of the Russian army?], TopWar, last modified October 31, 2017, https://en.topwar.ru/.

autonomous mode, with pod software detecting, classifying, and transmitting a jamming signal back to the threat radar.[25] In effect, they provide only self-protection jamming for aircraft, not electronic suppression of threat radars required for SEAD/DEAD. There are indications the VKS may have developed escort-jamming abilities to suppress enemy radars, but this capability is not confirmed, nor is there any indication that it has mastered the concept.[26]

Ukrainian air defenses have shot down at least one Su-35 and one Su-30SM equipped with Khibiny pods since the start of the conflict.[27] This is not altogether unsurprising, given the deficiencies of digital radio frequency memory jamming against modern SAM systems. The frequency agility of modern radar-guided SAMs can make it difficult for such a jammer to consistently replicate a return signal sufficient to mask the jamming aircraft continually.[28] The vital lesson regarding how the VKS utilizes these pods is that they are likely most beneficial when defending against a surface-to-air engagement and should not be relied on as a substitute for dedicated escort SEAD.

Finally, Moscow must also contend with the fact it requires adequate high-end forces in case of a conflict with NATO, and losses in Ukraine have put great pressure on the force. As one Russian observer has noted, "The more modern a vehicle we send to hunt for Ukrainian air defense systems, the less likely it will be shot down, but the more painful the loss will be."[29]

Given this, Russia's use of high-performance aircraft to conduct electronic attack for force-packaged groups of aircraft is perhaps technically possible but of limited capability and capacity and still immature in practice. As one 2016 analysis argues, "Substantiation of the necessity to mount electronic warfare equipment on the operational tactical aircraft, is . . . a prospective trend in military scientific research, requiring an immediate practical solution."[30] While Russia's experience in Syria's uncontested skies did provide relevant experience, considering the current performance of VKS tactical aircraft in SEAD/DEAD missions, it appears Russia has made little progress in the years since.

The lack of a high-performance, dedicated electronic attack platform leaves Russia with few options to nonkinetically suppress an adversary's integrated air defense system. With limited nonkinetic options, the only choice that remains is to try and eliminate threat SAM systems kinetically. With limited precision-guided standoff munitions to engage

25. Butowski, *Russia's Warplanes*, 85–86.

26. Roger McDermott, "Russia's Advances in Electronic Warfare Capability," *Eurasia Daily Monitor* 16, no. 135 (October 2, 2019), https://jamestown.org/.

27. Trevithick, "Ukraine."

28. Reuben F. Johnson, "Russian EW Weaknesses Endure While Other Nations Innovate," AIN Online, June 16, 2019, https://www.ainonline.com/.

29. Andrey Mitrofanov, "Неудобные вопросы: господство в воздухе над Украиной и его последствия" [Awkward questions: Air supremacy over Ukraine and its consequences], TopWar, last modified June 24, 2022, https://topwar.ru/.

30. V. I. Vladimirov and V. I. Stuchinsky, "Rationale for Combat Use of Aircraft EW Equipment at Operational Depth to Gain Information Superiority," *Military Thought* 25, no. 2 (June 30, 2016): 29.

and destroy adversary SAM systems, the VKS has few options to target an enemy's integrated air defense system.[31] One of the primary methods observed throughout the Ukraine conflict thus far has been the use of antiradiation missiles.

Designed to acquire and guide on the radar signature emitted by SAM radar systems, antiradiation missiles can be an effective tool if employed correctly. Russian Su-35S and Su-30SM aircraft have been observed flying combat sorties against Ukraine with load-outs of Kh-31 antiradiation missiles.[32] Yet based on videos appearing on social media, the employment altitude, flight profile, and ranges observed are unlikely to maximize the desired effects.[33]

Russian fighters have also been observed firing salvos of antiradiation missiles and then escaping the weapons engagement zone. Savvy radar operators can defend against this by blinking their radar system off and back on. With no radar emissions in the air, the missile loses its primary method of guidance and goes "dumb." While radars may temporarily be suppressed, the effect can often be measured in seconds. Surface-to-air missile operators will simply turn the radar back on once the antiradiation missile threat has passed and continue prosecuting aircraft. This tactic underscores the need for layered ISR, strike, and jamming capabilities. In addition, Russian pilots require well-developed operational concepts that are rigorously practiced with the right platforms. None of these requirements are present at scale in the VKS.

Poorly Developed Operational Concepts

Even successful modernization efforts in Russia over the last decade presented the military with a newer and equally challenging conundrum that remained unsolved on the eve of war in Ukraine. Russian aerospace forces made the cognitive and technological leap into sophisticated electronic attack capabilities, but translating those twenty-first-century developments into operational practice has revealed itself to be another challenge altogether. Russia went into the Ukraine conflict with immature operational concepts for both ISR and electronic attack.

For example, rapid, coordinated ISR for emergent target mapping and battle damage assessment is crucial in modern combined arms campaigns, especially in SAM-dense environments. Given the technical capabilities described above, VKS forces should have the ability to rapidly turn emergent SAM radar detections into strike operations on the

31. Bronk, "Mysterious Case."

32. Justin Bronk, "Getting Serious about SEAD: European Air Forces Must Learn from the Failure of the Russian Air Force over Ukraine," RUSI, April 6, 2022, https://rusi.org/.

33. Justin Bronk (@Justin_Br0nk), "Interesting footage showing use of Su-35S air superiority fighter purportedly over #Ukraine with a mixed air-to-air and Suppression of Enemy Air Defences (SEAD) missile load (Kh-31). Also carries Khibiny self defence pods. Still only looks like a singleton sortie, however," Twitter, March 7, 2022, 2:35 a.m., https://twitter.com/.

fly. But NATO officials have indicated Russia's ISR and targeting processes have not been up to the task in this conflict.

British Air Marshal Johnny Stringer, deputy commander of NATO's Allied Air Command, noted that "the transformation in US and NATO airpower over the last five decades has no equivalent in the VKS [Russia's air force], nor do the Russians have anything like the ISR-led strike capabilities of NATO Air Forces, nor the targeting processes to exploit them."[34] Indeed, analysts have observed it takes the Russian military at least 48 hours to process actionable intelligence and assign it to a strike platform.[35] This is wholly inadequate in a dynamic surface-to-air missile environment.

Russian airpower theorists were, in fact, aware of this problem well before the Russian war in Ukraine. In the 2008 Georgia War, the Russian air force conducted small raids using two to four aircraft. It did not use escort reconnaissance aircraft to detect pop-up SAM threats, nor did it employ electronic warfare to suppress detected Georgian air defense systems. In addition, it did not allocate special aircraft to destroy any detected air defense systems, and it could not conduct post-strike battle damage assessment.[36]

In this regard, operations in Syria may have provided some experience, but a review of the journal *Aerospace Forces: Theory and Practice*, the leading journal of airpower in Russia, reveals the VKS had not yet solved the problems exposed by the Georgia War.[37] Interestingly, the creation of fused intelligence over multiple combat platforms, so vital to effective emergent target mapping and battle damage assessment, was considered especially challenging; space-based ISR for tactical strikes was considered even more difficult.[38]

The failure to solve these problems poses a conundrum for Russian pilots in Ukraine. Russian military analysts themselves noted this in 2021:

> It has become more difficult to avoid destruction from the fire of mobile and covert low-altitude air defense systems. Climbing to medium altitudes calls for more effective neutralization techniques—jamming countermeasures against

34. Tim Martin, "Russia's Air Campaign Hampered by Poor ISR Based Strikes and Target Processing: NATO Official," Breaking Defense, November 4, 2022, https://breakingdefense.com/.

35. Bronk, Reynolds, and Watling, *Russian Air War*, 28.

36. Tsyganok, "Применение сил."

37. For example, see V. A. Vasiliev et al., "Otsenka urovnya razvedyvatl'nogo obsespecheniya udarnykh dystviy aviatsii" [Assessment of the level of support for air strike operations], *Vozdushno-Kosmicheskiye Sily: Teoriya i Praktika,* no. 15 (September 2020): 52–62.

38. N. T. Shevtsov and A. N. Moor, "Sposob dorazvedki ob'jektov protivnika pri vedenii boyevykh deystviy smeshannaoy aviatsionnoy diviziyey" [Enemy objects reconnaissance method during the conduct of combat operations by a mixed aviation division], *Vozdushno-Kosmicheskiye Sily: Teoriya i Praktika,* no. 19 (September 2021): 57–73; and V. A. Vasiliev et al., "Analiz vozmozhnostey kosmicheskoy razvedki po informationnomu obespechniyu upravleniya aviatsiyey pri vypolnenii ognevykh zadach" [Analysis of space intelligence capabilities for information support of aviation management in the performance of fire missions], *Vozdushno-Kosmicheskiye Sily: Teoriya i Praktika,* no. 17 (March 2021): 47–56.

> detection and targeting assets of medium-range air defense systems. However, as altitude increases, aircraft bombing accuracy diminishes to an unacceptable level.[39]

Further complicating the issue is that for all the Russian failures to effectively execute SEAD and DEAD in the Ukraine conflict, a host of additional contributing factors have left the VKS unable to conduct sustained, complex air operations to gain control over the skies above Ukraine.

Insufficient Training and Maintenance

Equally essential to understanding Russian airpower deficiencies is an analysis of Russian air force training, aerospace doctrine, and aviation maintenance programs.

Training and Doctrine

For any pilot, training, proficiency, and experience are at the forefront of a list of factors that contribute to success or failure in combat. VKS pilots log fewer than 100 flight hours annually for currency and proficiency.[40] This is approximately half of what US and UK aircrew receive for annual flight time. Indeed, Royal Air Force and US Air Force leadership have expressed concern about their aircrew's ability to maintain combat readiness with 180 flight hours per year.[41] Russia's low training rate is evident in the Russian war in Ukraine. Poor performance as a result of pilot training problems identified in the 2008 Georgia War has apparently continued. If the VKS focus on integrated air and missile defense occupies the majority of the 100 annual training hours, supporting missions like SEAD and DEAD are likely left on the cutting room floor. Further compounding the issues of aircrew ability is the rigidity of Russian tactical doctrine concerning the employment of VKS aircraft.

As demonstrated in the Zapad 2021 exercise, VKS aircrew are primarily trained to act in support of ground forces when not conducting long-range strike missions.[42] Unlike in Western doctrine, however, VKS pilots are heavily constrained in the execution of these types of strike operations. Russian airborne strike doctrine emphasizes the use of ground controllers to direct aircraft and "enslaves combat pilots to preplanned target sets."[43] This rigidity can often result in wasted ordnance on a mobile target that moves from where it was originally located. It does not provide flexibility for aircrews to engage emergent targets.

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39. Kurilov, Kiryushin, and Moiseyev, "Current Problems," 24.
40. Piotr Butowski and Thomas Newdick, "Russian Aggressor Squadron Gets Its First Su-35S Fighter Jets," Drive, October 4, 2022, https://www.thedrive.com/.
41. Bronk, "Mysterious Case."
42. Michael Kofman, "Zapad 2021: What We Learned from Russia's Massive Military Drills," *Moscow Times*, September 23, 2021, https://www.themoscowtimes.com/.
43. David Axe, "The Russian Air Force Is Back in the Fight in Ukraine. But It's Not Making Much of a Difference," *Forbes*, September 16, 2022, https://www.forbes.com/.

In contrast, Western aircrew frequently train in dynamic targeting and have more tactical flexibility. For most of the war, Russian tactical airstrikes have been carried out using traditional ground-control intercept tactics with unguided bombs and rockets against predesignated targets. Against SAM systems, VKS forces have also resorted to crude salvo tactics with antiradiation missiles against predesignated SAM radars.[44]

Aircraft Maintenance

Training and doctrine are not the only VKS deficiencies. Based on recent history, basic aircraft maintenance also appears to be a challenge. Recent catastrophic mishaps have highlighted a potential shortfall in Russia's ability to maintain combat aircraft. In April 2023, a MiG-31 jet burst into flames in flight and crashed near Murmansk. In September 2022, a Su-25 crashed shortly after takeoff, followed by an October 2022 incident where a Su-34 bomber experienced an apparent engine failure and crashed into an apartment building.[45] One Russian aviation maintenance professional has noted serious shortcomings, including

> delays in signing contracts with co-contractors; constant increases in cost beyond the scope of state service contracts and delayed processing of repair and components supply requests due to an excessive number of intermediaries involved in the organization of maintenance service; incomplete fulfillment of the entire volume of service requests; low revolving stock of spare parts; inadequate organization of aircraft repair shops for prompt repairs and troubleshooting; a poor claims mechanism for dealing with breaches of contract; lack of the necessary operational and repair documentation; and underqualified engineering and technical personnel or their shortage, including in field service teams.[46]

The cumulative impact of all these maintenance failures leaves little doubt the Russian aviation maintenance program is fundamentally broken. Maintaining a peacetime air force is in and of itself a significant challenge. Yet, since February 2022, Russia's aviation maintenance personnel have had to add an exponential increase in aircraft flight hours, parts wear, and battle damage to an already expansive workload.

The NATO Lens

Thus, Russia's air war in Ukraine offers crucial lessons for European NATO partners as they increase defense spending and embark on systematic upgrades across their joint forces, especially the air forces. The growing sentiment among European nations that the

44. Bronk, Reynolds, and Watling, *Russian Air War*, 1.

45. Thomas Newdick, "Su-25 Attack Jet Crash May Point to Wider Russian Airpower Issues (Updated)," Drive, September 12, 2022, https://www.thedrive.com/; and Emma Helfrich, "Russian Su-34 Fullback Jet Slams into Apartment Building in a Ball of Fire (Updated)," Drive, October 17, 2022, https://www.thedrive.com/.

46. Z. G. Omarov, "Problems of Aviation Equipment Operation at the Present Stage," *Military Thought* 31, no. 3 (September 30, 2022): 125.

EU and NATO are too reliant on the United States for defense is reflected in statements such as that of French president Emmanuel Macron, who has championed the concept of "strategic autonomy," the idea that European countries must invest in their own defense to diminish their reliance on NATO and, in turn, the United States.[47]

Russia's invasion of Ukraine has only exacerbated Europe's need to come to terms with NATO's overreliance on the United States for defense. But for all the bloviating about European strategic autonomy, are European NATO Allies taking action to decrease military dependence on the United States? Will NATO be prepared to execute effective, large-scale air campaign operations against Russia without the United States' full support?

Air dominance operations—and their necessary SEAD/DEAD component—are a critical case in point. Euro-Atlantic strategists have long pointed out the challenges presented by Russian integrated air and missile defense bastions in the Baltic states region, the Black Sea region, and elsewhere.[48] Suppressing and destroying these bastions will be the essential centerpiece of any military campaign against Russian aggression. But as the Ukraine case shows, a failure to enact focused procurement efforts for specific technologies and platforms, develop operational concepts, and provide extensive, ongoing training, can lead to strategic failure.

Procurement

Due to its increase in defense spending shortly after the Russian invasion of Ukraine, Germany serves as an excellent case study highlighting NATO member military modernization efforts. In February 2022, German chancellor Olaf Scholz announced Germany would dedicate €100 billion to modernize the German military and meet the NATO goal of 2 percent of gross domestic product spending dedicated to defense.[49] A portion of this investment was set aside for the purchase of new strike-fighter aircraft for the German air force.

Seeking to replace its aging fleet of Panavia Tornados, Germany initially favored the purchase of a combination of 30 F/A-18 Super Hornets and 15 EA-18G Growlers.[50] The Growler would have served as a fitting replacement for the electronic combat and reconnaissance (ECR) variant of the Tornado, continuing to fill the critical SEAD and DEAD role for the German air force.

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47. Handan Kazanci, "'Europe Needs to Gain More Autonomy on Technology and Defense Capabilities, Including from the US,' Says French President," AA [Anadolu Agency], last updated December 22, 2022, https://www.aa.com.tr/.

48. Robert Dalsjö, Christofer Berglund, and Michael Jonsson, *Bursting the Bubble: Russian A2/AD in the Baltic Sea Region: Capabilities, Countermeasures, and Implications* (Stockholm: FOI, March 2019), https://www.foi.se/.

49. Matthew Karnitschnig et al., "Inside Olaf Scholz's Historic Shift on Defense, Ukraine and Russia," *Politico*, March 5, 2022, https://www.politico.eu/.

50. Grant Turnbull, "NATO Investment Brings Electronic Warfare Back into Fashion," Global Defence Technology, https://defence.nridigital.com/.

In December 2022, however, Germany announced it would instead spend $8.4 billion on 35 Lockheed Martin F-35 Lightning II fighters.[51] This abrupt change highlights what has become a recurring pattern by European countries looking to modernize their air forces. Since 2018, Belgium, Poland, Switzerland, Finland, the Czech Republic, and Germany have pledged to purchase the F-35A Lightning.[52]

To its credit, Lockheed Martin has done an excellent job marketing the F-35 globally. It is currently the only exportable fifth-generation fighter in the world and, by the company's proclamation, capable of executing "any and all mission[s]" required of a modern-day military aircraft, including SEAD/DEAD and electronic warfare.[53] At first glance, the F-35 is especially appetizing for a NATO nation looking to modernize its air force with a fifth-generation, multirole fighter.

Any procurement decision for modernization includes a critical analysis of cost versus capability. Currently, one of the biggest driving factors behind European F-35 procurement is that the total cost of ownership for the platform is dramatically lower than its closest competitors. An assessment of Denmark's 2016 decision to purchase 28 F-35s reveals there is more to procurement decisions than the per-unit cost of the aircraft.

For example, Denmark compared the aircraft's service life across the three-competing contracts. While the F/A-18 Super Hornet and Eurofighter Typhoon are advertised as having a service life of 6,000 flight hours, the F-35 has an advertised service life of 8,000 hours.[54] This service life gap between the F-35 and the F/A-18 helped sway Denmark's decision to purchase the F-35 instead of the F/A-18. Because of the longer service life, Denmark purchased 10 fewer aircraft than it would have if it had chosen the F/A-18 or the Eurofighter. This translates into a more modern, more reliable, more capable aircraft for less than the price of a fleet of older, fourth-generation fighters.

But even if the current economic landscape makes the F-35 the most cost-effective modern fighter jet to procure, NATO countries must remain aware of the vulnerabilities of a Swiss-Army-knife fallacy: the idea of a one-stop-shop platform that can dominate all mission sets. Just because the F-35 can execute SEAD does not mean that it should be a primary asset for the suppression of adversary SAM systems.

Of Germany's 35 new F-35 aircraft, how many will be dedicated to executing airborne electronic attack against the Russian integrated air defense systems in a conflict, and are European countries willing to utilize fifth-generation fighters to conduct SEAD in support of fourth-generation aircraft? For every F-35 allotted to SEAD, one less aircraft

51. Sebastian Sprenger, "Germany Clinches $8 Billion Purchase of 35 F-35 Aircraft from the US," *Defense News*, December 14, 2022, https://www.defensenews.com/.

52. Vivienne Machi, "How the F-35 Swept Europe, and the Competition It Could Soon Face," *Defense News*, September 4, 2022, https://www.defensenews.com/.

53. "Air-to-Everything," Lockheed Martin, accessed January 21, 2023, https://www.lockheedmartin.com/.

54. Sydney J. Freedberg Jr., "F-35 Wins Denmark Competition: Trounces Super Hornet, Eurofighter," Breaking Defense, May 12, 2016, https://breakingdefense.com/.

executes an air-to-surface strike on a critical target or consummates air-to-air intercepts against Russian fighters and long-range bombers in contested airspace.

Although Germany ultimately decided against investing in the EA-18G, Berlin has acknowledged the importance of a dedicated tactical SEAD platform in a modern-day air force. In March 2022, German leadership announced a continued partnership with Airbus to develop the Eurofighter ECR as a replacement for the Tornado ECR.[55] This two-seat version of the Eurofighter would fill the role of a dedicated tactical SEAD/DEAD platform capable of escort and stand-off jamming. Germany expects delivery of these Eurofighters between 2025 and 2030, but as of January 2023, the aircraft was still in development.[56]

Operational Concepts

As seen with the VKS, however, just because hardware modernization is ongoing does not mean NATO's operational concepts have been suitable for success in the past. In NATO's 2016 *Allied Joint Doctrine for Air and Space Operations*, for example, a resources allocation table shows only a 10 percent allocation to SEAD in each of the first six days of a conflict.[57]

Realistically, at the outset of a conflict with Russia, a thorough integrated air defense system rollback will be necessary, requiring robust SEAD/DEAD prioritization. As Russia's experience in Ukraine highlights, failing to prioritize SEAD/DEAD operations in the initial period of war can lead to devastating consequences and a failure to achieve air dominance over the battlefield. Fortunately, however, NATO has identified that SEAD has been underprioritized and is taking steps to correct it.

In April 2017, NATO released a SEAD vision paper acknowledging deficiencies and outlining a plan to modernize its operational concepts: "By 2030 we want to be able to have a tiered force able to deliver multiple full effects across the full spectrum of an enemy's air defense system."[58] The first goal of this SEAD modernization process consisted of a capability audit that was to be completed by the summer of 2019, followed by a capabilities gap analysis to be completed by the following year. The audit began in June 2023 and is expected to take 18 months to complete.[59] The capabilities gap analysis is now forecast

55. Gaston Dubois, "Confirmed! F-35 and Eurofighter ECR to Replace Lufwaffe's Tornado," Aviacionline, March 14, 2022, https://www.aviacionline.com/.

56. Ricardo Meier, "Germany to Order 15 Electronic Warfare Eurofighters in Addition to F-35s," Air Data News, March 16, 2022, https://www.airdatanews.com/.

57. North Atlantic Treaty Organization, *Allied Joint Doctrine for Air and Space Operations* (London, UK: NATO Standardization Office, 2016), 4-19, https://assets.publishing.service.gov.uk/.

58. Tim Fish, "NATO Ponders SEAD Modernization as Russia Fields New Threats," *Journal of Electronic Defense* 41, no. 5 (May 2018): 26.

59. Richard Scott, "NIAG Study Group Explores Future SEAD Capability Options," Janes, June 30, 2023, https://www.janes.com/.

to be concluded by 2025.[60] With this modernization plan now three years behind, it is unclear if NATO will be able to meet its 2030 goal of being able to deliver "full spectrum effects" against an enemy's integrated air defense systems.

Training

Training must be factored into this equation as well. Just as Russian pilots suffer in combat proficiency from a lack of flight hours, the same effect may occur for NATO F-35 aircrew, who are expected to be proficient in the myriad mission sets the F-35 is capable of flying. In 2020, only 512 of the Luftwaffe's 875 pilots were able to meet the NATO target of 180 flight hours.[61] While this flight-hour deficiency was explained by Luftwaffe leadership as a result of maintenance issues with aging aircraft, it highlights a common problem for pilots of multirole aircraft. When facing flight-hour uncertainty, every flight hour a pilot spends on SEAD/DEAD training is an hour not spent practicing air-to-air intercepts.

While one would assume the loss of flight hours due to maintenance would subside once German pilots have their new, more reliable F-35s, the fact remains that training must be split across all mission sets, ultimately resulting in a deficiency in one or more of these areas. A dedicated SEAD/DEAD platform means those aircrew become experts in their mission set instead of trying to be jacks-of-all-trades.

Other Challenges

Additional challenges unique to a regional alliance such as NATO are compounding the delay of NATO's SEAD study. First, trust between nations is a sensitive and dynamic issue and may be inconsistent from country to country. Second, nations are constantly walking a tightrope of budgetary balance between national defense financial allocation and cooperative contribution. Third, duplication of effort becomes a concern where it can be difficult to determine how much of one capability should exist across all of NATO before it becomes cost prohibitive. Finally, there is the concern of "cross-contamination" of capabilities, where it becomes a liability for a country like Turkey to own and operate sensitive technology from both Russia and the United States.[62]

Conclusion

The Russian aerospace forces failure in Ukraine demonstrates that the success of modern-day air dominance operations comes down to more than just the hardware at

60. Richard Scott, "Rebalancing AEA/SEAD Capability in NATO," *Journal of Electromagnetic Dominance* (*JED*), April 2022, https://www.jedonline.com/.

61. Michael Peck, "Bad News NATO: German Pilots Aren't Getting Enough Flight Time," *National Interest*, August 19, 2021, https://nationalinterest.org/.

62. Stephen "Muddy" Watters, "Strengthening NATO AEA," *JED* 43, no. 1 (January 2020): 12.

one's disposal. While Russia's defensive-biased doctrine may have led to the undervaluing of offensive air operations, the effectiveness of modern ground-based air defense systems ensures it is more difficult than ever to build a sanctuary for aircraft to operate as safely and effectively as possible in combat. Any nation seeking to conduct successful air dominance operations in the twenty-first century, let alone achieve air superiority, must have the technology available to do so, aircrew with relevant training and experience, and sound operational doctrine.

Additionally, there must be an expanded emphasis on SEAD and DEAD operations across the joint and coalition forces. In Ukraine, Russia has proven that its air force is incapable of success in this arena. Thus far, NATO has shown it understands this requirement; although it currently lacks requisite airpower capabilities, it is taking steps to fill the seams and gaps. These questions remain: Will NATO effectively learn from Russia's failures, and will it be ready in time for the next major conflict? ✈

Microgrids

Energy Security for Overseas Bases

Nathan P. Olsen

Russia's targeting of Ukraine's power grid by Iranian drones and recent increases in natural disasters have highlighted the vulnerability of critical infrastructure and electrical systems worldwide. Disruptions to the power grid from an attack or natural disaster can pose a serious threat to military operations and readiness. To defend against this possibility, Congress needs to direct the Department of Defense to establish renewable microgrids at overseas bases, augmenting efforts already underway by the US Army. Such microgrids will ensure Joint Force resiliency by providing a reliable power source immune to attacks, extreme weather events, and energy market volatility. More importantly, these overseas microgrids will sustain the United States' global military advantage and the defense of US national interests and those of its Allies and partners.

Power grid disruptions from natural disasters or attacks against overseas military installations can pose serious threats to military operations and readiness. Congressional language directing the Department of Defense to establish renewable microgrids, or small local power grids, at overseas locations and authorizing and appropriating the requisite funds will ensure the military's ability to defend US national interests and those of its Allies and partners.

Operating independently of the host nation's electrical grid will provide the military with a reliable power source immune to attacks, extreme weather events, and energy market volatility. More importantly, installing microgrids at overseas locations will make the Joint Force more resilient and capable of ensuring US military advantage and securing the nation's top priorities.[1]

US Power Grid Vulnerability

The severity of threats to power grids at overseas bases is best appreciated by a better understanding of broader domestic power grid vulnerabilities despite the United States' relative geographic isolation from its adversaries. One vulnerability comes from the United States' reliance on fossil fuels for energy production. Approximately 79 percent of domestic energy

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1. Lloyd J. Austin III, *2022 National Defense Strategy of the United States of America* (*NDS*) (Washington, DC: Department of Defense (DoD), October 17, 2022), 18.

production comes from fossil fuels that could be impacted if pipelines fail in an attack or natural disaster.[2] Based on persistent—daily—monitoring of cyber threats to the US power grid by the Department of Homeland Security and the Federal Bureau of Investigation, the greatest cyber threats to the grid are intrusions focused on manipulating the industrial control system networks.[3] These intrusions typically result in malware taking over the industrial control system networks.[4] In fact, concern over vulnerabilities in the US electrical grid drove President Donald Trump to issue Executive Order 13920, declaring a national emergency concerning the threat of foreign adversaries creating and exploiting vulnerabilities in the US bulk-power system.[5]

The United States' energy infrastructure is also susceptible to extreme weather events. California residents struggled through a historic heatwave during the summer of 2022 when they were asked to conserve power in the early evening to prevent blackouts. As temperatures soared, energy officials were concerned the increase in air-conditioning use would overload the energy grid. In fact, power outages from severe weather have doubled over the past two decades across the United States.[6]

These extreme weather events also affect the US military. In February 2021, the Texas power grid failed in the face of Winter Storm Uri.[7] During the storm, several military installations experienced limited power because they relied on local utility providers as their primary source of power.[8] Bases in the region were without power for multiple days, and the outages caused mission impact at each of the bases.

The Biden administration recognized the significance of climate change on national security and issued Executive Order 14008 on January 27, 2021. The executive order states climate considerations would be an essential element of US foreign policy and national security.[9] Specifically, it directs the secretary of defense to consider the implications of climate change in developing strategic guidance documents for the Department of Defense.[10] The executive order was a precursor to the *National Security Strategy*, which identifies

2. US Energy Information Administration, "Consumption and Production, U.S. Energy Facts Explained," last updated August 16, 2023, https://www.eia.gov/.

3. Richard J. Campbell, *Electric Grid Cybersecurity*, R45312 (Washington, DC: Congressional Research Service, updated September 4, 2018), 8, https://crsreports.congress.gov/

4. Campbell, 9.

5. Exec. Order No. 13920, 85 Fed. Reg. 26591 (April 30, 2020).

6. Associated Press, "US Power Outages from Severe Weather Have Doubled in 20 Years," *Guardian*, April 6, 2022, https://www.theguardian.com/.

7. Rachel S. Cohen, "Winter Storm Uri Spotlights Gaps in Military Base Preparedness," *Air Force Times*, March 26, 2022, https://www.airforcetimes.com/.

8. *Installation Resiliency: Lessons Learned from Winter Storm Uri and Beyond, Hearing before the Subcommittee on Readiness of the Committee of Armed Services House of Representatives*, 117th Cong., 1st session (March 26, 2021) (statement of Brigadier General John J. Allen, commander, Air Force Civil Engineering Center, Air Force Materiel Command, Department of the Air Force), https://www.congress.gov/.

9. Exec. Order No. 14008, 86 Fed. Reg. 7619 (January 27, 2021).

10. Exec. Order No. 14008.

climate and energy security as the "existential challenge of our time."[11] Furthermore, in late September 2023, the Department of Energy provided grants to 11 states, tribes, and territories, the latest in over $1 billion in grants this year that are part of the Biden administration's $2.3 billion program to promote power grid resiliency.[12]

The US military is cognizant of the impacts of weather, energy market volatility, and attacks on the energy grid. In its Fiscal Year 2020 *Annual Energy Management and Resilience Report*, the Department of Defense reported 3,018 unplanned utility outages at military installations worldwide (87 percent were electrical) due to various issues.[13] Of the 3,018 outages, 649 lasted eight hours or longer.[14] Unplanned outages have increased each year over the past three years and cost the government an average of $10.2 million annually.[15]

In 2021 the National Academy of Sciences, Engineering, and Medicine acknowledged that

> because there is no way to make power systems completely invulnerable to intentional or accidental physical or cyber disruptions and to the effects of extreme weather events, the nation must move aggressively to create systems that can continue to provide basic services as they recover from disruption.[16]

Power Grid Vulnerability in Conflict

Shortly after the implementation of sanctions on Russia in mid-2022 due to its war in Ukraine, Russia's majority state-owned energy corporation Gazprom reduced its natural gas flow to Europe to 20 percent of its pipeline's capacity.[17] Gazprom claimed the shutdown was required to complete critical repairs to the pipeline. Later, in September 2022 the pipeline shut down completely for additional repairs. The situation grew even more dire after two Gazprom natural gas pipelines located in the Baltic Sea were damaged by explosions on September 26. The disruptions to the pipelines caused natural gas prices to surge and created panic across the European Union.

The disruptions to the natural gas pipelines caused many to speculate Russia was using its natural gas exports as a weapon to combat the sanctions placed on them and influence

11. Joseph R. Biden Jr., *National Security Strategy* (Washington, DC: White House, October 2022), 27, https://www.whitehouse.gov/.

12. Scott Patterson, "U.S. Rolls Out Grants for Power Grid," *Wall Street Journal*, September 29, 2023, A3.

13. Office of the Assistant Secretary of Defense for Sustainment (OASD [Sustainment]), *Department of Defense Annual Energy Management and Resilience Report (AEMRR) Fiscal Year 2020* (Washington, DC: DoD, September 2021), 25, https://www.acq.osd.mil/.

14. OASD (Sustainment).

15. OASD (Sustainment).

16. Committee on the Future of Electric Power in the US, Board on Energy, and Environmental Systems Division on Engineering and Physical Sciences, *The Future of Electric Power in the United States: A Consensus Report of the National Academies of Science, Engineering, Medicine* (Washington, DC: National Academies Press, 2021), 15, https://doi.org/.

17. Associated Press, "Russia to Cut Gas through Nord Stream 1 to 20% of Capacity," AP News, July 25, 2022, https://apnews.com/.

public opinion about its conflict with Ukraine. Russia's actions put the EU in a difficult situation because it relies on Russia for 35 percent of its natural gas.[18] European Commission President Ursula von der Leyen stated, "This is not only a war unleashed by Russia against Ukraine, but this is also a war on our energy, a war on our economy, a war on our values, and a war on our future."[19]

Russia took its battle against energy a step further when it launched extensive attacks against Ukraine's infrastructure. Russian drones struck power plants and substations, creating electricity, heat, and hot water shortages in many cities.[20] As a result of the attacks, Ukrainians were warned to prepare for blackouts and urged to ration energy, because over 30 to 40 percent of the country's total power infrastructure had been impacted.[21]

Global Power Grid Vulnerability

Unfortunately, these are not isolated incidents. Extreme weather has exacted a toll on electrical infrastructure across the world. The flooding that occurred in Libya on September 10 and 11, 2023, is just one of many weather events this year that have killed thousands, displaced millions, and devastated electrical infrastructure throughout the world.

And these threats have implications for US bases overseas. One outage of note created a significant mission impact at Incirlik Air Base, Turkey, in 2016. During the attempted coup in Turkey, the base lost power, resulting in a reduced number of combat missions flown out of the base in support of operations in Iraq and Syria.[22] The base received its power from the local energy grid and had to rely heavily on its emergency generators during the outage. Without the full complement of power on the base, combat operations were reduced, threatening broader American strategy in the region and having impacts beyond just the one installation.[23]

Undoubtedly, US overseas bases are in a situation where they are predominately dependent on host-nation and local energy supplies. Diversifying energy sources and moving toward a localized, US-run energy source—a microgrid—would lessen this vulnerability and increase overall reliability and resiliency. In addition to increased security and

18. Nina Chestney, "What are Europe's Options in Case of Russian Gas Disruption?," Reuters, January 27, 2022, https://www.reuters.com/.

19. Emily Rauhala and Beatriz Rios, "E. U. Proposes Emergency Energy Measures as Russia's War Tests Europe," *Washington Post*, September 14, 2022, https://www.washingtonpost.com/.

20. Dalton Bennett et al., "The Scale of Russian Attacks on Ukraine's Energy Infrastructure, Visualized," *Washington Post*, updated October 17, 2022, https://www.washingtonpost.com/.

21. Phil McCausland, "Ukraine Energy Minister Says Russia Has Hit Half of Country's Thermal Generation Capacity," NBC News, October 21, 2022, https://www.nbcnews.com/.

22. Graham H. Haydon, "Microgrids on Department of Defense Installations: Energy Policy's Impact on National Security" (master's thesis, Johns Hopkins University, December 2019), 5, https://jscholarship.library.jhu.edu/.

23. Haydon.

resiliency, microgrids will reduce transmission and distribution losses and the impacts of volatility in the energy market.

Although the *National Defense Strategy* and executive orders push the military services to build resilience in the face of climate change's significant threat, the military and Congress are not moving fast enough to overcome vulnerabilities to DoD electrical supply and systems.[24] Congress needs to authorize and fund renewable microgrids at DoD overseas installations as soon as possible.

Microgrids

In 2011, General David Petraeus bluntly summarized the military's dependency on power: "Energy is the lifeblood of our warfighting capabilities."[25] To put this into perspective, the Department of Defense is the largest consumer of energy in the United States.[26] Additionally, it is the largest property owner and energy purchaser in the United States with 281,780 buildings encompassing 2.3 billion square feet, generating an energy bill of more than $4 billion annually.[27] Such a high dependence on energy is a major vulnerability for the US military.

With its dependence on energy, the military is constantly searching for a resilient and reliable source of energy to support its mission. The Defense Department has historically relied on host-nation power and stand-alone generators to provide emergency backup power for buildings. In the event of a host-nation power outage, installations have a single backup generator hardwired into the facility at every building housing a critical load.[28]

On large installations, there are often more than 100 small generators dedicated to providing power for facilities during outages. If a base generator fails during an outage, the building is without power until the generator is repaired or replaced, or until power is restored. These generators require monthly preventative maintenance and access to fuel. Installations typically have centrally managed diesel fuel stockpiles that contain enough fuel to run base generators for two to seven days.[29] In a contested area or if fuel shortages exist, it is difficult to secure enough fuel to maintain operations without mission interruption.

The Department of Defense realized the current electrical configuration was a vulnerability and tasked the National Renewable Energy Laboratory to study the effectiveness of backup power systems used on DoD sites in the United States and Canada.[30] The study

24. Austin, *NDS*, 8.

25. Bill Lynn, "Energy for the War Fighter: The Department of Defense Operational Energy Strategy," *White House, President Barack Obama* (blog), June 14, 2011, https://obamawhitehouse.archives.gov/.

26. Neta C. Crawford, *The Pentagon, Climate Change, and War: Charting the Rise and Fall of U.S. Military Emissions*, Costs of War Project (Cambridge, MA: MIT Press, 2022), 2.

27. OASD (Sustainment), *AEMRR*, 6.

28. Jeffrey Marqusee, Sean Ericson, and Don Jenket, *Emergency Diesel Generator Reliability and Installation Energy Security* (Golden, CO: National Renewable Energy Laboratory [NREL], 2020), 4, https://www.nrel.gov/.

29. Marqusee, Ericson, and Jenket, 4.

30. Marqusee, Ericson, and Jenket, 2.

discovered well-maintained generators have a reliability of 80 percent after two weeks of run time.[31] Based on this information, the study determined a single, well-maintained emergency generator cannot guarantee emergency power for critical loads over multiday outages.[32] One way to overcome this vulnerability is for the military to isolate itself from the national power grid: installations can operate microgrids using renewable energy sources as their primary sources of power and use backup generators if the microgrids are impacted.

A microgrid is a localized group of electricity generators with the ability to operate independently from the host nation's electrical grid. The combination of electricity generators, advanced controls, and an energy storage system composes a single, independent, integrated power system. The electricity generators in a microgrid come from a variety of sources, including emergency generators, prime generators, combined heat and power plants, renewables, and batteries.

The ability to separate and isolate itself seamlessly with little or no disruption to loads within the microgrid during a grid disturbance is a key feature of this technology. Microgrids are often considered significant to improving energy resilience for critical infrastructure and services, especially those related to national security and critical community functions.[33]

The term microgrid first officially appeared in the late 1990s when the Department of Energy started to examine electrical grid reliability and resiliency.[34] The Department of Energy started to invest significant money into the concept when it initiated the Smart Grid Research & Development Program. In an effort to optimize grid operations, the program kicked off several demonstration projects aimed at meeting peak load reduction, achieving renewable energy mandates and directives, and maintaining energy surety and reliability at critical facilities, including military installations.[35]

In 2010, the Department of Defense and the Department of Energy entered into a memorandum of understanding to enhance energy security, including grid security.[36] But US interest in microgrids truly blossomed after Hurricane Sandy hit the US East Coast in October 2012.[37] Heightened interest in microgrids stemmed from the results Princeton University received from its microgrid throughout the storm. During the hurricane, Princeton was able to disconnect from the main power grid and maintain power and

31. Marqusee, Ericson, and Jenket, 17.

32. Marqusee, Ericson, and Jenket.

33. US Department of Energy (DoE), *Microgrid and Integrated Systems Program* (Washington, DC: DoE, 2022), 6, https://www.energy.gov/.

34. Martin Anderson, "Microgrid: History, Definition, and Uses," Bridgestone Associates Limited (website), June 25, 2020, https://brdgstn.com/.

35. Dan T. Ton and Merrill A. Smith, "The U. S. Department of Energy's Microgrid Initiative," *Electricity Journal* 25, no. 8 (2012), http://dx.doi.org/.

36. Memorandum of Understanding between the U.S. Department of Energy and the U.S. Department of Defense Concerning Cooperation in a Strategic Partnership to Enhance Energy Security, July 22, 2010, https://www.energy.gov/.

37. Anderson, "Microgrid."

operations within its own microgrid without any interruptions.[38] The microgrid allowed the campus to serve as a "place of refuge" where police, firefighters, paramedics, and other emergency-service workers staged and charged essential equipment.[39] The success of microgrids during Sandy spawned microgrid programs of varying size and complexity in all the states affected by the storm.[40] As of October 2023, there were approximately 687 operational microgrids capable of producing 4,357 megawatts.[41]

Elements of a Microgrid

Storage

One of the most important components of a renewable energy microgrid is an energy storage system. Renewable energy sources like the sun and wind are unpredictable and often suffer from supply interruptions. The nature of renewable sources creates a dependence on storage requirements.[42] The energy storage system works as a buffer and absorbs power when there is a surplus and releases power when there is a deficit.[43]

Having a storage system ensures power quality and availability are not interrupted. Renewable power systems with an integrated storage system can overcome supply interruptions and provide reliable power to its users. It is even possible for a renewable microgrid equipped with a storage system to increase electrical power resilience with better outcomes than using a backup diesel generator.[44]

Control and Load

Microgrids are typically managed through a central controller that monitors the system's operating parameters, coordinates power generation sources, and balances and controls electrical loads. This controller can also connect or disconnect the system from the main grid.[45] In a microgrid with storage, commercial off-the-shelf charge controllers link all power

38. Lisa Cohn, "History of Microgrids in the US: From Pearl Street to Plug-and-Play," Microgrid Knowledge (website), July 22, 2019, https://www.microgridknowledge.com/.

39. Morgan Kelly, "Two Years after Hurricane Sandy, Recognition of Princeton's Microgrid Still Surges," Princeton University Office of Communications, October 23, 2014, https://www.princeton.edu/.

40. John Kliem and Dennis McGinn, "Ingredients for a Microgrid at U.S. Department of Defense Installations," *IEEE Electrification Magazine* 8, no. 4 (2020), https://doi.org/.

41. DoE, "US Department of Energy Combined Heat and Power and Microgrid Installation Databases," US DoE, December 31, 2022, https://doe.icfwebservices.com/.

42. Thomas Price et al., "Microgrid Energy Management during High-Stress Operation," *Energies* 15, no. 18 (2022), https://doi.org/.

43. Beth Burmahl, "Let the Sun Shine: Argonne Technology Enhances Solar Option during Outages," Argonne National Laboratory (website), April 1, 2022, https://www.anl.gov/.

44. Janice Mallery, Douglas L. Van Bossuyt, and Anthony Pollman, "Defense Installation Energy Resilience for Changing Operational Requirements," *Designs* 6, no. 28 (2022), https://doi.org/.

45. Chuck Kirnik et al., *Financing Microgrids in the Federal Sector* (Washington, DC: DoE, 2020), 1, https://www.energy.gov/.

sources and smartly combine them to meet user demand. If the renewable power source is not meeting demand, the control system draws from the battery storage or from another power generator. The controller prioritizes essential loads and prevents mission-critical loads from being shed or interrupted.[46] These control systems also ensure energy is used as efficiently as possible and strive to deliver seamless performance.

Microgrid Energy Sources

Each microgrid is unique in its configuration and energy sources and is designed to solve a specific challenge or meet specific goals.[47] Ultimately, the load on the system defines the microgrid and what energy sources it needs. A microgrid with renewable energy as its primary source is an ideal solution for the military because it reduces the military's reliance on fossil fuels.[48] Few countries are able to produce useable fossil fuels in high quantities. Moreover, relying on other countries for fossil fuels to generate energy creates a dependence that can prove dangerous. Indeed, as climate-related natural disasters become more frequent and severe, microgrids can serve as increasingly valuable resources in support of uninterrupted power for military bases. Additionally, a sustainable microgrid helps the US military reduce its logistical footprint and protects it from attacks on the host-nation electric grid.

Regional

The US military has installations worldwide. The best source for a base's renewable energy microgrid depends on its location. One positive aspect of renewable energy sources is the rapid progress in the field. For example, the Middle East, primarily known as a region committed to fossil fuels, is building renewable energy capabilities. In fact, renewable electricity generation doubled in the Middle East between 2010 and 2020 and is anticipated to double again by 2024.[49]

The United Arab Emirates also plans to receive half of its energy from nonfossil fuel sources by 2050, and Egypt recently completed one of the world's largest solar farms, capable of producing 1.5 gigawatts of energy—enough to power over one million homes.[50] Some of this surge is attributed to the amount of sunlight received in the area and the vast, unpopulated desert, both of which are optimal for collection. As such, the Middle East provides the US military with several potential energy sources for microgrids.

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46. Mallery, Van Bossuyt, and Pollman, "Installation Energy Resilience."

47. Julieta Giraldez et al., *Phase I Microgrid Cost Study: Data Collection and Analysis of Microgrid Costs in the United States* (Golden, CO: NREL, October 2020), 2, https://www.nrel.gov/.

48. Edward Anuat, Douglas L. Van Bossuyt, and Anthony Pollman, "Energy Resilience Impact of Supply Chain Network Disruption to Military Microgrids," *Infrastructures* 7, no. 1 (2021), https://doi.org/.

49. Blain Brownell, "The Coming Renewable Energy Revolution in the Middle East," *Architect*, February 24, 2022, https://www.architectmagazine.com/.

50. "Arab States are Embracing Solar Power," *Economist*, May 7, 2020, https://www.economist.com/.

Solar

Clearly the most cost-effective, reliable, and abundant renewable energy source comes from solar photovoltaics. This technology is attractive because it offers a payback on investment in 2 to 15 years.[51] Generally, the more electricity used on the site and the higher the price for traditional electricity in the area, the shorter the payback period. Costs for photovoltaic systems have decreased by nearly 70 percent in the past 10 years, making them even more attractive.[52] Furthermore, these systems typically require very little maintenance, and while they might be targeted by enemy strikes, solar panel fields can be dispersed and hardened to limit their vulnerability.

Wind

Wind turbines are another renewable energy source available to the US military. These versatile machines can operate independently or be connected to a larger grid or energy system. Wind turbines are one of the fastest-growing energy sources in the world.[53] One reason for the recent growth of wind power generation is that wind is one of the lowest-priced energy sources available today. Furthermore, cost competitiveness in the field continues to improve with advances in science and technology.[54] Much like solar photovoltaics, the cost-effectiveness of the system depends on environmental conditions in the area.

Biomass

Waste disposal and management are critical issues at US military installations and therefore offer another attractive potential source of energy. Recent progress in the waste-to-energy field provides the military with multiple ways to generate energy from waste with minimal impact on health and the environment. The most common method is to incinerate waste with energy recovery. This process generally involves burning waste to boil water, which powers steam generators that make electricity and heat. This regulated method to generate electricity could help resolve security and safety issues caused by transporting waste from the base, while also providing a waste solution that is not harmful to military personnel. Adoption of this method of energy production will depend on its ability to reduce its operating costs and on technology increases.[55]

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51. Will Kessler, "Comparing Energy Payback and Simple Payback Period for Solar Photovoltaic Systems," *E3S Web of Conferences* 22 (2017), https://doi.org/.

52. "Documenting a Decade of Cost Declines for PV Systems," NREL (website), February 10, 2021, https://www.nrel.gov/.

53. Wind Energies Technology Office, "Advantages and Challenges of Wind Energy," DoE (website), accessed November 30, 2022, https://www.energy.gov/.

54. Wind Energies Technology Office.

55. DoE, "Biomass Explained: Waste-to-Energy from Municipal Solid Wastes," DoE, last updated December 28, 2022, https://www.eia.gov/.

Nuclear

Another autonomous power option for the US military is a nuclear microreactor. Microreactors use a small amount of low-enriched uranium to boil water and create steam, which spins a turbine to produce electricity. Placing a small microreactor—one the size of a standard shipping container—into a microgrid would likely provide all the power needed for an entire base. A study conducted on the feasibility of nuclear power at US military installations estimated a 40-megawatt microreactor could meet the electricity needs of about 90 percent of all military installations.[56]

Microreactors gained significant momentum in early January 2021 as a result of Trump's Executive Order 13972, which promoted the advancement of small modular reactors to support national defense and energy security.[57] Today, the Department of Defense is working with private energy companies to install microreactors at its facilities. For example, a pilot program at Eielson Air Force Base, Alaska, calls for a five-megawatt reactor to augment the existing coal and oil power plant and is scheduled to come online in 2027.[58] Yet while this may be a potential microgrid energy source at US bases, it may be politically unfeasible overseas, where proliferation concerns are paramount—though the use of low-enriched uranium limits the risk—and the potential for a direct strike by adversaries exists even if the microreactor is hardened.

Employing Microgrids Abroad

The Department of Defense is working diligently to gain energy security through microgrids at domestic installations. In 2012, it initiated the Smart Power Infrastructure Demonstration for Energy Reliability and Security Programs (SPIDERS) to aid in this process. Since its inception, more than 40 bases have carried out a preliminary study on installing a microgrid, developed plans for installation, or have a microgrid already in place.[59]

In 2018, the Army commissioned a major microgrid project at US Army Garrison Kwajalein in the Marshall Islands. The project, which integrated generators and photovoltaics to produce 2,000-kilowatt hours of energy, provides the base with a microgrid fully independent of the island's energy grid.[60] The success of this project and others led the US Army to identify microgrids as a priority in its strategy to address the impact of climate

56. Thomas Joseph Alford, "Off the Grid: Facilitating the Acquisition of Microgrids for Military Installations to Achieve Energy Security and Sustainability," *George Washington Journal of Energy & Environmental Law* 8, no. 2 (Spring 2017): 116.

57. Exec. Order No. 13972, 86 Fed. Reg. 3727 (January 5, 2021).

58. SAF/IEE Installation Energy, "Eielson AFB Announced as Site for Air Force Micro-Reactor Pilot," Energy, Installations, and Environment, US Air Force (website), October 15, 2022, https://www.safie.hq.af.mil/; and Kelsey D. Atherton, "A Remote Air Force Base in Alaska Is Getting Its Own Nuclear Reactor," *Popular Science*, September 13, 2023, https://www.popsci.com/.

59. Alford, "Off the Grid," 108.

60. Lisa Cohn, "Inside a $40M Army Energy Efficiency Project and Microgrid on the Marshall Islands," Microgrid Knowledge, February 16, 2018, https://www.microgridknowledge.com/.

change on the force. The Army intends to install a microgrid on every installation by 2035 and to pursue enough renewable-energy generation and battery-storage capacity to make its critical mission self-sustaining on all its installations by 2040.[61] The Army is setting the example for the other services to follow in the fielding of microgrids at installations.

Critics of the proposal to install renewable microgrids on military installations say the military's budget should be spent on other priorities to modernize the force and keep pace with China.[62] Yet significant long-term savings in transmission costs and energy efficiency outweigh the short-term costs of installation.[63] Specifically, certain components of a microgrid can be justified economically and paid for out of energy savings or avoided costs.[64]

Furthermore, the United States can look at potential cost-sharing ventures with host nations. Many overseas military installations are shared bases, with United States and host-nation forces occupying portions of the base. Creating a microgrid for all these forces would bolster the national security capabilities of each country. Pursuing this course of action also increases cooperation with US regional and global partners, which results in their increased ability to deter and defend against potential aggression.[65]

Each potential microgrid site is different and requires specific analysis and evaluation to determine how best to implement a microgrid. For example, an old or poorly maintained existing distribution system can impact the reliability of the microgrid system.[66] A recent National Renewable Energy Laboratory study reviewed cost information for 80 microgrid projects and determined associated costs varied, depending on the market segment and complexity of the microgrid.[67] The team concluded the more complex a project, the more expensive it is. Yet while the cost of a microgrid project is important for the military to consider, it would not outweigh the cost of national security and mission impact due to power loss, which is difficult to quantify monetarily.[68]

To overcome potential high microgrid installation costs, the military should conduct a risk and mission analysis assessment of its overseas bases to identify the risk to mission if a power outage occurs at each of its installations. The military has significant expertise in performing these analyses and has most of the necessary information to conduct them

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61. Department of the Army (DA), Office of the Assistant Secretary of the Army for Installations, Energy and Environment, *United States Army Climate Strategy* (Washington, DC: DA, 2022), 6, https://www.army.mil/.

62. Mike Glenn, "Navy Must Speed Up Shipbuilding, Modernization to Keep Pace with China, Russia at Sea, Analysts Say," *Washington Times*, October 30, 2021, https://www.washingtontimes.com/.

63. Rich Castagna, "Microgrids Deliver Resiliency, Security and Savings," IoT World Today (website), January 16, 2020, https://www.iotworldtoday.com/.

64. Kirnik et al., *Financing Microgrids*, 1.

65. Austin, *NDS*, 8.

66. Kirnik et al., *Financing Microgrids*, 4.

67. Giraldez et al., *Phase I*, v.

68. Christopher J. Peterson et al., "Analyzing Mission Impact of Military Installations Microgrid for Resilience," *Systems* 9, no. 3 (2021): 1, https://doi.org/.

quickly. Addressing the most critical installations first ensures the United States is using its money for the greatest benefits.

Part of this risk assessment should consider the energy production, sustainability, and energy storage of a potential microgrid as well as the installation's weather, purpose, size, and distance from the local utility provider.[69] An analysis of these factors provides decisionmakers with an understanding of the impact a microgrid will have on the base's energy resiliency before determining the type of microgrid to install.[70]

Once the bases are identified, the military must evaluate each base and identify its critical facilities. At each base, the military should identify the mission each facility contributes to, the load associated with conducting the mission, and the impact any loss of power would cause on mission accomplishment.[71] The second step in this analysis involves determining the set of scenarios that could disrupt the power supply and estimating the probability of each event occurring.[72] Performing this second level of analysis helps microgrid designers understand how to develop a microgrid capable of ensuring the highest probability of mission accomplishment.

One critical scenario for any military base is the potential for attack. Large solar photovoltaic fields and wind turbines are attractive targets for enemy forces. Hardening the electrical infrastructure or dispersing it to various locations throughout the base are ways to overcome this vulnerability. One possible way to disperse a photovoltaic field is to place solar panels on buildings throughout the base. Not only does dispersal make the grid a harder target to hit, but it also increases the ability of a base to provide power reliably and redundantly to its critical facilities.

Lastly, one major benefit of the burgeoning renewable energy sector is the decreasing cost of such systems due to its prevalence in the energy sector. The US Energy Information Administration reported electricity generation from renewable energy exceeded coal for the first time in April 2019. Even with the increase in prices for materials, shipping, and labor, the cost of renewable energy systems is roughly 40 percent less than building a coal or gas plant.[73] Battery energy storage systems are also decreasing in price, and the average global lithium-ion battery pack price has declined significantly since 2010.[74]

Microgrid costs are also trending downward as the system gains popularity in the commercial sector. Currently, microgrids make up 0.2 percent of the electricity generation of the national electrical infrastructure, but 2016 to 2019 saw a yearly increase of 62 to 68

69. Haydon, "Microgrids," 17.
70. Haydon.
71. Peterson et al., "Analyzing Mission Impact," 4.
72. Peterson et al., 5.
73. David R. Baker, "Renewable Power Costs Rise, Just Not as Much as Fossil Fuels," Bloomberg, June 30, 2022, https://www.bloomberg.com/.
74. Eric Lightner et al., *Voices of Experience: Microgrids for Resiliency* (Golden, CO: NREL in conjunction with Smart Electric Power Alliance, 2020), 42.

percent in the numbers of microgrids installed.[75] Furthermore, Department of Energy research and development targets for microgrids anticipate electricity generation capacity will be more distributed in nature, with capacity in 10 years likely being 30 to 50 percent distributed energy assets.[76]

Conclusions

Department of Defense policy dictates all military bases must insure they have reliable power to carry out their critical missions.[77] Russia's war in Ukraine highlights the vulnerability of relying on nonrenewable sources of energy for national security. Russia is using energy as a weapon against the resolve of the EU and its allies and partners and attacking the Ukrainian electrical infrastructure. If key US bases around the world are not able to access power, they will not be able to support combatant commanders in the defense of national interests and the safety and security of US Allies and partners. Although the Department of Defense recognizes the importance of reliable power, it is not implementing innovative solutions like microgrids quick enough.

Congress can help increase energy security and reliability in the military by mandating microgrids at overseas bases and providing funding to enact this mandate. US code already encourages the Department of Defense to "consider, when feasible, projects for the production of installation energy that benefits military readiness and promotes installation security and energy resilience."[78] The code elaborates on the direction provided and defines ways to increase security and energy resilience as "incorporation of energy resilience features, such as microgrids, to ensure that energy remains available to the installation even when the installation is not connected to energy sources located off the installation."[79]

These statements are helpful but need to be more directive, like the language in the US code regarding energy security for military installations in Europe. The Fiscal Year 2020 National Defense Authorization Act directed the secretary of defense to "ensure that each contract for the acquisition of furnished energy for a covered military installation in Europe does not use any energy sourced from inside the Russian Federation as a means of generating the furnished energy of the covered military installation."[80] The language provides the defense secretary an opportunity to waive the requirement as long as the Defense Department requires the energy to meet mission requirements and the risks associated with the decision are evaluated.

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75. Summer Ferreira et al., *DOE OE 2021 Strategy White Papers on Microgrids: Program Vision, Objectives, and R&D Targets in 5 and 10 years–Topic Area #1* (Washington, DC: DoE, April 2021), 10, https://www.energy.gov/.
76. Ferreira et al., 5.
77. Marqusee, Ericson, and Jenket, *Emergency Diesel*, 3.
78. 10 U.S.C. § 2911(h).
79. 10 U.S.C. § 2911(h)(B).
80. 10 U.S.C. § 2911.

Once Congressional language is in place, the first place to start is the most mission-critical overseas bases. Based on the *National Defense Strategy*, it is likely these bases will be in areas with the most impact on the United States' great power conflict with China and Russia. For example, the US Air Force is increasing the number of its bases across the Pacific over the next decade, to spread out and become more survivable in conflict.[81] Adding a microgrid to these new bases will increase survivability and the Air Force's ability to generate an air tasking order if the base encounters host-nation power interruptions.

Some countries where US bases are located are highly interested in international investment in solar projects.[82] This presents the United States with an opportunity to invest in solar projects on military bases and share the technology with its Allies and partners. Evidence of this occurred in early November 2022 when the United Arab Emirates and the United States signed a partnership to spur $100 billion of investments in clean energy projects and add 100 gigawatts of clean energy globally by 2035.[83] The agreement pushes each country to assemble and stimulate private and public sector funding for clean energy innovation, carbon and methane management, advanced reactors, and industrial and transport decarbonization.[84]

Power grid interruptions from a natural disaster or attack pose a risk to military operations and readiness. Congressional language authorizing and funding renewable microgrids at overseas locations will ensure the US military continues to defend our national interests and that of our Allies and partners. Operating independently of the host nation's electrical grid will provide the military with a reliable power source immune to attacks, extreme weather events, and energy market volatility. Ultimately, powering overseas installations with microgrids will enable Joint Force resiliency and secure continued US military advantage.[85] ✈

81. Audrey Decker, "Air Force Expanding Number of Bases in Pacific over Next Decade," Defense One, August 29, 2023, https://www.defenseone.com/.

82. Samuel Humphries, "A Bright Future: The Middle East's Solar Revolution," American Security Project (website), June 30, 2020, https://www.americansecurityproject.org/.

83. "UAE and U.S. Reach Deal for $100 Billion in Clean Energy Projects," Reuters, updated November 2, 2022, https://www.reuters.com/.

84. "UAE and U.S."

85. Austin, *NDS*, 18.

The Silver Lining in Information Warfare

Lauren McQuone

Despite significant progress in the field of meteorology over the past six decades, military leaders, planners, strategists, and operators are failing to embrace its current capabilities. Advanced meteorological analysis highlights the difference between adversarial and friendly vulnerabilities—given capabilities, risk delimitations, and behavioral norms and anomalies—thereby determining the marginal advantage: the silver lining. The contemporary utility of meteorological analysis is as novel a capability as it is an offensive one.

Technological advances are bounded by decisionmakers' cognitive limitations of how to best use them. In near-peer conflict fought within the margins and where advantages are marginal, users' lack of knowledge will cost the United States and its Allies. For example many decisionmakers wrongly assume that weather's best, if not only utility is in its most perishable form, such as area forecasts, flight weather briefings (DD Form 175-1s), and three-day forecasts. Despite exceptional progress in the field these past 60 years, meteorology's use by military leadership, strategists, planners, and operators has failed to progress apace, relegating an evolved capability to dated functionality.

The redeeming factor is that although this mindset seems to be a postmodern norm, time and preparedness are relative in conflict. There are, however, no assurances that the United States or those friendly to it will be the first to acclimatize to weather operations in a true information warfare context. If information warfare is to advance, decisionmakers' preconceptions about the sophistication and utility of weather knowledge must evolve.[1]

Unlike time and preparedness, a constant in conflict is that terrestrial and space weather often exacerbate vulnerabilities across all domains with zero partiality to actors; moreover, weather drives behavior. Advanced meteorological (met) analysis delineates the difference between adversarial and friendly vulnerabilities—given capabilities, risk delimitations, and behavioral norms and anomalies—thereby determining the marginal advantage: the silver lining. The contemporary utility of met analysis is as novel a capability as it is an offensive one.

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1. US Air Force (USAF), *USAF Strategy for Information Warfare* (Washington DC: Headquarters USAF, July 8, 2022).

Seize, Signal, and Subsist

In the middle of difficulty lies opportunity.

John Archibald Wheeler[2]

Timing is everything in warfare. Advanced met analysis in Joint intelligence preparation of the operational environment (JIPOE), especially in informing the Joint targeting cycle, can impose costs, just as its absence can incur costs. Thus, met analysis represents a valuable yet underused tool in information warfare. For example, with pattern-of-life and risk analysis of activities correlated to winds and sea states, the Department of Defense could better estimate adversarial courses of action and detect anomalous behavior of enemy aircraft. Such information could inform defensive actions ahead of an attack, or better yet, could be leveraged to expend enemy resources and time.

In another example, advanced early warning radars and integrated air defense systems (IADS) with detection ranges beyond 150 nautical miles (nm), paired with missiles that reach similar distances, pose standoff and targeting challenges to the suppression of enemy air defenses aircraft.[3] But all-weather radar sensing technologies and aircraft are subject to corrosion—for example, sea spray and sand accelerate corrosion processes in the presence of abundant oxygen and humidity.[4]

On average, a diurnal sea breeze extends 50 nm inland in the middle latitudes and as much as 150 nm in the tropics.[5] Corrosion is in fact among the largest life-cycle component costs for weapons systems sustainability.[6] These costs include reduced sensor reliability, lifespan, maintenance and repair downtime, and replacement acquisition, ultimately decreasing combat readiness. Patterned sheltering or relocation of assets can be indicative of deliberate offset. Additionally, the downtime critical to preventative and corrective maintenance cannot be eliminated for fixed early warning radars and IADS. This is where there are exploitable windows of opportunity if factored into friendly decision calculi, specifically attrition strategy and tactics science.

Weather can drive initiative—the choice to take the offensive and make exigent threats—in the physical environment. Deliberate and dynamic targeting could exploit sheltering, relocation, and downtime by planning to attack when an opponent's counterair assets are either diminished

2. John Archibald Wheeler, "The Outsider," *Newsweek* 93, no. 11 (March 1979): 67.

3. "Worldwide Equipment Guide," OE Data Integration Network (ODIN), accessed May 15, 2023, https://odin.tradoc.army.mil/.

4. Multiple authors, "Corrosion Management Meeting Proceedings," NATO Science and Technology Organization, November 29, 2018, https://www.sto.nato.int; and Eric Herzberg et al., "Estimated Impact of Corrosion on Cost and Availability of DoD Weapon Systems," LMI, March 2019, https://www.dau.edu/ (full database).

5. Karolina Slamova et al., "Mapping Atmospheric Corrosion in Coastal Regions: Methods and Results," *Journal of Photonics for Energy* 2, no. 1 (June 2012), https://doi.org/.

6. Eric Herzberg and Rebecca Stroh, "The Impact of Corrosion on Cost and Availability of U.S. Department of Defense Weapon Systems," NATO Science and Technology Organization, November 29, 2018, https://www.sto.nato.int.

or delayed. Climatologically informed deliberate targeting is straightforward, albeit untapped. Still, training to such targeting can be alternatively effective if it elicits behavior changes, specifically if the target audience trades greater environmental exposure for quicker response times, attritting its fleet with compounding corrosion. Meteorologically-leveraged dynamic targeting offers the element of surprise—which is achieved through intellectual edge, not iron alone—and creates opportunities to seize the initiative and influence tempo.

Imposing costs involves compelling an opposing (red) force to cease belligerent behavior, because the costs of that behavior exceed accepted benefits and/or are counterproductive. Nevertheless, successful cost imposition can itself incur costs to the blue force as a result of unexercised alternatives. Additionally, it is not a technological or numerical disparity that determines winning outcomes, as the 1979 Sino-Vietnamese War and Russia's current war in Ukraine have demonstrated, but rather a timely so-called "wisdom differential" between actors. Wisdom is the use of knowledge—distilled from learned information—in a profound way. Classical theorist Alfred T. Mahan wrote that "in war, the defensive exists mainly [so] that the offensive may act more freely . . . [and] a coast fortress defends the nation to which it belongs chiefly by the fleet it shelters."[7] A wisdom differential, then, is when decisionmakers use knowledge better than their opponent, resulting in actions that are at once timely, relevant, and costly to the opponent.

Because environmental uncertainty is central to human activity, advanced met analysis must be included when blue forces are deciding how to impose costs on red force lines of communication (LOCs) and logistics. Red defenses—be it fleet, IADS, or other—are effective insomuch as they protect the means to threaten blue LOCs and logistics.[8] Yet, due to the epochal shift of information warfare that began in January 1995 with the formation of the first DoD information warfare executive board, the effectiveness of red defense is equally dependent upon its ability to protect its own LOCs and logistics.

Unifying Weather, Cyber, and Data Science in JIPOE—Data Prioritization

Refined domain awareness is a precondition for decision advantage, and it entails weather-leveraged predictive analytics (in mission management) and retrospective analysis of red force cognitive processes and behavior. Decision advantage in today's complex postmodern environment exists only when assisted by speeds beyond human capacity. One should assume going forward that command and control, physically and functionally, has been and continues to be under persistent disruption. Despite this, there is an overreliance on signals intelligence (SIGINT). But this also presents an opportunity to capitalize on the hardship that disruption causes if military requirements are viewed not just as tangible assets but also as available cognitive capabilities.

7. Jakub Grygiel, "Arming Our Allies: The Case for Offensive Capabilities," *Parameters* 45, no. 3 (Autumn 2015), https://press.armywarcollege.edu.

8. Grygiel.

SIGINT

More sensors and feeds paradoxically amount to an infinitesimal value because data volume exceeds processing power and goes unused, overlooked, or referenced and filed. For compounding SIGINT volume, variety, and velocity to be actionable, collection, dissemination, and analysis prioritization coupled with data acceleration—assisted by numerical modeling, automation, and artificial intelligence (AI)—is vital. Such prioritization and data acceleration are possible where chaos and game theories intersect, expertise that resides within Joint force weather, cyber, and data science specialties.

Signals intelligence sensors, platforms, and dissemination signals by and large are subject to weather; thus, economical mission management cannot be divorced from predictive analytics. Knowing what sensors, platforms, and frequencies can be used can lead to the better use of limited blue resources. Further, met analysis also informs on red SIGINT options, increasing blue's ability to predict red maneuver and platform availability. Useful interception of red LOCs is entwined with conserving blue LOCs for when and where they make the greatest contributions to combatant command theater strategy. For example, tasking SIGINT collection of adversary signal sources during specific terrestrial or space weather conditions could inform red force thresholds, capabilities, and alternate courses of actions, if any.

AI and Predictive Analytics

As deliberate plans approach their execution window, combined game-theory-based artificial intelligence and predictive analytics should drive dynamic retasking by first eliminating less useful data and then accelerating trend and anomaly discovery via algorithm. This allows planners to elevate operational and tactical situations post-analysis by prioritizing missions with higher collection usability and lower lost link rates, but this is in contravention of standing deliberate plans where weather is an afterthought in the targeting cycle.

Electromagnetic Spectrum

Accelerating electromagnetic spectrum (EMS) information integration to provide commanders "scalable options to control conflict escalation" necessitates first addressing scalable situational awareness.[9] Due to congressional limits, the Department of Defense cannot expand in size to meet increasing demands, so given big data and bandwidth challenges—EMS, throughput, human capital, and cognitive capacity—scalability must instead be addressed by modernizing dated internal processes.

9. Mark Esper, *Department of Defense (DoD) Electromagnetic Spectrum Superiority Strategy 2020* (Washington, DC: DoD, October 2020), https://media.defense.gov.

Improved Processes

Further, the convergence of weather with other information warfare components necessitates changes internal to the weather community. In order to scale processes, software solutions must be decentralized to formulate courses of action, thereby decreasing cognitive complexity. This will enable operational and tactical personnel to make quick decisions. Converging weather and intelligence capabilities begins with determining the impartial uncertainty—environmental (weather) conditions—but requires a departure from static times-series graphics and time-consuming manual PowerPoint and Excel production. Available automation expertise makes the latter virtually unnecessary, and the Air Force Weather Virtual Private Cloud makes decentralization possible. Nonetheless, static graphics and manual production linger because planners and operators, weather personnel and otherwise, have grown accustomed to it.

The manpower and time required to generate disruptive innovation, which would increase the United States' military competitiveness, is tied up in short-term repetitive tasks, focused on responsiveness at the cost of progress. Sustainable, expediting software must eliminate multiple touches by weather personnel, be available on demand (integrating automation and AI algorithms), and be intuitive. Further, valuable metrics that inform present insights and future strategies, as opposed to vanity metrics, should be considered from inception in the software development process.

All forces are subject to weather, so the question is not if but how red forces decide and behave in certain environmental conditions and what their limitations and risk tolerance are in training and operations. Differentiating between red and blue forces' cognitive processes and behaviors under similar environmental conditions and determining actionable opportunities begin with advanced met analysis of how environmental information or live conditions situationally influence forces. Retrospective met analysis is challenging in this respect, however, because meteorology is predominantly future-oriented, data archiving saps resources, and career field silos persist.[10]

Software-augmented analysis prioritization, near real-time analysis—essentially mission watch, and collocated integration of information-warfare-versed weather specialists within intelligence teams and other subunits—are ways to work around those challenges. Game theory is predicated on the assumption that decisions are interdependent. Data that would illuminate routine versus anomalous behavior patterns and wisdom differentials in operational art (and then better inform tactics, techniques, and procedures) lie not with one specialty but where weather and intelligence converge. Still, neither function can provide that knowledge at a speed of relevance without cyber capabilities, nor can they measure its value to draw insights for improvement without data science. The ability to act on such

10. John G. Grimes, *DoD Information Sharing Implementation Plan* (Washington, DC: Office of the Assistant Secretary of Defense for Networks and Information Integration/DoD Chief Information Officer, April 2009), https://dodcio.defense.gov/; and USAF, *Strategy for Information Warfare*.

knowledge is power. But to render its effects that frequently manifest in conventional ways into a cognitive outcome is profound.

Getting at the Will to Fight

Met analysis long reduced environmental uncertainty for blue forces, yet the capability, including the ability to anticipate warfighting challenges, remains underutilized in Joint intelligence preparation of the operational environment, and in plans and operations. Decisionmakers tend to fixate on destroying or neutralizing red capabilities and view diminishing will as the consequence rather than the aim, losing sight that the will to fight is fundamental to war.[11] Cutting-edge technologies are useless sans the will to employ them as casualties rise.[12] Effectiveness in conflict is highly dependent upon the ability to protect one's logistics, and an actor that cannot sustain critical logistics risks mortality rates that come at the costs of the combatant's and general population's will to fight.[13] One example of this is exemplified by the management of the blood supply during crises.

An estimated 25 percent of combat deaths between 2001 and 2011 in Iraq and Afghanistan were solely due to exsanguinating hemorrhage—the severe and rapid loss of blood—and yet, these were potentially preventable with the timely evacuation to a definitive care location.[14] Associated discussions of time tend to focus on the golden or resuscitative hour, within which medical intervention—often involving blood transfusions—is considered to offer the best chance of trauma survivability.[15] Yet crises sometimes coincide with inadequate blood supply and when direct blood transfusions are either impractical or insufficient. Blood supplies are protected under medical neutrality but not from the environment. Time and weather, in effect, can beget the endgame. Climate and weather predictions of adversarial blood supply chain effects could improve JIPOE.

There is a narrow margin for error in transporting and storing blood, a temperature-hypersensitive substance, lest its chemical composition is compromised, risking safe transfusion or wastage. First, the time of year—that is, seasonal ambient temperature fluctuations—combined with distribution equipment suitability can pose challenges to maintaining blood integrity, especially the greater the diurnal temperature variation. Although blood products can be stored frozen to extend shelf-life, thaw time for whole blood

11. Ben Connable et al., "Will to Fight: Returning to the Human Fundamentals of War," RB-10040-A (Santa Monica, CA: RAND Corporation, 2019), https://doi.org/.

12. Connable et al.

13. Russ S. Kotwal et al., "The Effect of a Golden Hour Policy on the Morbidity and Mortality of Combat Casualties," *JAMA Surgery* 151, no. 1 (January 2016), https://pubmed.ncbi.nlm.nih.gov.

14. Robert L. Mabry, "Challenges to Improving Combat Casualty Survivability on the Battlefield," *Joint Force Quarterly* 76 (January 2015), https://ndupress.ndu.edu/.

15. Leslie Waghorn, "New Research Shows Golden Hour Trauma Care Saves Lives on the Battlefield," Vital Record: News from Texas A&M Health, November 4, 2015, https://vitalrecord.tamhsc.edu.

or its components is typically prohibitive in emergencies, and refrigerated or room-temperature blood must be transfused within specific timeframes or discarded.[16]

Second, inclement weather at donation sites—locations which may dually serve civilian needs—can delay supply replenishment. Third, weather can delay transport timelines and, in extreme situations, jeopardize temperature-controlled storage when power outages extend beyond backup generator capacity. Casualties are tactical-level effects, but tactical support like blood supply readiness, or lack thereof, can give rise to results of strategic proportions. Enough past wars' lessons reinforce that outcomes are not decided in a contest of technologies but that of wills. As a human endeavor, war demonstrates there are limits to society's acceptance of compounding loss of human life.[17]

In conflict, all initiatives and responses come at a cost. Prudent calculi considers whether an objective's value outweighs the price of the encounter and the appropriate utility of available capabilities in vying for the initiative. Seizing, retaining, and exploiting the initiative are contingent upon thorough, advanced preparation.

Weather in Training

Knowledge is always fundamental to seizing, retaining, and exploiting the initiative. But prescient knowledge of environmental conditions, correlated with adversary inclinations, choices, and limitations creates an offensive paradox: opportunities to operate offensively in an unrestricted manner multiply in inclement weather. Further, the ability to disclose what an adversary cannot do presents a unique opportunity to degrade their military power projection. In the context of airpower, the conventional perspective of an offensive action is that an F-22A, F-35A, B-21, or other aircraft delivers the munitions. The dissident perspective of the same action is that opportune weather delivers the aircraft.

In a highly-contested battlespace between next-generation aircraft and sophisticated anti-access and area-denial capabilities, visual flight rules conditions are neither conducive to seizing the initiative nor guaranteed if the adversary commences the attack. It is better to err on the assumption that air superiority will be local and temporary at best. Increasing that probability necessitates exploiting time frames when freedom of action is exclusive, reversing what are deemed favorable, marginal, and unfavorable flying conditions. Like a rain-wrapped tornado, aircraft advancement might be detectable given existing technology, but it is more difficult for an adversary to react as effectively at the time.

Risk in warfare is a certainty, not a probability. Nonetheless, if the political object is the goal, and warfare a means to reach it, then the most significant risk is not losing an asset, battle, or even the war, but falling out of play to terms unfavorable for the United States and

16. Matthew Bradley et al., "Combat Casualty Care and Lessons Learned from the Past 100 Years of War," *Current Problems in Surgery* 54, no. 6 (June 2017), https://www.sciencedirect.com.

17. Connable et al., "Will to Fight."

its Allies and partners.[18] It is a measured risk to train to and operate between and behind inclement weather rather than the way the Air Force does it now, in more stable environmental conditions. Such a hazardous posture is further complicated by the maturation of adversarial cyber and electromagnetic pulse capabilities, making communications delays and blackouts inevitable. Still, it is a posture that offers audacity, surprise, and a means to alter an operations tempo that will otherwise be rare in a future near-peer conflict.

Past high-intensity peer warfare preceded modern meteorology; thus, actors daringly played against the odds with a rudimentary understanding of weather. Today, prevalent norms are to avoid weather, so deviating and leveraging over 60 years of meteorological advances makes for calculated audacity.[19] The prerogative of surprise complements bold action; the unpredictability of time, place, and direction affords an adversary little to no physical and psychological respite. Within those moments of an adversary's unpreparedness and reactivity are opportunities to disrupt their operations tempo, interfering with their decision cycles while protecting one's own. But this depends on being more prepared. Risk acceptance in practice lends itself to risk transference to an adversary during a conflict.

Future conflicts will not involve pure high-intensity air combat but a hybrid approach with nonkinetic first strikes meant to affect information superiority well before any kinetic response, making it more consequential to recognize an unconventional offense. Although some actions may not bear doctrinal hallmarks, the purpose behind them is the better delineator. For example, consider a disinformation campaign exaggerating the severity of drought and the extant water shortages and food insecurity to trigger human displacement and instability within an adversary's borders. The action is intended as an offense play, but is unconventionally audacious, concentrated, surprising, and paced (tempo).

The purpose of any offense is to deny, degrade, disrupt, deceive, or destroy a target or target audience with real-world impacts to achieve broader military objectives. Leveraging coincidental timing of solar flares, geomagnetic storms, and damaging terrestrial storms for dayside operations is one example of influencing or annulling an adversary's decision calculus. Where satellite communications are nonviable or otherwise impaired and when high-frequency (3–30 MHz) beyond-line-of-site alternatives are disrupted, command-and-control options are limited to a period of minutes to days.[20]

Moreover, since high frequency is often the fallback for civilian emergencies, a state actor must prioritize its military and civilian needs and infrastructure recovery while encumbered by degraded communications. Another example is to leverage weather dictating the types of red forces employed and for which they are the least prepared, such as nonclimate-controlled

18. Carl von Clausewitz, *On War*, eds. and trans. Michael Howard and Peter Paret (Princeton: Princeton University Press, 1976), 87.

19. Eric Berger, "Modern Meteorology Was Born 60 Years Ago Today," Ars Technica, April 1, 2020, https://arstechnica.com.

20. Nathaniel Frissell et al., "High-Frequency Communications Response to Solar Activity in September 2017 As Observed by Amateur Radio Networks," *Space Weather* 17, no. 1 (January 2019), https://doi.org/.

aircraft at heights or ground components that prolong personnel exposure to the elements. Still, meteorological information flow is the proverbial double-edged sword of kinetic and nonkinetic wars, imperative to seizing any initiative militarily and, therefore, an early target.

Knowledge cuts through the fog of war, "the state of ignorance in which commanders frequently find themselves as regards the real strength and position, not only of their foes, but also of their friends."[21] Other national weather data availability will likely be sparse or unreliable preceding and in wartime, drastically affecting both sides' forecast accuracy. Yet the advantage will lie with whichever side possesses better modeling for and working weather knowledge of the contested region; specialists, not generalists, will be indispensable. Weather itself is inherently neutral and neutralizing, impartial to all actors, and ubiquitous to the point of being domainless. Still, it can be disarming in any battlespace of any time for those who use it effectively. The United States insists on the ability to inflict temporary or permanent effects at a time and place of its choosing, but for that to be true, there cannot be an exception for inclement weather.

Conclusion

The weapon of choice is knowledge. Military strength and position limits lie not in the physicalities of warfare but in cognitive biases. Environmental uncertainty is central to and a constant in human activity. Therefore, if any advantage is to be ascertained, much less exploited, in near-peer conflict, then military decisionmakers must break rigid preconceptions about the utility of weather. Defeat is often discussed as a cognitive outcome. Yet emphasis on tangible technological and numerical disparities obscures that the aim of any physical action is to influence perceptions and, thereby, attrit will. So, while conventional forms of attack may indirectly affect will, information warfare is the sole means of a direct attack on an adversary's will to fight.[22]

If the United States is to remain a global leader, particularly when key resources fall short, then its military must scale its cognitive approach. The determinants of military victory depend upon leadership, strategists, planners, and operators fully considering available capabilities, including accepting offensive paradoxes such as the concept that opportunities to operate unrestricted multiply in inclement weather. Every difficult situation offers an advantage; every cloud has a silver lining. The point is to make wise decisions at timely speeds. But this hinges on preparedness that takes time, and nothing can compensate for the loss of time. ✈

21. Lonsdale Hale, *The Fog of War* (London: Edward Stanford, 1896), XIX, 522.

22. J. Boone Bartholomees, "Theory of Victory," *Parameters* 38, no. 2 (Summer 2008), https://press.armywarcollege.edu.

Optimizing Security Forces Operations

Employing Risk-Based Strategies

Brandon L. Dinkins

A new Security Forces framework will modernize the forces and establish a comprehensive security posture that will in turn alleviate manning shortages and mitigate detrimental mental and physical health factors for Defenders. Key elements to the new framework include changing policy restrictions, reallocating resources, and improving protective standards.

Security Forces (SF) deficiencies negatively impact the Air Force mission and SF members' physical and mental wellbeing. As such, Security Forces need a new security framework that utilizes personnel and resources to build a more modernized and comprehensive security posture, one that alleviates manning shortages and mitigates deleterious effects on individuals' mental and physical health. Currently, no published works address SF's programmatic process and security requirements to show how they influence a sustainable security model. Operational efficiencies can be improved by changing policy restrictions, reallocating resources to more prominent threats, and creating new protective standards. A less manpower-extensive and more comprehensive approach to base security will avoid levying additional burdens on SF members.

Introduction

The US Air Force Security Forces, also known as Defenders, are the service security and police forces that conduct 24/7 operations to protect personnel and critical national defense resources. Defenders, representing the largest career field in the Air Force with more than 38,000 members, provide installation security efforts at home stations and overseas, including in hostile theater locations. As the service's law enforcement body, SF is primarily responsible for securing resources that provide strategic airpower and protect assets vital to US interests worldwide. Defenders' duties are physically and mentally demanding, and members accomplish many tasks, ranging "from writing tickets to investigating on-base incidents to make sure everyone and everything on every base is protected."[1]

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1. "Enlisted Security Forces," US Air Force (website), accessed December 17, 2022, https://www.airforce.com/.

Air Force missions largely depend on these individuals to protect their vital warfighting capabilities. For decades, Security Forces have applied a consistent security methodology to provide installation security and base defense capabilities. Yet this has led to security deficiencies and has negatively impacted missions and SF members. The Air Force can improve efficiency by reducing SF policy restrictions, reallocating resources to more prominent threats, and creating new protective standards. Security Forces need a new framework to utilize personnel and resources more effectively to build a more modernized and comprehensive security posture.

By and large, the SF foundation is rooted in requirements-driven policies that significantly restrict commanders from adequately utilizing their forces and forming an adaptive security posture. This method significantly limits how decisions can be made at the tactical level, and several areas of mandated regulatory compliance can form unintended installation vulnerabilities to active shooter attacks, unmanned aerial threats, or complex coordinated terrorist attacks. These inefficiencies routinely impact operational readiness and often require SF units to rotate in and out of 12-hour shift schedules. The threat is always evolving. Because Air Force installations vary in size as well as complexity, SF units require independent security posting strategies to leverage their existing manpower constructs more effectively.

Effectively adapting to threats by integrating security systems and trained SF members requires commanders to track crime and threat metrics, prioritize risks, and create comprehensive security plans. Maximizing SF operations involves methods that systemically build installation-specific strategies. These tailored strategies utilize SF members more effectively, apply appropriate levels of protection to critical resources, and create a sustainable security model that does not jeopardize Defenders' mental and physical readiness. Today, many SF members at Air Force installations worldwide have limited operational effectiveness due to redundant security concepts and restrictive security procedures. A new security management approach for SF posting and response can help create a more lethal, educated, effective, and ready force to meet the dangerous threats of today.

Culture Shift

Many policies that drive SF security operations have not changed since the Cold War. In addition, a wide range of requirements drive SF response priorities, and recent SF leaders such as Deputy Director of Security Forces Tim Gerald have pursued positive change for the entire force. Yet a culture-wide shift to address the many limitations of requirements-based security and the constraints in SF capabilities needs to be made in order to ensure effective and efficient security operations.

In his introductory video presentation to Defenders, Director of Security Forces Brigadier General Thomas Sherman emphasized the importance of a culture of change in today's force, addressing the current global environment, peer competition, and the ability of Security Forces to operate in various settings.[2] Sherman describes how culture

2. Tom Sherman, "Brig Gen Sherman's Message to Defender Nation," Defender Nation, March 10, 2023, YouTube video, 10:20, https://www.youtube.com/.

can shape the path of SF in determining what is needed for airbase defense. Highlighting the need to use technology, equipment, and innovation to transform the Security Forces into a system of record to manage the current battlespace, Sherman notes that Defenders must build the appropriate resources and acquisitions processes to sustain operations. Sherman acknowledges the use of innovation is imperative to shape future operations and create a more agile and comprehensive security posture.

The Problem with Integrated Defense

Procedural installation security guidance is defined primarily in Department of the Air Force Instruction (DAFI) 31-101, *Integrated Defense*.[3] The pacing threat and advancement of technological modernization involve ongoing efforts to improve security requirements and procedures. DAFI 31-101 provides a conceptual framework for the baseline standards of security implementation and defense strategies. Integrated defense is the governing policy that primarily directs how Security Forces implement specific security procedures on installations. It addresses establishing security for protection-level resources, installation access control requirements, and electronic security system implementations.

Yet these requirements often do not account for individual situations at installations; instead they represent a holistic application of security at a foundational level. Many units have unique mission sets with different geographic considerations, which creates challenges for SF commanders—often interchangeably known as defense force commanders (DFC)—to implement strategies unique to their missions. Deviations from integrated defense policies usually require higher-level waiver authority. The SF climate is not accustomed or conditioned to seeking those waivers, especially when it deals with securing protection-level resources. Therefore, higher-level policy should allow for more installation-level decisions to be made by DFCs and in coordination with installation commanders. Fostering a culture where DFCs have more influence to make changes at their level, applying a preponderance of evidence from threat intelligence to create security strategies, can significantly shift SF operations to a more efficient operational climate.

In addition to the challenges posed by a one-size-fits-all security strategy approach, innovation within the SF career field lags behind that of modern aviation and cyber systems across the rest of the Air Force. The Security Forces' innovation and advancement cycle is limited to yesterday's institutionalized standards and compartmented strategies. Defenders use an abundance of manpower to secure resources, critical assets, and airfields rather than integrate technology that augments or even replaces the need for manned security operations. DAFI 31-101 restricts commanders' ability to adapt security standards away from the prescribed requirements. The security convergence of technology and airbase defense can utilize systems to control installation access, surveil and monitor sensitive areas, and deter adversaries. Former Chief of Staff of the Air Force General Charles Q. Brown Jr. stated the Air Force will not grow

3. Department of the Air Force (DAF), *Integrated Defense*, DAF Instruction (DAFI) 31-101 (Washington, DC: DAF, 2020).

bigger in number; instead, the service must adapt to win wars.[4] Air Force Security Forces cannot continue to operate at their current manpower-driven capacity; instead, they must innovate and align with current technology to drive a more robust security posture.

A New Strategy

As within many military organizations, institutional inertia against change tends to persist in Security Forces. Some SF leaders remain steadfast with the status quo and refuse to adopt any new way of thinking. Yet SF leaders have the power to develop a more comprehensive model that reduces manpower requirements while still meeting the appropriate level of base defense and resource protection. Defender units are currently implementing a requirements-based security strategy where their forces are often dedicated to security resources within an inner restrictive area inside an Air Force installation perimeter. Those perimeters contain comprehensive security systems, high-occupancy buildings, structural deterrence, and low threats of hostile actors.

But this strategy requires a security presence that limits other policing activities, creating considerable vulnerability to other installation threats including gate runners, volatile domestic disputes, and active shooters in high-occupancy buildings outside the restricted area. Due to manpower constraints produced by the current security philosophy, as little as one patrol may be responsible for policing areas outside of the priority resources. Conversely, a more suitable strategy would include expanding security efforts across the installation while implementing a priority response matrix for those patrols instead of restricting them to areas with other delay-and-detect systems.

The requirements-based security strategy is the standard security process across the SF enterprise. Gaps in perimeter security have allowed a host of intruders to circumvent procedures at installation access control points. Early 2023 intrusions at Joint Base Andrews, Maryland, have highlighted the limitations in adequately securing Air Force installations, allowing perpetrators to access highly secure areas, even onto aircraft designated for senior US leaders.[5] These security deficiencies can create devastating consequences for high-value assets and disrupt critical mission operations. As one solution, robotic advancements can help strengthen security efforts without increasing the need for manpower.

Technological automation, such as surveillance, can be an effective security solution as it can relieve SF of monotonous and dangerous duties allowing them to provide services in other needed security areas.[6] Defenders at Patrick Space Force Base, Florida, use dog-like

4. Stephen Losey, "Gen. Brown: The Air Force Isn't Getting Bigger; To Win Wars It Must Move Airmen into Undermanned Jobs," *Air Force Times*, August 31, 2020, https://www.airtforcetimes.com/.

5. "Intruder Breaches Base of Air Force One, Shot Fired," CBS News Baltimore, updated February 7, 2023, https://www.cbsnews.com/.

6. Roman Prykhodchenko, Rui P. Rocha, and Micael Couceiro, "People Detection by Mobile Robots Doing Automatic Guard Patrols," in *2020 IEEE International Conference on Autonomous Robot Systems and Competitions (ICARSC)*, Ponta Delgada, Portugal, April 15–17, 2020, ed. Nuno Lau et al. (New York: Institute of Electronic and Electrical Engineers, Inc., 2020), https://ieeexplore.ieee.org/ .

quadruped unmanned ground vehicles (Q-UGVs) to assist in repetitive tasks like security patrolling around the installation and damage assessments, "saving significant man hours."[7]

This augmentation is an example of integrating technology with new-age security solutions to expand Defender capabilities without increased manning positions. These tools and complementary features are force multipliers and transition away from the static and predictable security model prescribed within DAFI 31-101. Using Q-UGVs is just one of many opportunities to increase security capabilities and reduce the manpower-driven standards correlating to existing SF policy. This strategy aligns with Sherman's intent to capitalize on technological advancement in the career field.

Evaluating Risks

Data consolidation and analysis are a cornerstone for driving informed decision-making. A cognitive approach with an evidence-based strategy can aid in creating a mission-capable security plan. Defense force commanders are mandated by Air Force policy to mass security efforts based on prioritized Air Force resources. Much of the security infrastructure is layered and augmented by a defense-in-depth philosophy where fencing, alarm sensors, and cameras, for example, enhance security integrity. Physical barriers and intrusion detection capabilities significantly enable responding forces to meet hostile actors before they enter protected areas. Yet the lack of innovative security concepts has created many static posts where Defenders are limited in their ability to provide security across different mission areas. A security response team is routinely required to provide inner and outer security for critical- and protection-level resources. But as a result, the team usually cannot provide additional coverage in other installation jurisdictions where a higher threat to personnel is more feasible.

Tracking criminal trends and threats allows DFCs to utilize their force more effectively, thus reducing inefficient policing and security posting. DFCs can reallocate forces to other base patrolling activities and not restrict area security patrols to resources where infrastructure and layered defense can deter and delay adversarial threats. Like the Department of Homeland Security's operations strategy, SF must rely on "timely and actionable intelligence" to evaluate and prevent threats accurately.[8] Directed patrolling, focused deterrence, and joint intelligence fusion can provide a comprehensive security construct that does not require additional manpower to support current posting requirements at SF squadrons around the globe. DFCs should be able to develop a well-defined defense strategy based on current threats and resource priorities.

Such a strategy encompasses more than armed Defenders—hence, the need to use technological detection capabilities and automated systems to augment many posts where complacency

7. Brett Tingley, "US Space Force Test Robot Dogs to Patrol Cape Canaveral," Space.com, last updated August 8, 2022, https://www.space.com/.

8. "Counter Terrorism and Homeland Security Threats," Department of Homeland Security (website), last updated May 30, 2023, https://www.dhs.gov/.

can build over time, especially when coupled with a high operational shift schedule and 12- or more-hour tours of duty. Formalizing an optimal and sustainable shift schedule can significantly reduce risk to installation personnel, resources, and Defenders. As noted by one research study, police officers who worked 12-hour shifts had a lower level of alertness and increased fatigue than those who worked 8–10-hour shifts, thereby creating the possibility of additional security risks and vulnerabilities.[9] Sleep deprivation can have a profound influence on officer safety and survivability by reducing core motor functions and cognitive acuity.[10]

The Risk-Analysis Process

Integrated defense policy significantly focuses on securing installations from external threats and bolstering security for priority resources. Yet increasing evidence shows that prioritizing risk from internal and external threats is a better utilization of forces and a more efficient method of preventing security incidents. Prioritizing risks requires leaders to analyze data and build a security framework that provides critical protection while not significantly detracting from other operational areas. The willingness to assess risk and apply a meticulous security plan for SF must not outweigh the cost of impacting members' overall mental and physical wellbeing. Therefore, commanders should also evaluate the risk to the wellbeing and effectiveness of SF in addition to the risk to resources and personnel.

Policing strategies should routinely adjust to the changing society and incorporate technology within constitutional parameters.[11] By more efficiently focusing security efforts, prioritizing risk ensures the readiness and modernization of base security aspects. Using intellectual energy to enhance the performance of Defenders as opposed to the old manpower-driven security philosophies can increase readiness by providing a more alert, trained force to meet current challenges.

The use of technology in the twenty-first century has changed the dynamic of warfighting and policing. Indeed, the use of technology and real-time monitoring can greatly enhance policing activities and augment SF to reduce specific manning requirements, better prioritizing risk. Unfortunately, Security Forces have had a "do everything" approach and continue to acquire other operational missions without allocating the appropriate resources to utilize capabilities effectively. For example, the use of counter-small unmanned aerial systems is a critical defense asset; however, many SF units are employing this critical capability with organic manpower and may not acquire additional manning billets to employ the system without detracting from other mission areas.

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9. Karen L. Amendola et al., *Shift Length Experiment: What We Know about 8-, 10-, and 12-Hour Shifts in Policing* (Washington, DC: Police Foundation, 2011), 14, https://www.policinginstitute.org/.

10. Rex M. Scism, "Human Fatigue in 24/7 Operations: Law Enforcement Considerations and Strategies for Improved Performance," *Police Chief Magazine*, accessed December 10, 2022, https://www.policechiefmagazine.org/.

11. Thomas J. Cowper and Michael E. Buerger, "Improving Our View of the World: Police and Augmented Reality Technology," 12, Federal Bureau of Investigation (website), February 2003, https://www.fbi.gov/.

Air Force Defenders have remained a superb fighting force. Nonetheless, their current functionality is not a sustainable model for future base defense strategies. Prioritization creates an accurate assessment methodology to better identify installation vulnerabilities. This can also create more synergy across SF program areas and better integrate security systems into routine operations.

Addressing Security and Policing Limitations

Identifying each aspect of critical systems and assets that require a certain level of protection is paramount to safeguarding them and establishing remedial actions that correspond to each vulnerability. Defenders can use security assessments to identify actions to reduce the risk whenever security gaps occur. Sometimes a collective effort is necessary to close those gaps and provide an analysis process to determine the best solution. A holistic view of program management is important, as well as developing operational compliance standards along the way. Many SF commanders have attempted to implement a modernized method of base security; however, this is not codified across the Air Force. In addition, SF commanders seeking to change the security response efforts must rely on installation commander approval to accept any risk associated with deviation from requirements.

The adaptable capabilities of terrorism have brought a whole new arena of threats, which have forced comprehensive strategies that have interconnections between different geographic locations. Furthermore, not all terrorist traffic and communication are detectable. The more contemporary methods that inspire lone-wolf actors and sympathizers to carry out hostile attacks against soft targets make prevention even more challenging. These threats in the United States and globally have dramatically increased, and of course many terrorist organizations have acted on them.

Military installations have seen more than their share of insider attacks and lone-wolf shooters as well. Notable attacks on military installations have revealed weaknesses in security capabilities and the need for a restructured methodology to prevent hostile internal attacks in addition to external ones. Nidal Hasan's Fort Hood attack in 2009 marked the beginning of "a new adaptation challenge for the Defense Department: rethinking what 'force protection' meant."[12] This attack style further shows the need to preemptively address security limitations rather than wait for a significant event to occur.

The military has encouraged and mandated active-shooter training and preparedness across base populations. This strategy does help to foster a mindset shift in the event of an active-shooter attack. Nevertheless, significant responsibility for stopping an active shooter and saving lives falls into the hands of Defenders. In active-shooter attacks, every second matters, and all too often, manning limitations impact the timeliness of responses. Moreover, the available patrols may be directly allocated to priority resources. Realistically, SF can employ an "all hands on deck" approach to these types of incidents and has, but

12. Amy Zegart, "Insider Threats and Organizational Root Causes: The 2009 Fort Hood Terrorist Attack," *Parameters* 45, no. 2 (Summer 2015): 39, https://press.armywarcollege.edu/.

this is more the exception than the rule.[13] Developing a strategy that allows a more flexible response capability to incidents can generate a rapid response to such high-level incidents. Allowing Defenders to transition beyond their restrictive protection-level post limits expands SF's capability to transition effectively when incidents occur.

Well-developed mitigation plans help build a formidable defense against attack as the evolving environment demands operational efforts exceed the level of existing actual and perceived threats. More resilience in physical security and efficient operations is the ultimate goal; however, enhanced standards have not always translated to foolproof and viable protection methods for those military installations and assets that support national defense. Still, enhanced standards and technology through layered defense allow Defenders to pursue other patrolling activities. Security Forces can utilize patrols as high-visibility deterrence, which helps increase the probability of detecting and deterring criminal acts and security breaches. In addition, such patrolling activity can have secondary beneficial effects by increasing public awareness of the installation and providing additional community enforcement services. This process takes dedicated response teams from static positions and deploys them across a range of security responsibilities, thus increasing their capability to defend the installation and still provide a response to high-priority resources.

Conclusion

Defenders continually answer the call to serve our nation. Their dedication to duty helps instill a feeling of safety throughout the installation and of assurance in the Air Force mission. Providing a comprehensive approach to base defense requires examining appropriate strategies to help build a more effective security and policing framework. Current security posting requirements are deeply rooted in headquarters policy and reduce mission effectiveness at the installation level. Applying an intelligence-driven operational methodology allows Security Forces to transition from reactive strategies to a proactive framework. Refining planning and risk-management strategies against more sophisticated threats is necessary to organize SF manpower and acquire a complementary security system. No single security strategy or detection system will work for every SF unit. Therefore, defense force commanders should identify which methods of security complements and enables their mission without negatively impacting the quality of workforce factors and the individual wellbeing of Defenders.

13. Headquarters, DAF, *Active Shooter*, Air Force Tactics, Techniques, and Procedures 3-4.6 AS (Maxwell AFB, AL: Curtis E. LeMay Center for Doctrine Development and Education, February 11, 2018), https://static.e-publishing.af.mil/.

Remaining a Day-One Player

The French Air and Space Force and the US Air Force

David Pappalardo
Andy Hamann

While roughly a tenth of the size of the US Air Force, the French Air and Space Force (FASF) is considered by some to be the Air Force's most near-peer partner—a fully capable, full-spectrum air force, backed by the political willingness to act. Admittedly, France remains a junior partner to the United States in any Washington-led coalition, and asymmetry will remain a structural feature of the transatlantic tie for the foreseeable future.

In *Allies That Count: Junior Partners in Coalition Warfare*, French professor of political science Olivier Schmitt explains that the utility of a junior partner's contribution depends on "whether the junior partner has a high degree of standing in the international system or on whether its military contribution is both integrated . . . and of a sufficient technological quality to cooperate with US forces."[1]

Although a junior partner, France is an Ally that counts, as much as for its political standing and willingness to use its forces abroad, as for the high-end, full-spectrum capability of its forces. This explains why French Minister of the Armed Forces Sébastien Lecornu and US Secretary of Defense Lloyd J. Austin signed a renewed joint statement in November 2022, reaffirming "the need to enhance our defense cooperation in order to enable our forces to jointly address the array of threats we face."[2]

This statement is also in line with former Chief of Staff of the US Air Force General Charles Q. Brown Jr.'s "Integrated by Design" approach, where the United States works with its Allies and partners through the coordination of people, policies, and processes. As Brown notes, Allies, including the FASF and the US Air Force, need to "collaborate

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1. Olivier Schmitt, *Allies That Count: Junior Partners in Coalition Warfare* (Washington, DC: Georgetown University Press, 2018), 12, https://doi.org/.

2. Joint Statement of Intent between Mr. Lloyd Austin, Secretary of Defense of the United States of America and Mr. Sébastien Lecornu, Minister of the Armed Forces of the French Republic, signed November 30, 2022, https://www.defense.gouv.fr/.

and make decisions together on interoperability, resource investment, information sharing, force development, and strategy from the very beginning."[3]

The French Air and Space Force has long been a day-one player in coalitions and conflicts along with the US Air Force and has started to collaborate more closely with the US Space Force. This relationship must not be taken for granted, because there is risk of an interoperability gap between the two sides as increasing numbers of European nations acquire the F-35 platform. As such, in today's advanced coalition operations, the two air forces must keep pushing hard to operate effectively together in a consistent and mutually reinforcing manner. Although progress continues, there is still many a slip 'twixt the cup and the lip to overcome the existing barriers.

Strong Partners Already

> *Interoperability: The ability to act together coherently, effectively, and efficiently to achieve tactical, operational, and strategic objectives.*[4]

As America's oldest ally, France has a long history of cooperation with the United States that it can continue to build on. Epitomized by American ace Eddie Rickenbacker, who, during World War I, flew the French Nieuport 28 and the SPAD XIII in the "Hat-in-the-Ring" Squadron, and Eugene Bullard, who joined France's Lafayette Flying Corps in 1916 as one of the first African American military pilots, the United States' and France's combined aeronautical roots run deep.

Similarly, World War II saw French airmen at the controls of US warplanes, partnering together across the breadth of air missions. More recently, operations in Iraq (1991), Bosnia (1992–95), Kosovo (1999), Afghanistan (2002–13), Libya (2011), and the Levant (since 2014) highlight that the French Air and Space Force and the US Air Force have continued this tradition of fighting alongside each other into the twenty-first century.

Exercises and Operations

In Operation Hamilton in April 2018 the French Rafale held the overall mission commander role, with US Air Force B-1s, F-15s, F-16s, and F-22s along with Royal Air Force Typhoons engaging in combined air strikes on Syria, following the use of chemical weapons by the regime. This operation demonstrated the FASF's day-one player prowess and serves as a model of interoperability, both in the planning and in execution of real-world present-day kinetic warfare, albeit without a credible air or ground defense from the adversary.

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3. Mackenzie Eaglen and Charles Q. Brown Jr., "Gen. Charles Q. Brown, Jr. on Air Force Defense Strategy and Innovation," American Enterprise Institute, August 29, 2022, YouTube video, 58:02, https://youtu.be/; and Charles Q. Brown Jr., keynote address, Global Air & Space Chiefs' Conference, London, UK, July 2022, 2, https://www.af.mil/.

4. Office of the Chairman of the Joint Chiefs of Staff, *DOD Dictionary of Military and Associated Terms* (Washington, DC: Joint Staff, 2021), 110, https://irp.fas.org/.

In both the US Central Command and US Africa Command areas of responsibility, the French Air and Space Force is performing combat operations and conducting combat support, intelligence, surveillance, and reconnaissance, and tactical airlift missions throughout these theaters in close collaboration with the US Air Force and US Joint forces.

Additionally, since 2018 the FASF has annually sent Rafale fighters, KC-135s, A330 multi-role tanker transports (MRTTs) air-to-air refueling aircraft, and its new A400M airlift aircraft to the US Indo-Pacific Command area of responsibility to perform high-intensity training in French territories as well as training, security cooperation, and strategic messaging, much like its US counterpart. In 2021, the FASF conducted the HEIFARA mission, which sent three Rafales, two A400Ms, and two A330 MRTTs to French Polynesia in less than 48 hours and immediately generated fighter sorties after a projection of more than 17,000 kilometers. After this initial phase, the FASF conducted air maneuvers with US Pacific Air Force's F-22As during WAKEA exercises to increase interoperability.

In July 2023, the FASF conducted the annual PEGASE mission, which consisted of an airpower projection of 18,000 kilometers in the Indo-Pacific region with 10 Rafale, 4 A-400M, 5 MRTTs, and 320 airmen. The crews departed France on June 25 and reached southeast Asia in 30 hours.

Notably, the FASF took part in the Mobility Guardian exercise in Guam and flew with US Pacific Air Force's F-35 during Northern Edge 23-2 to reinforce their interoperability. Three of the Rafales deployed in Guam landed in Palau on July 7 for exercises in distributed operations and agile combat employment and to strengthen cooperation.

In addition, the French Air and Space Force engaged with other French partners throughout the region, with security cooperation stops in Singapore, Malaysia, the United Arab Emirates, South Korea, Japan, and the French territories in the South Pacific, intending to strengthen France's cooperation in the Pacific region while supporting its citizens and interests, per its Ministry of Armed Forces' Indo-Pacific policy.

Further Bilateral Cooperation

Overall, the two air forces share a common strategic vision that uncontested air dominance is no longer assured. As such, they must adapt to win in highly contested environments and contribute effectively to the joint warfighting effort. Beyond exercises and operations, the current operational framework of bilateral cooperation includes operational engagement talks with proposals for a similar construct in the A5 plans and requirements lane as well as annual vice air chief talks.

Strong synergies exist between US Air Forces Europe (USAFE) and the FASF, particularly in USAFE's 603rd Air Operations Center and the FASF's command and control node in Lyon—the Commandement de la défense aérienne et des opérations aériennes—reinforced by a trilateral France-United Kingdom-United States (FRUKUS) air force partnership. In 2021, for instance, under this trilateral strategic initiative, France hosted an Atlantic Trident exercise with 12 US Air Force F-35s at a French airbase for over a month, the first time F-35s operated from a non-F-35 country. In the fall of 2023, the

UK will host the next Atlantic Trident exercise, featuring F-35s and Rafales employing advanced tactics, techniques, and procedures in a full spectrum of mission sets.

France and the United States have also long been partners in the space domain. France is considered a top priority by the US Space Command in terms of cooperative efforts. Indeed, France has capabilities and a strong industrial basis all along the space spectrum, not to mention strategic locations throughout the globe that serve as useful real estate for ground-based space situational awareness capabilities. Most importantly France and the United States "have a common assessment of threats and share the ambition to confront them accordingly," as recalled in the November 2022 joint statement of intent.[5] For all these reasons, France and the United States are constantly enhancing their cooperation in the space domain and have since 2009 "leveraged the Space Cooperation Forum to advance shared objectives, such as information-sharing, developing mutual education and training opportunities, and building towards combined operations."[6]

Balancing Integration with Autonomy

If the French Air and Space Force is to continue to play its part, it must not be complacent nor rest on its laurels. By the same token, the US Air Force must strive to make Brown's integrated by design imperative a reality rather than an aspiration that does not hold under scrutiny. These parallel efforts are paramount to overcome the existing barriers to a deeper and wider collaboration.

First, the word integration may be understood differently from the two sides of the Atlantic. As Brown explained during the September 2022 International Air Chiefs Conference in Washington, DC, " 'Integrated by Design' is the US Air Force's approach to developing people, policies, and processes, starting with Allies and Partners in mind."[7]

The core idea is not new, but the approach emphasizes execution rather than discussions to "collaborate and make decisions together on interoperability, resource investment, information sharing, force development and strategy from the very beginning."[8] In other words, it aims to increase integration at institutional and tactical levels, to maintain the leading edge over competitors. France is of course supportive of this philosophy and is eager to see it become a reality, as evidenced by the signing of the aforementioned joint statement of intent.

But integration also entails industrial risks for France as a junior partner—albeit a very important one—to the United States when integration and interoperability consist of providing Allies and partners with more American military equipment. This is why France is careful about the concept of interchangeability, a term coined by UK Chief of the

5. Joint Statement of Intent.
6. Joint Statement of Intent.
7. Charles Q. Brown Jr., speech, International Air Chiefs Conference, Washington, DC, September 15, 2022.
8. Brown, keynote address, 2.

Defence Staff Admiral Sir Tony Radakin to refer to moving "beyond interoperability" into an area of greater sharing and synergy.[9]

Admittedly, interchangeability would be "the holy grail of tactical integration because it would dramatically ease the burden of planning coalition operations," but it would also come with a high level of dependence vis-à-vis the United States.[10] In addition, US International Traffic in Arms Regulations (ITAR) complicate cooperation between France and the United States at the industrial level, because they limit the exchange of technical data and give the United States a vote on France's arms sales policy.

In short, these regulations and the ever-increasing US defense industrial muscle shed light on the difficulty for France in overcoming the conundrum between a better integration with the United States in all warfighting domains and the preservation of its strategic autonomy. The latter must not be understood in terms of decoupling, but rather of self-sufficiency—that is, the ability to provide more resources and the willingness to take on more responsibilities for its own defense. Indeed, a state can be part of an alliance and yet be seeking self-reliance in the face of new threats and security issues. As Florence Parly, former French minister of armed forces, stated, "Hesitating between strategic autonomy and Atlantic alliance is a bit like asking a child if he prefers his mother or his father."[11]

For France, interoperability with the United States in particular is essential to be able to continue to operate together seamlessly like both nations have over the last 100 years. One of the biggest challenges for the FASF will be to remain a day-one player with the US Air Force while preserving its ability to act independently, when necessary, especially in the nuclear deterrent mission.

Yet this challenge is daunting with the significant acquisition of the F-35 across Europe, which makes it more difficult for France, as the FASF will not operate Lockheed Martin's flagship. There are currently over 150 F-35s in the European theater, with well over 500 more planned for the region. Interoperability with the French Rafale and Rafale exports is critical for coalition operations. It is a challenge for France; it is a challenge for NATO. As the retired French Vice Chief of the Air Staff General Frédéric Parisot regularly warned, with the resurgence of near-peer competitors, NATO cannot afford to have divided airpower—between the F-35 community and the others—within the current operating environment.

Added to this current challenge of interoperability between the French Rafale frontline fighter, the growing F-35-capable nations, and the Joint all-domain command and control/

9. Richard R. Burgess, "U.S., UK. Naval Leaders Cite Advances in Interchangeability," *Seapower Magazine*, October 20, 2020, https://seapowermagazine.org/.

10. Stacie Pettyjohn and Becca Wasser, *No I in Team: Integrated Deterrence with Allies and Partners* (Washington, DC: Center for a New American Security, December 2022), 11–12, https://s3.us-east-1.amazonaws.com/; and Megan Eckstein, "U.S., U.K. Navies Working to Achieve 'Interchangeability' in Carrier Forces, Collaboration on Unmanned and AI," US Naval Institute, October 20, 2020, https://news.usni.org/.

11. Florence Parly, minister of the armed forces of France (statement, Defence Summer Universities, Paris, France, September 2018).

advanced battle management systems command and control networks is the fact that both the United States and France are working on the next generation of fighter, command and control, and networked systems-of-systems. It is critical that these advanced systems are not developed without integrating by design from the start.

New Framework

The time has come to focus on implementation. In September 2023, the FASF and US Air Force signed a letter of intent "that elevates and intensifies cooperation across the bilateral spectrum to help achieve integration by design."[12] More specifically, Generals Stéphane Mille and Brown decided to strengthen their cooperation along several lines of engagement to face the challenges ahead, enhance day-zero interoperabilty, be ready to win as a team in highly contested air and space environments, and contribute effectively to the joint warfighting effort.

The first line of engagment concerns bringing in the concept of partner interoperability at the beginning—at strategy and doctrine development, well before aircraft are fielded. Indeed, interoperability is not only about technology and datalinks.

Future operational concepts and analysis through efforts such as wargames, scenarios, table-top exercises, or combined planning can help fix the gap in mutual understanding and include discussions of theories of airpower. Far from being exhaustive, the list of concepts includes (1) human-to-autonomy teaming; (2) collaborative combat aircraft; (3) resilient basing and agile combat employment; (4) Joint all-domain command and control and advanced battle management systems; and (5) near-space operations.

Concerning the last issue, China's spy balloon that floated across the United States in early February 2023 could introduce a new avenue of cooperation between the US Air Force and the FASF, as France is about to release its strategy of Higher Airspace Operations—operations within the unregulated near-space area—while at the same time President Joseph Biden has announced that an interagency review is underway "to study the broader policy implications for detection, analysis, and disposition of unidentified aerial objects that pose either safety or security risks."[13]

Also, information-sharing is vital to the success of multinational and bilateral operations, as discussed earlier. Consequently, the FASF and US Air Force can work on overcoming institutional barriers to change the information-sharing paradigm to allow more routine operational exchange of information.

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12. Charles Q. Brown Jr. (@GenCQBrownJr), "I was very pleased to join my French counterpart, Gen. Stéphane Mille," X (Twitter), September 19, 2023, 8:01 a.m., https://twitter.com/.

13. "Press Briefing by Press Secretary Karine Jean-Pierre and National Security Council Coordinator for Strategic Communications John Kirby," White House (website), February 13, 2023, https://www.whitehouse.gov/; and Christina Mackenzie, "France Considering Options for 'Unexploited' Higher Airspace Region," Breaking Defense, January 13, 2023, https://breakingdefense.com/.

The two services acknowledge the dual value of common exercises, both for readiness and strategic signalling. As such, they can better synchronize planning whenever it is possible and desirable. The French Air and Space Force's participation in the recent US Indo-Pacific Command-led Large Scale Global Exercise 2023 offered a threefold opportunity that was capitalized on: increase interoperability, test agile combat employment concepts with US Pacific Air Forces, and signal France's commitment to protect its interests in the region. Atlantic Trident 2023 and other future exercises offer similar opportunities in the European theater.

Education and training are also critical lines of effort—whether through professional military education, combined training, or specific courses—as well as expanding exchange and liaison officers' positions within each other's operational units and staffs.

Additionally, the US Air Force and FASF could strengthen their cooperation in terms of capability development (including innovation) in relationships between, for example, the French Procurement Agency and US Air Force/A5, and within the joint Cooperative Oversight of Programs process to consider the incorporation of each other's priorities, technology, and systems much earlier in the development process, such as with the French Future Combat Air System/Next Generation Fighter and the US Air Force's next generation fighter as well as other advanced and future systems.

In parallel, the FASF and the US Space Force and US Space Command will continue to advance partnerships in the framework of the terms of reference signed in 2022 to develop information-sharing at increased levels of security classification, establish mutual education and training opportunities, and build towards combined operation in space.

Conclusion

The French Air and Space Force and the US Air Force must continue working together to be more integrated by design. Yet integration does not mean assimilation, and FASF will have to balance the need to strengthen integration with the preservation of its autonomy, for nuclear deterrence, for its industrial policy, and in terms of strategic signaling. Admittedly, as the authors know and have witnessed, France is a demanding Ally, but it is reliable as much for its capabilities as for its will to use force when necessary.

This is particularly true in the air and space domains where France is—and must stay—a day-one player alongside the United States. In short, France and the United States must continue to foster comprehensive reflection on air and space domains, discuss threats and challenges, and above all, put forward concrete policy orientations. To hedge against a more demanding future, four key words must shape strategic thinking: readiness, preparedness, sustainability, and interoperability.

The new framework, signed this September, is an opportunity to nourish ourselves on each other's experiences and perspectives in order to facilitate future military engagement and protect common security interests. France and the United States can only be stronger

together. In the words of the famous French airman and writer Antoine de Saint-Exupéry, "There is only fertile the great collaboration of the one through the other."[14] ✈

14. Antoine de Saint Exupéry, *Citadelle* (Paris: Gallimard, 1948).

The Air War in Vietnam

Michael E. Weaver. Texas Tech University Press, 2022, 640 pp.

Just when you think you have read all there is to know about the war in Vietnam, particularly the air war there, a skilled academician—in this instance Michael E. Weaver—pens a persuasive historical tome using previously classified materials and documentary policy evidence in a new comprehensive work. Weaver, currently an associate professor of history at the US Air Force's Air Command and Staff College at the Air University in Alabama, breaks down his analysis of the air war via six mission sets: aerial refueling, air superiority, reconnaissance, airlift, close air support, and coercion and interdiction. Rather than plow old ground, Weaver skillfully looks at each of these mission sets not through the lens of sortie counts, missions flown, and bombs dropped—which have been argued to be the worst measures of success in this war, and any war for that matter—but via true effectiveness markers grounded in the mission objectives of the specific campaign or operation and filtered through the lens of US policy goals for the overall war. In this context, *The Air War in Vietnam* is a unique and new contribution to the historical account.

Shortly after beginning the book, most readers will intuit the notion that the Air Force's use of airpower in the prosecution of the war was mostly successful. It was the waging of the war as a whole that was a failure, and Weaver soberly sets out establishing why. With effectiveness as the book's unifying theme—the author rightly notes how he and his colleagues "wrestle constantly" with this, as there is no agreed-upon definition of effectiveness—Weaver posits that America simply forgot the lessons of its past fighting victories. The total war mentality leading to World War II's triumph was a high-water mark that was never to be reached again because of restrictions placed on potential targets. In numerous cases time and again, Weaver explains how field commanders were prohibited from attacking not only specific general target categories, but also specific targets themselves. Airspace constraints, too, limited airpower's effective reach and power because of limitations shackling air commanders. Limitations that might incite overt involvement by the Soviet Union and China were assiduously avoided at nearly all costs, which resulted in the micromanagement we are all familiar with, and sadly, in a war that fell short of national goals.

As noted previously, Weaver uses established policy goals outlined in the State Department's *Foreign Relations of the United States* series to specifically link air operations to national policy and strategy goals, something never done before in scholarship. This dynamic is often overlooked in narrow examinations of war histories and analysis because the two are inextricably linked and a treatment of one is not complete without the other. As a strategist and former commandant of the US National War College, the premier Joint and interagency strategy war college, I teach my students to think about strategy as Weaver would. Holistic approaches that incorporate and analyze all the instruments of power and their interrelationship along with the war's ends, ways, and means, while assessing costs and risks, is a proven methodology for analyzing success in the broader context of national security strategy, which is exactly what Weaver has accomplished here.

Weaver explains the Vietnam War at its core as a siege of North Vietnam. Paring back his evidence and arguments reveals the truth of that supposition as the United States prosecuted a containment strategy in the hopes it would not expand into open conflict with the North's satellite patrons. As strategically sound as this idea may have been, its execution was akin to fighting with both hands tied behind the back, and it frittered away the tactical and operational gains made on a regular basis. For example, when a US bombing campaign or other supporting operation had the North on the ropes, policy dictated a pull back or cease-fire to allow for negotiations to take place. This would often result in the North promising to negotiate a certain peace it never intended to keep while it generated forces for the next battle. This cycle repeated itself numerous times during the war, and the United States never learned, let alone applied, this lesson. Weaver notes that as a result of the existential way the North fought to survive and win, the United States was never going to win because limited war always results in limited outcomes—and that is exactly what happened.

Ultimately, for the United States, Vietnam contributed to larger Cold War geopolitical goals, according to Weaver. Over hundreds of meticulously researched pages, he aptly demonstrates this nuanced point. America needs to realize yet again that limited war prosecution will often result in limited results, and that if victory is truly the purpose, defining goals and objectives more narrowly in the context of participation is a requirement that can never be overlooked. This book will add measurably to the historical record and is a must-read for all Vietnam War and airpower enthusiasts and scholars.

Brigadier General Chad T. Manske, USAF, Retired

The Media Offensive: How the Press and Public Opinion Shaped Allied Strategy during World War II

Alexander G. Lovelace. University Press of Kansas, 2022, 400 pp.

Alexander G. Lovelace, a scholar at the Contemporary History Institute of Ohio University, has made an excellent contribution to history with *The Media Offensive: How the Press and Public Opinion Shaped Allied Strategy during World War II*. This book argues that in their concern over public opinion, the media—encompassing print, radio, and reporting by uniformed personnel—and the military significantly influenced strategic, operational, and tactical aspects of warfare.

This proved particularly true in the case of the US Army, which encompasses Lovelace's focus of investigation. In essence, he claims that nationalizing warfare on an industrial scale carried the public into the conflict simultaneously as participants and stakeholders. This caused World War II to witness a "media revolution," where the power and speed of radio, print, and movies "massively increased" media influence over the population (18). Lovelace argues that maintaining public support via the news developed into a national line of effort influencing many important decisions in the Pacific and European theaters, a trend which previous scholars have understudied.

The book generally works chronologically from the outbreak of the war in 1941 through the defeat of Germany in 1945. The examples are primarily from the European theater, although General Douglas MacArthur's use of media outlets to influence popular US opinion to support his return to the Philippines is also discussed. Lovelace claims the media had a symbiotic relationship with the military and each used the other—the military to gain support on the home front, and the media to write stories that captured the nation's attention. Yet since both the military's and the public's common goal remained the defeat of the Axis, these interests between the population and state aligned. For example, to better serve the public's desires, the US military conducted operations like the Doolittle Raid, the invasion of North Africa, and the seizure of Rome—indirect and perhaps inefficient uses of resources, but operations which nevertheless demonstrated its ability to respond to threats quickly and with success in a way the American public appreciated.

Throughout the text, Lovelace analyzes the strategic decisions of historical figures, such as George C. Marshall, Dwight D. Eisenhower, George S. Patton, and many other generals. Lovelace argues that total war facilitated an evolution in the perceived prominence of media stories due to the importance of public support required to prosecute such wars. Consequently, news stories influenced military decision-making to a point not previously experienced in American history.

In the final section, Lovelace argues that the close bond between the US Army and the American media that developed during World War II would not carry on to later limited wars, like the proxy wars utilized to combat communism on the Korean Peninsula or in Indochina in the 1950s and 1960s. These Cold War conflicts resulted in a strained relationship of distrust between the military and the media. Instead, the media grew to be skeptical of the information provided by the military, which was perceived as deceptive propaganda. Meanwhile, military leaders came to disdain reporters as biased and self-serving. The contrast with the earlier dynamics might leave the reader to believe the media/military relationship was irreversibly altered following World War II.

Yet the prospect of total war remains in the twenty-first century, as demonstrated by the Russian war in Ukraine. As such, this book provides lessons still applicable to today and the future.

Although *The Media Offensive* is an excellent read, there are a few limiting aspects of this work. Lovelace admits that his study does not include the media's influence over Marine Corps operations in the Pacific, a topic rich with scholarly opportunities and iconic moments. Perhaps he might return to that subject in a future project. He also confesses that the media's influence over combat operations had limits and was not always the decisive factor in the decisions made. Correspondingly, the narration often describes the many factors influencing decisions without clarifying if military objectives or media publicity had the greater effect on the decided outcomes. This makes it difficult for the reader to assess exactly what influence the media—or public opinion—had or if certain strategic decisions simply made practical military sense. Additionally, while the introduction and the conclusion are written masterfully, some of the chapters' content reads more like a narration of events rather than an analysis providing the same powerful arguments exemplified in the beginning and closing portions. Nevertheless, Lovelace does circle back in at least one chapter to draw out his main arguments about media influence, which provides an enhanced and scholarly perspective on those events. This methodology might have worked better if used throughout.

This book will prove interesting to a wide audience. Consequently, I highly recommend it for history buffs but also for current practitioners of military science as well as international affairs and political science. The lessons revealed about how the media can influence military decision-making can be applied as a case study to compare with other periods of time. Lovelace only briefly utilizes this methodology in his short comparison with the Korean War and the Vietnam War. In contrast, there remains ample opportunity to examine this nascent time frame in World War II and the application of those lessons learned in the modern era, an age where the term "media" has become so prolific and influential that it increasingly requires numerous qualifiers to define. Radio, print media, and film have been compounded with other digital forms, like social media, social networking, and social medium platforms, to name a few. In short, this work enters into a rich academic space with further opportunities to explore. Lovelace's contribution will prove foundational to future studies on strategic influence.

Robert S. Burrell, PhD

The Polar Pivot: Great Power Competition in the Arctic and Antarctica

Ryan Patrick Burke. Lynne Rienner Publishers, 2022, 261 pp.

In 1947, America was beginning to reckon with an Arctic paradox. The polar reaches were at once a valuable strategic location for the United States and also a site of American vulnerability. The first chief of staff of the nascent US Air Force, General Carl Spaatz, described this paradox: "Through the Arctic, every industrialized country is within reach of our strategic air. America is similarly exposed. We are, in fact, wide open at the top."[1] Ryan Patrick Burke's new monograph, *The Polar Pivot*, revisits this opportunity/vulnerability dichotomy. Burke shows that today, more so than in the period following World War II, the polar regions should be a primary focus of American security discourse because they are the most likely venues for competition and conflict.

Burke brings an impressive resume and background knowledge to the task of redefining the strategic importance of the polar regions. He is currently a professor and deputy department head in the Military & Strategic Studies department at the US Air Force Academy, where he is the

1. James Reston, "Pact with Canada Affirms Agreed Defense Principle: Stations Were Discussed Last Summer, but Appropriation Has Been an Issue," *New York Times*, February 13, 1947, 17.

research director for the Homeland Defense Institute, its joint partnership with US Northern Command. Since January 2021 he has been the co-director of the Modern War Institute at West Point's Project 6633, a platform for discussion and debate about polar security. The publication of Burke's book coincides with that of his Project 6633 co-director, Elizabeth Buchanan. While Buchanan's work focuses on Russia's Arctic strategy under President Vladimir Putin, Burke's book outlines the threats to US security in the polar regions from both Russia and China while also proposing a strategy for the United States to adopt. One of the main contributions of Burke's research to the body of scholarly debate is to describe the security considerations in the Antarctic and the Arctic, the former often neglected in favor of the latter.

Burke's overall argument is that the high latitudes should be more of a focus for international security dialogue as both will likely become contested geographies in the future. In support of this overall point, he makes three subordinate claims. First, he claims that the polar regions are not newly relevant but have historically been geopolitically significant. Burke describes the relevant recent history of great power competition in the Arctic and Antarctic—a useful exercise which grounds his later theorization and recommendations in a historical context. His chronological accounting highlights the ways in which the liberal order and its international institutions provided security and rules-based norms during the Cold War. He takes this approach to contrast the ways in which America's revisionist peer competitors challenge those norms today.

Burke's second claim establishes why the polar regions are so important. To this end he evaluates certain categories that will be more influential than others in terms of future polar security. Through an alliterative device that anchors his independent variables, he describes the "four polar Cs" of regional security: commons, claims, covenants, and cosmos. Burke defines the commons as "regions of shared access and activity" and asserts that freedom of action within the commons is an enduring American interest (46). While the United States was distracted by other geopolitical events during the preceding 20 years, Russia and China have leveraged advantages created by warming oceans to challenge free and open access to the polar regions. Some of the ways in which those states do so is through territorial claims of ownership. Burke argues that contrary to the liberal internationalist contention, international institutions like the Arctic Council and Antarctic Treaty are not sufficiently credible to maintain the status quo.[2] This is because no mechanism is in place to ensure compliance. Thus, he argues, the resulting international agreements are grounded in wishful thinking.

Burke states that Russia and China will become economically incentivized to break international laws and customs in accordance with neorealist theory, which posits that states pursue power amidst the anarchy of the international system. Burke argues that the United States must be prepared to secure its own interests because America exists within a state system where no legally binding agreements will prevent its enemies from pursuing what is in their own national interests. Therefore, Burke suspects that the covenants—his third C—may be less useful in the future than they were during the Cold War period of liberal hegemony. Burke's cosmos, his fourth C, refers to the celestial commons where he sees increasing competition for access, specifically with respect to the polar infrastructure that allows for space-based communication capabilities.

Burke's third claim is that some states will have greater influence in the polar regions than others and that they have agendas which are evident from their present behavior. He delineates the international players, grouping them into a typology consisting of four categories depending on intent, comprised of posture and policy, and capability, comprised of presence and power. According to this distribution, only three states fall into the polar power category denoting the strongest

2. G. John Ikenberry, "Why American Power Endures: The U.S.-Led Order Isn't in Decline," *Foreign Affairs*, November 1, 2022, https://www.foreignaffairs.com/.

powers: China, Russia, and the United States. One strength of Burke's analysis is that it avoids simply grouping China and Russia together. While both are dissatisfied with a status quo that favors the United States, they have divergent motivations and goals. This nuanced presentation suggests that different policy approaches may be necessary depending on the region (Arctic versus Antarctic) and actor (China versus Russia).

The pivot in the title of Burke's work recalls the Mackinderian phrase familiar to political geographers, that the so-called Eurasian heartland represented decisive terrain around which the future of the world order pivoted.[3] Perhaps a more fitting allusion, however, is to the would-be "Pacific pivot" of the Obama administration.[4] Burke argues that the United States should turn its attention geographically from Europe and the Pacific but also intellectually from its default inclination toward liberal approaches to international relations.

In place of this approach, Burke suggests a transactional style of international politics aligned with the neorealist playbook. This, he argues, will prevent America from falling into a Thucydidean polar trap. A strength of this approach is that it moves the United States from a knee-jerk militaristic response yet allows America to still demonstrate its assertiveness and leadership. One outstanding question with Burke's recommendation, however, is whether this policy prescription will result in Russia and China willingly assuming the status of a subaltern power. The answer to this question may deal more with whether the United States is in close competition with China, as Burke suggests, or whether it retains unchallenged unipolarity, as others argue in the neorealist camp.[5]

Perhaps the strongest point in Burke's presentation is that it avoids becoming mired in a climate debate and instead takes anthropogenic change as a given. Rather than debating the science he substitutes two relevant questions: 1) What are the geopolitical security implications for all countries of a warmer Earth?; and 2) What should the United States do about it? To the first question, Burke believes the most pressing implication will be the rush to secure economic interests in newly navigable areas of the North and South Poles. To the second, Burke recommends the United States develop a realistic polar strategy now, while it can, rather than later, when it must (202).

The framework of Burke's polar pivot strategy encompasses what he calls projection, protection, prevention, and preservation. Of these four, the most fully articulated is projection, which he argues will allow the United States to demonstrate its commitment to the region. To this end, Burke proposes somewhat counterintuitive suggestions—for example, to stop focusing on building icebreakers, and instead build ships with ice-hardened hulls—and other novel ideas. To the latter point, Burke articulates an interesting idea to create a new US Polar Command or POLCOM that would encompass territory above and below 60 degrees latitude north and south. This new combatant command would cover two independent areas of responsibility and address what Burke sees as a design flaw in the current unified command plan. According to Burke, the plan is cluttered in the North and confusing in the South due to competing responsibilities amongst current regional combatant commands.

The Polar Pivot is an important, interesting, well-researched, well-reasoned, and logically argued presentation of an increasingly important and often neglected geopolitical region. Burke presents rational arguments in support of his transactional approach, which fits comfortably within the current scholarly debate about where the United States should invest its attention and finite resources in a world of strategic competition. In contrast with authors who point to the Indo-Pacific, or others

3. Gearóid Ó Tuathail, "Putting Mackinder in His Place: Material Transformations and Myth," *Political Geography* 11, no. 1 (1992), https://doi.org/.

4. "Pacific Pivot," *Harvard Political Review*, November 2, 2012, https://harvardpolitics.com/.

5. Stephen G. Brooks and William C. Wohlforth, "The Myth of Multipolarity: American Power's Staying Power," *Foreign Affairs*, April 18, 2023, https://www.foreignaffairs.com/.

who suggest Europe, Burke makes a compelling case that the future of great power competition will be in the polar extremes. It then follows that the United States should begin planning and posturing for strategic competition there today. Burke's blueprint for American polar defense, security orientation, and influence is a vital contribution to this important debate.

Lieutenant Colonel James M. Davitch, USAF, PhD

U.S. Go Home: The U.S. Military in France, 1945–1968

M. David Egan and Jean Egan. Schiffer Publishing, 2022, 608 pp.

U.S. Go Home is a twofold adventure for readers. First, it offers a nuanced view of life for Americans in post-World War II France, as known on a personal level by authors M. David Egan and Jean Egan. David Egan was stationed at Trois-Fontaines in northeastern France as commander of the 39th Ordnance Company in the early 1960s. Second, it is a thoroughly-sourced monograph, as the Egans channel Edward Gibbon and his six-volume work, *The History of the Decline and Fall of the Roman Empire*, to detail and then detail some more the who, what, where, and when of the US military presence in a country that was the keystone of European Cold War defense. At 608 pages, the level of such detail is both extraordinary and pedantic. Indeed, as an example, a reader learns the address of the dependent school at Fontainebleau (Villa Lavaurs at 88, rue St.-Honoré), the cost of a school lunch there in 1952 (30 cents), and how and where American student drivers were tested ("In Spring 1966, *Compagnie républicaine de sécurité* personnel arranged red and white striped traffic cones to form a large figure-eight driving circuit behind the warehouse and hospital buildings at Lariboisiére") (201).

Unfortunately, however, the why is lacking. Why did France force the United States to leave in the late 1960s, after nearly two decades of infrastructure and supply buildup following World War II? The subject of strategic cooperation is broached in the second chapter of the book, where the authors discuss the American and Allied decision to station US troops permanently in Europe and rearm Europe to deter the Soviet Union, and the essential leadership of General Dwight Eisenhower to the nascent NATO buildup. In a war with the Soviets, NATO expected to have to fall back to the Rhine River and launch a counterattack through France's Rhône valley. As for specificity on why the United States was in France, the chapter begins with analytical promise: "The enormous US Army logistics system and the US Air Force's forward-based, nuclear-capable jet aircraft that would be located in France were essential components of the military strength of the new [NATO]" (31). Yet any further discussion of the Franco-American relationship and its deterioration is postponed until the book's final chapter.

In that chapter, the authors chronicle the United States' abrupt change in direction to conclude in its forced withdrawal from France. Likewise, the Egans themselves make an abrupt change: whereas, seemingly every installation, exercise, and daily life anecdote are covered in minutiae for nearly 500 pages, an analysis of why French President Charles de Gaulle ordered the withdrawal is a mere four pages. The reader learns that a series of social and political blunders and miscommunications, including French concerns about sovereignty infringements and the US closing of 27 installations in France, resulted in de Gaulle announcing on March 7, 1966, that the United States must be out of France by April 1, 1967. Interestingly, de Gaulle's demand matched Secretary of Defense Robert McNamara's own plan to withdraw US forces from France.

In Operation FRELOC ("fast relocation"), the United States faced an unprecedented challenge: withdrawing more than 70,000 personnel and dependents, relocating 728,000 tons of matériel, rebasing more than 180 Air Force aircraft, closing more than 190 installations, and moving eight headquarters. The Egans conclude that Operation FRELOC was successful "[b]y most measures" (508). They also offer 10 reasons why the withdrawal weakened the defense of Europe, the main reason being lost strategic depth.

Despite the omission of the rationale behind the US withdrawal, the book—titled after communist propaganda from a Korean War disinformation campaign—provides a well-researched history of the US military in France. The first chapter sets the stage by describing the damage from World War II, the redeployment and occupation of US troops, and the Berlin blockade and airlift. The Korean War and its impact on US forces is highlighted, but notably and seemingly unnecessarily, the Soviet-American air war in Korea is introduced to the unsuspecting reader. The chapter concludes with the formation of NATO and the 1948 bilateral agreement to station US troops in France. The latter is stated as fact with the analysis confined to a sentence: "France . . . was militarily weak and depended on NATO and the United States for its security" (28).

The authors then highlight the importance of France. With its Atlantic ports and distance from the Soviet Union, France was to "become the operational headquarters and logistical hub for the defense of the West" (67). Interestingly, but perhaps unnecessarily, the third chapter diverts to chronicle the training and Atlantic crossing of 1950s Army personnel. France offered 39 Army and 21 Air Force locations to the United States to establish a permanent presence. France was also instrumental to NATO war plans, as it approved the locations for 14 dispersed operating bases, which had the purpose of preventing the Soviets from destroying entire wings. Chapter 4 then turns to the struggle in terms of labor, materials, and political disputes to construct US military facilities and infrastructure in France.

In chapter 5, the Egans provide a historical account of the selection of Camp des Loges for US European Command headquarters, the service of the Counter Intelligence Corps, and the US diplomatic, military presence in the Paris area. Chapter 6 focuses on the establishment of Allied Air Forces Central Europe at Camp Guynemer in Avon and Allied Forces Central Europe at Fontainebleau. NATO routinely conducted exercises to practice aerial combat, nuclear bombing runs, and coordinated air-land operations. The chapter concludes with de Gaulle notifying NATO in 1966 that France would withdraw from Supreme Headquarters Allied Powers Europe.

Chapter 7 is about military installations at Orléans, including the US Army Communications Zone (ComZ) headquarters at Caserne Coligny, an organized zone of logistical installations designed to support forward-based combat troops in Germany. Chapter 8 details the location and purpose of medical facilities in France, including the construction of dual-purpose standby hospitals—barracks and classrooms during peacetime and hospital wards during wartime—and the subsequent haggling over the sale price of those hospitals as the United States withdrew from France in 1967.

Chapter 9 focuses on the Advance Section, tasked to supply US troops during a crisis. The chapter starts with the section's establishment of its headquarters at Caserne Maginot in Verdun and then describes the dozen major depots extending eastward from Vitry-le-François to Metz. Chapter 10 covers the west coast of France, where military officials planned to use ports at Bordeaux, La Rochelle, Nantes, Brest, Cherbourg, and Lorient to offload supplies in time of war. Forty-eight offshore discharge exercises were conducted to determine the best methods to quickly offload and avoid Soviet targeting. The chapter includes an interesting diversion on the filming of the war classic *The Longest Day* on an island off the coast of La Rochelle. Chapter 11 covers the Base Section installations, which included ports and depots in Bordeaux, La Rochelle, and Poitiers. Base Section was responsible for supplying war reserves to Seventh Army in Germany.

Certainly, *U.S. Go Home* is an impressively researched monograph. No fact concerning logistics or the individuals involved seems to be left out, as evident until the end with the book's concluding sentence: "First Lt Robert A. Hefferman, Commanding Officer of the 77th Trans Co from Ingrandes, rode 'shotgun' on the last FRELOC truck out of France" (519). The book is a culmination of more than 400 interviews and research from 50 archives. Most chapters have over 200 references, and the reference section of the book totals 63 pages.

Yet to the dismay of any student of international relations or Cold War history, the overabundance of research does not carry over to the sentiment behind the book's title, *U.S. Go Home*. Four pages of analysis and one top 10 list represent a dearth of evidence for why the United States withdrew from France. It is clear that the communists in France wanted the United States out, but there is no mention of the impact of these domestic malcontents on de Gaulle's decision-making. In fact, as noted, when the United States withdrew, there was a significant negative impact on the French economy. The reader is left to fill in the gaps about why the United States went home: Was de Gaulle's decision based solely on US missteps? Or was it based on domestic political factors? Or both? Perhaps it was part of de Gaulle's grand strategy?

Still, in terms of the who, what, where, and when of the 22 years the US military was in France, *U.S. Go Home* sets the standard. It is definitive, unmatched, and a necessary inclusion in the scholarship of military history.

Bradley F. Podliska, PhD

Modern South Korean Air Power: The Republic of Korea Air Force Today

Robin Polderman. Harpia Publishing, 2021, 256 pp.

Modern South Korean Air Power: The Republic of Korea Air Force Today by Robin Polderman provides a detailed and timely look at the aircraft and armament used by the South Korean Air Force in a region that is home to some of the most influential powers in the world. Since the early 1950s, the heavily industrialized nation of South Korea (Republic of Korea, or ROK) has seen steady growth and is now the world's seventh-largest exporter and 11th-largest economy. As the Cold War on the Korean Peninsula gathered momentum, the development of the Republic of Korea Air Force (ROKAF) became one of the nation's top priorities. While initially dependent on the United States for its aircraft, South Korea's aviation industry has matured rapidly, and ROKAF's use of indigenously manufactured equipment is on the rise. Since 1949, the ROKAF has served as a core power of the republic's national defense, and its importance has grown even more as twenty-first century technology has helped level military playing fields around the region.

The nucleus of the ROKAF—officially established as an independent air force on October 1, 1949, by Presidential Decree No. 254—was formed by an air unit of the Department of Internal Security, which received 10 Piper L-4 Grasshoppers on September 4, 1948, delivered straight from the United States and assembled by South Korean technicians, a foretaste of things to come for many years. When the Korean War began five years after the republic's independence when North Korean armed forces crossed the 38th Parallel, the ROKAF could field no more than 22 aircraft, including the aforementioned L4s, and two additional L-5 Sentinel light observation aircraft and 10 AT-6 Texan trainers imported from Canada. To help bolster the ROKAF, South Korea was provided F-51D Mustangs, formerly known as P-51Ds, as US and UN air and ground forces began their drive against North Korean and eventually Chinese Communist forces back north across the 38th Parallel.

During the 1950s and '60s the ROKAF was equipped with more modern jet aircraft like the F-86 Saber, F-4 Phantom, and F-5 Tiger fighters. Additionally, forward air control and short-range transport aircraft, a vital component to any in-depth defense of the Korean Peninsula, were fielded to the ROKAF during this period. The Vietnam War, which saw the Republic of Korean Army committed to ground operations in defense of South Vietnam, also saw the ROKAF support Republic of Vietnam (North Vietnam) forces with a transfer of 41 F-5s to the South Vietnamese Air Force. Since the 1980s, the ROKAF, organized and structured along US Air Force lines, has participated in both internal defense, playing a standby role in the 1980 Gwangju student riots, and external operations, supporting coalition forces in the Persian Gulf War and Global War on Terrorism in the Middle East. The ROKAF, manned by 65,000 personnel, operates a force

of 720 combat aircraft using both foreign and indigenous built airframes and defensive missile systems, primarily as a strategic counter to its North Korean Air Force counterparts. *Modern South Korean Air Power* highlights—through 177 high-quality maps and photos, along with in-depth analysis—cover the full spectrum of ROKAF combat aviation power.

The author provides eight chapters and two appendices detailing ROKAF origins, the ROKAF today, South Korea's national airpower strategy over the Korean Peninsula and defense against its near abroad interests like Communist China and Russia, ROKAF aircraft, and the future of ROKAF programs. Students of the ROKAF "Hot and Cold War" will note the author's description of ROKAF's transition from exclusively American-made aircraft sold, like the F-35, under terms of a mutual ROK-US defense treaty to the procurement of Russian aircraft like the Kamov Ka-32 helicopter and the development of indigenous built aircraft like the Daewoo Heavy Industries KT-1 Woongbi ("Great Leap" in Korean) trainer—a transition made to address both the age of US-built aircraft and to reduce operating costs. The author's approach highlights that while US designs still dominate the ROKAF's fleet, like a number of US long-term Allies, South Korea is taking steps to diversify its force to produce and project a world-class airpower.

Of particular interest to readers is the book's detailed description of Korea Aerospace Industries and Indonesian Aerospace's joint development program of the supersonic fighter aircraft, the KF-21 Boramae ("Fighting Hawk" in Korean). The South Korean-led development program endeavors to produce an advanced multirole fighter for both nations' air forces. An aircraft stealthier than any fourth-generation fighter that does not carry weapons internally like its many fifth-generation contemporaries, the KF-21 is expected to be armed with a range of air-to-air and air-to-surface missiles, and possibly even air-launched cruise missiles. The twin-engine fighters will come in single- and two-seat versions. The first test flight was conducted on July 19, 2022, after publication of this book, with manufacturing scheduled to begin in 2026. At least 40 aircraft are planned to be delivered by 2028, with South Korea expecting to deploy a total of 120 aircraft by 2032. The Boramae will also be available for export, and Poland has already expressed an interest in joining the program. The book highlights, with the development of the KF-21, South Korea's ambition of becoming one of the top seven nations in the aviation industry by the 2030s.

At a time of great geopolitical instability between great powers as seen by Russia's recent invasion of Ukraine, *Modern South Korean Air Power*'s analysis of ROKAF current and future air weapons systems and platforms is both relevant and timely, given how the Ukrainian military has leveraged modern western technology against a numerically superior, but technologically lagging, Russian armed forces. Finally, in Chapter 8, the author provides an excellent synopsis of North Korea's threats, of ROKAF's dealings with violations of South Korea's airspace by nuclear-capable states China and Russia, and of standing disputes with neighboring Japan.

For military air planners, the information Polderman provides on South Korean airpower will prove useful in the post-Operation Enduring Freedom planning and doctrine development environment. Yet what is missing from an otherwise professionally written book is a chapter on tactical air traffic services and aviation maintenance organizations, as well as fuel/ammunition support equipment vital to the employment of modern combat rotary winged platforms. Correcting this omission of ROKAF support organizations would provide a clearer picture of how South Korean air commanders might employ their assets in the heart of East Asia. Otherwise, Polderman's book provides a solid picture of how ROKAF operates within an extremely dynamic and complex security environment in which South Korea has long since realized that it can secure a lasting peace on the peninsula only by preparing for war.

Like all Harpia Publishing books, the print quality of *Modern South Korean Air Power* is excellent, and the book is worth the read. The chapter on ROKAF aircraft is as in-depth as any aviation enthusiast would like, and the book's chapters provide detailed descriptions of how ROKAF airpower serves as an integral part of South Korea's role in providing stability to the Asia-Pacific

region. Like Harpia's other series of books on airpower in Asia—including *Modern Chinese Warplanes: Chinese Air Force – Aircraft and Units*; *Modern Taiwanese Air Power: The Republic of China Air Force Today*; and *Red Dragon "Flankers": China's Prolific "Flanker" Family*—Polderman's work offers an insightful overview of combat airpower in an economically important, but volatile region of the globe.

Colonel Jayson A. Altieri, USA, Retired

Wars of Ideas: Theology, Interpretation, and Power in the Muslim World

Edited by Ilan Berman. Rowman & Littlefield, 2021, 172 pp.

After nearly 22 years since the September 11, 2001, attacks, the United States now finds itself with a military force and workforce with individuals born after the attacks occurred, including those just joining the service or already serving for a handful of years, and recent college graduates starting careers in national security and foreign policy. At the same time, a large portion of current and soon-to-be senior military leaders have spent all or a majority of their careers fighting the war on terror. But as Ilan Berman argues in his introduction to his edited work *Wars Of Ideas*, despite "an explosion of academic and professional interest in counter-terrorism since 9/11," the United States has yet to adequately address the "struggle for salience" within the Muslim world that motivated the attacks, having instead focused "extensively on militarily defeating malign extremist actors" (1–2). Berman sees the "wars of ideas" as the struggle between extreme radical and moderate Islam that constitutes the "intellectual battlefield" the United States confronts today (2).

Berman is the senior vice president of the American Foreign Policy Council and a Middle East regional security expert who has consulted for the CIA, Department of Defense, and State Department. In *Wars of Ideas*, Berman has edited a collection of six essays, with two of his own bookending the collection with an opening essay on the Islamic State and a closing essay on learning from Allies. Contributions discussing Central Asia, Morocco, Indonesia, the United Arab Emirates, Jordan, and Saudi Arabia fill the space between. Berman's assembled authors are experts in their areas: religious scholars, professors, security analysts, and think tank fellows.

Like the book as a whole, each section is relatively brief and provides an overview and history, followed by an analysis and assessment of the modern situation. Svante Cornell's Central Asia chapter is of interest in the current geopolitical environment, as it touches on the evolution of Islam in the region, then the rediscovering of its ties with the rest of the Muslim world after the fall of the Soviet Union. For a time, this movement sought secular statehood and government, something changing in Turkey under the rule of Recep Tayyip Erdoğăn.

Another interesting section is Azyumardi Azra's essay on Indonesia, a vital discussion given its status as the world's largest Muslim nation and the third-largest democracy. An analysis of Indonesia's "Third Way" Islam—"which is distinct from, and more inclusive than, its Arabic counterpart"—fits nicely into a book seeking to break down a war of ideas (77).

As the discussion of the world's largest Muslim population being a democracy is noteworthy, so is one on the custodian of Islam's holiest sites and its post-Salafist trajectory. Kamran Bokhari states in his section, "No country in contemporary history has played as significant a role in the struggle for the soul of Islam as has Saudi Arabia" (123). This section is the strongest of the book, providing a history of the initial two failed attempts and the third and final successful attempt that created the Kingdom of Saudi Arabia in the 1930s. It offers as thorough a history as possible in a few pages. Growing cooperation with America and the West is focused on the First Gulf War and the reaction and fallout from 9/11. A good deal of writing centers on attempts at reform, modernization, and the conflicting priorities of the kingdom's religion along with its push toward Vision 2030, its masterplan to transform the state through broad social and economic reforms. While the

book is a few years old, the writing provides a solid background for those seeking to understand the stories currently in the news.

Berman has edited a work that does what it sets out to do to bring a better understanding of modern Islam and its struggles with extremism beyond discussions of terror tactics and military responses. *Wars of Ideas* also demonstrates well that while Islam, specifically Sunni Islam, is one faith, different states and regions are impacted by the issue of extremism and handle it differently. Many points of the book, especially Berman's closing chapter, discuss the need to learn from and work with partners to understand Islam and its approach to its radical adherents. The focus on cooperation is essential and commendable in the current world.

An area for improvement is one that Berman himself acknowledges and addresses on the very first page of content. Berman points out that Islam is the world's fastest-growing faith, with over 1.8 billion followers, an overwhelming 85 percent that is Sunni. While Berman identifies that there is indeed extremism that comes from Islam's Shia, he states that Iran's role in Islamic radicalism "is unique . . . and beyond the scope of this work" (iii). While Berman is quite correct in this assessment of Iran's role, the chapters discussing the Islamic State and the Gulf countries—specifically Saudi Arabia—may have benefited from a brief discussion regarding the relationship between Shia beliefs and extremism. Or, more simply, how do reactions to Shia beliefs and actions affect the issue at hand?

Wars of Ideas is well worth the read for those seeking to understand better the battlefield of ideas regarding the struggle against radical Islam. At only 172 pages, including references, acknowledgments, and contributor biographies, the book is a quick and highly accessible read for those seeking to gain understanding beyond the kinetic struggles that occur. The work is also highly beneficial as a primer for those wishing to learn more about what specific countries and regions are doing to address the issue.

Lieutenant Colonel Jason Baker

Russia's Path to the High-Tech Battlespace

Roger N. McDermott. Lynne Rienner Publishers, 2022, 470 pp.

Roger McDermott fills a gap in the literature on the West's perception of Russian combat capabilities with *Russia's Path to the High-Tech Battlespace*, demonstrating how the Russian military has created the military theory, command and control (C2), and advanced weapons to continue threatening US and Western interests. He provides key insights into Russian decision-making, C2, and military modernization. McDermott's work is exceptionally well researched, drawing extensively from Russian primary sources, especially professional military journals, general news outlets, and specialized military news sites. As McDermott demonstrates, despite missteps and apparent setbacks from its overt invasion of Ukraine on February 24, 2022, Russia remains a potent military power. It may not reach parity with the West, but it retains the theoretical, organizational, and technological potential to continue disrupting the international order for the foreseeable future. This book is a useful overview for military and policy professionals confronting Russian aggression.

McDermott is a leading Western expert on the Russian military. He serves as a senior fellow in Eurasian military studies with the Jamestown Foundation in Washington, DC, and is a visiting senior research fellow at the department of war studies at King's College in London. Further, he is an assistant editor for the *Journal of Slavic Military Studies*. He has authored numerous articles and books, including *The Reform of Russia's Conventional Armed Forces* (2011).

Russia's Path to the High-Tech Battlespace continues his research tracking Russian military modernization. His work nests in the body of English-language literature on Russia's military, providing details not available in other sources. Bettina Renz and Igor Sutyagin have written on Russian

military reform but with greater focus on the military overall, especially new weapons and logistics. Several researchers evaluate ongoing Russian military performance, notably Dmitri Trenin, Justin Bronk, and Michael Kofman, but McDermott provides the foundation to better understand the military actions those writers describe. Finally, much like McDermott, researchers such as Timothy Thomas and Charles Bartles present concepts from the Russian point of view; however, McDermott emphasizes how the Russian military is achieving its own vision of future warfare.

McDermott organized *Russia's Path to the High-Tech Battlespace* in two main parts. His first four chapters review Russian military theory, outlining the modernization of the Russian military based on its updated doctrine, then providing specific case studies of Russian military modernization. This section culminates with a chapter evaluating Russia's performance in Syria as a case study to understand to what degree the Russian military has reached its own modernization goals. Then McDermott dedicates each of the last three chapters to Russia's most advanced weapons: hypersonic missiles, electronic warfare, and unmanned aerial vehicles. He considers these in light of Russian warfare theories, their planned employment, and examples of fielding and use. These chapters give context to the media hype involving Russian advanced weapons, where technical specifications are sometimes confused for capability. Understanding how the Russian military plans to use such weapons sets expectations for Western military planners who may confront them.

McDermott concludes that Russia can indeed perform advanced warfare tasks using modern systems, but only in limited operations. Russia's C2 is sufficient to steer limited operations, such as in Syria, but does not have the depth for large-scale combat operations. His conclusion stems from the link between Russia's beliefs in the changing nature of war and its battlefield outcomes.

The Russian military understands warfare development in terms of generations. According to Russian military discourse, civilization has progressed through multiple generations with advances in technology and improvements in military art. Advanced nations are now fighting in the sixth generation of warfare, characterized by high precision weapons and a quickened reconnaissance-strike contour. Nations which have achieved the level of network connectivity required for sixth-generation warfare control the speed and timing of combat operations. Conventions of earlier generations of warfare may still be necessary in specific contexts, such as with counterinsurgency or what the West terms low-intensity conflict, but a nation possessing superior sixth-generation capabilities can choose the time and pace of war to be successful. From Russia's own analysis, as McDermott describes, it has not fully realized sixth-generation warfare. It has the advanced weapons, though not always with the C2 networks to make it fully effective.

Airpower exemplifies Russia's incomplete progress towards sixth-generation warfare. Advanced airpower is an essential element of sixth-generation warfare, though Russia views it almost exclusively in the form of precision strike. Airpower allows combatants to apply force with greater rapidity and lethality than other platforms. This leads Russian analysts to describe sixth-generation warfare as noncontact war, where precision munitions could affect targets with minimum risk. From the Russian perspective, in contrast to Western theories, airpower is considered purely a vehicle for precision-guided munitions. Neither McDermott nor any of the Russian theorists he quotes discuss the requirement for air superiority. Russia's failure to consider air superiority, and McDermott's lack of discussion regarding Russian air theories, illustrates the doctrinal shortfalls which have perhaps led to Russia's poor performance. In terms of real battlefield outcomes, Russia has proved unable to gain air superiority during its conflict in Ukraine. In turn, this has reduced the Ukraine war to an attritional, high-contact campaign, with significant losses of manpower and materiel. Without air superiority, Russia has been unable to fight the kind of war it planned, as McDermott describes.

Since *Russia's Path to the High-Tech Battlespace* was published just as Russia was invading Ukraine in 2022, McDermott did not have the opportunity to review his assessment. In the foreword, Bartles briefly touches on that disconnect, noting the impact operations in Ukraine may

have on Russia's future development. That the Russian military struggled to employ its advanced systems in a large-scale conflict proves McDermott's point that its military modernization was uneven and incomplete. As Bartles notes, however, over the next decades the Russian military may absorb and implement the lessons it is learning in Ukraine to continue its path forward.

Beyond its insight into the Russian military mind, *Russia's Path to the High-Tech Battlespace* highlights the importance of beliefs in shaping the conduct of wars. Russian theories regarding sixth-generation warfare are closely linked to the Western concept of the revolution in military affairs. This concept, popularized in the 1980s and 1990s, posited the nation that can gather and exploit information the fastest will be the most successful in combat.

Over the past three decades, the US military has achieved an advanced level of network-centric warfare. Nowhere is this more evident than in the robust American networks providing C2, as well as sensor-to-shooter links. The US military's information dominance is arguably its greatest strength. Yet recent struggles to implement joint all-domain C2 illustrate that Western militaries should not take this advantage for granted. Constructing networks, weapons, and the training to use them effectively will take deliberate effort. Despite the work McDermott describes Russia has taken to achieve this level of warfare, its struggles underscore how important it is to get it right.

Lieutenant Colonel J. Alexander Ippoliti

DEPARTMENT OF THE AIR FORCE

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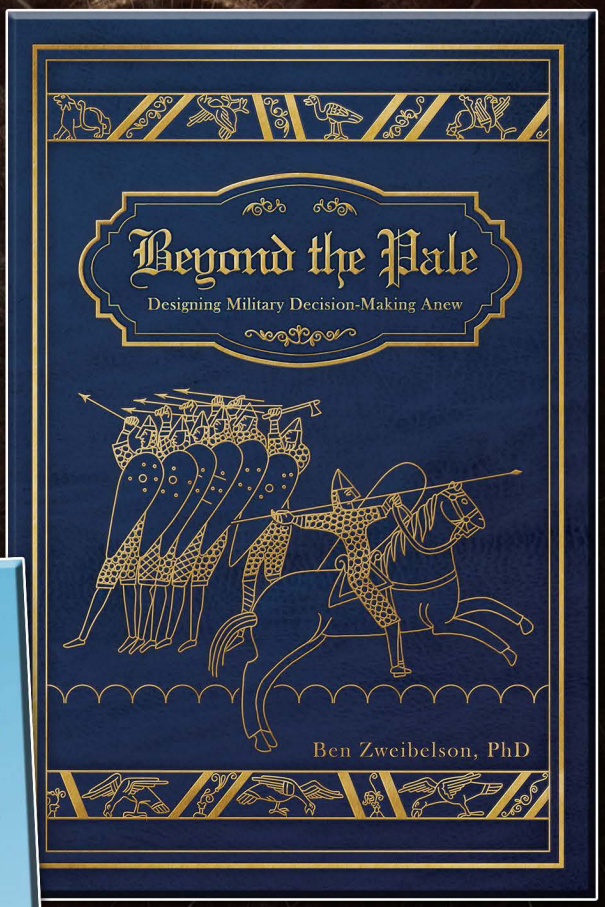

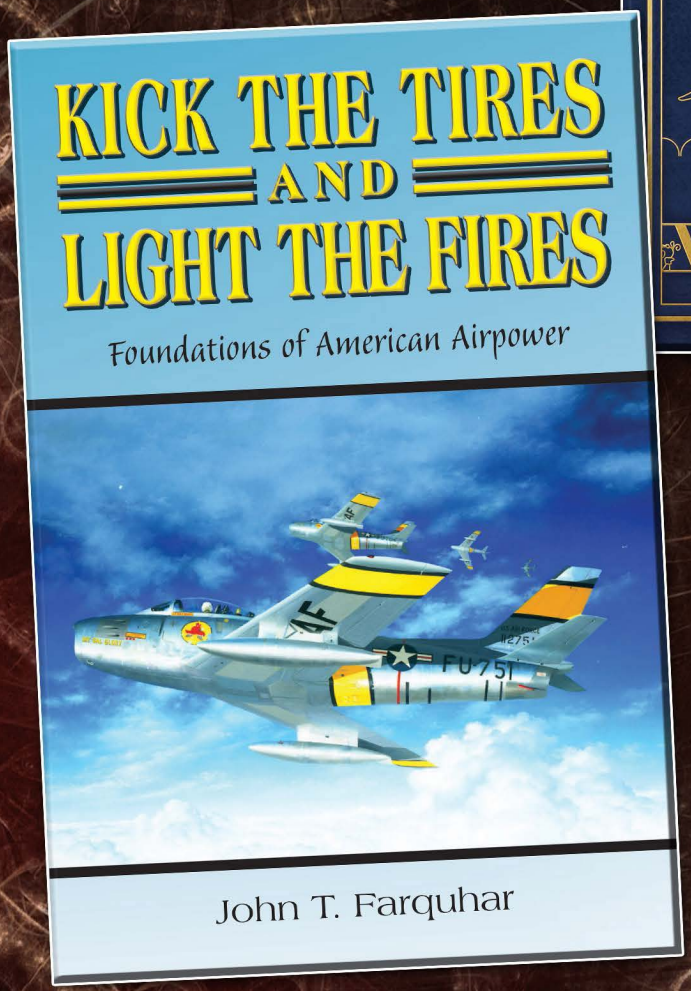

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