
ASPJ
Air & Space Power Journal
Vol. 33, Issue 3
Fall 2019

ASPJ Air & Space Power Journal

Air & Space Power Journal
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The *Air & Space Power Journal* (ISSN 1554-2505), Air Force Recurring Publication 10-1, published quarterly in both online and printed editions, is the professional journal of the United States Air Force. It is designed to serve as an open forum for the presentation and stimulation of innovative thinking on military doctrine, strategy, force structure, readiness, and other matters of national defense. The views and opinions expressed or implied in the *Journal* are those of the authors and should not be construed as carrying the official sanction of the Department of Defense, Air Force, Air Education and Training Command, Air University, or other agencies or departments of the US government.

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SENIOR LEADER PERSPECTIVE

Leveraging Our War-Fighting Capabilities through the Lens of Operational Contract Support

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> *Those who are victorious plan effectively and change decisively. They are like a great river that maintains its course but adjusts its flow...they have form but are formless. They are skilled in both planning and adapting and need not fear the result of a thousand battles: for they win in advance, defeating those that have already lost.*
>
> —Sun Tzu

Electrical power lines, contorted sheet metal, and piles of rubble littered the ground. Palm trees, which served as flying projectiles, laid inside facilities. Roofs of buildings were stripped bare leaving interiors exposed to moisture, ripe for mold and ensuing dry rot. This was the destruction that Hurricane Michael left behind on 10 October 2018 after the Category 4 hurricane pummeled Tyndall Air Force Base (AFB), Florida. Within hours, defense contractors arrived on scene to conduct aerial surveillance using drone technology, assess airfield damage, remove debris, generate emergency power, and establish communications. Throughout Tyndall's relief and recovery efforts, the power of operational contract support (OCS) provided a strategic response capability to the United States Air Force (USAF), our amazing Airmen, and the local community.

Left. An 821st Contingency Response Group forklift unloads cargo near a Tyndall AFB hangar damaged by Hurricane Michael.

Right. A destroyed fire pit training facility and Air Force Civil Engineer Center (AFCEC) Environmental building

(Sources: A1C Caleb Nunez, 6th Air Mobility Wing Public Affairs, and the Air Force Installation and Mission Support Center)

OCS greatly benefits commanders who comprehend the importance of its use and how to leverage and employ it to shape the battlefield—to fight and win our nation's wars. When properly planned and executed, OCS positively influences the tactical, operational, and strategic environment. Understanding OCS is not just the commander's business; it is everyone's business—and all components critical to a successful campaign gain from appreciating the strategic impacts of OCS. Likewise, commanders and decision makers charged with contingency support, such as those leading Hurricane Michael relief and recovery efforts at Tyndall AFB, should recognize and take advantage of the interconnectedness of OCS throughout the planning process. This article presents lessons learned from the recent USAF emergency response activities (i.e., Hurricane Michael and Super Typhoon Yutu) and the United States Indo-Pacific Command (INDO-PACOM) pressure campaign to cover the basics of OCS, articulate how OCS is an indispensable war-fighting capability, and offer potential OCS training and exercise opportunities that should be exploited for the future.

Understanding the Basics of OCS

> *Cultivating a lethal, agile force requires more than just new technologies and posture changes; it depends on the ability of our warfighters and the Department workforce to integrate new capabilities, adapt warfighting approaches, and change business practices to achieve mission success. The creativity and talent of the American warfighter is our greatest enduring strength, and one we do not take for granted."*
>
> —2018 National Defense Strategy (NDS)

Joint Publication (JP) 4-10, *Operational Contract Support*, defines *OCS* as "the process of planning for and obtaining supplies, services, and construction from commercial sources in support of joint operations."[1] Further, OCS involves three lines of effort (LOE): *contract integration*, *contracting support*, and *contractor management*. These LOEs, commonly referred to as "pillars," parallel their OCS activities: *plan*, *procure*, and *manage*. A general appreciation of these pillars enables the integration of these capabilities into the campaign planning and strengthens our ability to achieve the USAF's mission—to fly, fight, and win. . . in air, space, and cyberspace.

Contract integration (the *plan* pillar) occurs before and during all planning phases to anticipate and synchronize contracting support into the operation. In this LOE, requirement owners define and develop their requirements, and commanders (or designees) validate, approve, and prioritize these needs against those of competing mission partners or functions.[2] Determinations are also made as to whether requirements can or should be filled organically (by military forces) or nonorganically (via a contract). This analysis is best accomplished by a multifunctional team evaluating the pros and cons of each choice (e.g., to award a contract for a service

that could be accomplished by military assets and use those organic resources elsewhere). Establishing a multifunctional team of subject matter experts, doctrinally known as an *OCS integration cell*, helps to evaluate emerging requirements and limit confustion. For example, when recovering Tyndall AFB after Hurricane Michael, early requirements were generated by forces on the ground in Florida and by the Air Combat Command (ACC) Crisis Action Team (CAT) at JB Langley-Eustis Virginia. Complicating matters, multiple labor sources—both military and contractor—were requested to complete same or similar tasks and caused a duplication of effort. Following the devastation, tarping and building assessments were sought by three different entities: the Rapid Engineer Deployable Heavy Operational Repair Squadron or Redhorse, Air Force Contract Augmentation Program (AFCAP) contractor, and the base operations support contractor. To create a unity of effort and deconflict demands from across the ACC CAT, the 325th Fighter Wing, Air Force Installation Mission Support Center (AFIMSC), and newly stood up task forces (TFs)—the TF Phoenix commander, Col Patrick Miller, instituted a requirements review board (RRB) rooted in OCS doctrine.

Since this RRB was key to synchronization efforts as well, the ACC director of contracting, Col Derek Blough, sent one of his best staff officers from the Air Force Installation Contracting Center (AFICC), ACC's operating location (AFICC/KC) to Tyndall to facilitate the implementation of OCS, examine priorities, and meet leadership's expectations. Once implemented, the RRB included representation from the 325th Mission Support Group (325th MSG) squadrons, three new TFs (i.e., TF Phoenix, TF Raptor tasked to make Tyndall's F-22 Raptors flyable, and TF HARP dedicated to the base's most valuable asset—its people), and all other base units with mission-essential requirements. Co-chaired by the 325th MSG commander, Col Matthew Jefson and Colonel Miller, this RRB met daily and orchestrated the employment of OCS to meet leadership expectations and address the devastation after Hurricane Michael. As a result, the successful execution of Tyndall's RRB reinforced to all stakeholders the necessity of this *contract integration* capability during all planning stages and the imperative of speed and agility.

Similarly, joint planning in the Pacific is underway to identify, validate, and prioritize requirements crucial for the first 30 days of the Korea Plan. Additionally, RRBs have been employed in US Central Command (CENTCOM) for years and are significantly more regimented because of the pace of operations and high audit interest in theater. In future conflicts, leadership should learn from these lessons and consider an RRB mirrored after Tyndall's more expeditious method and balanced against CENTCOM's standardized approach while avoiding any lengthy or administratively burdensome requirements validation processes. Regardless of how formalized an RRB becomes, speed and agility must remain integral factors.

Through the *contracting support* LOE (the *procurement* pillar), contracting professionals execute their authority and coordinate contracts in support of joint operations.[3] Having a general knowledge of the various contract vehicles accomplished by high-performing contracting units across the globe is valuable. Other great resources include the Air Force's Civil Augmentation Programs (AFCAP) and the Army's Logistics Civil Augmentation Programs (LOGCAP), which deliver a rapid-response capability in support of contingency and expeditionary operations. Within hours of Hurricane Michael's assault, the AFCAP contracting officer, Alex Larson, worked with the AFCEC, AFICC, and the 772nd Enterprise Sourcing Squadron (ESS) to direct the AFCAP contractor to mobilize and start contract performance. In the aftermath, the contracting community recommended an undefinitized contract action (UCA) to provide the swiftest method to begin on-site performance. Within 48 hours, the 772nd ESS and AFICC gained approval from the Secretary of the Air Force for Acquisition to issue a UCA, which allowed the contractor to commence immediate recovery work up to a limited preestablished ceiling price. A few days later, the need for more contract support and funding became apparent. Therefore, the AFIMSC's combined AFCEC-AFICC-772nd ESS-Resource Management Team worked tirelessly to obtain expedited approvals to raise the UCA threshold and secure debris removal, damage assessment, mold mitigation, and grading. Furthermore, the contractor established facilities for temporary lodging, containerized kitchens, dining tents, hand-washing stations, showers, and latrines. The recovery team was also able to leverage contracts the local 325th Contracting Squadron (325th CONS), commanded by Maj Steven Fletcher, and the regional US Army Corps of Engineers already had in place (e.g., base maintenance contracts, engineering services, and privatized utilities). Existing contracts were utilized to build temporary perimeter fences, lease mobile office space, and fulfill many other needs. After requirements from Tyndall's RRB were approved, contracting activities quickly coordinated and determined the most appropriate contract vehicle to procure mission essentials while simultaneously ensuring supplies like generators and water did not compete with the local population's needs.

The last OCS LOE, *contractor management* (the *manage* pillar), involves control, support, and integration of contractor personnel and associated equipment deployed for use in the operational area.[4] Due to increases in weapons technology and the need for technical support, defense contractors play a critical role across the full spectrum of conflict. For example, fifth-generation fighters and intelligence, surveillance, and reconnaissance assets typically deploy with a fairly significant contractor footprint. The figure portrays this continuum as depicted in JP 3-0, *Joint Operations.*[5]

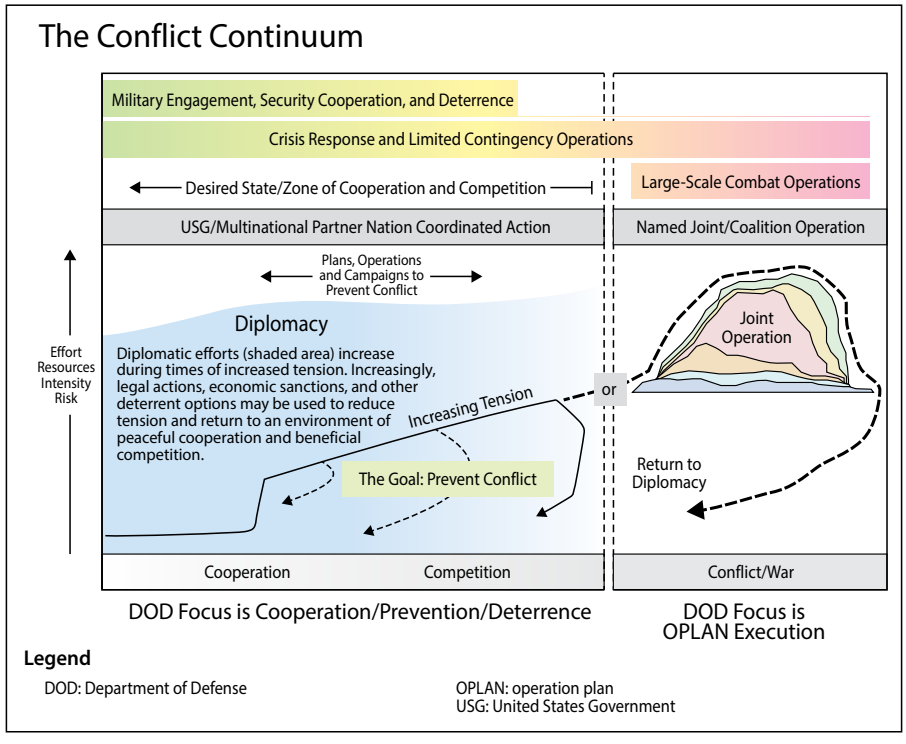

Figure. The Conflict Continuum, Joint Publication 3-0, *Joint Operations*

Given these technological advances, the DOD requires proper government oversight to ensure contractors are performing in accordance with contract terms and conditions. To conduct this surveillance, contracting officers delegate oversight duties to a contracting officer's representative (COR) from the requirement owner receiving the contract services rendered. After the requiring activity's leadership nominates a primary and alternate, CORs are responsible for connecting with the contracting officer throughout the life of the contract to surveil and document the defense contractor's performance, which is why CORs must possess the requisite subject matter expertise.

In addition to establishing a collaborative "COR-contracting officer" relationship to ensure contractor oversight, it is important for commanders and war planners to weave defense contractors into the total force site picture, especially in the deployed environment. With both Operations Enduring and Iraqi Freedom (OIF), this became even more imperative when the ratio of contractor personnel to military personnel on the battlefield became equal to or greater than 1:1.[6] As commanders determine what government-furnished life support to provide (e.g., dining facility privileges, fitness center access, etc.), they must also evaluate how

many contractor personnel can be supported within the current environment, the potential costs of providing the support, and the associated security and legal implications that may arise from allowing contractors to live on base and utilize these services. For instance, due to the wreckage in the surrounding area after Hurricane Michael, base leadership initially authorized contractors to sleep on base and use the dining tent. These authorizations, typically reserved for contractors in deployed environments, were instituted at Tyndall AFB to accelerate recovery and minimize downtime. Once businesses and local restaurants reopened, the 325th CONS commander worked with wing leadership and the contractor to bring a responsible end to and transition off these exigent services. For these reasons, contractor management remains one of the most dynamic and complex aspects of OCS.

OCS is An Indispensable War-Fighting Capability

> *Thus, it is that in war the victorious strategist only seeks battle after the victory has been won, whereas he who is destined to defeat first fights and afterwards looks for victory.*
>
> —Sun Tzu

A basic appreciation of the OCS LOEs, or pillars, enables planners and decision makers to integrate OCS as a war-fighting capability. Likewise, OCS tenets are employed across the full spectrum of conflict from peace to war, including military engagement, security cooperation, deterrence, crisis response, disaster recovery, limited contingencies, or large-scale combat to enable agility and mobility. One concept to reinforce this needed flexibility is the Combat Support Wing (CSW), currently being tested to provide rapid deployment capability in complex, highly contested areas. To sustain such a high ops-tempo and allow for smaller footprints, OCS planning and execution are indispensable. For example, the devastation experienced at Tyndall AFB with Hurricane Michael indicate that OCS expertise (e.g., understanding how best to prioritize, triage, and incorporate contractor support and nonorganic commercial solutions into the plan) will be essential to recovering a base in the event of a future enemy attack. Consequently, as initiatives for the high-end fight are crafted, leaders should include knowledgeable and experienced OCS professionals in their planning discussions and deliberations.

Similarly, to bolster credible war-fighting capability, OCS experts should be familiar with accomplishing an "Aspects of the Operational Environment" (aOE) in the early planning stages. As JP 3-0 states, "Time spent 'to the left' allows the DOD to develop a deeper comprehension of the environment to see and act ahead of conflict flashpoints, develop options, and maximize the efficiency of resources."[7] A depiction of this "to the left" area is shown in JP 3-0's *The Conflict Continuum* (see figure) and displays a notional phasing construct demonstrating contingency

activities in an environment of cooperation and competition, before reaching conflict or war. As advised by the Commission on Wartime Contracting in Iraq and Afghanistan, reliance on contractor support during contingencies introduces sizable risks that are not present in peacetime.[8] Thus, to mitigate these potential risks, an aOE analyzes the operational environment and conditions using an OCS lens and the political, military, economic, social, infrastructure, and information systems process.[9] In concert with and using the information obtained from key stakeholders (e.g., security forces, finance, civil engineering, communications and chief information officer, intelligence, logistics, legal/staff judge advocate, personnel, manpower, services, and joint planning counterparts), OCS professionals develop an initial aOE and refine these products while conducting country visits. For instance, in INDO-PACOM, the US Pacific Forces (PACAF) was designated the lead service for contracting coordination in 2014. Since then, OCS experts from AFICC/KH (PACAF operating location) have initiated an aOE throughout the Pacific. In the same way, other combatant commands would benefit from partnering with skilled OCS personnel to mirror INDO-PACOM's process and devise aOEs for their areas of responsibility.

> *We will emphasize intellectual leadership and military professionalism in the art and science of warfighting, deepening our knowledge of history while embracing new technology and techniques to counter competitors.*
>
> —2018 *National Defense Strategy*

Commanders who appreciate OCS and consider its second- and third-order effects in operational planning also take advantage of the nonkinetic power OCS yields to shape the environment—this is the "art and science" of war fighting. Think about the well-known Route Irish, which became notorious during OIF because it was the only connection between a primary operational base and the local airport in Iraq and was constantly under attack. Littered with trash, this road provided concealment for insurgent ambushes and improvised explosive devices to target military forces traveling the route. The commander's objective was to increase security along the road. Accordingly, the supporting contracting office awarded a contract to employ laborers to remove trash along the deadly road. In the daytime, workers removed the debris efficiently; however, rather than dispose of the trash, they stored it near their homes and returned the garbage at night, which allowed them to arrive the following morning with a job to do. They replicated this process daily, creating multiple strategic effects. First, it limited the opportunity for insurgents to hide IEDs, improving security and achieving the commander's primary objective. Second, the local economy was positively impacted due to the employment of local contractors. Finally, the majority of contractors hired were young

men between 18–25 years old—the age group targeted by terrorist organizations—which provided them an alternative to joining the insurgency.[10]

This real-world illustration of planning for and integrating OCS into operations also highlights the flexibility OCS offers to freedom of movement. As covered in the *Basics of OCS*, the USAF's global contracting capability acquires supplies and services rapidly for our military forces and requirement owners anywhere in the world. With proper planning and coordination, essential services and commodities such as tents, latrines, food services, and even security and aircraft maintenance can be performed by defense contractors while allowing Airmen to concentrate on other mission priorities and the USAF to dramatically reduce the demand on military airlift. During recovery efforts after Super Typhoon Yutu, the Federal Emergency Management Agency (FEMA) experienced challenges getting supplies from the Northern Mariana Islands to Saipan.

Subsequently, to aid in joint Saipan and Tinian relief efforts, USAF contracting officers deployed to Saipan. Once on the ground, these contracting officers leveraged the 36th CONS in Guam as reach-back support to obtain urgently needed goods and services much swifter than FEMA could set up their procurement network. The most critical requirement these enablers provided was fuels support until Defense Logistics Agency's (DLA) operations were established. Similar to Tyndall's RRB, contracting professionals in theater also assisted TF West with an OCS construct to determine organic versus nonorganic support decisions, which ultimately reduced stress on the amount of sealift and airlift used.[11] Planners would gain by incorporating these recent OCS successes and lessons learned when faced with evaluating extensive mission lift requirements.

The civil-military impact of OCS is another factor commanders and planners should be sensitive to, since it may help influence the environment for our military forces. For example, establishing contracts with local vendors often bolsters the surrounding economy, both politically and financially. In addition to the advantages buying locally may have, commanders should deliberate the unintended consequences of procuring locally. Especially after natural disasters, consuming limited resources could have negative repercussions if it competes with what citizens need for their livelihood, results in inflating prices, or causes necessities to become unaffordable to locals. Disaster response contracting support may not be as detailed or to the level as operation plans; however, OCS expertise is key to deploying contracting officers quickly and enabling environmental scanning, commercial vendor assessments, local procurement availability, and tradeoff analyses regarding resources for requirement owners and decision makers to consider.

Exploiting OCS Training and Exercise Opportunities

Modernization is not defined solely by hardware; it requires change in the ways we organize and employ forces.

—National Defense Strategy

Since OCS is an indispensable capability, expertise must continue to be developed and cultivated across the DOD. To grow the educated and experienced OCS professionals that the department needs, this section offers potential OCS training and exercise opportunities that should be exploited to expedite the learning required. In recognition of the rise in relevance of OCS in today's national defense environment and its strategic implications, the Joint Staff (JS) published JP 4-10, *Operational Contract Support*, in 2008 to provide doctrinal expectations for joint forces and components. This doctrine drove a requirement for a dedicated OCS annex, known as Annex W. At this time, there is minimal USAF-level guidance on how to implement the concepts of OCS. Moreover, the USAF has not formally adjusted its organization at the component level to incorporate this new mission area; thus, it frequently becomes an additional duty for our staff officers. Further, the principles of OCS are not mentioned in USAF Installation Emergency Management Plans or Base Support Plans, even though these references provide vital support when implemented, as was discovered in Tyndall's relief and recovery operations. To complicate matters, USAF officers outside of contracting and logistics may not be exposed to OCS until intermediate developmental education (e.g., Air Command and Staff College). Fortunately, proactive readers have a few resources they can tap into to accelerate their OCS familiarity. For instance, Joint Knowledge Online offers an online introductory OCS Course, and the JS J-4 offers a more intensive two-week residence Joint OCS Planning and Execution Course, which focuses on responsibilities throughout the spectrum of conflict.

From 2014–17, the JS even sponsored an annual OCS Joint Exercise (OCS-JX) for several hundred USAF, US Army, Defense Contract Management, and DLA Joint Contingency Acquisition Support Office personnel from multiple functional backgrounds to improve DOD's OCS capabilities. Regrettably, in 2018, this premier OCS-JX was unfunded and cancelled for the long-term without any current plans to resurrect it. Moreover, for those assigned to combatant or component command staffs, OCS may be incorporated into most command post and table-top exercises but is not always included in base-level readiness or command-wide exercises. Therefore, it is the authors' opinion that the joint force and services would reap a huge return on the investment by modifying the previous OCS-JX curriculum and learning objectives to establish a new multifunctional exercise that addresses the current training gap, incorporates recent lessons learned, and improves OCS integration across all functional and staff equities—

not just contracting, logistics, and transportation—to enhance planning and readiness across the enterprise. In the interim, reaching out to logistics and contracting staff for more information to increase your functional area's aptitude, talent, and awareness of OCS would be beneficial and is encouraged.

Conclusions

> *Plan for what is difficult while it is easy, do what is great while it is small. The difficult things in this world must be done while they are easy, the greatest things in the world must be done while they are still small. For this reason, sages never do what is great, and this is why they achieve greatness.*
>
> —Sun Tzu

Commanders who understand the basics of OCS, appreciate the strategic implications of how OCS reinforces the elements of national power, and plan for OCS effectively are postured to support the DOD objectives and priorities. In addition, as our *NDS* specifies, we must be capable of defeating our enemies and achieving sustainable outcomes to protect the American people and US interests. OCS is a war-fighting capability that should be leveraged to achieve these outcomes. Defense contractors have and will continue to play an integral role in supporting our military forces at home station, overseas, and in future conflicts. In the case of recovering Tyndall AFB, Saipan, and Tinian, a few personnel on the ground armed with OCS knowledge, critical-thinking, and collaboration skills ensured mission requirements were met with speed and agility. This article shared lessons learned from Hurricane Michael, Super Typhoon Yutu, and INDOPACOM's progress on its aOE in the Pacific to explore the OCS fundamentals, emphasized the significance of OCS war-fighting capability, and recommended valuable education and training opportunities to exploit OCS further. Ultimately, just as Sun Tzu teaches on planning, leveraging OCS allows us to take advantage of preemptively *doing what is difficult while it is easy* and position ourselves for *greatness* to dominate before a crisis hits. ✪

Notes

1. Joint Publication (JP) 4-10, *Operational Contract Support,* 16 July 2014, I-2, https://www.jcs.mil/.
2. JP 4-10*,* 16 July 2014, I-2.
3. JP 4-10*,* 16 July 2014, I-2.
4. JP 4-10*,* 16 July 2014, I-2.
5. JP 3-0, *Joint Operation*, 17 January 2017, Incorporating Change 1, 22 October 2018, VI-2, https://www.jcs.mil/.
6. Defense Science Board, *Task Force on Contractor Logistics in Support of Contingency Operations,* Office of the Under Secretary of Defense for Acquisition, Technology, and Logistics, Washington, DC, June 2014, 12, https://www.acq.osd.mil/.

7. JP 3-0, *Joint Operation*, 22 October 2018, VI-3.

8. Commission on Wartime Contracting in Iraq and Afghanistan, *Final Report to Congress Transforming Wartime Contracting Controlling Costs*, Reducing Risks, 2011, 28, https://cybercemetery.unt.edu/.

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11. Col Brian Ucciardi, interview by co-author, 17 January 2019.

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FEATURE

Unexplained Physiological Episodes

A Pilot's Perspective

Lt Col Justin J. Elliott, USAF
Maj David R. Schmitt, USAF

He then pulled his "green ring" to release a direct flow of emergency oxygen to the mask—the last step in the checklist— the step a decade of training had promised was a guaranteed solution. He did not feel better.

—Lt Col Justin J. Elliott, USAF
Maj David R. Schmitt, USAF

What goes through a pilot's mind when he has exhausted his checklist with no improvement to his current condition? A pilot's pathway to safety is his checklist—a series of simple, linear steps that bring the comfort of years of knowledge to the cockpit environment during panic and crisis. Pilots who experienced aircraft emergencies when a checklist failed recall the surge of adrenaline and pounding heart-thumping accompanying the panicked thought of "What now?"

Now imagine the emergency your checklist failed to address is physiological. Imagine the visceral fear as you feel increasingly dizzy and light-headed with your vision darkening and limbs going numb. Combine the fear with the psychological

panic that ensues when you reach that last step of your procedure, and you only feel worse. Mentally put yourself in this moment, and you will understand what numerous fighter pilots in the past decade have called an unidentified physiological event (UPE). Listen to their stories, and you will hear them describe an environment where nothing they were taught worked to save them.[1]

The High-Performance Fighter Environment

High-performance aircraft were built to train and fight. At the advent of fighter aviation, "high-performance" aircraft flight envelopes stayed well within the human physiological envelope.[2] One hundred years later, the F-22 joined the ranks of fighter aircraft with an unaugmented flight envelope that well exceeds the human limits in g-force and altitude.[3] Only flight control limiters prevent the inconvenient F-22 "passenger" from routinely outperforming himself with the pull of a stick. Yet despite the meteoric advancements in aircraft performance during the past 100-plus years, hypotheses about human performance in flight remain largely unchanged.[4] Put simply, aerospace physiology has not kept up with high-performance aircraft. As a result, even our most modern fighter aircraft feature life support systems designed against an oversimplified set of assumptions: Our systems were designed to defeat hypoxia and decompression sickness; therefore an "excellent" system was one that delivered maximum oxygen and maximum pressure to the pilot.[5] Some of these assumptions are proving grossly inaccurate.

The ideal life support system for flight is one that provides the concentration and flow rate of gases that the human demands in a given situation—no more and no less. Too much pressure creates resistance a pilot must forcefully breathe against and too high a concentration of any molecule in a gas concentration forces the pilot's body to compensate for the nonideal mixture.[6] These two statements seem obvious, yet the breathing and pressurization systems found in today's high-performance aircraft are not designed to meet that criteria.

Current State of Physiological Incidents

As a result, UPEs are on the rise. As of the drafting of this article, UPEs have become a primary concern for both the USAF and US Navy (USN). Both the USAF and the USN deputy chiefs of staff testified before Congress in February 2018 and answered a request to explain their plan to solve this problem for their respective services.[7] Since 2007, the F-22, F-35, F/A-18, F-15, F-16, T-6, and T-45 have each reported *at least* 10 UPEs that are not explained by classic physiological training.[8] The F/A-18, operated both on and off aircraft carriers by the US and foreign governments, has reported more than 603 UPEs in the same pe-

riod of time.[9] UPEs are reported in benign phases of flight, and even on the ground before takeoff, making classic hypoxia and decompression sickness diagnoses essentially impossible.

Rates Across the Department of Defense

The UPE rates are likely due to a combination of increased awareness and reporting, aircraft part failures due to fleet age, or design flaws. In some cases, the prevailing cause is more obvious than in others. Newer aircraft like the F-35 and F-22 are being examined for design flaws that create inherently poor breathing environments. Older aircraft like the F-15, F-16, and A-10 are being studied for maintenance breakdowns.[10] In the middle, aircraft like the T-6, T-45, and F/A-18E are reaching the mature point in their life cycles when design errors should have been found, and major maintenance breakdowns have not yet surfaced.[11] In all cases, however, the DOD increased awareness and reporting—some of which was intentional, and some surfaced when fighter pilots started appearing on television refusing to fly—makes it difficult to discern exactly how significant this decade's UPE spike is. One thing is certain, however. These UPEs are aircraft-agnostic, oxygen system-agnostic, engine-agnostic, and even flight envelope-agnostic. They are occurring in every type of high-performance aircraft in the DOD, and they are occurring at every point in the flight envelope from the ground to the highest fastest corners.[12] In fact, the only aircraft that seem immune from these UPE spikes are our heavy transportation aircraft where pilots and passengers alike breathe pressurized ambient cockpit air with no life support gear. This fact alone is information worth digesting.

Well-Publicized Examples

The DOD's UPEs have made headline news repeatedly since two F-22 pilots broke the ice on "60 Minutes" in May 2012.[13] For the first time in memorable history, Air Force fighter pilots refused to fly. The feeling among F-22 pilots at the time was akin to that of a community stricken by a series of crimes that all fell into the category of "unsolved."[14] Faith was broken between the Air Force's investigative bodies and the pilots who were told the aircraft was "fixed." Several iterations of fixes were added to the F-22 before the Air Force found one that seems to be working. Wholly missing from these trials, however, was any effective communication to the pilots regarding the reasons behind the fixes and the current state of the aerospace medical science. Looking back six years later, the group of doctors and physiologists working the F-22 case had pieced together much of the cutting-edge knowledge that is changing our training and checklists today but

instead of keeping the pilots informed of these discoveries, Air Force leadership instead levied new procedures and added new system components with little explanation of why.

One pilot recalls violating his "mask-up" checklist repeatedly during the heart of the Air Force's hunt for cockpit contaminants, and he broke the rule to survive.[15] The Air Force inserted a carbon filter into the breathing air delivery line to the pilot to filter contaminants that were not present. In doing so, they restricted a flow rate that soon was proven to be already overly restricted to begin with. "I would fight as long as I could with my mask up, trying to adhere to the rule as long as I could stand it," he recalls. "Then I would turn around from the fight so air hungry that I had to rip my mask off my face just to catch my breath. Once I had recovered, I put my mask on and tried again."[16]

While the F-22 was the first to make the news, it was hardly the only aircraft dealing with similar unexplained crashes and emergency landings. The F/A-18 community had been chasing contamination in their oxygen systems since 2007, and despite never finding any elements of significance, their search remained focused on one potential problem to the exclusion of others.[17] It was not until 2017 when their UPE count hit 500 incidents for a single type of aircraft that the USN opened its aperture to other potential problems.[18] In April 2017, the USN reported that more than half its F/A-18s were unable to fly due to UPE investigations.[19] Within a month, the T-45 fleet was grounded as well.[20] Public news sources began reporting in October 2017 that the F-35 fleet was cancelling flights due to UPEs.[21] In February 2018, the T-6A, the USAF's primary flight trainer, was grounded as a rash of UPEs peaked with a set of nine incidents within a 48-hour period.[22]

What does a typical UPE look like? Each UPE contains some details unique to the aircraft and environment, but they share common elements as well. The example that follows illustrates a typical UPE for this era. In 2015, an F-15C pilot was flying a routine training mission on a clear day when he noticed he felt less than 100 percent. Typical of the culture of the time, the pilot chose to continue the mission rather than confess his symptoms—breathing problems were for F-22s, and the F-15C had a liquid oxygen delivery system, largely thought to be immune to malfunctions.[23] Shortly thereafter, the pilot felt his hypoxia symptoms—tingling, dizziness, and a lack of concentration—and chose to return to base and initiate his emergency checklist. He pushed his regulators to maximum flow and concentration, felt the pressure at his mask, and took a breath. He did not feel better. Assuming his regulator had failed, the pilot then pulled his "green ring" to release a direct flow of emergency oxygen to the mask—the last step in the checklist—the step a decade of training had promised was a guaranteed solu-

tion.[24] He did not feel better. At this moment the emergency became a UPE. The pilot's checklist and knowledge were both exhausted, and he felt he had no choice but to sprint back to base before he passed out from hypoxia. He landed the jet almost incapacitated and did not feel normal again until several minutes after he exited the aircraft.[25] An initial maintenance examination of the aircraft found nothing to explain the pilot's symptoms, nor did the current state of physiological training. Hence, this emergency was unexplained.

Put simply, the objective of this article is to prevent harrowing incidents like the one above from happening again. Through education, communication, and a simple "do no harm" inflight technique, this article hopes to mitigate future UPEs.

High-Performance Aviation Physiology

> *Man must rise above the Earth—to the top of the atmosphere and beyond—for only thus will he fully understand the world in which he lives.*
>
> *—Socrates*

A necessary first step in understanding the nature of current high-performance physiological troubles is gaining a basic knowledge of the various systems at play. A jet pilot represents a complex physiological system that is constantly attempting to maintain a normal physiological state. Any change to typical bodily homeostasis will likely result in some manner of response on an autonomic level. Thus, the simple act of keeping a person alive in a high-altitude environment requires alterations to the respiratory environment, which must then elicit a bodily response. As a result, the very life support *systems* meant to satisfy respiratory requirements could, in fact, create unfavorable consequences because of the complex interactions between these two sometimes constantly varying systems. The importance of approaching these issues from a system-system interaction perspective cannot be overstated, as time and again a "properly functioning aircraft" and a healthy well-functioning pilot combine to create an unexplainable physiological episode.

Defining the Pilot Respiratory Environment

Description of the Environment

At its most basic level, the challenge of operating in the high-altitude regime is simply a function of pressure. This is driven by the nature of the atmosphere itself and is then compounded by introducing high-gravitational (high-g) forces into the mix during fighter maneuvering. Understanding these problems can inform a reflective study on the development of life support systems over time.

Earth's atmosphere at almost all altitudes is composed mostly of nitrogen (78 percent) and oxygen (21 percent).[26] A common misconception is that there is a lower percentage of oxygen at high altitudes. Instead, thin air at altitude is the result of a drop in the number of molecules of oxygen present in any given volume of air due to the decrease in atmospheric pressure at high altitudes. At sea level, a person breathing air will have an amount of oxygen in their lungs that is described by the term P_aO_2, which is the pressure of oxygen in lung alveoli. This is sometimes referred to as the *partial pressure of oxygen* with a value of 103 mm Hg (mercury) at sea level. As altitude increases, and the pressure of the air drops, aviators must breathe a higher percentage of oxygen to maintain 103 mm H_g P_aO_2.[27] Put another way, the intent of supplemental oxygen is to keep an aviator's respiratory system breathing at sea-level equivalents.

An additional and unique challenge of the high-performance fighter environment is increased gravitational forces, where blood pools in the lower extremities, and internal organs—specifically the lungs—are also compressed. The most obvious hazard of these forces is a g-induced loss of consciousness caused by a loss of blood (e.g., oxygen) in the brain, but the gravitational effects on the lungs are also concerning.

Life Support Systems

Based on the above hazards of high-performance flight, an appropriate life-support system must provide: a pressurized cockpit to minimize hypobaric conditions, supplemental oxygen to provide sufficient P_aO_2, and some manner of assistance to the pilot in resisting gz forces over time.

To minimize hypobaric conditions, the cabin pressurization schedule typically used by modern fighter aircraft holds cabin altitude below a 15,000 foot cabin altitude for the majority of their tactical time with a preponderance of that time spent at an 8,000 foot cabin altitude.[28] USAF regulatory guidance limits cabin altitude to a 25,000 foot maximum without a pressure suit to mitigate the risk of decompression sickness.[29]

With those cabin altitudes in mind, a fighter breathing system must be able to provide supplemental oxygen on a regular basis to satisfy sustained flight up to a 25,000 foot cabin and provide emergency protection up to the maximum aircraft altitude in case the pressurization system fails. Physiologically, this means delivering a percentage of O_2 (oxygen gas) such that P_aO_2 is 100–03 mm Hg (sea-level equivalent) at all sustained altitudes (less than 25,000 foot cabin). In an emergency decompression scenario, sea-level (SL) equivalent P_aO_2 can be maintained up to an aircraft altitude of 33,700 foot by breathing 100 percent oxygen. Above that point, 100 percent oxygen must be administered under positive pressure—

pressure breathing for altitude (PBA)—to make up for the extremely low atmospheric pressure of the breathing environment, although in practice PBA typically begins at 40,000 foot.[30]

The manner in which military aircraft provide oxygen support generally fall into three different categories: gaseous oxygen, liquid oxygen (LOX), and an onboard oxygen generation system (OBOGS). Gaseous oxygen and LOX systems are well-known and have been used for many years without substantial functional deficiencies. However, aircraft maintainers were required to service these systems periodically with ground-based stores that created logistical challenges in maintaining these systems.

The advent of OBOGS seemed to be the panacea for those logistical hurdles as OBOGS can produce oxygen on board the aircraft continuously. This production eliminates logistical hurdles, allows long flight durations, and eliminates any battle damage fire/explosion considerations. OBOGS consist of two or more cylinders (sieves) of a crystalline substance called *zeolite*. When a zeolite sieve is pressurized, typically by sending high pressure engine bleed air into the sieve, the zeolite structure absorbs nitrogen but allows oxygen and argon to pass through as the product gas, which is approximately 90–95 percent oxygen. The nitrogen-saturated zeolite can be purged simply by depressurizing the sieve, making the process reversible and cyclical. Thus, using two or more alternating zeolite beds allows for a almost continuous supply of high-oxygen concentration air for the aircrew.[31] New fighter aircraft (F-15E, F-16 Block 50+, F-18E/F, T-6, F-22, F-35, and others) have been designed with an OBOGS while some aircraft, which previously used LOX, have been retrofitted with OBOGS for logistical reasons (F-16, F-18C/D, T-45, AV-8, and others.)[32]

OBOGS systems all follow the same basic principles to produce an oxygen-enriched gas. However, the same cannot be said about the delivery mechanism of that gas to the pilot, which varies in many ways that will be briefly summarized here. In general, there are two different methods of delivery: continuous flow and pressure demand. In a continuous-flow system (F-18, T-45), breathing gas is continually delivered to the pilot through his mask whether he is breathing or not.[33] In contrast, pressure-demand systems only provide breathing air in response to aviator inhalation through a regulator. This method allows for flexibility in the delivery of breathing gas, enabling gas dilution (termed *airmix*), and pressure breathing (for g or altitude). The engineering trade space created by these systems have led to their use on virtually all USAF aircraft although implementation varies in two distinct ways.

First, is whether or not the regulator provides airmix, whereby cockpit air is mixed with the output of the OBOGS or LOX system to provide the pilot with

an appropriate percentage of oxygen to maintain 100–103mm H_g P_aO_2. This mixture was the standard method of delivery in older aircraft (F-15, F-16, and A-10).[34] In contrast, many newer airframes do not provide airmix in the classic sense (that is, through a dilution regulator) but rather vary oxygen content by controlling OBOGS cycle times.[35] As a result, the F-18, F-22, F-35, and T-6 all provide significantly higher percentages of O2 to aircrew than their predecessors (with F-18 being 90–95 percent continuously). A representative delivery schedule for these systems can be seen in figure 1 below, with oxygen content beginning in the 50–60 percent range (well above the SL equivalent) and increasing to 90–95 percent in an 11,000 foot cabin. It should be noted that because of OBOGS cycling, the actual oxygen output of the OBOGS varies in a sinusoidal nature, represented by the large width of the oxygen content range. The effects of a continuously varying oxygen content on a pilot are unknown.

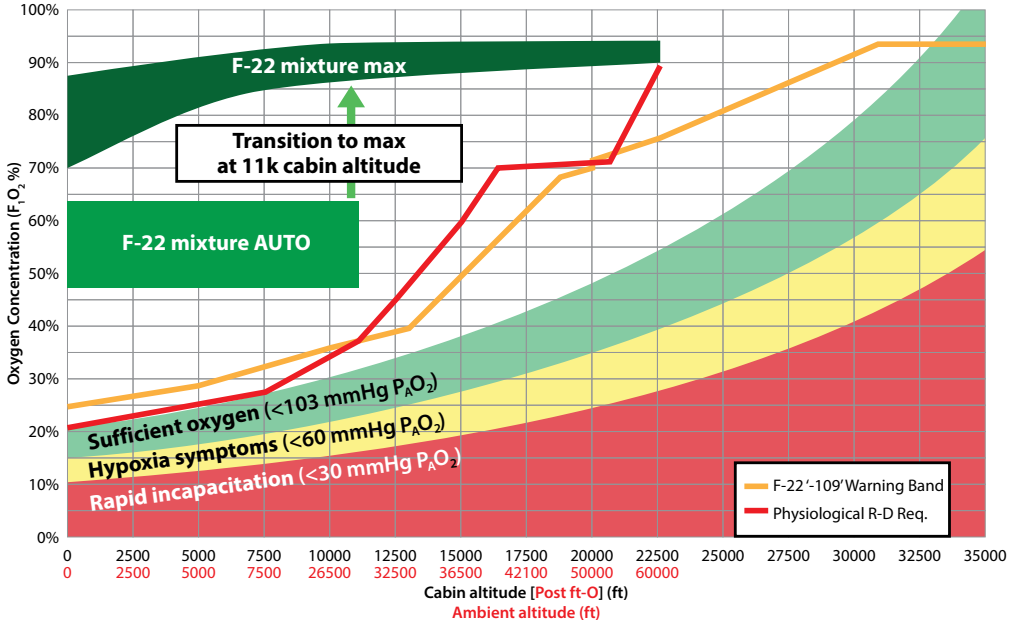

Figure 1. Figure shows the F-22 Oxygen Delivery Schedule with oxygen content beginning in the 50–60 percent range and increasing to 90–95 percent in an 11,000 foot cabin.

(Source: USAF Scientific Advisory Board, *Report on Aircraft Oxygen Generation*, 45)

The final critical difference is the presence or absence of a plenum in the breathing line. A plenum is a storage container of gas (air or O_2) that can provide a fill-in source of breathing gas during a system shutdown, interruption, or breath-

ing demand surpassing the available supply. For LOX aircraft utilizing a dilution regulator, the cockpit essentially functions as a plenum. However, because most OBOGS aircraft do not use a dilution system, a dedicated plenum should be required, but implementation varies greatly from airframe to airframe. Plenum volumes range from 262L (F-15E), to 250 cu in (A-10, F-16, T-6), to 97 cu in (F-18), to 0 cu in (F-22). The smaller plenum volumes, particularly in OBOGS aircraft, mean the complicated human system is directly connected to OBOGS without any buffer to account for system abnormalities on either side. A summary table of these OBOGS systems in USAF and USN aircraft can be found in the US Air Force Scientific Advisory Board's *Report on Aircraft Oxygen Generation*: https://apps.dtic.mil/dtic/tr/fulltext/u2/a567568.pdf.[36]

Possible Undesirable Outcomes

Outcomes, as discussed in this article, refer to the physical condition in an aviator that is most closely responsible for the symptoms they experienced. This does not refer to the start of a chain of incidents that lead to symptoms but rather the final step in that chain. Possible outcomes linked to UPEs include a lack of oxygen in the brain termed *hypoxia* (hypoxic, histotoxic, hypemic, or stagnant), too much or too little cerebral CO_2 (hypercapnia or hypocapnia), or nitrogen bubbles in the bloodstream (decompression sickness). These conditions can result in similar symptoms, are well discussed in other literature, and are important to identify to treat the aviator medically. However, the mechanism that caused the outcome to occur carries greater significance in determining how UPEs happen.

Potential Causal Mechanisms

Mechanisms represent the means by which a certain outcome occurs. For example, in the case of a system malfunction that results in increased breathing resistance, then hyperventilation resulting in hypocapnia (outcome), the ventilation issues (increased resistance and hyperventilation) represent the mechanisms of the system with the system malfunction being the trigger event that started the negative physiological chain. While, in this example, correcting the trigger condition may seem to be the solution, if the trigger is not readily apparent (as is the case in most of today's incidents), a solid understanding of the various mechanisms can be a valuable analysis and risk-reduction tool.

Ventilation Issues

The human respiratory system, from a control system design perspective, represents perhaps the greatest compensation device in existence. Human autonomic

respiration manages P_aO_2 and P_aCO_2 levels, blood pH, and a variety of factors through careful control of the rate and depth of respiration. However, this compensation device is finely-tuned to its normal respiratory environment, which typically consists of near sea-level pressure, standard oxygen levels in the air, few pollutants, and no restrictions to inhalation or exhalation (for a healthy individual). These normal conditions represent a series of assumptions made by the body about its environment and define the area to which it should continually strive to compensate back to. As such, when exposed to a demonstrably new environment for a short period of time (e.g., high-altitude, or a fighter life support system), the body is unable to change its stated assumptions (acclimatization) and instead continues to search for its original condition set. This is a critical fact to remember when considering the various ventilation (e.g., respiratory) mechanisms that can result in negative outcomes.

Hyperventilation as a mechanism is defined as an increase in the rate and/or depth of breathing, such that minute ventilation (volume of gas exchanged in the lungs each minute) is increased above normal. Of the outcomes discussed above, hyperventilation most readily leads to hypocapnia in a properly functioning respiratory system as the increased ventilation results in additional CO_2 elimination without any change in the body's production of CO_2. However, hyperventilation does not always lead to hypocapnia, depending on the severity of the hyperventilation, individual body physiology, or an already compromised respiratory system. In the latter case, a person might not be able to increase minute ventilation above normal due to blockages or restrictions in the respiratory tract as these conditions typically lend themselves to CO_2 retention due to the lack of ventilated lung tissue available for CO_2 exchange. There are multiple different well-documented causes for hyperventilation that all make logical sense when viewed from a system compensation perspective. These include hypoxia, breathing restriction, increased thermal stress, psychological stress, and hyperoxia.[37]

It *should* go without saying that hyperventilation is a natural compensation technique used by the body to reachieve its normal state. Despite this fact, there still exists a strong tendency to equate hyperventilation with a lack of mental or emotional control, which results in a prejudice against admitting to hyperventilation inflight and hampers investigative efforts. It is incumbent upon each member of the aviation community to divorce hyperventilation as a medical mechanism from the classic image of a panicked individual breathing into a paper bag. An aviator experiencing hyperventilation is a *natural human reaction* to external stressors for that person's physiology on that day and should be viewed through a critical, rather than visceral, lens.

Hypoventilation as a mechanism is defined as a decrease in the rate and/or depth of breathing such that minute ventilation is reduced. Typically, this mechanism leads to an outcome of hypercapnia, as the reduced ventilation leads to CO_2 retention. In the medical community, most conditions that lead to hypoventilation revolve around some kind of respiratory disease (COPD, asthma, etc.) that limits the body's ability to effectively exchange gases.[38] From an aviation perspective, the closest analogous scenario is when a pilot's lung volume is decreased or restricted in some manner, either by an additional medical mechanism or by tight-fitting life support gear. Additionally, increased breathing resistance has been shown in multiple studies to lead to hypoventilation in a large group of aviators.[39] From a compensation perspective, this represents a pilot subconsciously trying to avoid increased resistance by decreasing minute volume, a different but also observed compensation technique than that discussed previously regarding *hyper*ventilation.

Ventilation (V)/perfusion (Q) mismatch is another potential mechanism that could lead to blood gas imbalances as an outcome. The ratio of V (air breathed into the lungs) to Q (blood flowing through the lungs) typically remains balanced at a value of about 0.8 under normal conditions. What this means physically is that there is almost the same amount of oxygenated air brought into the lungs to provide O_2 and remove CO_2 as there is venous blood to soak up O_2 and provide CO_2 for the lungs to off-gas. In a well-functioning respiratory system, if one factor changes (e.g., increased perfusion during exercise) the other changes as well to maintain the V/Q balance (e.g., increased respiration during exercise). If one of the factors changes without a response from the other (due to respiratory disease or impairment, changes to blood flow patterns, etc.) the body's blood gas ratio can become out of balance, leading to hypoxia, hypercapnia, or hypocapnia depending on the type of mismatch (i.e., high or low V/Q). These mismatches can occur throughout the lung, but can also happen locally (i.e., only in a specific region). This is especially true under G, where the lower lung can be shunted (V/Q=0), and the upper lung over-ventilated as seen in figures 2 and 3.[40] While history would suggest these localized ratio changes do not create negative outcomes independently, they could combine with other mechanisms to foil the body's natural compensation ability.

Breathing Resistance and Work of Breathing

Work of breathing (WoB) as a mechanism is defined as an *increase* in the amount of physical work required by the pilot to execute a breath and includes both inspiratory and expiratory work. It is typically not a mechanism that leads directly to an outcome but instead leads to another mechanism such as hyper - or

hypo-ventilation, depending on the individual. However, it does represent an important mechanism that is potentially one step closer to the trigger issue, and thus one step closer to fixing problems in the future.

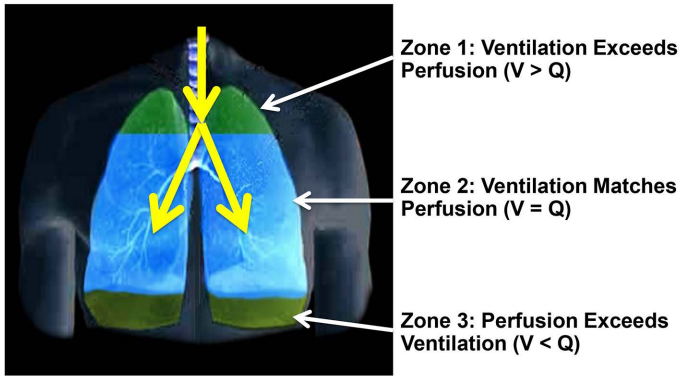

Figure 2. Figure shows how perfusion exceeds ventilation in the typical localized V/Q ratios.

(Source: Dr. Gregg A. Bendrick, *Atelectasis in High-Performance Aircrew*, slide 22, Powerpoint presentation)

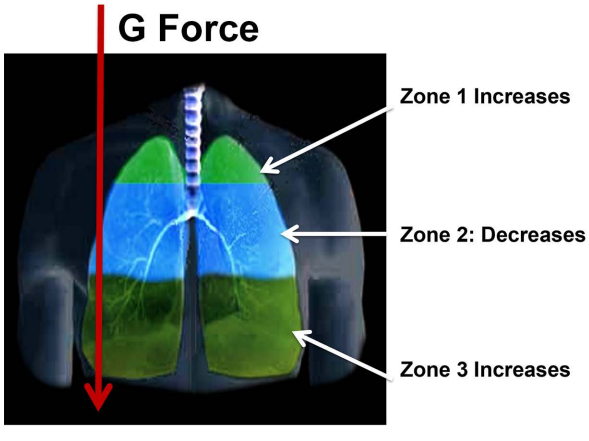

Figure 3: Figure shows the effects of high g-forces on V/Q ratio. Figures 2–3 demonstrate how the lower lung can be shunted (V/Q=0) and the upper lung over-ventilated.

(Source: Bendrick, *Atelectasis in High-Performance Aircrew*, slide 24)

Increased WoB is generally caused by increased breathing resistance or impedance. As the work required to breathe increases, most humans will begin to compensate for the increased work, either through increased or decreased ventilation which, depending on the person, will result in either hyper - *or* hypo-ventilation

and possibly an ensuing outcome. During inhalation, any resistance present inline in the breathing system itself, whether from system connectors, small diameter hoses, contamination filters, a lack of a large plenum (breathing reserve), or OBOGS cycling issues, will necessarily cause an increase in WoB for that breath. Similarly, any physical restrictions on the pilot's chest/abdomen (tight-fitting survival gear, G-suits, equipment vests, etc.) will resist the chest's expansion during inhalation and increase the amount of work required to take that breath. During exhalation, various factors such as exhalation valve cracking pressure, safety pressure, and constant flow pressure (if applicable) can also affect the exhalation resistance and increase WoB.

In most aircraft today, although the literature asserts WoB must be minimized in totality,[41] impedance issues have typically been outprioritized by hypoxia (both histotoxic and hypoxic) and DCS concerns or discounted completely, resulting in safety pressure, small connectors, filters limiting gas flow to the pilot, and physical impediments to normal respiration (tight gear, survival vests, exposure suits, etc).

Hyperoxia

Hyperoxia as a mechanism is defined as a P_aO_2 of greater than normal (>100-103 mmHG). On the surface, this seems counterintuitive as oxygen is typically thought to "only be beneficial" due to its necessary life-sustaining properties. However, breathing excessive quantities of O2 can have multiple effects leading to other mechanisms or outcomes, including atelectasis, delayed otitic barotrauma (ear blocks), hyperventilation, reduced cerebral blood flow, hypo or hypercapnia (depending on the individual), and oxidative stress.[42] With such far-reaching effects, O2 delivery to pilots should be carefully controlled to provide both adequate O2 to prevent hypobaric hypoxia while simultaneously avoiding the effects discussed above. Unfortunately, this is not the case in the majority of our fighter aircraft today.

Atelectasis

Atelectasis is a physiological mechanism wherein lung alveoli collapse and remain closed due to a lack of gaseous pressure within the alveoli itself. In general, atelectasis in an aviation environment has been attributed to a combination of a high O_2 concentration, high g-forces, and wearing restrictive gear (i.e., a G-suit).[43] In these cases, g-forces and tight gear create a large low V/Q area in the lower lung, where high O_2 concentration air is rapidly absorbed *in totality*, thereby collapsing the alveoli due to a drop in total pressure.[44] Collapsed alveoli no longer ventilate, creating a shunt, until the alveoli are reopened. In essence, the result of

atelectasis is a temporary reduction in functional lung capacity. Studies performed since the 1950s to quantify this reduction, have uncovered several "knowns" about atelectasis. First, O_2 concentrations above 50–60 percent, flight gear that either restricts chest expansion or compresses the diaphragm, and high-g forces put pilots at risk of developing significant atelectasis in flight. Second, the respiratory effects of atelectasis are *not* insignificant and can reduce lung volumes by 30 percent as a mean value, with possible individual variation above that. Third, these effects are not purely transient as some level of atelectasis will be present until a forced full lung expansion is performed to clear it. In practice, if an aviator is exposed to risk factors which create atelectasis in the first place, he will likely be unable to fully re-expand his lungs in flight and/or prevent a reoccurrence of atelectasis formation later in the sortie. When these factors are combined with the status of current aircraft life support systems and AFE, which almost perfectly match atelectasis risk factors, it seems likely that many current fighter aircrew members execute at least part of their tactical maneuvering with some level of reduced lung function due to atelectasis.

Bringing it All Together: Interactions of Potential Causal Mechanisms

With the above "knowns" in mind, consider an aviator who is stepping to fly in a current fighter type aircraft. This means her aircraft's OBOGS produces an excessive and constantly varying amount of oxygen in the breathing gas for most of the flight envelope, and she is likely wearing a large amount of aircrew flight equipment (AFE) (a dry suit, harness, survival vest, partial pressure suit, full-coverage G-suit) that will restrict and constrain lung expansion along multiple axes. These factors, combined with the high-g environment (well above the levels tested in the above studies), will create atelectasis that will likely persist or reoccur for the duration of the flight, resulting in an approximate 30-percent reduction in lung volume and an associated shunt of unoxygenated blood. The body will likely attempt to compensate for this reduction but will be challenged to do so because of and complicated by interactions with other mechanisms.

First among these complications is the hyperoxia that partially caused the atelectasis in the first place. This hyperoxia causes the aviator to hyperventilate slightly to compensate for reduced CO_2 transport ability and reduces cerebral blood flow (possibly causing mild hyper or hypocapnia depending on her body chemistry). The high O_2 gas content will also likely prevent P_aO_2 from dropping because of the atelectasis produced shunt, making the shunt a latent condition that is essentially "lying in wait." Additionally, this hyperventilation will likely take the

form of increased breathing rate, not depth (due to the AFE), which would both prevent temporary reexpansion of areas of atelectasis and would exacerbate the V/Q mismatch caused by the shunt. If no additional demands are placed on the body, it will likely be successful compensating to maintain a physiological balance, as evidenced by the various atelectasis studies which found no serious medical outcomes from atelectasis, only pilot annoyance and discomfort.

However, now consider an additional mechanism in the form of increased WoB. Using current airframe examples, this could be due to safety/continuous pressure (F-18, T-45, F-22, and F-35), restrictive AFE (all depending on the mission), small hoses/connectors (all), ECS/OBOGS pressure transients (if insufficient plenum size), a lack of instantaneous flow capacity (all), or a simple aircraft malfunction (kinked or broken hose, stuck valve, etc.). The aviator's body now tries to compensate for WoB through ventilation changes (hyper or hypoventilation) while simultaneously compensating for the effects of high O_2, V/Q mismatch and shunt, and reduced lung function. And remember, not all of these mechanisms are static, with the WoB changing constantly due to the pilot's exertion and the oxygen output of her OBOGS also constantly changing with little or no plenum to soften the variance.

This is a significantly dynamic and complex problem for a human body to sort out. There likely exists some level of *physiological margin* for each individual on any given day that represents the maximum amount of compensation their system can perform. In the aviation world, this would be analogous to stall margin in a jet engine. A pilot's physiological margin can be overwhelmed *acutely* by a single event (e.g., rapid decompression) or *systemically* whereby the confluence of multiple different constantly varying factors in both the aircraft and human system stack on top of each other at the right time to overwhelm the pilot's compensation ability. Viewed through the prism of this theory, it should come as no surprise that the fighter aircraft of today continually take a "well-functioning" human system and a "well-functioning" aircraft system and create a UPE. As the various mechanisms described above interact with and change the body's compensation methods, they become out of sync, compound, and produce seemingly unexplainable results.

Conclusions: How Can This Help in the Air?

As complex the systemic and variable breathing problems discussed above are, the airborne solution for the pilot appears to be simple and most importantly is virtually the same regardless of which outcome is at play. From hypoxia to hypocapnia, our bodies are built to combat any breathing irregularity automatically, provided nothing is stopping us from doing so.[45] Therefore, our approach to solv-

ing these problems is simple: Do not try to diagnose physiological problems airborne. Instead, first ensure you have enough oxygen to breathe—hypobaric hypoxia is still the top threat. Once you have eliminated the oxygen variable, get to a safe place that mirrors the open-air breathing environment of Earth's surface (ideally somewhere below 10,000 foot), remove any impediment to your breathing (i.e., your mask, tight gear, etc.), and relax until you feel recovery begin. In other words, go to "Colorado," hold until you feel better,[46] then go home. Whether the initial problem was hypoxia, hypocapnia, work of breathing, atelectasis, hypercapnia, or a likely combination of factors, if a pilot can relax and breathe restriction-free open air at an earth-like mixture, she is working toward recovery.

Think back to the opening of this article to the pilots who reached the definitive end of their physiological checklists with no condition improvement. The procedure would allow pilots to cope with this UPE where their checklists do not hit a definitive end. This "do no harm approach" provides pilots with the tools to handle UPEs to their conclusion in a scenario where the underlying trigger, mechanism(s), and outcome are in doubt. The aerospace medicine field is rapidly progressing in its understanding of these issues, but substantial questions and unknowns still remain. Airmen should not fear these unknowns but rather embrace airborne procedures that possess a robustness in their triage of airborne symptoms until the many interactions between aviators—and the systems meant to keep them alive—are fully understood. ✪

Notes

1. Interview with F-15 mishap pilot (name redacted: safety privilege), (Nellis AFB, NV: 16 January 2016).
2. Ryan Mayes, PhD, "Addressing COPE Fighter First Semi-Annual Symposium," (Denver, CO: 16 April 2017).
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4. Mayes, "Addressing COPE Fighter."
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6. Steve Iscoe and Joseph A. Fisher, "Hyperoxia-Induced Hypocapnia: An Underappreciated Risk," *Chest Journal* 128 (2005): 430–33, https://europepmc.org/abstract/med/16002967.
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8. Mishap Database, "Characterizing and Optimizing the Physiological Environment of Fighters (COPE Fighter)," (Wright-Patterson AFB, OH: 4 May 2018).
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FEATURE

Space Pirates, Geosynchronous Guerrillas, and Nonterrestrial Terrorists

Nonstate Threats in Space

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> *One of the policy implications of the second space age is that the availability of advanced space capabilities on the commercial market can potentially bring the advantages of space within the reach of rogue nations and non-state actors.*
>
> —Todd Harrison, Zack Cooper, Kaitlyn Johnson, and Thomas Roberts
> "Escalation and Deterrence in the Second Space Age"
> *Center for Strategic and International Studies*

President Donald J. Trump's 2017 *National Security Strategy* (*NSS*) posits the return of great-power competition, particularly calling out Russia and China as rivals, and highlights the need to reemphasize space both for defense and commerce.[1] Shortly after the publication of the *NSS*, the president called for the creation of a Space Force, at least partly to defend US security and economic interests in space, and then directed the Pentagon to create a Space Force with his signing of Space Policy Directive-4 on 19 February 2019.[2]

China and Russia continue to develop a range of antispace capabilities, including computer viruses, jamming, lasers, and antisatellite missiles. Yet losing space

superiority to other major powers is a far cry from being targeted in space. Despite the fact that great-power competition will include rivalry in space, space also involves a great deal of cooperation, for example, between the US and Russia, and with the International Space Station.[3] As a result, the most likely scenarios involving attacks against US interests in space may not come from other states. Instead, they involve nonstate actors seeking to challenge the existing international order, overturn the status quo in their countries, or profit from the lack of attention paid to them by the community of nations.

There is danger in focusing too heavily on great-power competition and extending it into space. One potential consequence is the creation of a self-fulfilling prophecy through the security dilemma; by emphasizing the probability of conflict between great powers, and by enhancing military capabilities to address potential threats, a state actually increases the likelihood of conflict.[4] A second problem is that focusing too much on states ignores the potential threat of nonstate actors who may be harder to deter because they have less fear of reprisal, are less concerned about escalation to war, and have less to lose by targeting space assets. Adam Routh suggests that as the commercial space sector grows and provides more value to the global economy, "this growth will increase the cost to those who wish to attack space systems." But that growth focuses on the second-order consequences of states attacking in space and ignores those nonstate actors who do not care about the world's economy or would relish the ability to weaken the global economic system.[5]

This article examines the nature of the threat from nonstate actors. Although the impetus for the article is the potential rise of a US Space Force, the ideas expressed here are applicable to all states with interests in space. It focuses on three types of nonstate actors: two with political motivations (guerrillas and terrorists) and one with mostly economic motivations (pirates). It derives its ideas from scholarly work and historical examples of how these actors traditionally behaved toward states, then extrapolates to potential activities against space assets.

The article is divided into three sections. First, it examines two different types of political actors: guerrillas and terrorists. It discusses the differences between the terms, examines how those differences are relevant to the space domain, and then uses their historical behavior to forecast how they might act against space assets in the future. The article then examines one type of commercial actor, pirates, specifically focusing on their motivations and potential types of activities. The article concludes with some recommendations for states to prepare for their eventual rise and the threat they pose and to deter these types of attacks.

One assumption this article makes is that there will be no direct great-power confrontations in space, at least in the near future. Despite the US's renewed em-

phasis on great-power competition, this article assumes they will deter each other from initiating conflict in space for fear of escalation. While a war could escalate into the space domain,[6] it is flawed to assume that as more states are active in space, they are more likely to have conflict. More states have nuclear weapons today than they did in the 1950s, but a war between the nuclear powers is no more likely today than in the past. For now, the most likely threat of attacks against the space capabilities of any country will come from nonstate actors engaging in new forms of asymmetric warfare. The exact nature and purpose of the attacks will depend on the actor and their goals, which is a heavy emphasis of the sections below.

A second assumption is that the primary threat involving space and nonstate actors will be attacks directed from Earth against the space capabilities of states, rather than attacks that emanate from space. It is still difficult and expensive to place an object in orbit—only a handful of states have that ability[7]—so it will be a while before nonstate actors with violent intentions could weaponize space. However, nonstate actors will develop space capabilities at some point in the near future, even if those capabilities involve simply degrading satellites or stealing communication signals. The ability of western companies (Rocket Lab, Virgin Galactic, and so forth) to develop space capabilities of some type shows that nonstate actors can access space with minimal assistance or funding from states. SpaceX alone plans to deploy thousands of broadband satellites (Starlink) and requested approval for one million earth-based ground transmitters.[8] Not only does this illustrate the growing capabilities of nonstate actors, but it also highlights the number of potential vulnerable targets that are already accessible by nonstate actors.

As states become more reliant on space and as the cost of participating in space declines, it would be overly optimistic to believe that nonstate actors will not become increasingly greater threats, not to mention that nonstate actors can already carry out attacks on the ground that would have negative consequences for a state's interests in space, such as targeting launch facilities or personnel.[9] To prepare for some of these potential challenges, it is important to understand the nature of the actors that may present a threat.

Political Actors

Two types of violent political actors who may have an interest in attacking a country's space assets are guerrillas and terrorists. The differences between these two groups are often perceived to be academic and are biased by one's perspective of a conflict. But understanding the difference is important for decision makers because they relate to the behavior of the group, the degree to which the group has popular support, and how a group will respond to different types of government actions.

One of the most important distinctions between the two types of actors is that guerrillas generally attack military and government targets while terrorists generally attack civilian targets. Because of this distinction, guerrillas see the population as their support base that must be educated to the cause and won over while terrorists see the population as a means to an end that the group must target to achieve its goals. Mao Tse-tung, and later revolutionaries who followed his model, saw guerrilla warfare as part of the second phase of a revolution, the first phase being organization and the third phase being a conventional war.[10] Thomas Marks suggests that violence was a part of every phase of Mao's revolution, and interpreting violence (both terrorism and guerrilla warfare) as only part of the second phase is a misreading of Mao that is common among DOD counterinsurgency documents.[11]

For Mao, the type of violence a group uses is a function of the capabilities of the group relative to those of the state and the level of support the group receives from the local population. This means that whether a group targets civilians or military forces will depend on its capabilities, though Mao also saw the risk of targeting civilian populations and then having to rely on that base for support.

According to David Galula, there are two approaches to an insurgency, each involving five phases, though only the first two phases differ, while the last three phases are the same in each approach. In one approach, which he typically ascribes to revolutionary movements, the first two phases are about building the organization, educating the masses, and establishing a base of support from the population. The third phase then adopts violence in the form of guerrilla warfare. In an alternative process, which Galula relates primarily to nationalist movements, the first two phases use violence to educate, mobilize and build the organization. The first phase uses random acts of terrorism to garner attention to the cause. The second phase involves more selective terrorism to weaken the regime and strengthen the group before the group advances into the third phase of guerrilla warfare.[12]

In addition to the distinction between targeting civilians and combatants, guerrilla forces are generally larger organizations while a terrorist group may include just a handful of individuals. This distinction affects their behavior in several important ways. Guerrillas generally want to hold and keep territory to gain autonomy or independence from their existing government or to take over the government at some point in the revolution. Terrorists usually prefer to avoid holding territory or are not large and powerful enough to do so. Also, guerrillas are more likely to use conventional military tactics and are organized in a hierarchical way, much like a conventional military organization. Terrorists are more likely to use unconventional types of attacks and are more often organized as cells or in ac-

cordance with the concept of leaderless resistance, in which small cells operate autonomously with few connections across cells or between a cell and the larger organization's leaders.[13]

These structural differences further influence the behavior of groups and their vulnerability to government activities.[14] Hierarchical organizations are much more likely to follow the vision of the leader and engage in activities that more obviously reflect the strategic goals of the group. For this reason, guerrilla and terrorist leaders who want personal power, especially those who want to remain in power after achieving success, are more likely to create groups with this type of organization. There are two negatives to this structure: it is easier for strangers to join as new members, and it is easier for one member to gain a great deal of information about the workings of the organization. As a result, it is easier for government agents to infiltrate the organization and thus potentially to defeat it.

Groups with leaderless or cellular structures are more difficult to infiltrate and defeat because new recruits are usually someone known to existing members of the cell. Also, since there are no links between cells, members are unable to identify those in other cells or even the leadership. It is also more difficult to predict the behavior of leaderless groups because they do not answer to a single leader or follow one person's strategic vision. Cells within the organization may even engage in behavior that is rational for themselves but contrary to the interests of the movement as a whole, making it more difficult for a leader to control the organization. As a result, deterrence is more challenging against leaderless organizations.[15]

Despite these differences, the organizations themselves often muddle the distinction between guerrilla warfare and terrorism by engaging in both types of activities. In contrast to the concept of discreet phases, groups that are generally guerrillas sometimes attack civilians, and terrorist groups sometimes attack military targets. The distinctions will likely become even blurrier in space with many satellites having dual-uses, involving both military and civilian capabilities. Attacks against the Global Positioning System (GPS) constellation, for instance, could be targeting the US military or US society, or even nonstate actors dependent on the GPS system. Only the intent of the attack would help determine whether it would be considered guerrilla warfare (attacking military targets) or terrorism (attacking noncombatants), though that would only happen after the identification of the perpetrator, at which point that would be a mostly academic distinction. The result would be the same for the US government and the millions of people and businesses that rely on GPS.

Even if the differences between the groups were clear, should we consider personnel in space to be civilians or military? US astronauts who come from the military typically remain on active duty while seconded to the National Aeronau-

tics and Space Administration (NASA). Others who serve as scientists, engineers, and medical professionals, for example, are civilian federal employees. Also, not even the military officers would qualify as combatants while engaged in a space flight since they are not armed, nor are they in a combat zone.[16] Unless engaged in offensive space operations, most astronauts are noncombatants. As a result, attacks against them would be terrorism rather than guerrilla warfare (or war crimes if perpetrated by a state).

Having discussed some of the similarities and differences between the two types of actors, let us now turn to their likely activities. The distinction between guerrilla and terrorist will not fully determine their behavior as much as their purpose will, but the purpose often indicates which types of attacks a group will use and so contributes to whether a group is labeled guerrilla or terrorist. Important distinctions within each category may also influence a group's behavior.

Guerrillas are often domestic groups targeting their own government with the goal of establishing an independent state, or they are engaged in a struggle against a foreign power that they view as an occupying force.[17] Historically, many of these types of groups were motivated by a revolutionary cause (the Marxist-Leninist ideology of the Revolutionary Armed Forces of Colombia, as an example, or the Maoist ideology of Peru's Shining Path), where they sought a dramatic change in society and the government. Others are motivated by a desire for independence (like the Liberation Tigers of Tamil Eelam (LTTE) in Sri Lanka).[18] They may receive aid or support from outside parties, which can include financial, ideological, and military support and even personnel, but they typically have local rather than global goals. As a result, attacks in space by guerrillas would likely target their own government's capabilities or states that appear to be meddling in their national affairs. One example was the insurgency's use of jamming during Operation Iraqi Freedom. According to the "Space Threat Assessment 2018," insurgents deliberately jammed commercial satellite communications links used by the US military.[19] As long as those actors stuck to purely military targets, they would remain—at least in an academic sense—guerrillas.

Because most guerrillas would like the international community to view them as having legitimacy, and they would like to govern themselves at some point, either as a separate state or in a newly reconstituted state, they often refrain from attacks that are potentially costly to the civilian population, though there are exceptions where guerrilla groups engaged in terrorist activities. Also, guerrillas often value the sympathy or support of other states and of the international community. As a result, it is unlikely that groups that fall closer to the guerrilla side of the spectrum will engage in attacks against space interests that have long-term and broader consequences. For instance, these groups are unlikely to use kinetic

weapons to attack space assets. Such attacks would create a debris field that could subsequently damage other states' assets and potentially hurt or inconvenience civilian populations. Such consequences would weaken international support and so guerrilla groups will likely refrain from such activities. That does not mean kinetic attacks will not happen, just that they are more likely to be the work of terrorists who are less concerned with international perceptions. Instead, attacks by guerrillas are more likely to focus on effects like degrading an orbit, disabling a capability (like a state's communications satellites), or blinding a surveillance satellite to reduce a state's military advantage when engaging with the guerrilla forces.

Because of the similarities between space and cyberspace, we should also expect groups to engage in multidomain attacks using any available new technologies. As early as 1999, hackers seized control of a British military communications satellite with a home computer.[20] Guerrilla groups historically engage in a variety of cyber attacks, mostly to harass governments or to deny service to government agencies. For example, the LTTE, the now-inactive Tamil insurgent group in Sri Lanka referenced earlier, often engaged the Sri Lankan military in guerrilla warfare but also carried out terrorist attacks. It had a cyber unit as early as 1997 that frequently targeted the government. Beyond using its own website for propaganda and financing, the LTTE hacked government networks, engaged in denial of service attacks, and engaged in propaganda and counterpropaganda by hacking websites. In 2007, they even pirated a US satellite to send broadcasts to other countries.[21] Similar types of attacks are likely to occur against space assets as more groups gain the capability to do so.

Terrorist attacks against space capabilities could come in a variety of forms based on numerous motivations. Terrorist motivations could be driven by nationalism or a revolutionary ideology, similar to what motivates guerrillas but targeting civilians to achieve the group's goals. Groups also use terrorism for a variety of other reasons that may be local, regional, or global. Examples include religious differences, for antitechnological purposes, or simply as part of a neoanarchist movement hoping to prevent governments from becoming even more powerful through the exploitation of space.

Terrorists engage in several different types of tactics, against a variety of targets, though the target is often linked to the broader goals of the group. For instance, Marxist groups are more likely than others to target private businesses, religious groups are more likely than other types of groups to target other religions, and white supremacist groups often attack minorities or minority businesses. Given that terrorists—and guerrillas, for that matter—generally attack targets that are consistent with their strategic goals, what would motivate groups to target a country's space assets? It could simply be a group that wants to reduce the power of the

state or a group that opposes the state's ideology. Also possible are attacks by groups that oppose the weaponization of space or that oppose technology more broadly, focusing on a state's policies in space rather than the nature of the state itself, much as single-issue terrorists focus on a state's treatment of animals or its abortion laws. Many Americans oppose spending money on space when there are economic or social problems at home, so it is not too much of a stretch to expect violence in opposition to using resources on space.[22]

Terrorists are generally less concerned with political backlash than are guerrillas. They are less likely than guerrillas to worry about the ramifications of creating debris in space or of inconveniencing civilian populations. That means terrorists are more likely to employ some type of kinetic capability, such as antisatellite rockets. This is consistent with the record of terrorist activity on the ground, which overwhelmingly involves the use of bombs or explosives. According to the Global Terrorism Database, bombings account for 49 percent of all terrorist activity between 1970–2017. For comparison, the next most common tactics are armed assaults and assassinations, accounting for 25 percent and 11 percent, respectively, though there is some temporal and regional variation.[23]

Also, while terrorists often attack targets related to their goals, they sometimes attack symbolic targets or targets intended to elicit a reaction (usually an overreaction from a government).[24] The al-Qaeda attack on 9/11 was as much for symbolic value and to get a US response as it was to achieve a group objective. As a result, we cannot rule out the possibility of a terrorist group attacking a state's space interests to generate publicity or to show it has the ability to attack a target even in space.

Having said that, such a capability will be difficult for independent groups to achieve in the near-term. Because terrorists are generally less capable than guerrillas, those who are capable of attacking space interests will most likely be either larger organizations with the ability to develop applicable resources, and/or groups that have a state or corporate sponsor that provides those capabilities. While the most likely source may be a state sponsor, states are also more likely to reign in their proxy groups to avoid retaliation from the target. As long as only a small number of states could carry out an attack in space, states will be reluctant to furnish terrorist groups with those capabilities, out of fear of easy attribution and retaliation.

On the other hand, as the number of actors with such capabilities grows, attribution will become more difficult, and states may accept the risk of allowing a proxy to carry out an attack if it weakens an adversary's ability to wage war or defend its interests. And as the cost of entry comes down, more groups will have the ability to carry out attacks. Even smaller independent groups now have the

ability to carry out conventional attacks against launch facilities on the ground and personnel affiliated with space. According to a 2008 briefing by Randy Jones, director of the Defense Intelligence Agency's Missile and Space Intelligence Center, terrorists already had the ability to engage in cyberattacks and the jamming of satellites and could disable satellites with lasers by 2020.[25]

There are several other ways groups could target a state's space assets. Once a group has the ability to put something in orbit, it could self-detonate and the debris field itself would threaten any assets in that orbit. Authorities are particularly concerned about nonstate actors being able to use our own technology against us. One fear is of satellite systems being used for microwave-like attacks. Another is the targeting of the atomic clocks on GPS satellites, which could effectively "warp time."[26] Given there are already private companies capable of launching objects into orbit, we should not assume these are simply theoretical scenarios.

Although it may seem unlikely terrorist groups would target space capabilities, it is not without historical precedent. As far back as 1972, groups were thinking about using attacks against space assets to enhance their cause or gain more publicity. The Black September Palestinian group threatened an attack against the Apollo 17 mission, specifically to murder or kidnap the crew or their families. That same group killed Israeli athletes at the Munich Olympic Games earlier that year, so NASA took the threats seriously.[27] Joshua Gelernter claims the attacks were thwarted, while Eugene Cernan's autobiography suggests security patrols were added to the families' homes and schools, but no attack took place.[28] More recently, in 2003, NASA increased security for the Columbia shuttle launch, out of concern that al-Qaeda would attack the launch pad because of the Israeli astronaut on the flight.[29] In 2013, a letter threatening terror attacks was found at an Indian Space Research Organization (ISRO) facility in Bangalore, India.[30]

It is one thing to threaten an attack, or for an agency to be concerned about attacks, but there have been real attacks against ground installations and satellites. On 3 August 1984, just two days before the launch of an Ariane satellite, the French left-wing group Action Directe bombed the European Space Agency's (ESA) Paris headquarters, injuring six people.[31] The ESA was also hacked in 2015 by the group Anonymous, resulting in the leak of thousands of credentials.[32] Also, an ISRO computer was infected with malware, which could have given hackers control of rocket launches and satellite separation.[33] While violent extremist organizations are not responsible for these last two attacks against ESA and ISRO, the incidents illustrate the existing capabilities of nonstate actors.

Also, if states continue to use their space capabilities to target nonstate actors, then we should expect space assets to become a bigger target for these groups. As an example, the Indian government used its satellites to help strike terrorist camps

in Kashmir.[34] Such uses of technology are valuable but also invite retaliation against the technology itself, or its operators.

One tactic used by modern terrorists is suicide bombings.[35] While this type of attack is often associated with Islamic extremist groups, not all Islamic groups engage in the tactic and other types of groups use suicide bombings. The most prominent non-religious group to use suicide bombing is the now-inactive LTTE, discussed above. There is significantly less history of suicide bombings being carried out by either right-wing or left-wing groups, or by single-issue groups (groups engaged in violence over a specific interest like animal rights, environmental rights, antiabortion, and so forth). Because of the difficulty of putting people in space for the near term, terrorists are unlikely to use this tactic against assets in space, though it may still be used by certain types of terrorist groups—presumably those already inclined to the use the tactic—against ground facilities and personnel.

While the distinction between terrorists and guerrillas often seems academic, the difference is real and important because it is based on the activities of the group, and that affects the degree to which any particular group poses a threat to a state's interests in space. While the distinction is important, just as important is the group's motivation for carrying out violent attacks in the first place, regardless of whether they are directed at civilians or military, on the ground or in space. The conclusion discusses some of the ways these groups respond differently to state actions and proposes measures to both deter and defend against actors motivated by political goals, particularly when compared to those motivated by commercial interests.

Commercial Actors

Although we cannot rule out the possibility of companies engaging in a variety of activities against competitors, including corporate espionage, theft of intellectual property, and sabotage, the most likely near-term scenarios involve what is more accurately thought of as piracy. In these scenarios, nonstate actors, operating either on their own or under the direction of a company or state, will engage in violent activities against a state's interests in space. These attacks are less likely to be about causing mayhem or achieving some political goal and are more likely to involve the types of activities that can generate a profit for the group or garner market advantages for its sponsor. From October 2010–September 2011, NASA computers experienced more than 5,400 incidents of malicious software or unauthorized access, in some cases described as having "full control over those networks." Some of these, according to investigations, may have come from individual hackers and some from foreign intelligence services, but others were carried out by criminal groups attempting to profit off the information they obtained.[36]

Unlike guerrilla warfare and terrorism, where there is neither a consensus academic definition nor an accepted definition in international law, there is a United Nations definition of *piracy*. Article 101 of the United Nations Convention on the Law of the Sea (UNCLOS), adopted in 1982 and currently ratified by 167 states, defines piracy as:

> (a) any illegal acts of violence or detention, or any act of depredation, committed for private ends by the crew or the passengers of a private ship or a private aircraft, and directed:
>
> (1) on the high seas, against another ship or aircraft, or against persons or property on board such ship or aircraft;
>
> (2) against a ship, aircraft, persons or property in a place outside the jurisdiction of any State[37]

This definition is an appropriate starting point for attacks by nonstate actors in space, given the lack of state jurisdiction, and because it includes attacks against property and not just people.[38] There are two interesting elements of the UNCLOS definition when applied to *space piracy*. One is that it obviously focuses on maritime piracy but ignores broader acts of theft that one could also describe as piracy. These acts can involve the theft of intellectual property, theft of communication signals and the information they contain, or even the theft of property itself.[39] The second interesting element of the UNCLOS definition is the phrase "for private ends," which is somewhat broad, but which I interpret to mean for profit or for commercial gain. This sets apart nonstate actors who engage in piracy from the guerrillas and terrorists who engage in violent activities for political gain.

If nonstate actors believe it is possible to profit from any of these activities, then we will see space pirates emerge. Three likely sources of revenue from this type of activity include groups: 1) operating on their own and selling what they steal (most likely information); 2) acting as a proxy for a company targeting its competitors (most likely involving sabotage or corporate espionage); or 3) having a state sponsor that provides financial support in exchange for sowing disorder on an adversary. While this third source of funding blurs the line between commercial and political activities, if the group does not itself have political goals in attacking targets, then it is acting purely for private, mercenary ends and is a commercial actor.[40]

Groups operating off the coasts of Somalia and western Africa are perhaps the best illustrations of modern-day maritime piracy. These groups may have some political goals in terms of controlling their local territory (that is gaining or preserving power), but their activities against commercial shipping are primarily for profit and even their territorial goals are ultimately about financial security. In

most cases, these groups seize a ship and its cargo and eventually release crewmembers. Although pirates have killed some crewmembers, most would rather receive a ransom for the release of the crew. North Atlantic Treaty Organization and European Union operations against piracy have been relatively effective,[41] and this provides one possible model for dealing with space piracy. One state acting alone cannot resolve the problem, because threats to commerce affect the international community, and actors engaged in that behavior will need to be dealt with collectively. Nor do current counterpiracy operations adequately address the root causes of piracy, which often involve a breakdown of local government. Likewise, current international law is not set up adequately to address the problem of space piracy.[42]

On the other hand, recent cyberattacks suggest that states that are the target of attacks by a company or state using a nonstate proxy will be left to deal with the attack largely on their own.[43] That does not mean international cooperation cannot work under such circumstances, just that it is less likely when multiple interests are not being threatened. It does mean states need to be thinking about the ramifications of similar behavior in space, and whether current laws and treaties sufficiently address the problem. One reason the US has not ratified UNCLOS is concern over the potential precedent it might set for space.[44] But that may be the best reason for the US to ratify UNCLOS now because it would provide states greater flexibility and leverage to go after nonstate actors responsible for carrying out attacks in space.

Conclusions and Recommendations

This article is a preliminary examination of the possible threats to states from nonstate actors. It cannot possibly cover all the scenarios that threaten space capabilities or utilize space to threaten states themselves. It is intended as a starting point to spur thinking about the reality that future conflicts will not involve just great powers, as much as the DOD might be more comfortable preparing for peer competition and distancing itself from the types of operations it employed in the last decade and a half. A 2016 Chatham House research paper suggested that, along with nation-states and individual hackers, "cyberthreats against space-based systems include... well-resourced organized criminal elements seeking financial gain; [and] terrorist groups wishing to promote their causes, even up to the catastrophic level of cascading satellite collisions."[45] States clearly pose the greatest threat to space assets if we only focus on capabilities. The more likely threat comes from nonstate actors. If we stop thinking about asymmetric warfare or the ability of nonstate actors to influence states, then states will be caught off-guard by at-

tacks that should otherwise be anticipated. This is as true in the space domain as it is on the ground.

Unfortunately, current technology makes space an offense-dominant domain. Despite the cost and technological difficulty of reaching space, it is relatively easy to carry out attacks, at least compared to the cost of defending capabilities in space. As the cost of entry declines over time, if offense remains dominant, then the application of asymmetric space warfare by nonstate actors will become an even greater threat to all states with interests in space. A critical question moving forward is whether the space domain, by its nature, will perpetually favor the offense or if defense will eventually become prominent. The history of warfare suggests that when offense has the advantage, governments will pursue more effective defenses, to overcome an adversary's offensive advantages. As a result, one thing states must do is pursue defensive capabilities in space, both to defend against attacks from nonstate actors and to reduce the likelihood of war.[46] Violence between states become less likely when leaders believe it is easier to defend than to attack, so while it can be difficult to distinguish between offensive and defensive capabilities, enhancing the defensive capabilities of all space assets will reduce the threat of nonstate actors without decreasing stability in the international system.[47]

Where that distinction between *terrorist* and *guerrilla* might matter most is in how states deal with those who carry out such attacks, though states traditionally deal with domestic actors the same way regardless of their label and nationality.[48] The fact that space is not sovereign territory for any one country would further complicate things because it would necessarily involve international law. Although attacks may target people on the ground, most attacks in space would be directed against property, posing a challenge for states that want to identify such attacks as terrorism. The Federal Bureau of Investigation definition of *terrorism* includes attacks against property,[49] and although the DOD definition leaves room for attacks against property, it does not specifically reference such attacks as being acts of terrorism.[50] As a result, attacks by nonstate actors against a civilian asset in space, might not be considered an act of terrorism by the DOD but would be terrorism by the FBI as long as it satisfied the other elements of the definition. These issues are beyond the scope of this article, but the broader point is that many states still struggle with how to deal with nonstate actors who engage in political violence on the ground. This will be further complicated when non-state actors begin to target state capabilities in space.

Beyond emphasizing defensive measures, to what extent can states deter any of these nonstate actors from engaging in attacks against space interests? All three types of actors discussed in this article—pirates, guerrillas, and terrorists—are generally rational, so by traditional deterrence logic they should be deterrable.

However, selfish actors are deterred more easily than those who are acting for selfless reasons,[51] so pirates should be more easily deterred than either guerrillas or terrorists since pirates are pursuing a financial gain that directly benefits them, rather than a political goal that might only benefit future generations. That does not mean deterrence will not work against groups with political motivations, but the same challenges for deterring terrorist groups on the ground apply to deterring their activities in space. According to the CSIS Space Threat Assessment 2018, "Deterrence can be particularly challenging for non-kinetic, electronic, and cyber methods of attack because these can be more difficult to detect and attribute and can have reversible effects."[52] States will have to be clear what activities they wish to deter, increase their ability to assign attribution to specific actors, and then have the ability and will to respond if actors ignore their deterrent threats. At the same time, states have to be cautious of overreaction, because terrorists often attack to elicit an extreme response from a government, which further increases awareness of the group's cause or sympathy for the group itself.

In the case of state or corporate sponsors, states will also have to make deterrent threats against them and must again have the ability and will to punish those sponsors for the activities of their proxies. Also, maintaining the support of international partners and various populations will be critical and perhaps limit the ability of states to respond using military force, but the other instruments of national power (diplomatic, informational, and economic) may be more effective against these groups and their sponsors. This means understanding the reasons a group might engage in violence and addressing any legitimate complaints that lead people to join that group to reduce the number of sympathizers in the population and shrink the possible base of support.

Beyond developing the defensive capabilities to reduce the effects of an attack, and enhancing attempts to deter nonstate actors, how will we treat captured pirates, guerrillas, and terrorists? The answer is complicated by the nature and location of the attack, the citizenship of the responsible actors, and who captures them and where. The jurisdiction would likely be that of the international community since national sovereignty does not extend into space. Yet even that is more complicated because states own their space assets. As with cyberattacks that could emanate from anywhere, an attack against a US satellite would likely fall under US jurisdiction to prosecute, assuming the responsible parties could be arrested and extradited to US soil. In the end, states and the international community need to expand discussions dealing with nonstate threats to space because such responses will necessarily rely on a mix of individual state laws, international law, and international norms. Hopefully, this article pushes leaders toward thinking in those terms and avoiding a tunnel-vision focus on great-power competition. ✪

Notes

1. However, the *National Security Strategy* does not refer to these rivalries as hostile. Executive Office of the President of the United States, *National Security Strategy of the United States of America* (Washington, DC: US Government Printing Office, December 2017), https://www.whitehouse.gov/wp-content/uploads/2017/12/NSS-Final-12-18-2017-0905.pdf.

2. In a statement at the beginning of the third meeting of the revived National Space Council, President Trump said, "I'm hereby directing the Department of Defense and the Pentagon to immediately begin the process necessary to establish a Space Force as the sixth branch of the armed forces." Sandra Erwin, "Trump: 'We Are Going to Have the Space Force,'" *Space News*, 18 June 2018, https://spacenews.com/trump-we-are-going-to-have-the-space-force/; and Mike Wall, "Trump Signs Directive to Create a Military Space Force," *Space.com*, 21 February 2019, https://www.space.com/president-trump-space-force-directive.html.

3. Hanna Krueger, "In Space, U.S. and Russia Friendship Untethered," *NBC News*, 30 September 2017, https://www.nbcnews.com/news/us-news/space-u-s-russia-friendship-untethered-n806101; and Simon Saradzhyan and William Tobey, "US-Russian Space Cooperation: A Model for Nuclear Security," *Bulletin of the Atomic Scientists*, 7 March 2017, https://thebulletin.org/2017/03/us-russian-space-cooperation-a-model-for-nuclear-security/.

4. Robert Jervis, "Cooperation under the Security Dilemma," *World Politics* 30, no. 2 (January 1978): 167–214, https://www.jstor.org/stable/2009958?seq=1#page_scan_tab_contents; and Charles Glaser, "The Security Dilemma Revisited," *World Politics* 50, no. 1 (October 1997): 171–201, https://www.jstor.org/stable/25054031?seq=1#page_scan_tab_contents.

5. Adam Routh, "The U.S. Military Should be Doubling Down on Space," *DefenseOne.com*, 1 August 2018, https://www.cnas.org/publications/commentary/the-u-s-military-should-be-doubling-down-on-space.

6. Gen John W. "Jay" Raymond, head of US Air Force Space Command stated: "Space is a warfighting domain just like air, land and sea. We have to be prepared to fight a full range of operations." Quoted in Colin Clark, "Exclusive: War in Space 'Not a Fight Anybody Wins'—Gen. Raymond," *Breaking Defense*, 6 April 2017, https://breakingdefense.com/2017/04/exclusive-war-in-space-not-a-fight-anybody-wins-gen-raymond/.

7. As of 2018, 72 governments had a space agency. Of those, 14 had proven orbital launch capabilities, only three of which have put a human into space (India hopes to be number four by 2022). Peter Farquhar, "Australia Finally has a Space Agency—Here's Why It's about Time," *Business Insider Australia*, 2 July 2018, https://www.businessinsider.com.au/australia-space-agency-value-2018-7; and Swati Gupta, "On Independence Day, Modi Promises Manned Space Mission," *CNN*, 15 August 2018, https://www.cnn.com/2018/08/15/asia/india-manned-space-flight-intl/index.html.

8. Arthur Villasanta, "SpaceX to Build 1 Million Earth Stations to Track 12,000 Satellites, FCC License Details," *International Business Times*, 10 February 2019, https://www.ibtimes.com/spacex-build-1-million-earth-stations-track-12000-satellites-fcc-license-details-2761987.

9. In 2004, Russian military security forces placed the Baikonur Cosmodrome on the top of its list of potential terrorist targets in Kazakhstan. James Oberg, "Earthly Threats for a Spaceport: Baikonur Faces Future Insecurity Without Military Presence," *Space Review*, 26 June 2006, http://www.thespacereview.com/article/647/1/. After 9/11, the US became particularly concerned with security involving the shuttle program, as well as how to use the space program in the War on Terror. Also, *see* Denise Chow, "NASA & Military After 9/11: Grappling with US Space Security," *Space.com*, 8 September 2011, https://www.space.com/12867-september-11-nasa-military-space-security.html.

10. Mao Tse-Tung, *On Guerrilla Warfare* (Champaign, IL: University of Illinois Press, 2000).

11. Marks cites Joint Publication 3-24, *Counterinsurgency Operations*, as one example. *See* Thomas Marks, "Mao Tse-tung and the Search for 21st Century Counterinsurgency," *CTC Sentinel* 2, no. 10 (October 2009): 17–20, https://ctc.usma.edu/mao-tse-tung-and-the-search-for-21st-century-counterinsurgency/.

12. David Galula, *Counterinsurgency Warfare: Theory and Practice* (Westport, CT: Praeger Security International, 1964), 30–42.

13. Louis Beam, a white supremacist leader, wrote one of the earliest works on this model. Beam, "Leaderless Resistance," *The Seditionist*, 12 February 1992, http://www-personal.umich.edu/~satran/PoliSci%2006/Wk%2011-1%20Terrorism%20Networks%20leaderless-resistance.pdf.

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15. Gregory D. Miller, "Terrorist Decision Making and the Deterrence Problem," *Studies in Conflict & Terrorism* 36, no. 2 (February 2013): 132–51, doi: 10.1080/1057610X.2013.747075/.

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17. The DOD definition of a guerrilla force is: "a group of irregular, predominantly indigenous personnel organized along military lines to conduct military and paramilitary operations in enemy-held, hostile, or denied territory." Joint Staff, *Joint Publication 1-02: Department of Defense Dictionary of Military and Associated Terms* (15 February 2016), s.v. "guerrilla force," https://fas.org/irp/doddir/dod/jp1_02.pdf.

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46. John Hyten made a similar call in 2002 about the need to better prepare for all future conflicts in space, whether involving states, companies, or individuals. He argued that while the US should not yet deploy weapons to space, it needs to expedite its efforts to develop them. John Hyten, "A Sea of Peace or a Theater of War: Dealing with the Inevitable Conflict in Space," *ASPJ*

16, no. 3 (Fall 2002): 78–92, https://www.airuniversity.af.edu/Portals/10/ASPJ/journals/Volume-16_Issue-1-4/Fall02.pdf.

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49. The FBI definition of terrorism is: "the unlawful use of force or violence against persons or property to intimidate or coerce a Government, the civilian population, or any segment thereof, in furtherance of political or social objectives." US Department of Justice, Federal Bureau of Justice, *Terrorism in the United States 1998* (Washington, DC: Government Publishing Office, 1998), 28 C.F.R. Section 0.85. Interestingly, the NATO definition of terrorism is more similar to this than it is to the DOD definition in terms of including attacks against property.

50. The DOD definition of *terrorism* is: "the unlawful use of violence or threatened violence, often motivated by religious, political, or other ideological beliefs, to instill fear and coerce governments or societies in pursuit of goals that are usually political." Joint Staff, *Joint Publication 1-02*, Department of Defense Dictionary of Military and Associated Terms, 15 February 2016, s.v. "terrorism," https://www.jcs.mil/Portals/36/Documents/Doctrine/pubs/dictionary.pdf/.

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FEATURE

Thinking Differently about Air Bases

Evolving with the Evolving Strategic Environment

Col Kevin L. Parker, USAF

This 2016 statement from Miranda A. A. Ballentine, the former assistant secretary of the Air Force for Installations, Environment, and Energy, remains true today and is a call to action for the Air Force, DOD, and Congress. "The Air Force is currently maintaining installations that are too big, too old, and too expensive for current and future needs."[1] The USAF has performed the same core missions from its bases since 1947. How the service performs those missions has changed drastically since then. According to the *Air Force Future Operating Concept*, this evolution will continue.[2] Despite these changes, the Air Force's bases will remain essential because "the foundation of Air Force readiness and lethality is an integrated network of resilient installations."[3] However, changing factors in the strategic environment demand that the service changes the way it operates, maintains, modifies, and protects its permanent air bases.

Many concepts in this article apply to Base Realignment and Closure (BRAC), but BRAC is not the only answer. BRAC is indeed sorely needed and necessary to reduce costs; however, neither BRAC, nor reforms on the margins, will adequately prepare Air Force bases for the future. Without deliberate adaptation,

today's bases will not meet the demands of the future strategic environment. Achieving different outcomes will take new thought and actions. Thinking differently about air bases requires starting with strategy, breaking down installations to the fundamental functions they perform, and rebuilding the network of bases with strategy in mind.

What's Changed?

With continued fiscal pressure, the service will still be asked to do more than its resources allow.[4] This gap is unlikely to close with constrained federal budgets and growing mandatory spending. Fiscal relief in the 2019 defense budget did not solve all challenges.[5] The 2018 *National Defense Strategy* (*NDS*) called for providing lethal combat capabilities at less cost with better management, affordability, budget discipline, and financial stewardship.[6] Lack of resources may sound like a timeless problem, but the cumulative effect has contemporary consequences. The 2019 US Air Force Infrastructure Investment Strategy states, "Two decades of taking risk in infrastructure created a fiscally unsustainable posture" and that current funding levels will create "readiness and lethality risks due to continued and increasingly rapid degradation of infrastructure."[7]

There are also operational changes. Global reach—the ability to quickly create effects around the world—has long been one of the Air Force's fundamental competencies. Global reach has meant the ability to launch intercontinental ballistic missiles or fly anywhere worldwide to drop bombs or supplies. Whether B-2 bombers on 40-hour missions, orbiting space capabilities, unmanned intelligence, surveillance, and reconnaissance platforms, or effects produced through cyberspace, much more of the Air Force now has global reach compared to 1947. Adversaries have similarly grown in global reach. Cyber, missile, and terrorism threats present risks for air bases with a new level of complexity. In an era of great-power competition as described in the *NDS* and hybrid or gray zone warfare, the line between peace and war is now thin and porous—and is likely to become more so.[8] These changes in the strategic environment should influence the Air Force's approach to its installations.

What Functions Do Air Bases Perform?

The evolution of air bases may not have kept pace with the changes in airpower and the strategic environment. Not every base serves the same purpose. The types of assigned missions span a wide range, but most bases look and feel similar despite specialized missions. Exploring possibilities for improvement requires a detailed look at the types of air bases that exist and the functions they perform. There

are four major categories of Air Force installations: force employment, force generation, force development, and institutional headquarters.[9] Some bases serve a combination of these categories, but the functions are consistent across the service.

Force employment is the first major category of air bases. Airmen project airpower against adversaries from these bases, which include locations within and outside the US. There are three types of force employment bases: direct-power projection, bases stateside with ongoing combatant commander missions, and integrated reach-back bases.

Direct-power projection bases are typically overseas, have assigned forces under a combatant command, and are within operational reach of probable military objectives. One example is RAF Lakenheath in the United Kingdom with personnel and F-15s assigned to US Air Forces in Europe under US European Command. Bases in this category face increasing ballistic missile threats, which create greater challenges to survivability of forces while on these installations. Countering this changing threat may drive new weapons and operational concepts. Until those long-lead-time changes occur, direct-power projection bases will remain consistent into the future.

The second type of force employment bases consists of installations in the US conducting combatant commander missions. Many of these missions have been performed from the states for decades. For example, homeland defense missions in airspace control and fighter intercepts now under US Northern Command date back to when America's air forces were envisioned as key to coastal defense in 1933.[10] Nuclear deterrence forces with intercontinental ballistic missiles under US Strategic Command also fit this category. These missions are being conducted around-the-clock, every day from installations within the US.

The third type of force employment base is the integrated reach-back base. This continually evolving category is home to combatant commander missions that have not traditionally been performed from within the US. These missions were previously performed within a forward theater of operations, but advances in technology and telecommunications have enabled over-the-horizon operations. One example is intelligence processing, exploitation, and dissemination (PED) conducted at distributed common ground stations with globally networked intelligence capabilities. This mission was formerly performed in a forward theater out of necessity to meet dynamic requirements in a relevant timeframe. Once telecommunications advanced significantly, much of PED was moved out of theater to be performed as reach-back. Well-removed from harm's way, analysts are now connected with information collection platforms to provide timely intelligence to units engaged in operations.

Other advances have allowed over-the-horizon operations to evolve from mere reach-back to now actively participating in battlefield operations with limited forward physical human presence. MQ-9 Reaper operations exemplify this type of mission. Launch and recovery teams, with small footprints, make up the forward presence. Separate mission control elements perform flying and intelligence collection from the US with no proximity ties to a runway. In attack squadrons, these remote elements can even strike targets. Cyber operations go a step further because they can be performed entirely from the rear with no forward presence.

War-fighting headquarters (not an organize, train, and equip Title 10 headquarters) also fit in the integrated reach-back category. Air Force component headquarters, along with the command and control (C2) functions for conducting combatant-commander-directed operations, are part of the apparatus to employ airpower. One example is an air operations center (AOC), a C2 organization for wielding airpower for joint force commander objectives. AOCs provide strategy, targeting, weaponeering, and direction to units conducting air operations, but they do not need to be directly in harm's way. For example, the AOC for Operation Odyssey Dawn over Libya in 2011 was a continent away in Ramstein AB, Germany.[11]

Force generation is the second major category of air bases; these bases are home stations for units not actively engaged in mission operations but could be tasked to do so. These bases are where units prepare for the moment when they are called into action. When returned from forward operations, units use these bases for rest and refit. The home station is primarily used for operational proficiency training to be ready for the next fight. This is where aircrews fly training missions to maintain currency in their wartime skills. Deployment readiness is a key component of force generation bases. Not only do these bases support readiness but assigned units must also be prepared to mobilize and deploy to a theater of operations so they require the infrastructure capacity to support the deployment of assigned forces. Force generation deployment timelines vary by assigned mission type and component; that is, active duty forces are usually postured to "get out the door" quicker than Reserve component units.

Force development is the third major category of air bases and includes training and education, depot maintenance, research and development (R&D), and acquisition functions. These bases develop the force—Airmen and their weapon systems.

The Air Force trains and educates Airmen at all levels. Training missions include basic training for initial officer and enlisted entry into service. Technical training covers applied skills through courses within career specialties through basic and advanced level courses, including undergraduate flight training. Educa-

tion units provide Airmen with knowledge and thinking skills through professional military education and other offerings.

Depot maintenance, another force development activity, provides major overhauls and modifications to weapon systems—mostly aircraft. Depots perform maintenance support beyond the scope of line or field-level maintenance units. Without depot maintenance, B-52s and C-130s would not still be flying after more than 50 years. Depots keep planes flying by extending their service life and making them more capable through weapon system modifications. These upgrades make platforms more capable through efficiencies, added capabilities, and modernization. Depots provide force development by sustaining a viable force and handing improved assets back to the operational force.

The last type of force development base—R&D—explores science and technology for potential military applications. These missions take promising technologies and conduct specific research to further develop them for fielding. Acquisition functions then procure and field operational systems. Management of research, development, testing, and procurement is performed at R&D bases, which primarily develop the "machine" portion of the force.

Institutional headquarters, the fourth and final major category of bases, are necessary to operate and sustain a viable force. Headquarters performing the C2 of assigned forces under combatant commanders were covered above in the force employment category. But the headquarters mission to organize, train, and equip forces for use by combatant commanders, as specified by Title 10, is largely administrative in nature. Institutional headquarters bases host administrative functions required for running a large organization, such as personnel management, payroll, household goods movement management, centralized management of installations support, and so forth. Examples of Air Force and joint organizations that perform these functions are the Air Force Personnel Center, Defense Finance and Accounting Services, Joint Personal Property Shipping Office, and Air Force Installation and Mission Support Center. These examples and others administer the business of the force. When considered together, functions of the four major base types build on each other to produce airpower: administer the force at institutional headquarters bases, develop the force at force development bases, generate the force at force generation bases, and employ the force at force employment bases.

Where Should Air Bases Be?

For some functions, location matters from a geostrategic perspective. For force employment, weapon systems have to be within operational range of the likely locations on which they will be expected to create effects. This means an air-to-ground fighter unit must be within reasonable flight times of targets it is expected

to strike. Similarly, tanker units must be within reasonable flight times of the refueling tracks where they will be needed. These principles are no different than when Giulio Douhet considered force structure and locations of a budding Italian Air Force in 1921.[12]

For force generation, key attributes are those that contribute to mobilization and training; location can matter here too. For Army units, force generation requires deploying thousands of tons of materiel to a fight, so access to railroad and ship transportation nodes are important. Although proximity to transportation nodes is also key for air forces, they are slightly less critical due to the ability to airlift Air Force assets, aircraft that can self-deploy, and the need to get to the fight quickly.

Some force development bases benefit from favorable location characteristics. For example, to maintain necessary levels of readiness in flying units, regions with predominantly fair weather and access to ranges are beneficial. Weather is also important to some, although fewer, activities of force development bases. For basic training, weather should be sufficient to accommodate outdoor activities like marching. Undergraduate flying training needs predictably good flying weather with infrequent interruption from extreme winds, fog, or storms. In contrast, professional military education and most technical schools could take place at any location. Similarly, institutional headquarters have no location requirements driven by weather, terrain, or geostrategic interests.

What Is on Air Bases?

With a grasp of where bases should be, analyzing air bases further requires evaluating what is inside the fence-line. Airmen, facilities, and equipment on any air base are partially tied to the assigned missions from the categories above (force employment, force generation, force development, institutional headquarters). The concentric rings shown below (see fig. 1) describe how tightly these activities connect to assigned missions. Among all resources on a base, some are directly tied to generating the assigned mission (that is, fighter pilots, maintainers, and maintenance hangars at fighter force generation bases; or missileers, maintainers, and silos at ICBM force employment bases). This set of resources performs **mission generation** and is the tightest ring of activities around the mission. This ring is necessary to conduct the mission but alone is not sufficient to sustain mission operations or a viable force.

Mission support, the next ring out, is made up of activities that enable mission generation; that is, supply functions, fire stations, telecommunications network operations, and so forth. Many of these activities are necessary to generate the mission, especially over an extended period of time. For example, launching all

scheduled sorties is possible on one day, but repeating the same schedule the next day often requires resupply.

Community support, the farthest ring, is full of activities like commissaries, child development centers, libraries, and so forth. Few of these have a direct link to mission generation but most do impact keeping Airmen happy, healthy, productive, and importantly—re-enlisting. Community support is not necessary to fight, but it is key to having a fighting force. These concentric rings not only describe what activities are on air bases now but can inform what should be on air bases in the future.

Figure. Concentric rings show how tightly community support, mission generation, and mission support activities connect to assigned missions.

Not all bases are created equal. Air National Guard and Air Force Reserve bases have few community support facilities because most citizen Airmen who make up the Reserve component do not work on base full-time. In their citizen role, they have jobs, homes, and communities outside of the Air Force. They also typically spend more time in their communities before relocating, which allows time to establish robust ties with support networks. These factors allow Reservists and Guardsmen, in their Airmen's role, to rely significantly less on Air Force-provided community support.

Most active duty bases function, look, and feel much the same with many similar activities and facilities. Almost all include a commissary, base exchange (retail sales store), dining facility, dorm complex, family housing, fitness center, and chapel. This generally standardized look and feel may be comforting to Airmen who have spent most of their adult lives on Air Force bases, but it may not match the future strategic environment. Like the Reserve component, each active

duty base should have its mission support and community support activities tailored to fit its purpose and circumstances.

One potential strategic mismatch is military family housing on air bases. As worldwide missile threats proliferate in range, lethality, and quantity, leaders should consider the appropriateness of housing families on bases.[13] Continuing to house families on overseas bases may be seen as irresponsible, especially where missile flight times from adversaries are shorter, providing less warning. With further proliferation, the differences between missile threats on bases within the US and those outside will diminish. The future will also require deliberating the appropriateness of housing families on base within the homeland. Housing is only one of many examples of what could or should shift off base.

What's outside the Fence?

Few air bases are self-contained islands; so, equally important to what is inside the fence-line, is what lies outside. Some Air Force bases grew up from civil airports after expansion of the Army Air Corps in World War II.[14] Much like early coal mining towns, these outposts grew into cities in their own right. Since there were not enough facilities and services to eat, live, exercise, educate dependent children, or worship, the Air Force (or its organizational predecessor) built dining facilities, houses, gyms, schools, and chapels. These basic services spread to commissaries, exchanges, libraries, clubs, intramural sports fields, swimming pools, and various morale, welfare, and recreation facilities and services. Life on an Air Force base became familiar and relatively standard from place to place. Many mission support and community support services were necessary, and all were added value to Airmen. However, those were different times in a different environment. Despite growth outside the fence, bases have remained mostly unchanged and now have duplicative community support activities on and off base.

Military family housing is one area that has incrementally adapted to off-base growth. The Air Force mechanism for defining housing requirements for on-base housing is a Housing Requirements Market Analysis. Its methodology includes defining a floor requirement for on-base housing consisting of two primary components. First is the group of "key and essential personnel" who are required to live on base for command and control or response needs. Second is 10 percent of military personnel assigned to the base. This second component's purpose is to "maintain a viable military community." After these two floor requirements are met, the methodology looks to maximize the use of off-base housing. If community housing can accommodate all other military families, then no additional housing will be built or maintained on base. Only the deficit that community housing cannot absorb drives a requirement for additional on-base housing. DOD

and Air Force policy stress reliance on the private sector as the primary source for housing for accompanied personnel.[15] With this methodology, housing is one of the bright spots where the services and facilities on base have adapted to off-base community growth.

Although housing is a bright spot for some modernizing adjustments, it still has room for improvement. The methodology still includes a 10-percent floor to maintain a military community on base. As a requirement driver, it is unclear why the DOD allows and the Air Force wants non-key- and- essential families to live on base or why 10 percent is sufficient to form a "military community." Where adequate community housing has sufficient capacity, there is no evident need for the Air Force to house families on base. One example is Aviano AB, Italy, which has no on-base housing at all, but the 31st Fighter Wing assigned there accomplishes its mission every day without on-base housing for key and essential personnel or a "military community" on base. The floor requirement methodology is an anachronistic policy by the Air Force and DOD; its continuance drives a significant bill for maintaining government housing (even if through privatization) and the staff to run it. Based on the annual price tag, the value of the military community feeling for such a small population may not be worth the cost and warrants a policy refresh.

Other base services also need a take another look at evaluating the availability of identical services in local communities. Here are a few examples. Maxwell AFB is in Montgomery, Alabama's capital city of 200,000 people. Maxwell has a base exchange, while there are three major shopping areas and three major discount retailers within 12 miles. There is also a commissary on base even though there are eight major grocery store chain locations within 10 miles. There is even another separate commissary on Maxwell's Gunter Annex just 11 miles away. Similarly, Langley Air Force Base in Hampton, Virginia has a base library despite the presence of seven different public library branches (Hampton, Newport News, and York County) within 10 miles.[16] On-base services are available to all military personnel, not just those on base. But, off-base residents have to drive farther from their homes to shop or check out books on base. The added convenience for the small populations that live on base hardly justifies these facility and operating expenses. Some might view these free or discounted services as military benefits, but compensation packages could be adjusted to address a change and still create overalls savings.

On-base, government-provided services should be strictly limited to those which are necessary but unavailable (or inadequate) in the local community. The term *necessary* could be open to interpretation, so it requires clear limits. Food, housing, child care, and basic retail items within reasonable convenience should

round out the list of *necessary* services. Any additions to these necessary services might be beneficial, but the decision to add any should not be at the installation level. Base commanders will naturally want to add recreational opportunities and more convenient services to increase the quality of life of their Airmen and families. Although these are always well-intentioned efforts, wing commanders can make local decisions with enterprise-wide impacts (costs and benefits) on the entire Air Force. They simply lack the information to adequately compare their own location to others at a point in time. Additional services should only be considered by Air Force Headquarters in instances where data exists reflecting a lack of specific services and how that gap leads to documented lower mission productivity or retention below force sustainment rates. Base commanders are indeed the most informed on mission impacts, and their input should be highly valued; however, these inputs should be provided to headquarters leaders, who can make decisions with full consideration of more comprehensive factors. Except for rare circumstances, bases should rely on their local communities. Installations should self-perform only where necessary services are unavailable or too limited in capacity to service the military population.

The Air Force should aggressively pursue the provision of more base services from outside itself and the DOD. There is a small office under the assistant secretary of the Air Force for Installations, Environment, and Energy chartered to seek out and develop community partnerships in the best interest of the service. After only a few years, this office has produced several agreements with positive return on investment.[17] One such mutually beneficial partnership agreement at Robins AFB, Georgia allows military medical staff to conduct required certification training at local community hospitals rather than traveling to other government facilities, saving the Air Force $434,000 and the community $2 million.[18] These efforts should continue in a more deliberate manner to divest more services not requiring the government to self-perform. Even with increased efforts, these initiatives, wholly reliant on willing participant communities and enterprising public officials, will only reap dividends at a glacial pace.

A more radical approach, although more difficult, would be to leverage a competitive environment through a new round of BRAC. In previous rounds, BRAC commissions developed a list of recommended bases to close and re-align. Throughout the process, potentially affected communities gathered data, compiled their own analysis, rallied support, and laid out a compassionate defense for how their particular communities were great places for bases. The 2005 BRAC Commission cited receiving over 200,000 pieces of correspondence.[19] Similarly, the 1991 BRAC Commission claimed more than 100 phone calls per day.[20] The DOD should not resist this natural, self-preserving enthusiasm from their partnered

defense communities. Instead, DOD should work with Congress to adjust the BRAC process to capitalize on this energy and achieve better BRAC outcomes.

Commercial industry models may provide helpful insights to structure a BRAC process. When a major auto manufacturer seeks a location to build a new assembly plant, it does not hide its list of possible sites until reaching a decision. The company knows many communities would love to host a new business to create jobs and increase tax revenue. Capitalizing on this keen interest, the automaker engages in negotiations with a shortlist of communities. In negotiations, the automaker considers many factors including skilled labor availability, access to transportation hubs, and cost of living. One of these factors is the package of incentives the local communities or governments may offer. The automaker creates a competitive market where communities offer incentives such as tax breaks, donations or inexpensive leasing of land, upgrading the transportation network, and the like.

If ever authorized another BRAC, DOD should put a list of defense communities on notice and capitalize on their energy early to create a competitive market. Communities should not only be able to provide input of fact, but they should also be able to make offers to influence the analysis and outcomes. Tax incentives from local governments may not be appropriate for Air Force bases, but there are endless possibilities they can offer to "sweeten the deal" to keep a base in their town or region. Examples could include subsidies to local homeowners and landlords, incentives for businesses who provide services Airmen need such as fitness centers and child care centers, and actions to improve school ratings to help improve retention in the service.[21] These incentives could result in lower housing costs and divestiture of government-run services, lowering the overall Air Force cost to run its installations. Previous BRAC rounds have realized savings just from closures and realignments, but future rounds could also leverage competitive markets to achieve even more recurring savings while also moving faster to a more affordable installation model.

Developing a Strategy

With an understanding of what functions bases perform, where they should be located geostrategically, and how they interact with local communities, a new strategy could make Air Force bases more effective and efficient. This strategy should come from evaluating different combinations and permutations of missions and locations. The first step would be to consider starting from scratch where all the chess pieces (missions) are removed from the board (the map), then start purposefully laying the pieces back on the board. The first pieces to place would be the force employment missions, those directly engaged in combatant com-

mander operations, where geostrategic locations matter. An example is choosing a location for an alert fighter intercept mission. To be effective, this mission must be along an avenue of likely approach from an adversary. Since starting completely from scratch is cost prohibitive, this mission should likely go to an existing fighter base with infrastructure already in place. When utilizing existing bases, the primary siting factor must be meeting mission requirements. All force employment missions with geostrategic interests should be similarly placed.

Before moving on to place the next set of missions, force employment bases should be evaluated for any adjustments that can create efficiencies. Specifically, each warrants an evaluation of the utilization rate of expensive infrastructure and a check for efficient combinations. For example, the location of a space launch mission greatly influences its operations due to the physics of orbits, planetary paths, gravity, and rotational speed closer to the equator. So space launch would be one of the first missions to place. One facet of expensive infrastructure for space launch is reliable electrical power. Since ideal launch windows only occur with limited periodic recurrence, having highly reliable power is essential to ensure an outage does not delay a launch and force waiting until the next launch window.[22] Providing electricity with the needed reliability is expensive. Other missions have similar needs for uninterrupted electrical power. One example is an MQ-9 mission control element, which must maintain constant communication with any remotely piloted aircraft (RPA) it is operating. Unlike space launch, RPA control missions can happen from anywhere in the world. A combination to produce better efficiency would be to co-locate an MQ-9 mission control element on a space launch base. This would allow for the two separate missions to benefit from the same expensive investment in highly reliable power. The alternative, which is the status quo, is to replicate the infrastructure and service in two different locations rather than maximize the utilization of expensive infrastructure.

One method of measuring infrastructure utilization rate is evaluating the daily sortie rate per runway. As an example, the B-2 mission has a small number of operational aircraft assigned to a single base. It likely has a low sortie rate for its runway, even including T-38 sorties B-2 pilots fly for proficiency. Air Force Reserve flying units with as few as eight mobility aircraft assigned have similarly low runway utilization rates. Runways, taxiways, airfield lighting, fire response coverage, and tower operations are sunk costs regardless of their utilization rates. So, where mission requirements do not drive specific locations, or where slight adjustments to existing locations would still meet geostrategic mission requirements, missions should be consolidated. One example is McEntire Joint National Guard Base, South Carolina, where the 169th Fighter Wing flies F-16s just 21 miles from Shaw AFB's 20th Fighter Wing that also flies F-16s. Consolidating

combinations would garner efficiencies and maximize the utilization of expensive infrastructure.

After meeting geostrategic interests and maximizing utilization of expensive infrastructure, where bases and mission should go is a matter of efficiency. Force generation bases, focused largely on readiness training, should be located within regions of predictably good flying weather and minimized flight time to available ranges. Less flight time reduces fuel costs and flying hours, which drives a reduction in maintenance requirements and extends aircraft service life. Better aircraft availability and minimized downtime can also increase student throughput, so similar efficiencies are possible with the few force development missions that have weather requirements; that is, undergraduate pilot training. Finding these efficiencies, while still meeting operational needs, is the next step of optimizing the basing and force laydown.

Many force development missions, like technical schools, could be located at any base. The same is true for institutional headquarters. Three main interests should influence basing decisions for missions without specific location requirements. The first is the available capacity in existing facilities and infrastructure. Capacity assessments determine how much additional mission of different types a base could take. For scenarios where an additive mission doesn't quite fit, the cost of constructing the additional needed capacity must be considered.

The second interest is the cost associated with permanent changes of station (PCS) for members transitioning from one base to another. The Air Force should seek opportunities in basing that would allow for fewer PCSs, similar to institutional headquarters are typically on a base that it oversees; that is, Air Combat Command Headquarters on Joint Base Langley-Eustis, Virginia creates cross-flow opportunities with the 1st Fighter Wing there. Analyzing existing assignment data could reveal what bases most of the headquarters staff come from (inbound) and goes to (outbound). For example, officers can transition from a tour in the 2nd Bomb Wing to a headquarters tour at Air Force Global Strike Command—both at Barksdale AFB, Louisiana—with a no-cost permanent change of assignment (PCA) rather than a PCS. A PCA avoids the costs for travel, dependent travel, household goods shipment, and dislocation allowance. Many locations like this exist today, but an evaluation is warranted to determine which bases feed the most personnel directly to institutional headquarters staffs and if efficiency opportunities exist.

A primary candidate for evaluation is the set of force development missions at Maxwell AFB. Maxwell is home to Air Force officer professional military education. Several hundred field-grade officers PCS to Maxwell each year to be students at Air Command and Staff College and Air War College. Each school is

one-year long, and the majority of students PCS upon graduation. Opportunities for PCAs are extremely limited, because there are few other missions at Maxwell. Some existing programs leverage PCAs with deliberate assignments to instructor duty with a planned follow-on tour as a student, but these are few in number. Classrooms, auditoriums, and library space are not expensive facilities compared to airfield infrastructure and highly reliable power, so they could be relocated to pair with missions that would feed more PCAs for students. Simple analysis could determine where the percentages of students come from before or go to after their year at school. Alternatively, bringing one of the institutional headquarters to Maxwell would gain similar efficiencies.

The third major consideration is the operating cost of a mission at a particular location. In weapon systems, the lifetime operating and sustainment costs always exceed the initial acquisition cost. Installations are similar, but the long-term costs include basic allowance for housing, cost of living adjustments, locality pay, utilities rates, civilian recruiting incentives, area cost factors for construction, temporary duty travel costs to and from the base, facility and program operating costs, and so forth. Relying on off-base community support and leveraging competitive markets could reduce these costs.

Using the three main factors of capacity, PCS costs, and operating costs, the Air Force could evaluate permutations and combinations of non-location-specific missions at different bases. The analysis should include Reserve component opportunities as well as joint and sister service tenants who occupy space on Air Force bases. This type of analysis is no small task but could identify savings by moving missions through a BRAC round. Even without BRAC, smaller movements to create efficiencies are possible under authorities already residing with the Secretary of the Air Force. Small moves with positive returns on investments would provide useful case studies to further BRAC advocacy. The four BRAC rounds are still providing $8 billion in annual recurring savings. The 2005 round added another $4 billion in annual savings.[23] European Infrastructure Consolidation, at a cost of $1.4 billion, will save $500 million annually.[24] The closure of RAF Mildenhall, United Kingdom alone will save $125 million each year, so a single closure can create real savings.[25]

Conclusion

Current and future challenges in the national security environment demand a thoughtful approach to Air Force installations. Not everything is changing—air bases will remain the platforms by which Air Force units fly, fight, and win in air, space, and cyberspace. But increasing threats against air bases, expanding global reach and interconnectedness, and demanding fiscal constraints call for change.

Today's air bases—what they do, where they are, what is on them, and what services they self-perform—are not ideal for the future. The current state is the result of a legacy force laydown and decades of suboptimized, evolutionary, and local decisions. Preparing the Air Force for the future will require thinking differently about air bases.

Applying new thinking requires analysis by a combination of Air Force planners and installation support professionals. Their starting point should be what functions bases perform—force employment, force generation, force development, and institutional headquarters. Some of these functions have geostrategic interests that should influence their locations. For functions without geostrategic interests, there are opportunities for efficiencies through combining multiple functions onto fewer bases. Efficiencies can come from maximizing the utilization rate of expensive infrastructure, reducing PCS moves, and migrating to bases with lower operating costs. The Air Force can drive down operating costs by divesting activities, especially in community support, that local communities can adequately provide in sufficient capacity. The Air Force and DOD can also creatively incentivize local communities to lower operating costs. Since defense communities have great motivation to keep their bases, it is possible to create a competitive market to DOD's advantage.

None of these actions will create an ideal force laydown or affordable installations overnight. However, without a strategy to work toward these outcomes over time, Air Force installations will continue to drift further out of alignment with the demands of the future strategic environment. With the actions outlined here, nested in a deliberate strategy, the Air Force can and should incrementally adapt its installations to meet modern needs. ✪

Notes

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9. The categories and terms listed here are not in current Air Force doctrine as used. In fact, there are no terms in Air Force or joint doctrine to describe what functions bases perform. As described here, these proposed terms are helpful to a better understanding of installation functions.

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VIEW

Maximizing Human Capital with Innovative Talent Management Strategy

Chiefs Leadership Course 19-B
Flight 9, Excellence

Introduction

This study will analyze the Air Force's strategy to maximize human capital and how the enterprise applies talent management processes. Additionally, the research will determine if the Air Force should leverage and adopt other corporate talent management models to effectively manage our human capital with agility. Specifically, this study will compare Air Force corporate talent management processes to industry, Army, and other civilian processes to develop strategic talent management strategies.

Current State

The 2018 *National Defense Strategy* states that talent management (TM) requires a "broad revision of talent management among the Armed Services, including fellowships, civilian education, and assignments that increase understanding of interagency decision-making processes, as well as alliances and coalitions."[1] This sentiment carries forward from the 2015 *National Military Strategy* (*NMS*), which called for a system that "incentivizes faculty, rewards critical thought, and promotes our most innovative minds. Continuous, demanding education inspires new ideas and identifies better ways to accomplish our missions."[2] This analysis will determine how well we are meeting these objectives.

Senior leaders are requesting their senior enlisted counterparts be their intellectual sparring partners in providing critical thinking conversations to propel the mission forward with the multitude of fiscal constraints. There have been many articles published in *Air & Space Power Journal* that highlight the need and proposed courses of action (COA) on how to develop and codify talent management for our officer colleagues. The Human Capital Annex (HCA) to the United States Air Force (USAF) Strategic Master Plan, dated May 2015, provided specific dueouts and milestones focused on improving talent management (see table 1).[3]

Table 1. HCA objectives and tasks supporting talent management

Identifier	*Descriptor*	*Time Frame*
TM1	Adapt human capital management and talent management practices within the Air Force to ensure an institutional human resources (HR) system capable of rapidly recognizing and adapting to the changing environment.	6–10 years
TM1.1	Develop a modernized architecture for human capital management within the Air Force that will enable talent management of an agile workforce.	0–5 years
	Employ a multifunctional research group to develop alternatives to current practices that include updated career progression models, updated career lengths, assignment processes, lateral entry, time-in-grade, and promotion processes to provide a greater variety of career paths and more individual control over career trajectories and promotion systems to meet mission requirements.	FY 19
	Expand partnership with the Office of Personnel Management, Congress, and the other services to modernize personnel management legislation.	FY 20
TM 1.2	Incorporate progressive feedback mechanisms into development and assessment processes.	0-5 years
	Study best-practice instrumentation, rollout, and follow-up processes in large, complex, diverse and successful organizations and ensure funding resources are available in programming.	FY 17
	Present actionable recommendations.	FY 18
TM 1.3	Incorporate updated HR management practices to increase accountability in areas of diversity and inclusion for senior leaders and other leaders occupying critical roles. Study best practices in accountability for diversity and inclusion.	FY 17
	Present actionable recommendations.	FY 18
TM 1.4	Partner with leading assessment experts to develop and implement in-depth assessment processes for command and other critical leadership roles. Partner with leading experts in executive assessment to develop and present recommendations.	FY 18
	Implement an actionable and affordable option.	FY 20

Source: USAF, "Human Capital Annex to the USAF Strategic Master Plan," 2015.

The Directorate for Personnel Operations (AFPC/DP2) and Accessions Branch (AFPC/DP3DA) execute force development. Functional managers are responsible for developing personnel within their functional communities utilizing institutional governance structure. Their respective organization—the Air Reserve Personnel Center for Reserve—handles Total Force Partners Force Development. Each state, territory, or district for the Air National Guard has the responsibility for their members. The successful execution of force development will maximize the capabilities of all Airmen and ensure that development opportunities are transparent and visible to all Airmen. Competency requirements at each grade/rank have been identified to produce the desired capabilities at various levels of leadership.[4] An enterprise solution still requires local commander and senior leader involvement regarding talent management.

Force development depends on the senior rater, commander/director, and supervisor; their involvement is critical in making deliberate decisions about individual members to identify and maximize the capabilities of Airmen. Air Force Instruction (AFI) 36-2640, *Executing Total Force Development,* outlines Airman Development Plans for officers and Individual Development Plans for civilians. Officers and civilians utilize My Personnel (MyPers) and express their respective career preferences. The enlisted force utilizes MyPers and the Enlisted Quarterly Assignment Listing Plus to express their career preferences. Airmen have a responsibility for maintaining awareness of development resources and actively participating in their career development and advancement.[5] Airmen must know and value the language of all Airmen and the institutional competencies (IC).

The Air Force relies on ICs as the foundation in the development of professional military education (PME) programs as the cornerstones in critical thinking, which is key to human capital management. Air Force Manual (AFMAN) 36-2647, *Institutional Competency Development, and Management*, implements AFI 36-2640, and outlines ICs purpose is to: enhance leadership performance, provide a set behavior standard, and translate requirements and values into behavioral indicators.[6] The Air Force develops talent through PME; the 2018 NDS states it is "to be used as strategic assets," and that it "has stagnated, focused more on the accomplishment of mandatory credit at the expense of lethality and ingenuity."[7] PME correlates with an individual's rank, providing specific focus and intent based on the ICs. Table 2 shows PME by rank as outlined in AFI 36-2640 based on the tactical, operational and strategic level.

PME is further characterized by which level of IC the member must understand for successful completion. Proficiency-level definitions below are in AFMAN 36-2647:

- Basic (B)—Airmen are focused on learning and developing a foundational skillset.
- Intermediate (I)—Airmen continue to learn and develop professional skills.
- Proficient (P)—Airmen level knowledge of issues and objectives to design and develop solutions.
- Skilled (S)—Airmen leverage knowledge of strategies and issues to develop, present, and implement solutions.
- Advanced (A)—Airmen impact the organization and the Air Force by leveraging their knowledge and expertise across the theatre to identify and address the critical success factors for complex areas.

Table 2. Career field functional, career broadening, special duty and paths (officer and enlisted) comparison

Grade	*Military Experience (Officer)*	*Professional Military Education*	*Grade*	*Military Experience (Enlisted)*	*Professional Military Education*
O1-O2	NAF / Wing / Unit / Flight AO Career Broadening / Special Duty Executive Officer SPO / FOA / Center AO	Initial Skills Training	E1-E3	CDC / OJT Upgrade Training (5-Level) Technical Training School (3-Level) Broadening Experiences: Special Duty, Retraining, etc.	E4 - Airman Leadership School E2-E3 - First Term Airmen Course E1 - Basic Military Training
O3	NAF / Wing Staff Unit-Level Leadership Joint / HAF / MAJCOM AO Executive Officer SPO / FOA / Center AO Career Broadening / Special Duty	Squadron Officer School Language Training Advanced Academic Training	E5-E6	Upgrade Training (7-level) Broadening Experiences: Developmental Special Duty Retraining Special Duty, etc.	Intermediate Leadership Experiences SEJPME I Professional Enhancement Seminar NCOA DL Course AU ABC CCAF
O4-O5	NAF / Wing Staff Executive Officer Squadron CC Unit-Level Leadership SPO / FOA / Center AO Career Broadening / Special Duty	O4 – Air Command & Staff College O4 – Joint / AFIT, EWI / AAD (AFIT)	E7-E8	Skill Level Upgrade (9-level) NAF / MAJCOM / HQ USAF / Joint / AEF Broadening Experiences: Developmental Special Duty Retraining, Special Duty etc.	Advanced Leadership Experience SEJPME II Professional Enhancement Seminar
O6-O7	Joint Air Staff MAJCOM NAF / Wing Staff Wing CC Group CC	Senior O5-O6 – Air War College Senior O5-O6 – National Defense University O5-O6 – Sister Service/International School O5-O6 – Fellowship Senior O6-O7 – Senior Leader Development Senior O6-O7 – Wing Commander Course Senior O6– O7 – Group Commander Course	E9	CMSAF Joint Air Staff CFM Wing CCC MAJCOM MFM Group CEM	Senior Leader Development Air Staff CEM Orientation CCM Orientation Chiefs Leadership Course CMSgt Orientation

Source: AF/A1DI, "Institutional Competency Development and Management," 15 September 2016.

PME carries forward from the 2015 *NMS*, which calls for a system that "incentivizes faculty, rewards critical thought, and promotes our most innovative minds. Continuous, demanding education inspires new ideas and identifies better ways to accomplish our missions."[8] Proficiency is built into the PME courses beginning at basic military training (BMT) or the appropriate officer accession program. Table 3 shows a comparison of where each IC subcompetency is taught and at what level.

Table 3. Proficiency-level behaviors for each IC sub-competence based on PME

B = Basic I = Intermediate P = Proficient A = Advanced S = Skilled	USAFA (Officer)	ROTC	OTS	AMS	SOS	ACSC	AWC	BMT (Enlisted)	ALS	NCO	SNCOA	CLC	USAF Supervisor Course	Advanced USAF SupervisorsCourse	Supervisors Refresher Course	Civilian Personnel ManagemenCourse	Military Personnel Management Course
Sub-competency																	
Operational and strategic art	B	B	B	B	I	P	S			B	I	P	I				
Leverage technology	B	B	B	B	I	P	S			B	I	S					
Unit, Air Force, joint and coalition capabilities	B	B	B	B	I	P	S			B	I	S					
Non-adversarial crisis response	B	B	B	B	I	P	S	B	B	I	P	P					
Enterprise structure and relationships	B	B	B	B	I	P	S	B	B	I	P	S		B			
Government organization and processes	B	B	B	B	I	P	S	B	B	I	P	P					
Global, regional, and cultural awareness	B	B	B	B	I	P	S	B	B	I	P	S					
Strategic communication	B	B	B	B	I	S	S	B	B	I	P	S	P	P	P		
Resource stewardship	B	B	B	B	I	P	S		B		P	S	P	P	P	P	P
Change management	I	I	I	I	P	P	S		B	I	P	A	P	P	P		
Continuous improvement										I	P	S	P	P	P		
Vision	B	B	B	B	P	P	S		B	I	I	S	P	P	P		
Decision making	I	I	I	I	P	P	S		B	I	P	S	P	P	P		
Adaptability	B	B	B	B	I	P	S		B	I	P	S	P	P	P		
Develops and inspires others	B	B	B	B	I	P	S		B	I	P	S	P	P	P	P	P
Takes care of people	B	B	B	B	P	P	S	B	B	I	P	S	P	P	P	P	P
Diversity	B	B	B	B	P	S	S	B	B	I	S	A	P	P	P	P	P
Builds team and coalitions	I	I	I	I	P	P	S		B	I	P	S	P	P	P	P	P
Negotiating	B	B	B	B	I	P	S		B	I	S	A	P	P	P	P	P
Ethical leadership	B	B	B	B	I	P	A		B	I	S	A	P	P	P	P	P
Followership	B	B	B	B	P	S	A		B	I	S	A	P	P	P	P	P
Warrior ethos	I	I	I	I	P	S	A	B	B	I	S	A	P	P	P	B	B
Develops self	B	B	B	B	P	S	A	B	B	I	S	A	P	P	P	P	P
Speaking and writing	I	I	I	I	P	I	A		B	I	S	A	P	P	P	P	P
Active listening	I	I	I	I	P	I	A	B	B	P	A	A	S				

Source: AF/A1DI, "Institutional Competency Development and Management," 15 September 2016.

As detailed above, the Air Force has outlined specific direction, goals, and milestones to develop proficient and high performing Airmen deliberately. It is important to analyze other models of talent management to understand the effectiveness of Air Force processes fully.

Talent management is used in the early stages of the accession process with the Air Force Work Interest Navigator (AFWIN).[9] AFWIN provides a match of jobs based on personality style and Armed Services Vocational Aptitude Battery scores. This matching enables the right person to get the right job and decreases job mismatches while capitalizing on performance when accession requirements do not interfere.

Furthermore, Air Force Recruiting Service talent manages regarding special warfare (SW) Airmen. Applicants take a physical ability stamina test for the specific SW career specialty, and if accepted, they continue the development process to get mentally and physically prepared. The developer must give the "thumbs up" before a job can be reserved and the applicant sent to BMT.[10] In general, the Air Force does a good job of using these early talent management tools to meet the HCA statement that "declining personnel strength and constrained annual budgets, recruiting efforts are increasingly more critical and require more precision to access the individuals we need. Operational imperatives require us to leverage diversity and inclusiveness across the force and develop Airmen with unique skills to match evolving needs and address emerging challenge."[11] Once accessed, the talent management process turns to development and retention.

Air Force Human Captial Management hinges upon the Continuum of Learning (CoL). CoL is outlined within AFI 36-2640, *Executing Total Force Development,* and is designed to integrate opportunities using the IC as outlined in AFMAN 36-2647, *Institutional Competency Development and Management*. *CoL* is defined as "a career-long process of individual development where challenging experiences are combined with education and training through a common taxonomy to produce Airmen who possess the tactical expertise, operations competence, strategic vision and joint proficiency to lead and execute the full spectrum of Air Force and joint missions."[12] While analyzing the effectiveness of Air Force talent management, it is important to discuss private sector and other service processes.

Private Sector and Army Processes

Talent management in private sector industry is just as robust and vital as it is in the Air Force. Many leading business industry firms are investing a tremendous amount of time and effort to enhance their human resource directorates as evi-

denced in the plethora companies, programs, and articles when you do a simple internet search. In a recent article from *Human Resource Magazine* titled "Creating and Effective Human Capital Strategy," a major focus is put on measuring an organization's progress toward being a strategic human resource business partner.[13] With an ever-changing, diverse workforce and global competition at its height, organizations will need to focus on talent management programs to continue sustainable performance into the future. The Air Force is no different. In the civilian sector, human resource professionals can add value by providing administrative support service and becoming strategic partners who can help corporate leaders develop long-range business strategies. *Human Resource Magazine* provides a detailed checklist to aid organizations in determining how strategic they are (see table 4). Some of the key aspects of this checklist regarding measuring human capital strategy focus on the organization's current talent pool, efficiency, effectiveness, impact and the overall human resource strategy of an organization.[14]

In studying talent management best practices, the Black Rock Corporation must be considered. The Black Rock Corporation is the world's largest asset management firm, and they rewrote the playbook on talent management. One of the key aspects that make this company so successful is their approach to strategic and operational insight into fields such as talent planning and recruitment, ensuring a high-performance culture, developing employees, talent reviews, accession planning, and networking and collaboration tools.[15]

The Black Rock Corporation has developed an extensive process for reviewing all employee's talent reviews and promotion opportunities. This organization targets employees whose diverse background and expertise will benefit the organization into the future.[16] The Air Force has a similar strategy currently in place for their enlisted Airmen concerning human capital strategy—the incorporation of enlisted development teams (EDT). The enlisted Airmen have leveraged these Air Force specialty teams to vector the most qualified individuals to serve in key leadership positions within their Air Force specialty. However, anecdotal evidence suggests that the EDTs are not consistently aligned with the Air Force. Each team is composed of career-field specific experts, and not all EDTs are currently using multiple avenues to determine the right individuals are vectored into the best positions.

Networking and collaboration tools are another one of Black Rock's strengths. This innovative organization is leveraging online chat rooms and a collaboration hub to foster dialog between employees and senior human resource managers. This initiative allows the firm's leaders to truly engage with their workforce to determine the future goal for each individual, as well as form a basis for future opportunities within the organization.

Table 4. How strategic are you?

How strategic are you

Review these four checklists to rate your behavior as an HR strategic partner. Check all that apply. The questions create a continuum of progress from least to most strategic.

How do you manage talent?

By:

- Maintaining records
- Auditing and controlling
- Servicing as human resource service provider
- Developing HR systems and practices

How do you engage in strategic business activities?

Do you:

- Help identify or design strategy options
- Help plan implementation for strategy
- Help identify new business opportunities
- Assess the organization's readiness to implement strategies
- Help design the organization structure to implement strategy
- Assess possible merger, acquisition or divestiture strategies
- Work with corporate board on business

What is your HR strategy?

- A data-based talent strategy
- A human capital strategy integrated with business strategy
- A provider of analytical support for business decision-making
- A provider of HR data to support change management
- A driver of change management
- The author of rigorous data-based decisions about human capital management

How well do you measure HR effectiveness?

Do you measure efficiency by:

- Measuring the financial efficiency of HR operations such as cost-per-hire, time-to-fill or training costs
- Collecting metrics that measure the cost of providing HR programs and processes
- Benchmarking analytics and measures against data from outside organizations

Do you measure impact by:

- Measuring the business impact of HR programs and processes
- Measuring the quality of the talent decisions made by non-HR leaders
- Measuring the business impact of high vs. low performance in jobs

Source: Lawler and Boudreau, "Creating an Effective Human Capital Strategy," *Society for Human Resource Management,* August 1.

The Air Force has a similar tool—MyVector—that allows enlisted Airmen to align with mentors and map out a career path that best suits them. This tool is underutilized and is not capturing the potential of all enlisted members. MyVector is a career-field specific tool the EDTs can utilize to make key leadership moves. If all members take advantage of this tool and their future roles within the

Air Force, the EDTs leverage talent management more effectively within their Air Force Specialty Code (AFSC). The Air Force must continue to learn from leading-industry best practices, along with other organizations within the DOD, such as the United States Army (USA).

The USA has determined it must recruit competent Soldiers and continuously develop its service members for employment to optimize performance. To meet the needs of the service component, the *Army Talent Management Strategy (ATMS)* institutes talent management as its strategic concept to exploit human capital management and includes Army leadership's objectives to meet its future requirements upon the complex battlefront and enhance Army readiness. This is in line with Air Force initiatives as evidenced by the statement that "defines the emerging necessity for our Air Force to become a more agile, diverse, inclusive, and capable force in a rapidly changing environment. Success in that endeavor rests squarely upon providing the right Airmen, sufficiently developed, equipped, and organized, to defend national interests through airpower."[17] For years, the Army has addressed "competency" as a desired attribute of its Soldiers but has evolved to further state it is necessary for one to be "talented." Much like the Air Force, the ATMS aims to build upon one's talents and form teams of talented professionals to sustain its workforce and meet the challenges of tomorrow's operational environment.[18] By optimizing the productivity of each Soldier and aligning an individual's unique talents against organizational talent demands, the Army ensures the mutual benefit of both the individual and the service component by aligning the most talented personnel to the right job at the right time, assigning a Soldier where the member can maximize his or her contributions.[19] This study focuses on what the Air Force is currently executing regarding talent management. Additionally, it compared some private sector and sister service approaches to talent management. Next, research will analyze performance gaps this study revealed in talent management.

Agile Methodology. The Air Force HCA states that it will take agile and innovative approaches to meet talent management and Airmen retention challenges. The HCA states, "In addressing human capital, A Call to the Future emphasizes how our Service will 'pursue a strategically agile force to unlock the innovative potential resident within our Airmen and then it follows under Intended Audience.' This document is intended for action by Headquarters Air Force, Major Commands, Core Function Leads, and Total Force Component leadership to provide direction in developing policies, procedures, and program choices."[20] Yet it has specific timelines and due-outs following a top-down waterfall project management model. Currently, the HCA addressed six strategic goals; however, the only progress to be found remains in the strategic and theoretical realms. The

Air Force can better address progress if it were to follow the US Digital Service (USDS) playbook based on agile innovation methodology, which has already demonstrated successful results.

In the USDS *Fall 2017 Report to Congress*, there were 11 projects underway that all had met significant milestones using this methodology, to include delivering an online training environment to the Transforming Federal Information Technology (IT) with Digital IT Acquisition line-of-effort. This innovation framework grants access to the Airmen at large and allows for all three tactical, operational and strategic level domains to provide immediate and continuous user input/user experience feedback. Additionally, it could leverage Airmen as force multipliers in the development of such applications.

The entire force has the desire to tackle the major objectives outlined in the HCA. To facilitate and energize a collaborative total force effort, a transparent forum where the major lines-of-effort are managed, should be created and highly publicized. As new ideas and items are being developed, Airmen should be able to use and provide that iterative feedback and more rapid delivery to the field. This type of environment would also benefit from the natural innovative and collaborative spirit of the Airmen voluntarily contributing and participating in the processes.

Research-Focused Gaps

Accessions. Experience and research identified a disparity in our ability to gain and appropriately use the talent of the new accessions. New recruits are joining the Air Force with completed (or almost completed) advanced degrees; however, they are not being gained to the equivalent AFSC. Often times due to recruitment quotas, ASVAB scores or simply a desire to serve now and do not want to wait for the specific AFSC to become available for a "guaranteed job." Alternatively, those who are interested in joining the Air Force take a significant pay cut from their civilian job, which means the Air Force is missing out on these creative thinkers who have experience to enhance the mission.

Career Talent Management. Based on the professional experiences of the team, current talent management practices focus mostly on officer development. Talent management for the enlisted force is limited to human resource management programs geared toward matching talent against vacant authorizations based on rank, AFSC and skill level. The few unique opportunities offered to the enlisted ranks either focus solely on developing advanced education competencies, enhancing leadership and management skills or broadening functional skills, none of which provide a clear path to maximize the return on investment.

Methods for attracting new talent through accessions are outdated, therefore limiting the pool of prospective candidates. The *NMS* specifically states: "Our military and civilian professionals are our decisive advantage. They are the foundation of our operational excellence and our ability to successfully innovate. Therefore, we are dedicated to building creative, adaptive professionals skilled at leading organizational change while operating in complexity. To accomplish this, we are evolving our organizational culture and strengthening our leadership."[21]

Agile Methodology. The real challenge for the Air Force as a whole will be to create the ecosystem of Innovation and agile project management to accomplish its goals of transforming itself from the industrial age model to an information age talent and human capital management model.

Proposed Courses of Action

Accessions COA. Another avenue to consider would be to institutionalize career option changes. One way could be to reduce standards for entry based on the AFSC entering to attract a larger talent pool, supporting retention and talent management with pay incentives, or adjusted pay tables based on an increase for scope of responsibilities, leadership positions held and their education level. For instance, Airmen joining with a master's degree within the AFSC become staff sergeants versus an Airman Basic. Recognizing leadership skills are gained as they grow within the Air Force, yet they often have leadership skills from their civilian experience, similar to how an Airman who enters the Air Force with a master's degree in Music becomes a technical sergeant after training. Institutionalize changes that encourage potential recruits to view military service as a viable career instead of a means to an end.

Career Talent Management. While the Air Force has stated the vision of talent management, there is an obvious disparity between the opportunities available for our enlisted and officer corps. The Air Force needs to enhance the current talent management platform, utilizing MyVector and mimicking (and improving) existing officer initiatives, focusing on Airmen once they become career Airmen. A MyVector or LinkedIn type program links that Airmen to their career field manager beginning the talent management and vectoring them to a strategic position. By introducing talent management earlier in an Airman's career, we will gain a greater return on investment, developing specific individual Airmen plans like our officer and civilian counterparts have available. The Air Force needs to expand on the partners with industry to the enlisted; attending Exxon, Google, or Coca-Cola and seeing how agile and diverse they manage their mission gains us a more critical-thinking, disruptive innovator with a "There is no box" mindset.

AFI 36-2640, *Executing Total Force Development* provides the guidance on how the Air Force manages its most important weapon system—its people. The enlisted corps forms EDTs similar to the officer corps. These vectors intend to align Air Force mission needs with knowledgeable enlisted leaders. However, filling these positions are hindered by Air Force instructions not allowing the movement of high performing individuals due to permanent change of station (PCS) guidance. Instead of relying on filling the key leadership position (KLP) and key developmental position (KDP) positions as they become vacant from a list of eligibles (provided they meet PCS rules) and apply for the positions when published on the Assignment Management System. KLP and KDP positions tend to be at the senior noncommissioned officer level; however, talent management needs to begin earlier in the Airmen's Air Force career. The Air Force needs to thoughtfully and deliberately grow Airmen to be ready to fill the KLP and KDP positions.[22]

Agile Methodology. The current Industrial Age model of strategic initiative management works in theory; however, to be agile and innovative, the HCA should call for a holistic bridge for all Airmen to include tactical and operational levels. If the Air Force desires to implement agile and innovative methods, it should more closely follow the USDS Playbook to address talent management issues. The first two plays for innovation are to: "1. Understand what people need. 2. Address the whole experience, from start to finish."[23]

A first experiment to leverage today's technology, to meet the rapidly changing talent management skillsets and IC the Air Force needs, would be to build an application similar to LinkedIn. This app would integrate items found in MyVector, the Assignment Management System, Education and Training Course Announcements, Talent Market Place, Senior Leader Career Management System, Enlisted Performance Reports, and LinkedIn, using data metrics to match position descriptions, training, skillsets, and interests required to an individual's record would mirror what the civilian sector has developed. Also, the specific ICs and their specific competency levels and technical expertise can be better defined and leveraged, rather than the current generic training and assignments found in MyVector. This would be accomplished similarly to "Skills" and "Skills Endorsements" used in LinkedIn, providing better personnel assignment choices for career field managers and commanders. The Airmen would be more able to vector their careers, development and gain access to, and customize their military and civilian training choices by having a transparent model with realistic feedback on their current "Skills Endorsements." Further, Airmen and supervisors would have a better tool to establish goals during their Airmen Comprehensive Assessment to mentor job descriptions that match their interests and skills for future job assignments. These are all tools that are being used by the Air Force, that do not talk to

each other, and do not leverage current technical capabilities of data analytics for force development and talent management found in the civilian sector.

Conclusion

As referenced in the *Harvard Review* article, "Building a Game-Changing Talent Strategy," Black Rock has consistently outperformed their peers in the arena of talent management. This organization has a tremendous sense of pride and a concrete mission, similar to the USAF. Talent management and human capital are imperative to our *National Military Strategy*—we must retain our war-fighting edge for the all-volunteer military. Talent management has increased during the past few years, but there is still room for improvement. Given the courses of action provided in this research, the Air Force is headed in the right direction with applications such as MyVector. In an effort to attract and retain talent in the enlisted force, the Air Force will need to continue to evolve its talent management strategies as outlined in this research. As we continue to enhance our programs, we need to evolve leveraging twenty-first-century skills to develop that critical thinking sparring partner our senior leaders desire—the disruptive innovator who has the knowledge, skills, and experience in the Air Force journey. A more effective talent management system will attract more talent and produce Airmen who view military service as a career, not a job. ✪

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Chief Leadership Course Flight 19-B, Flight 9, Excellence

Chief Leadership Course Flight 19-B, Flight 9, Excellence was instructed by CMSgt Michael Young, USAF, and included students CMSgts Mark Pennock, David Arnett II, Scott Decker, Gregory Gwyn, JoLynn Kari, Elaine Lewis, Gregory Locke, Tige Platt, Carlos Pubillones, Brian Shul, Carl Snider, and Glen Thompson.

VIEW

A Plan for a US Space Force

The What, Why, How, and When

Lt Col Jonathan Whitney, USAF
Maj Kai Thompson, USA
Maj Ji hwan Park, Republic of Korea Marine Corps (ROKMC)*

> *We are going to have the Air Force, and we are going to have the Space Force—separate but equal.*
>
> –President Trump
> National Space Council press conference, 18 June 2018

(Source: United Launch Alliance/DoD Image Library)

Introduction

The president's direction emphasizes the ongoing, status-quo mentality that our current strategy for the national security of space cannot hold and that in the coming decade the US's reliance on space-enabled capabilities will be challenged. In 2010, USAF Gen C. Robert Kehler, then the commander of the US Air Force

*The authors wish to express their gratitude to their Joint Forces Staff College faculty advisor, Lt Col James Pochopien, USA, for the help and guidance he provided on the article.

Space Command (AFSPC), noted that our strategic approach has not changed since the collapse of the Soviet Union, and we need to safeguard our military, intelligence, and commercial space assets against China, Russia, and other state actors' (i.e., Iran or North Korea) space and counterspace capabilities that will threaten de facto US superiority in space, effectively how the US wages war.[1] As the US's space war-fighting capabilities continue to be challenged by near-peer countries, we must reestablish the US Space Command (USSPACECOM) as a unified combatant command (CCMD) to coordinate our efforts to avoid and prepare for conflicts in space.

Current US Military Space Organizations

To justify why a dedicated organization for the space domain is needed, we need to understand the current space military organizations of the US and its nearest competitors—Russia and China. As the US military's tactical exploitation of space grew in the 1950s, the needs for an organizational entity to develop, train, and equip the military with space capabilities and expertise became more apparent. In 1982, AFSPC was created under the USAF, followed later by the separate joint force USSPACECOM CCMD in 1985 (see fig. 1).

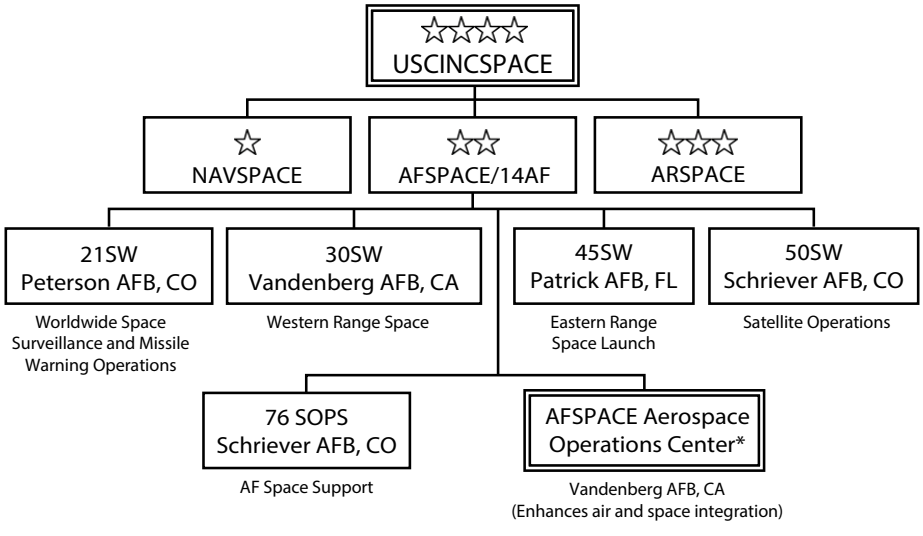

Figure 1. USSPACECOM organization in 1985
(Source: Air University Space Reference Guide, Second Edition, August 1999)

To meet its function to conduct war fighting as a CCMD, USSPACECOM developed the first doctrine for the military for the integration of space capabilities into conventional military operations as the dependence on such systems by

our military, and increasingly among our closest allies, grew exponentially. As part of Secretary of Defense Donald Rumsfeld's initiative to transform the US military, USSPACECOM was merged under US Strategic Command (USSTRATCOM) in 2002 in the unified command plan, which aimed to improve combat effectiveness by speeding up information collection and assessment for strategic decision making.[2] The joint force space component commander now acts as an unofficial subunified CCMD headquartered at Peterson AFB, Colorado. Its core missions are space-lift operations and to develop, acquire, deploy, operate, manage, and maintain satellite constellations of 77 satellites and their respective ground (control and user) segments. As the primary service responsible for military satellites, it is fundamentally important to the US military, our national security interests, and commercial customers for the USAF (through AFSPC) to conduct these space operations to have assured and free access to space.

The US Army's (USA) space mission is organized under the Space and Missile Defense Command (SMDC) and Army Forces Strategic Command (ARSTRAT) as component commands to USSTRATCOM. They provide satellite communications (SATCOM) by conducting satellite space control and support operations and missile defense operations for the Army, joint force, allies and partners, which enable multidomain combat effects, and the detection of strategic attacks.[3] As the DOD's SATCOM system experts, the Army's 53rd Signal Battalion ensures access through five distributed broadband SATCOM operations centers located worldwide for active payload management for all military users in joint operations. By integrating SATCOM with positioning, navigation, and timing support, the SMDC provides critical friendly force tracking capability to the combatant commanders, support agencies, allies and multinational partners for the execution of location functions such as emergency message alerts, notifications and tagging, tracking, and positioning.

The US Navy (USN) integrates space capabilities through their network of Marine Operations Headquarters. Space Support Working Groups provide support to space systems and services such as data encryption, signals intelligence, information operations, cyberspace, and electronic warfare impact operations.[4] As the DOD's lead service for narrowband SATCOM, the USN operates, manages, and maintains three satellite constellations of 12 satellites through their Navy Satellite Control Network in support of US forces, international partners, and allies. The USA and USN services represent the biggest users of space systems and have the largest numbers of user equipment.

The US Marine Corps (USMC) integrates space capabilities and effects for use in decentralized combined arms operations conducted by a Marine air-ground task force and joint forces by having billets assigned to joint land force compo-

nents, various services, and joint commands.[5] Marine Expeditionary Forces also receive space support directly from the Army's space support elements and ARSTRAT assets.

Although each service brings specific capabilities to the fight, it is important to understand our adversaries' capabilities as well. China and Russia, our near-peer competitors, have increased their military space emphasis from their organizational structure and investment in kinetic physical and nonphysical kinetic threats to counter the US in the space domain. This article will now explore the steps China and Russia have taken to change their space warfare capabilities. Our adversaries' changes must drive the US to explore ways to counter this emerging threat and posture it to maintain our necessary combat power projection dominance.

Chinese Military Space Organization

Traditionally China's armed forces have been modeled in the same Soviet-era, top-heavy command structure that remained a fundamentally ground force–centric organization. Besides lending itself to a single-service operation, Chinese space forces were hindered in their development of a force capable of conducting modern joint operations by the People's Liberation Army's (PLA) bureaucratic resistance to changing their outdated command and control structure (C2) in which the services, rather than theater commanders, possessed operational authority during peacetime (see fig. 2).

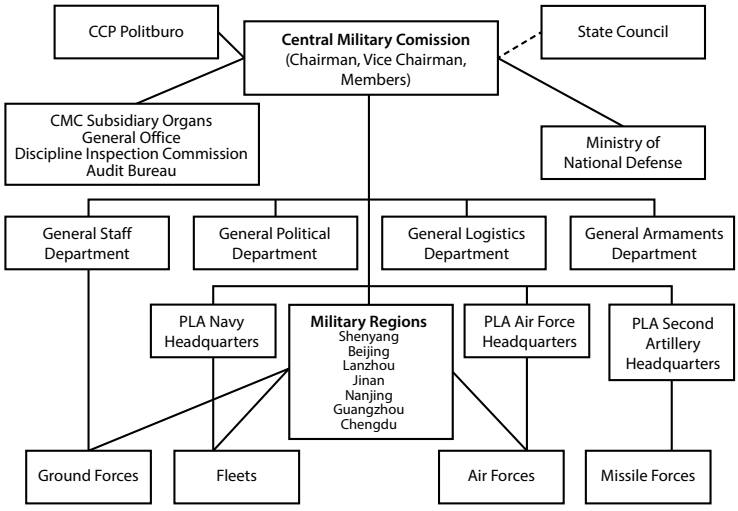

Figure 2. The PLA prior to 2015

(Source: Phillip C. Saunders and Joel Wuthnow, *China's Goldwater-Nichols? Assessing PLA Organizational Reforms*, *Joint Force Quarterly* 82 [July 2016]: 68–75).

In late 2015 and early 2016, Central Military Commission chairman and Chinese Communist Party General Secretary Xi Jinping announced the most wide-ranging restructuring of the PLA since 1949 (see fig. 3).[6] The reforms included the establishment of the Strategic Support Force (SSF) charged with overseeing Chinese military space, cyber, and electronic warfare capabilities.[7] Rather than treating space as a standalone military domain, the SSF focused on how space, along with electronic warfare and cyber, can be used to increase jointness for military effects. The SSF is organized with four subsidiary departments: General Staff, General Armament, Network Systems, and Space Systems. The Space Systems department is responsible for the launch and operation of satellites to provide the PLA with C2, communications, computers, intelligence, surveillance, and reconnaissance capabilities. However, what is less certain is the scope of the force's counterspace mission. Based on its launch and satellite operations functions, the SSF's Space Systems Department would be responsible for the co-orbital counterspace mission. The SSF's Network Systems could use radio frequency signals to jam satellite communications and Global Positioning System signals, and the use of malicious software would be capable of disrupting computer network operations in satellite tracking and control ground systems.[8]

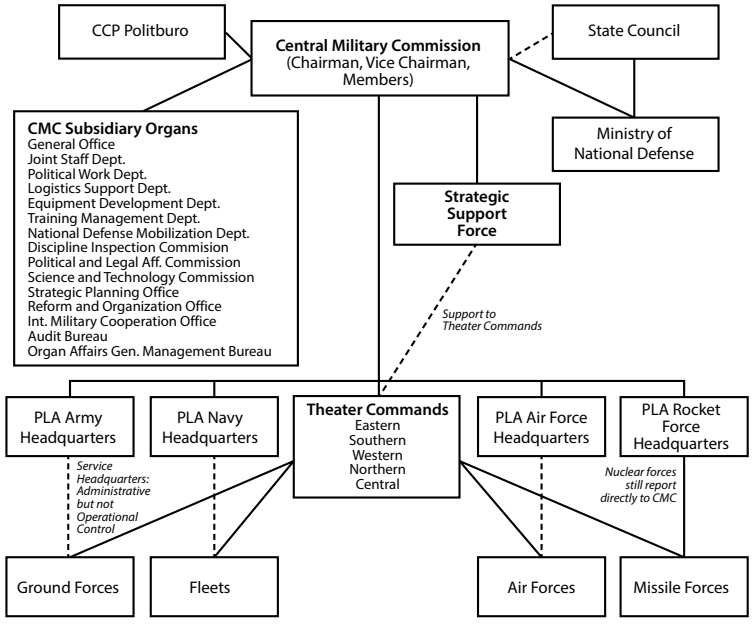

Figure 3. The PLA since reform in 2015
(Source: Saunders and Wuthnow, *China's Goldwater-Nichols?*, 68–75)

China's counterspace capabilities, like their successful demonstrations of direct-ascent antisatellite (ASAT) capabilities, may have been retained by other parts of the PLA, although it is also possible that such capabilities have been transferred to the SSF without public announcement. Another kinetic physical weapon was identified in December 2016 when China released a white paper detailing its plans to expand the "strength and size" of its space program by increasing its investment in space activities by an estimated $6 billion to fund additional space capabilities.[9] The plan has a robotic lunar program made up of several missions that will accumulate with China becoming the first country to soft-land the Chang'e 5 lunar probe on the far side of the moon to collect samples, return to a satellite in orbit, and return to Earth (planned for this year). On the surface, these peaceful space missions appear largely scientific and improve China's capacity to explore deeper into space. This complex, precision maneuvering in space beyond satellite location maintenance has military implications as a dual-use technology to apply a co-orbital kinetic kill capability that would work to exploit the US and its partner's vulnerabilities in space.

Russian Military Space Organization

Russian space forces were subordinated under the Russian Aerospace Forces in 2015 with the stated missions of monitoring space objects for the identification and prevention of potential threats to the Russian Federation in and from space, spacecraft launches, controlling and managing their satellite systems (including integrated ones intended to be used for both military and civilian purposes,) and a number of other tasks.[10] In contrast to President Trump's direction, Russia is following the current USAF organizational model of keeping a majority of its space forces integrated with the air force (see fig. 4). Maxim Shepovalenko, an analyst at the Moscow-based Center for the Analysis of Strategies and Technologies, attributed this unified aerospace theater structure to the evolving aerospace technologies and its decision to move away from maintaining an operational dividing line for fighting in the air and space theaters. This strategic viewpoint of their offensive and defensive strategic goals requires a unity of effort and command to adapt to the changing nature of war.[11]

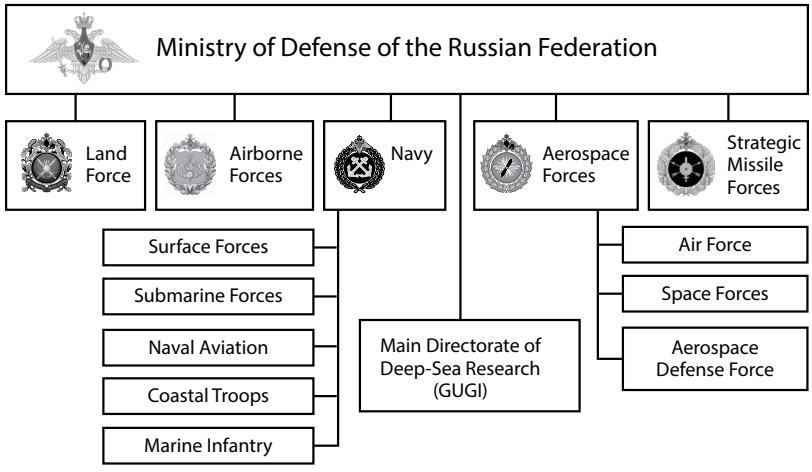

Figure 4. Current Ministry of Defense of the Russian Federation
(Source: Ministry of Defence of the Russian Federation, "Space Forces")

To counter the US in the space domain, Russia has focused on both kinetic and nonkinetic physical weapon capabilities. The Soviet Union conducted multiple successful destructive ASAT test using the Istrebitel Sputnikov missile system between the late 1960s and early 1980s.[12] While the Russians are not believed to have an operational kinetic ASAT capability right now, they continue to develop their PL-19 Nudol missile that is capable of striking a satellite in low-earth orbit (LEO) and is expected to be operational within the next several years.[13] Similar to the Chinese, Russia is also raising the threat level by advancing the development of high-maneuverability or "killer" satellites. Most notably, in September 2014 Russia's Olymp-K satellite reached orbit and then undertook a series of irregular maneuvers, which came within seven miles of a pair of Intelsat communications satellites.[14] While this on-orbit technology demonstration of proximity operations could have peaceful applications such as satellite refueling or repair, it can just as easily be used against an adversary.

Ground-based antennas have been able to jam Global Positioning System signals and communication transmissions. Directed-energy or lasers, high-powered microwaves, and either aircraft-mounted or ground-based electromagnetic pulse weapons would target LEO satellites. Lasers would be used to temporarily dazzle or permanently blind optical sensors while microwave weapons can disrupt or disable electronics on LEO remote-sensing and missile defense satellites.[15]

As we have outlined throughout, our near-peer space capable countries have invested heavily in their force structure, tactics, and weapons capabilities to deny, degrade, disrupt, destroy, and manipulate the US military's asymmetric advantages in space. We need a proportional, funded, and consolidated organization to

coordinate our efforts and maintain dominance in the future conflicts while reducing overhead costs and integrating joint war fighting functions.

How the Future Space Organization will be Created

Constitutionally, only Congress has the authority to "raise and support armies" like the Space Force and to cover the cost of such realignment under Title 10 of the US Code.[16] The Pentagon has already been working a response to the 2018 National Defense Authorization Act (NDAA) mandate to study to how best to organize the space missions. The response was to be completed with the interim report delivered in June 2018 and a final report to Congress delivered in August 2019.[17] The final report reviewed four major focus areas: 1) research, development, acquisition, and sustainment, 2) organization and governance, 3) joint war fighting, and 4) workforce development. Most recently, the 2019 NDAA language requires the DOD to develop a plan by year's end to establish a separate, alternative process for defense space acquisitions, with respect to space vehicles, ground segments, and terminals to expedite the current unresponsive, bureaucratic acquisition process.[18] However proactively, the Air Force had started an uncoordinated major overhaul of the acquisition, development, and deployment of military space and ground control segments processes at the Space and Missiles Systems Center at Los Angeles AFB, California and will be completed later this year.

While it will take the Pentagon many years to lay the groundwork for a future new organization regarding its objective, staffing, and funding levels, there are multiple options for how the management of the space war-fighting domain could be organized. Whether the Space Force is a separate branch, a corps resting under the Department of the Air Force, or a separate CCMD, it should address the basic functions of a military service: to provide, integrate, and employ the forces. As Gen (ret.) Anthony Zinni, USMC, retired, explained during a 2018 Joint Forces Staff College seminar, the focus here should be on the integration portion.[19] The US military has been successful with centralizing control into a single organization like the US Transportation Command, US Special Operations Command or US Cyber Command (USCYBERCOM) by eliminating multiple stovepipe organizations and increasing interoperability of mission assets. These commands also demonstrated the need for a focal point as the sole leader that speaks for and is responsible for implementing the mission's future organization, resourcing (budget), capabilities requirements, and employment strategy. To make sure space war fighting gets the priority it needs, a focused and separate command and commander must be established. This need was further highlighted by Gen John E. Hyten during his 26 February 2019 Senate hearing when he clearly stated he cared desperately about space but as a commander of US Strate-

gic Command, space will never be his number one priority.[20] The joint integration of space operations is accomplished by having dedicated space personnel proportionally staffed in all aspects of Joint Force Headquarters and the Joint Staff in addition as a service component to each CCMD.

The most effective way to keep the US ahead of our adversaries in providing, operating, and defending space capabilities is the re-establishment of USSPACECOM. The model to create USCYBERCOM should be used again as the Air Force, Army, Navy, and Marine Corps all have space experts that can be pulled to draft the mission theory, doctrine, and strategy. Using the CCMD structure would eliminate the immediate bureaucratic minutia required for creating a new organization and would build on the existing integration and jointness of multiservice operations. This would also give the organization the opportunity to determine how, if when, intelligence (e.g., National Reconnaissance Office), governmental (e.g., National Aeronautics and Space Administration or the National Oceanic and Atmospheric Administration) or commercial (e.g., SpaceX or the United Launch Alliance) space entities will be integrated with this organization.

The other organizational options would distract from the need for a warfighting focus with space now. As the former Secretary of the Air Force, the Honorable Deborah James explained in a 30 July 2018 Brookings Institution panel, a service branch organizes, trains, and equips the military force but it doesn't conduct the war fighting, which is the CCMD's function.[21] The last time an independent branch was created was when the Air Force separated from the Army in 1947. But the USAF relied on the almost two decades that the leadership had between World War I and II to develop their airpower strategy and technology. We have the opportunity to form a force without an extreme crisis like a space or regional conflict to drive its implementation but instead based on our ability to anticipate. While more progress still needs to be made on the theory of space domain-specific war fighting (doctrine, strategy, operational concepts/principles, and tactics),[22] the technology required to be effective is still very much in the developmental phase. The DOD needs the structure of a CCMD to outpace real and present threats to America's reliance on space for defense and commerce.

General Hyten made a series of space organization recommendations to Congress in 2017 and a number of them were part of the 2018 NDAA.[23] Specifically, the following authorities, capacities, and capabilities must be designated to the focused and empowered space domain lead:

- Oversee the acquisition, development, and deployment of military space and tactically employed and strategic-level ground control segments.

- Act as the single authority for enterprise-wide defense system architect and integrator for the overall space architecture to ensure all service's requirements were adequately addressed.
- Create a rapid space capabilities office with its mission to quickly design and acquire major, new, affordable space capabilities. This mission has been demonstrated by USSOCOM to leverage rapid prototyping to field experimental technologies into acquisition programs.
- Serve as the executive agent for space requirements in Joint Requirements Oversight Council deliberations.
- Establish national space security executive committee to provide strategic and policy guidance for all DOD space acquisitions.

The creation of a separate space corps or branch (AKA Space Force) is only a question of time. The DOD should follow a top-level change process in conjunction with an analysis tool like the McKinsey 7S management model (see fig. 5).[24] The McKinsey 7S model (with the 7S being structure, strategy, systems, skills, style, staff, and shared values) assesses and monitors changes in a proposed future organization to help identify what needs to be realigned. Once the military can ensure an effective space mission execution and demonstrate capability and capacity to produce direct combat effects in and from space to US military operations, the necessary bureaucratic actions should be taken in a defense authorization bill.[25]

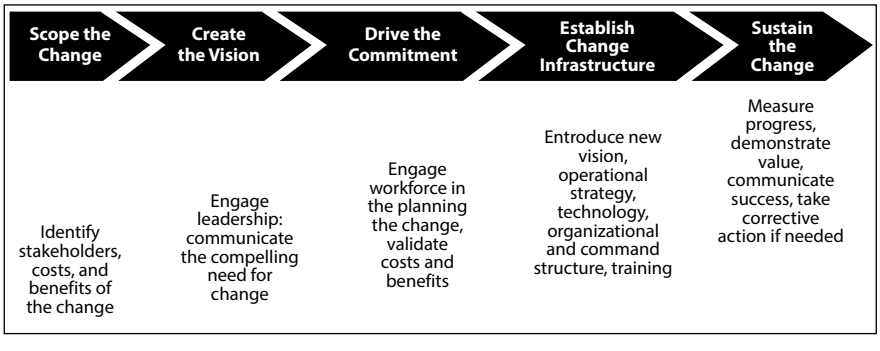

Figure 5. Space Force Organizational Change Process

(Source: Hayes, Theory and Practice of Change Management, 137)

The current DOD proposal for standing up a Space Force (nicknamed the 1601 report after the congressional provision in the 2018 defense policy bill) includes creating the US Space Command as a new unified combatant command, building a cadre of space officers called the "space operations force" to provide space expertise to the combatant commands, establishing the Space Development Agency as

a joint space procurement effort to leverage prototyping and experimentation to rapidly field new capabilities, and the creation of a dedicated space staff in the Pentagon, led by an Undersecretary of the Air Force for Space (see fig. 6).

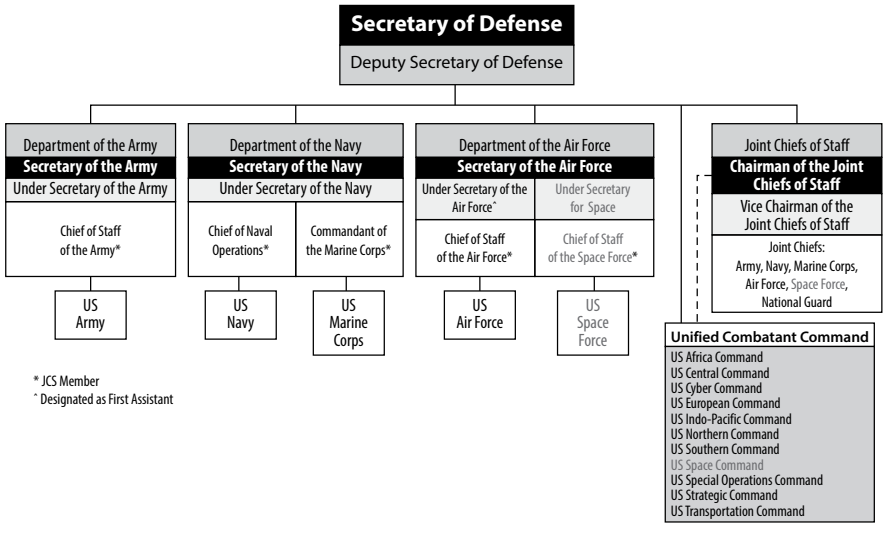

Figure 6. Space Force Organizational Alignment within the Air Force.

(Source: Senate Armed Services Committee, "Space Force Hearing, HON Heather Wilson, Secretary of the Air Force")

The initial space staff will be established in October 2019 with the Space Force resources—personnel and budget authority—transferred from the existing military services and phased in over five years (2020–24). Full operational capability is projected in Fiscal Year 2024. This proposal is expected to balance the benefits of elevating, unifying and providing additional focus to space as a war-fighting domain, yet does so in a cost-effective way.

Moving forward with our national space security strategy that is already being challenged by near-peer competitors, Pentagon officials have prepared the request for legislative action that would allow for the creation of a new CCMD (USSPACECOM) as the combat arm for space. Increased coordination among all of the US combatant commanders, the National Reconnaissance Office, and the intelligence community is needed to ensure USSPACECOM has the insight to integrate the space domain with other DOD strategic capabilities. USSPACECOM must be positioned to field capabilities to deter our adversaries from attacking our vital on-orbit space systems and should deterrence fail, defend our vital national military and commercial interests, and prevail against competitors who challenge them. ✪

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BOOK REVIEWS

Howard Hughes: Aviator by George J. Marrett. Naval Institute Press, 225 pp.

Howard Hughes: Aviator is a thoroughly researched and well-documented biography on Howard Hughes, with the central perspective on the part of his widely-chronicled life spent in aviation. Written by a former test pilot for Hughes Aircraft Company, the book is an easy-to-follow, informative guide that provides not only a deeper understanding of US aviation history, but also Hughes' enigmatic life.

The author, George Marrett, is a former US Air Force fighter and test pilot with approximately 8,000 flight hours accrued in more than 40 types of aircraft. He joined Hughes Aircraft Company as an experimental test pilot upon his return from service as a rescue pilot in the 602nd Fighter Squadron during the conflict in Southeast Asia. Marrett writes with authority on the technical aspects of aviation. The close attention paid to aircraft specifications and performance both benefit and hinder comprehension, depending on the reader's needs, interests, and prior knowledge. Helping to balance the story, Marrett fills the biography with numerous firsthand accounts from pilots who worked and flew with Hughes. These anecdotes help shape a holistic understanding of Hughes as an aviator and boss beyond simple flight performance. Of note, however, the sidebar background provided on these ancillary characters, as well as their specific dialogue or interactions with Hughes, prove distracting at times and do not always add immediate value to the story.

Similarly, being a focused biography, the larger context of Hughes' personal life was mostly disregarded. Marrett's choice to exclude this content could have been because he felt these external factors had little to no impact on Hughes' aviation life, or perhaps it was his own technical bias toward discussing aircraft performance and development. For a non-test pilot or aviation aficionado, more personal context on Hughes might have proved useful to gain a greater understanding of his legacy and impact.

As previously mentioned, this biography is well-documented and contains a useful list of resources, indexes of aircraft and actors, aviators, and associates, along with a dedicated section of maps and photographs in the center of the book. I recommend the reader to start with the last chapter, "Legacy of Howard Hughes." In hindsight, this brief summary of the work would have proved useful in understanding the timeline and highlights of Hughes's life, as well as understanding the author's perspective before delving into the details of the book.

The author begins with Hughes's first flight at age 14 in the fall of 1920 and spends the first chapter recounting his increasing love for aviation, interspersed with background details about his simultaneously developing success as a film producer. Chapter 2 details his largely successful attempts to break various aviation records. This chapter also contains a plethora of information about the types of aircraft he chose and how they were modified to eclipse Charles Lindbergh as the world's best aviator, a primary goal for Hughes.

World War II was a major turning point in Hughes' aviation. Chapters 3–4 discuss the development of Hughes Aircraft Company and his many failures as an army contractor, as well as a pilot. Following his 1946 near-fatal crash in the XF-11 and the "successful" flight of the HK-1 flying boat in 1947, Hughes lost all interest in his aircraft company. While Marrett does not attempt to delve into Hughes' psychology and his abrupt disinterest in flying, neither do the slew of other biographers of this enigmatic man. Regardless, by this point in Hughes' life, his contributions to aviation were indisputable and his place in the figurative pantheon of aviation history secure.

Chapters 5–6 explain the transition of the company into alternative leadership and their jump to aviation electronics, which would become the mainstay of its very profitable business. While his aircraft company flourished, chapter 7 describes Hughes' involvement in the development of transport aircraft for the Trans World Airline, or TWA, as well as the ensuing legal battles and his loss of control over the company.

Meanwhile, due to his own eccentricities, coupled with an increasing codeine dependence (initiated by the physical pain resulting from his over eight automobile and airplane crashes by 1947), Hughes's life fell into a slow yet pronounced downward spiral. Chapters 9–10 wrap up the biography by discussing the end of Hughes's life and his ensuing legacy.

Howard Hughes is a fascinating character in American history. Although he accomplished his three greatest goals in life: to become the world's most famous film producer, the world's top aviator, and the world's richest man, this biography focuses on how his love for aviation truly shaped his life. *Howard Hughes: Aviator* proves an excellent work for those interested in the technical development of aviation over the last century, as well as to those who are interested in Hughes's life and legacy through the lens of aviation. Those looking for a larger picture of Hughes or aviation history would do well to have a grasp of context and content before delving into the finer points of this biography.

Capt Marissa Kester, USAF

Architect of Air Power: General Laurence S. Kuter and the Birth of the US Air Force by Brian D. Laslie. University Press of Kentucky, 229 pp.

Architect of Air Power is a biography of USAF Gen Laurence S. Kuter. Brian D. Laslie is the deputy command historian at North American Aerospace Defense Command (NORAD) and US Northern Command, as well as an adjunct professor at the USAFA. He is also the author of *The Air Force Way of War: U.S. Tactics and Training after Vietnam*. Laslie's work joins a collection of other Air Force biographies that he references in the preface, namely works covering George Kenney, Carl Spaatz, Pete Quesada, and Claire Chennault (p. xi). As an examination of the birth of the USAF, the biography joins works such as Bernard Nalty's *Winged Shield, Winged Sword: A History of the United States Air Force*, Herman Wolk's *Reflections on Air Force Independence*, and Walter Boyne's *Beyond the Wild Blue: A History of the U.S. Air Force*.

The creation of an independent USAF in 1947 by the National Security Act was the culmination of persistent planning and uphill struggle on the part of US military aviation going back decades. Several notable individuals were key players in this process—Gen Billy Mitchell, Gen Henry "Hap" Arnold, Gen Dwight D. Eisenhower—and others—but Laslie argues that General Kuter—an officer not covered as frequently or as completely— played a highly significant role in USAF development as well.

The stated purpose of Laslie's work is to correct this historiographical oversight by providing a biographical account of Kuter's life that is—in the author's own words—"as much about what was occurring around Kuter as it is about the man himself" (p. 4). Laslie is aware of the dangers in writing biography, namely that the work can lose its objectivity and become unnecessarily laudatory in its coverage of the given subject. This is a challenge, however, that Laslie recognizes and addresses, even if there are relatively few (but forthright) mentions of Kuter's shortcomings (pp. 53, 55, 67–70, 138, 143–144, 162). The portrait that emerges is one of a career aviator, an officer not given to the bravado and maverick nature that often characterized the more famous military leaders from the period, but notable because of his quiet and persistent influence, masterful organizational skill, and successful leadership (p. 160).

Laslie moves quickly through Kuter's early years in Illinois and at West Point, demonstrating the quiet, honest, and determined outlook that would come to characterize Kuter's career (pp.

5–18). Kuter's entrance into military aviation came, by his own admission, to simply become a "better field artilleryman" (p. 16). However, Kuter succeeded in his flight training, survived washout, and soon gained considerable experience with flight testing, bombardment, and organization. It was Kuter's next assignment, as a student at the Air Corps Tactical School (ACTS), that would place him at the center of American airpower development (pp. 27–28).

Laslie's approach is to focus on the accomplishments and events that demonstrate Kuter's contributions to the growth of American aviation as well as the events that comprised and surrounded this development. Kuter's time at the ACTS as a student and an instructor prepared him for intimate involvement with the future of airpower in more powerful venues and established Kuter as a strategic thinker, ardent supporter of aerial bombardment, and a rising star within the Army Air Corps. This experience also prepared him for one of the notable contributions as Laslie heralds in his introduction—the development of the Air War Plans Division—Plan 1 (AWPD-1), a document that would serve as the first articulation of a comprehensive air plan (pp. 31–47). Laslie asserts that Kuter not only played an instrumental role in the development of AWPD-1, but he was a principal author of the document and responsible for securing much of the required approval (p. 48).

Laslie's coverage of Kuter's assignments and activities during World War II illustrate the consistent, as opposed to dramatic, progression of Kuter's career and development as a skilled organizational leader. By the end of 1942, Kuter had become the youngest general of his time and the youngest since William T. Sherman, was directly involved with the internal organization of the Army Air Force (AAF), and successfully managed various moving pieces of the war effort as the deputy chief of staff, AAF (pp. 56–62). While Kuter's rank as brigadier general limited his opportunities for combat assignment overseas, combat experience was necessary for further career development. The lack of significant combat distinction, Laslie points out, perhaps explains the lack of biographical treatment hitherto, though in error (p. 2). Laslie highlights that while Kuter's overseas assignments frequently changed rapidly, leaving little time for him to lead or to see his projects through (p. 122), this was because Kuter's organizational acumen was constantly in demand (pp. 71, 85, 128). By the war's end, Kuter had served in every major theater of conflict and was being pursued by civilian airlines, political appointments, and further military assignments (pp. 64–136).

Following the Berlin Airlift, where Kuter's new command, the Military Air Transport Service, performed an instrumental role, Kuter's career ascended through a variety of increasingly important and strategic administrative positions—commander, Air University, commander of the Far East Air Forces, commander of the Pacific Air Forces (PACAF), and commander in chief of the North American Air Defense Command (NORAD) (pp. 137–169). Throughout this time, Kuter's leadership consistently exhibited the same calm, firm, and determined influence that characterized his earlier assignments, and he was responsible for significant achievements, such as the creation of the PACAF (p. 148) and the development of the Cheyenne Mountain Operations Center at NORAD (pp. 167–68).

Laslie's conclusion, rather than a traditional restatement of argument and evidence, is an epilogue fitting of a narrative biography. It reveals the efforts of Larry and Ethel Kuter, intent on recording Kuter's compelling experiences for posterity, even as Kuter himself was succumbing to emphysema. Laslie reiterates that Kuter's contributions to the birth and growth of the USAF warrant an effort to fill the historiographical gap that had hitherto overlooked his importance and the "mountain of archival sources" Kuter left behind as a prolific writer and diarist (p. 175). Here, as in his introduction, Laslie's feelings toward Kuter are clear, the biographer's bias that is difficult to mask.

If his assertions regarding Kuter's importance, and thus his validity as the subject of historiographical attention, are not sufficiently demonstrated throughout the body of the work, perhaps

it is because Laslie intended for Kuter's accomplishments to speak for themselves—and it is an impressive record. The inclusion of additional analysis and argument would serve as useful guideposts for the reader, otherwise adrift among Kuter's various achievements. Ultimately, Laslie presents carefully a researched and well-composed work. His source material draws from the collections of the USAFA, the Air Force Historical Research Agency, and the National Archives and Records Administration, to name a few, and includes oral history material as well as declassified documents and personnel records germane to the subject at hand (pp. 203–206). This biography is recommended both for the general reader as well as those examining the early history of American airpower and its principals.

Philip C. Shackelford

Massachusetts Aviation by Frederick R. Morin and John Galluzzo. Arcadia Publishing, 2016, 128 pp.

In *Massachusetts Aviation*, the passionate duo of Frederick R. Morin and John Galluzzo draw upon their shared love of history to provide a short, but insightful monograph about the busy aviation history of the Commonwealth of Massachusetts. Morin's deep understanding of the material, supplemented by his work as the past president of the Massachusetts Aviation Historical Society, former director for the Massachusetts Air and Space Museum, and personal piloting experience, lend itself well to Galluzzo's experience telling the unique picture-centric history narrative that Arcadia Publishing is known for.

The book is photo-intensive, and each page is dominated by at least one picture that encompasses almost half of the page. The narrative is driven by the captions that accompany each picture, and they range from a few dozen to almost 200 words per picture. This book, by design, focuses more on the details of the photographs to engross the reader more than the words do. The captions simply guide the reader along the path that the pictures lay out for them. The authors did not try to make any deep arguments or attempt to reimagine history, they simply laid out the facts as presented in a series of black and white photographs from the first century of aviation. If the authors had a specific purpose in mind, it was to ensure that the legacy of Massachusetts' aviators and innovative pioneers is remembered and maintains a place in history.

Massachusetts Aviation was clearly a passion project for its authors, and it will appeal to anyone who has similar interests: aviation pioneers, military history, and Massachusetts history. The book introduces the readers to the dawn of Massachusetts aviation: the 1910 Harvard–Boston Aero Meet. It was here that the larger-than-life personas of Wilbur Wright, Glenn Curtiss, a young Franklin Delano Roosevelt, President William Howard Taft, and British aviation pioneer Thomas Sopwith shared the same converted grass field near the railways and witnessed aviation history. During this aero meet, the debates of airpower were put to the test, and Lt Jacob Fickel, US Army, became the first person to ever shoot a rifle from an airplane—a full year before the first combat application of airpower during the Italo-Turkish War in 1911. Of similar airpower importance were the bombing competitions, where civilian pilots attempted to hit mock targets starting at an altitude of 100 feet. With the Secretary of the Navy's encouragement, the champion was challenged to hit the target (a mock battleship) from an altitude of 1,800 feet, which he managed to do.

After hitting on the surprising number of aviation firsts (the first naval air reserve base) and interesting ties to the aviation elite (Amelia Earhart helped fund an early civilian airfield), the book weaves its way into the military aviation history of Massachusetts. With then Lt (later Rear Adm) Richard Byrd's efforts after World War I, the Navy established the Naval Air Reserve (NAR), its first airfield began use in 1923 (two years before the NAR was officially established) on the same site as the 1910 Harvard–Boston Aero Meet. From there, the reader is

greeted with a series of biplanes, monoplanes, amphibious airplanes, blimps, and helicopters from the Navy's years in Massachusetts. The airfields proudly supported British flight training during World War II and antisubmarine warfare from World War II through the Cold War until the base was hit by the Base Realignment and Closure Commission in 2005.

The Air National Guard is also discussed in detail in the brief histories of some aviation pioneers that accompany their pictures. Through the pictures and captions, the reader follows the birth, growth, and varied missions of Otis Field, Westover Air Reserve Base, and Logan International Airport. The authors carry the story from the earliest plans for a "Massachusetts Military Reservation" in 1935 to the actions of the 102nd Fighter Wing on 11 September 2001, when two of its aircraft were the first to respond in the skies over New York City.

An aspect of the history that may surprise many readers is the role the Coast Guard played in the development of aviation. Driven by the thought of a Massachusetts Coast Guard commander who believed that aerial searches would enable better patrol of the coast during the Prohibition Era, the Coast Guard acquired its first airplane. From there, Coast Guard aviators developed the first amphibious airplanes—designed with sea rescues in mind. Perhaps less heroic, but equally groundbreaking, was the Coast Guard's use of their airplanes in conjunction with homing pigeons to notify the Gloucester fishermen where the schools of fish were located.

The historical narrative ends with a series of one-page stories to explain pictures and some multipage tales from various points in Massachusetts' aviation history. The construction of the aircraft carrier USS *Lexington* (CV-2), the doomed *Hindenburg*'s overflight of Boston, and Massachusetts' role in both the creation of the modern jet engine, and the rockets of the Space Age round out the tale that began on a field in Cambridge in 1910.

Ultimately, this book is light on historical detail but heavy on material. Any part of this historical monograph could quite easily fill a book of similar size and be genuinely entertaining to aviation and local history buffs alike. However, the authors deliberately kept each topic short to fit in as much as possible within the deceptively broad scope of Massachusetts aviation history. As an aviation enthusiast and Massachusetts native, I was undoubtedly the target audience, but this book will also interest those who enjoy an intimate—and often candid—look at the people, events, and locations of the past. The purpose of this book was not to set the record straight or uncover new details, but to "urge one and all to keep their eyes on the Massachusetts skies" (127), and that goal the authors met with ease.

Capt Daniel W. McLaughlin, USAF

Military Aviation in the Gulf South: A Photographic History by Vincent P. Caire. Louisiana State University Press, 2016, 160 pp.

Vincent P. Caire begins this short, pictorial book with an advisory. This book does not act as an inclusive history of avionics throughout the South. He acknowledges that this would be virtually impossible. However, the author manages to pack decades of history into this little book and then some. The Gulf South plays host to the majority of pilot training for every branch of the US military. In a few short pages, Caire lays out how this developed over the years from the earliest flights of the Wrights' to current military flight training. The book's 6 chapters, 3 appendices, and more than 150 photographs touch on the highlights of aviation development and events. Several full-page color photographs are included, with a plethora of gray-scale photos as well. Many of the photos have never been published. Caire also utilizes several "features," where specific tales are recounted. For example, the Pensacola Navy Yard, the Doolittle Raiders, and the Blue Angels all have a two-page spread. Caire is an aviation historian based in Louisiana, has also acted as a television producer, and it shows. This work focuses on the high points and important impacts in the Gulf South. True to form, there is no mention of bases or events outside of this area.

The largest portion of this work focuses on developments made during World War II when the scramble to establish bases and aircraft was in full force. However, the author notes specifically though that the time between the world wars was extremely productive for aircraft but is generally overshadowed by wartime events. True aviation enthusiasts will be delighted to note that an entire chapter is devoted to these 23 years between the wars.

The presence of full-page photographs and specific features serves to make the narrative somewhat choppy. This is not a book that can easily be read cover-to-cover without pause, but the title does indicate that this is a focus on *photographic* history rather than written. It should be noted that the color photographs included in the center of the book are randomly sorted chronologically, which seems to contrast with the rest of the book. The strategy behind why the Gulf South was so important to the development of aviation is pointed out in several instances, which will delight those who value this logistician viewpoint. Interestingly, the author notes whom each base or field was named for. This is a special touch to remember many aviators who lost their lives.

All in all, *Military Aviation in the Gulf South* is an entertaining and concise look at the development of an area rich in military and aviation history. There are several impactful features and spectacular photographs. The dialogue is easily read, although occasionally disjointed. This work will be a delight to aviation enthusiasts; however history buffs may be left wanting just a bit more.

Capt Miranda Debelevich, USAF

America's Digital Army: Games at Work and War by Robertson Allen. University of Nebraska Press, 2017, 228 pp.

On a superficial level, *America's Digital Army* appears as nothing more than a historical recap of a now defunct Army recruiting program that used a video game called *America's Army* to attract teenage recruits. But, upon closer inspection, its author, Robertson Allen, an anthropologist and ethnographer, now working in the private sector at the Hartman Group, plumbs deeper meanings within this framing device of a video game's life and death. His thesis is a two-sided coin—its visible top side being a straightforward exploration of "recruitment and training through digital technologies" (p. 9), while its more covert underside delves into whether such a campaign militarizes civilian relationships in America as a whole, by constructing "everyone, even nonplayers of games, as virtual soldiers, whose labor is available for deployment" (p. 10).

Because Allen's thesis is multilayered ("militarized relationships," recruitment, and gaming) his work has few, if any, peers. His study does enter the anthropological discussion of a militarized society that echoes Catherine Lutz's *Homefront: A Military City and the American Twentieth Century*. Both Lutz and Allen suggest that a physical military presence on home soil can too easily "gobble up" civilian reality. But so, too, does Allen's book explore the difficulties outlined by the National Research Council's monograph on recruiting an all-volunteer army. Works on games studies, such as Simon Parkin's *Death by Video Game: Danger, Pleasure, and Obsession on the Virtual Frontline*, round out Allen's topics of interest.

First-Person Shooter gaming is, in fact, what initially attracted Allen to study *America's Army*. His opposition, as a graduate student, to the Iraq War progressively became discordant with the very games that he enjoyed playing. Not only for their forms of violence but also for the obviously "underlying ideological and political messages that were [being] voiced....For example, the games *Conflict: Desert Storm* and *Conflict: Desert Storm II—Back to Baghdad* celebrated the 1990s Gulf War in Iraq but were strategically released as commercial products during the period leading up to, and immediately following, the 2003 Iraq invasion" (p. 14). Allen was forced to admit that his antiwar stance as an individual was at odds with such beloved games that "speak about war, and maybe not in ways that I entirely like" (p. 14).

Curiosity aroused, Allen began to look at the issue critically; focusing on one combat game in particular. Becoming attached to the Army Game Project through the good graces of the proj-

ect's director, Dr. Casey Wardynski, in 2006, Allen obtained the green light to begin anthropological and ethnographic fieldwork among the software developers and military veterans involved in the creation of *America's Army*. His findings, like his thesis, are diverse.

As an anthropologist, he found a "process of pervasive cultural militarization, enacted in part through the harnessing of high-tech labor and the intermeshing of the technologies and economies of entertainment and war" (p. 31). But as someone in a position likened to that of an embedded journalist in a semimilitary environment, he also uncovered the real difficulties of recruitment in an increasingly digital age where brochures handed out by Army recruiters hold little interest for teenagers.

Such problems with recruitment were what first led project director Wardynski, who conceived of the Army Game Project, to ask, "Could we do [the recruitment process] virtually by getting kids interested in the army, by test-driving, by virtually being a part of it?" (p. 48) Tactical war games, of course, are nothing new. There are the games of chess, created in India sometime around the sixth century, the Chinese game Go, which dates back at least 2,500 years and is believed to be the oldest board game still being played, and the latecomer game of Kriegsspiel, created in 1812 to train Prussian officers in strategic maneuvers. But it was with the visual component added by computers in the late-twentieth century that the move to a whole-body war simulation was spawned, a development that began pushing us ever closer to a true virtual reality.

The question arises in such games then as to what exactly is real? The player's physical and emotional responses are real. The visual narrative is not. How does this hybrid reality affect the game's representation of combat? Is the "test-drive" recruiting analogy then at all accurate? Real and virtual are further confused when actual human soldiers are used as templates for the game's "Real Heroes" characters. But these characters, like the spritz of blood players see when online characters are killed, are "highly sanitized and polished" (p. 81) with no trace of the real-life problems suffered by their inspirations who might be struggling with PTSD or a rocky reintegration back into the home front.

For these and other reasons, *America's Army* was not without its critics, despite having garnered an impressive array of software awards and being "consistently ranked among the most played online games" (p. 7). Complaints ranged from how it trivialized actual combat to its glorification of violence. Vocal opponents warned of its effects on children.

But neither success nor public outcry would affect its eventual fate. Due to a rise in military recruitment during the Great Recession, funding for the Army Game Project was "extensively cut in 2009" (p. 11). Allen explains that as:

> of 2016 the program is dramatically diminished, with an uncertain future, but the questions raised by the circulation of *America's Army*... are [still] very much apropos in a society shaped by the economy of war, immersed in the interactive spectacles of conflict, and distracted by a pervasive overload of information (p. 11).

I found the book profound in its anthropological discussion but a bit too scattershot with its inclusion of technical aspects of the game, the poor relations between the army and the software developers, and the personal idiosyncrasies of the project's director. All are interesting, but diluting what is, essentially, a fascinating start to studying the military's use of dual-reality (both actual and virtual) systems to train soldiers or to aid them in combat.

Diana Clark Gill

Eyes for the Phoenix: Allied Aerial Photo-Reconnaissance Operations, South-East Asia 1941–1945 by Geoffrey J. Thomas. Hikoki Publications, 1999, 272 pp.

Military forces first used aircraft for reconnaissance. Aerial photography grew into a science during World War I, but at the same time other, more glamorous roles for aircraft emerged—

pursuit and bombardment. These roles tended to garner more attention than observation and reconnaissance, and it can be debated that this continues to the present day. A book covering Allied photo-reconnaissance (PR) in the Southeast Asia theater in World War II, therefore, has a chance to make a positive impact on the historiography of that war. Geoffrey J. Thomas has produced such a book in *Eyes for the Phoenix: Allied Aerial Photo-Reconnaissance Operations*.

The author is a retired architect who served in the British Army in the Southeast Asia theater. While in the service, his interests led him to delve into the official records concerning aircraft colors and markings, and his zeal is very evident in this fine book. The author's main sources were British and American archives and some of the men who were involved in these operations.

Thomas describes the myriad PR platforms used by the allies and weaves this into a narrative of the overall course of the war in the Southeast Asia theater. His narration of individual sorties and the personal heroism of the aircrews sheds light on a little known aspect of the war. Although US Army Air Forces aircraft and units are well represented, the book is heavily slanted toward British forces. However, this is understandable given the author's background and his experience in the theater.

The book is chock full of photographs—more than 320 of them. Six full color plates that show aircraft colors, markings, and insignia will please modelers and enthusiasts. In addition, Thomas devotes about 100 pages of text to describing aircraft markings, paint schemes, and colors. There are many maps—three of them in color—that help the reader orient himself to the vast area covered in this book.

Thomas has included comparatively few examples of the photographs produced by these reconnaissance units, but these few are probably sufficient to give the reader an idea of their overall work. Likewise, there is no in-depth coverage of the work of the unsung support personnel who maintained the aircraft and equipment of the units. There is, however, a fine two-page reminiscence of a British army photo developer. The absence of a bibliography and footnotes makes it difficult to check the author. There is no index, so following any particular man or unit is impossible.

The book is so densely packed with good information that it's difficult to do justice to it in the space constraints imposed by this review format. Suffice to say, it is difficult to imagine a book that would surpass this one for this topic. It is highly recommended for anyone interested in the Pacific air war.

Maj Peter L. Belmonte, USAF, Retired

OSS Operation Black Mail: One Woman's Covert War Against the Imperial Japanese Army by Ann Todd. Naval Institute Press, 2017, 280 pp.

Ann Todd energetically eternalized the harsh realities of the unsung heroes in *OSS Operation Black Mail*. In particular, the account accurately followed Elizabeth "Betty" McIntosh, the living legend and a retired case officer, who used black propaganda with her team in the China–Burma–India theater against the Imperial Japanese Army. Todd intimately portrayed McIntosh with eye-opening details as the acting head of the morale operations branch for the entire theater, which was an incredible feat in itself. After all, "although acting chiefs had come and gone in SEAC [South East Asia Command] and China, never had there been one for the entire theater," which speaks volumes to how Washington knew that McIntosh was genuinely a force-multiplying leader (p. 108). Thus, Todd weaved covert historical events into a page-turning intelligence literature while remaining true to history.

Todd's way of writing is not only captivating but also extremely educational because of her in-depth research on the subject and era. After all, Ann Todd had spent time in the military and graduated with a doctorate in History from the University of Texas at Austin. The author crafted the major highlight of this particular covert war from start to finish into 17 captivating chapters:

(1) The Voyage before the Storm, (2) War, (3) Recruitment, (4) Learning to Lie, (5) In Theater, (6) Operation Black Mail, (7) Rumors and Threats, (8) Laying down the Sword, (9) A Woman in Charge, (10) Onto Calcutta, (11) China, (12) The Last Summer, (13) A Great Catastrophe, (14) Mercy Missions, (15) Operation Iceberg, (16) Going Home, and (17) Home. Todd researched and provided context at every opportunity to help the audience to understand McIntosh's leading role in the covert war. With no surprise, Todd had more than 120 sources in her bibliography for this book.

If there were only enough time to read one chapter, "Operation Iceberg" would be the one to read because it covered the subtle and profound realities of operations, which history books tend to lose. History textbooks will teach that Operation Iceberg had five objectives: "(1) interrogate prisoners of war, (2) begin war crimes investigation, (3) survey American property, (4) gather information about the members of Operation Caprice, and (5) gather information about both Ripley I and II" (p. 175). Todd unearthed the realities of what life was like for Jane in Operation Iceberg. For example, "as a woman, Jane was not allowed on the ship, and so would be flown in on the first postwar plane" (p. 173). Many people know the outcome of history from textbooks, but very few understood the realities of how history happened.

While *OSS Operations Black Mail* enriches the intelligence literature to a high degree, one problem with the book is that McIntosh seems to be too flawless. This potential author bias could be a consequence of interviewing McIntosh, but not every character that occurs in the book due to death. Todd's *OSS Operation Black Mail* is a book meant for anyone who truly wants to know the realities of black propaganda during the theater of "Confused Beyond Imagination."

1st Lt David Chui, USA