ASPJ
Air & Space Power Journal
March–April 2014
Volume 28, No. 2
AFRP 10-1

Senior Leader Perspectives

Ricochets & Replies

Features

Departments

Global Vigilance, Global Reach, Global Power for America

The World's Greatest Air Force—Powered by Airmen, Fueled by Innovation

Gen Mark A. Welsh III, USAF

The Air Force has been certainly among the most adaptable parts of our national military instrument of power. Every Service has made some adaptations, but I would suggest [that the Air Force's] seems to me, in my experience, to be most prominent, most visible, most important.

—Gen Martin Dempsey, USA
Chairman of the Joint Chiefs of Staff

The Enduring Importance of Airpower

This past year, the United States Air Force released a vision statement that focuses on "Airmen, Mission, and Innovation."[1] It recognizes Airmen as the power behind the Air Force and acknowledges the importance of innovation to our story. I encourage Airmen to understand and explain their role in producing airpower for America by telling the Air Force story through their own unique perspective. Building upon our vision, this article defines the Air Force's five enduring core missions: air and space superiority; intelligence, surveillance, and reconnaissance (ISR); rapid global mobility; global strike; and command and control.

Early airpower advocates, such as Brig Gen William "Billy" Mitchell, understood that "the future of our nation is indissolubly bound up in the development of air power."[2] By integrating airpower capabilities within and across air, space, and cyberspace, Airmen bring to life the Air Force's core missions. Today, Airmen utilize emerging technologies in air, space, and cyberspace. We are the only service that brings them together in ways that permit our sister services the freedom to maneuver without fear of attack by enemy air forces. America has only one force specifically designed and precisely employed to exploit the unique global advantages realized from operating in air, space, and cyberspace.

The Power of Airmen

The service's unmatched capabilities exist because of the imagination, innovation, and dedication of its people. Airmen have historically pioneered new ways to shape the fight and reinvent the battle itself. Whereas pre–Kitty Hawk warriors relied on breaking through fortified lines, Airmen have always sought to go over, not through, fortifications to defeat our enemies and achieve the nation's objectives.

Air Force Core Missions

Airmen bring to the nation's military portfolio five interdependent and integrated core missions that President Truman originally assigned as airpower roles and missions to the Air Force in 1947. Today, we call these our core missions: (1) air and space superiority; (2) ISR; (3) rapid global mobility; (4) global strike; and (5) command and control. Each of these is, in its own right, vitally important; however, no single core mission functions independently. Airpower is maximized when Airmen leverage its unique characteristics—speed, range, flexibility, precision, lethality, and persistence. The Air Force is effective because its interdependent operations are synchronized to provide an unparalleled array of options, giving America the ability to respond quickly anywhere in the world.

Air and Space Superiority: Freedom from Attack and Freedom to Attack

From the Pacific island-hopping campaign of World War II to operations today, air superiority has been and remains an essential precondition to successful military operations. It includes the ability to control the air so our military forces do not have to worry about being attacked from the air, while also ensuring that the joint force has the freedom to attack in the air, on the ground, and at sea. The Air Force has given our joint partners ample reason not to worry—not since 15 April 1953 has an enemy combat aircraft killed a service member in the American ground forces. Without air superiority, our military would have to radically change the way it fights, at the price of lives lost.

America's freedom to operate effectively across the spectrum of conflict also rests on its exploitation of space. As the nation's space force, the Air Force provides critical capabilities that enhance the military's capacity to navigate accurately, observe clearly, communicate securely, and strike precisely. The ability to access and exploit space, even when others try to deny us, remains vital.

Intelligence, Surveillance, and Reconnaissance: Eyes and Ears on Adversaries

The Air Force has embraced globally integrated ISR as one of its feature calling cards. ISR is the foundation upon which every joint, interagency, and coalition operation achieves success. Our ISR Airmen identify and assess adversary targets and tactics with greater accuracy and speed than ever seen in the history of warfare. In 2012 alone, Airmen enabled the removal of 700 enemy combatants from the fight and identified over 100 weapons caches and explosive devices that would have otherwise targeted American and partner forces. Air Force ISR is about helping leaders make informed decisions to maintain deterrence, contain crises, or achieve success in battle. It allows policy makers to minimize uncertainty about our adversaries and their capabilities by providing knowledge that gives commanders a decision-making advantage. Globally integrated ISR permits American forces to carry out functions that they previously performed with much greater risk of danger and at higher cost. In the past decade, Air Force ISR has operated primarily in permissive environments, but tomorrow's fight may involve the most advanced air defense systems. In contested future environments, gaining and maintaining an ISR advantage will become increasingly difficult, and the Air Force will have to adapt its ISR capabilities for these operations.

Rapid Global Mobility: Delivery and Recovery on Demand

American power can be projected quickly anywhere on the earth as a result of the Air Force's ability to fly air refueling tankers and cargo planes globally on short notice. It provides swift deployment, in-flight refueling, and the means of sustaining operations from major combat to humanitarian relief. Rapid global mobility is woven into our history from the Berlin airlift to today—an Air Force transport departs on a mission every two minutes, every day of the year. Rapid global mobility is vitally important to every Soldier, Sailor, Marine, Airman, and Coast Guardsman because of our ability to evacuate wounded troops from the battlefield to emergency rear-area field hospitals. In one case, the Aeromedical Evacuation System flew a wounded Marine from a remote region of Afghanistan directly to Andrews AFB, Maryland. All told, he arrived at Bethesda Naval Hospital less than 21 hours after he was wounded. Today, the Air Force is flying patients across the globe—patients so critically wounded that most US hospitals would not consider moving them out of their intensive care units. Airmen continue to strengthen the efforts of our own government and international partners with the unique capability to get to the fight quickly, remain in the fight, and return home safely.

Global Strike: Any Target, Any Time

Global strike means that the nation can project military power more rapidly, more flexibly, and with a lighter footprint than other military options. The Air Force's nuclear and conventional precision-strike forces can credibly threaten and effectively conduct global strike by holding any target on the planet at risk and, if necessary, disabling or destroying it. Whether from forward bases or enabled by in-flight refueling, global strike derives from a wide range of systems that include bombers, missiles, special operations platforms, fighters, and other Air Force aircraft. This capability, unmatched by any other nation or service, will grow in importance as America rebalances its force structure and faces potential adversaries who are modernizing their militaries. The Air Force will focus future efforts on updating global strike assets to ensure that American forces are prepared to act when, where, and how they are needed.

Command and Control: Flexibility and Resiliency

Airmen execute the Air Force's other four interdependent and enduring core missions enabled by robust, adaptable, and survivable command and control systems. The Air Force provides access to reliable communications and information networks so that the joint team can operate globally. The delivery of airpower is intimately dependent upon operating effectively in cyberspace, which can increase the efficiency and effectiveness of air and space operations and help integrate capabilities across all domains. Adversaries are also making advances by linking their own combat capabilities electronically, creating military challenges that our forces must be prepared to address. The Air Force will field advanced command and control systems that are reliable, resilient, and interoperable, while recruiting and training innovative Airmen to operate them.

Airmen + Core Missions = Global Vigilance, Global Reach, Global Power

Each Airman, regardless of his or her specialty, contributes by providing—*Global Vigilance, Global Reach*, and *Global Power*. There are many examples of innovative Airmen bringing our five core missions together. During Operation Allied Force, two B-2 stealth bombers departed Whiteman AFB, Missouri, and attacked targets in Serbia, each dropping 16 satellite-aided precision bombs and paving the way for the rest of the initial aerial attack force. In 2011 the Air Force answered the call to help enforce a United Nations–sanctioned "no-fly zone" over Libya. In early 2013, F-22s, B-52s, and B-2s flew training sorties to South Korea to signal America's resolve and ability to deliver weapons globally. For the last two decades, the Air Force has provided close air support, airlift, and ISR in support of Operation Enduring Freedom.

America's Asymmetric Advantage

The Air Force's culture of "over, not through" gives our nation an incomparable capacity to act either independently or in full collaboration with our joint, interagency, and coalition partners. The Air Force's core missions will continue to serve America's long-term security interests by giving our nation and its leadership unmatched options to confront future challenges. Defending the nation's interests during the last 20 years has dramatically increased the level of adaptability, creativity, and coordination between and among our sister services, interagency partners, and allies. Through it all, Air Force airpower has repeatedly deterred conflict, controlled escalation, and, when tasked by the nation's leadership, destroyed an adversary's military. Investments in Air Force readiness and future capabilities are essential if the United States is to maintain an agile, flexible, and ready force. Every Airman—and every citizen—should take pride in the fact that the United States Air Force will always provide *Global Vigilance*, *Global Reach*, and *Global Power* for America. ✪

Notes

1. *The World's Greatest Air Force, Powered by Airmen, Fueled by Innovation: A Vision for the United States Air Force* (Washington, DC: Headquarters US Air Force, 10 January 2013), http://co.ng.mil/News/PublishingImages/13-01-10-USAF-Vision.pdf.

2. William Mitchell, *Winged Defense: The Development and Possibilities of Modern Air Power—Economic and Military* (Tuscaloosa, AL: University of Alabama Press, 2009), ix.

Gen Mark A. Welsh III, USAF

General Welsh (USAFA; MS, Webster University) is chief of staff of the US Air Force, Washington, DC. As chief, he serves as the senior uniformed Air Force officer responsible for the organization, training, and equipping of 690,000 active duty, Guard, Reserve, and civilian forces serving in the United States and overseas. As a member of the Joint Chiefs of Staff, the general and other service chiefs function as military advisers to the secretary of defense, National Security Council, and president. General Welsh is a graduate of Squadron Officer School, Air Command and Staff College, Army Command and General Staff College, Air War College, and National War College.

Let us know what you think! Leave a comment!

http://www.airpower.au.af.mil

Joint Force Multipliers

America's Airmen Transition to the Resolute Support Mission

Maj Gen Jake Polumbo, USAF
Mr. Wesley Long, USAF

A nonstandard force of Airmen, both individual augmentees (IA) filling positions on joint manning documents and joint expeditionary tasked (JET) Airmen, is deployed to Afghanistan, helping transition the nation from current combat operations to the Resolute Support mission. This transition focuses the North Atlantic Treaty Organization's efforts more squarely on enabling Afghan forces to provide security for their nation through "training, advising and assisting."[1] Airmen supporting the joint force through individual augmentation are long-standing and predate the current Operation Enduring Freedom mission. However, support to the joint force also includes a sizeable number of Airmen who are individually tasked, trained, and deployed to conduct missions not always within their core skill sets. The US Air Force's support to the joint fighting team in Afghanistan is as varied as it is important. Most Air Force support is provided by standard units conducting normal missions within their core capabilities. For the most part, these standard-force Airmen prepare, deploy, and operate as a unit. Requirements for JET Airmen, on the other hand, have evolved from what was once considered a temporary solution to offset other services' manpower shortfalls to a permanent element of the Global Force Management Allocation Plan. This means that filling JET taskings will remain a consideration long after Afghanistan when the Resolute Support mission is terminated, and Airmen will continue to undertake them with professionalism and pride. As we transition to a new phase of operations in Afghanistan, now is the time to identify hard lessons won on the battlefield while acknowledging outstanding achievements and contributions to the joint force by nonstandard forces.

Sustaining the Joint Force

Across the board, Airmen contributed magnificently in the past dozen years around the globe. When it comes to Afghanistan, though, our nonstandard forces faced numerous challenges during their predeployment preparation and on the battlefield as they integrated into unfamiliar units without the benefit of their normal Air Force support structure. Identifying the challenges faced by our Airmen and working to provide solutions are a fundamental aspect of leadership. The processes to train, prepare, and deploy JET and IA Airmen have evolved over the years. Those predeployment challenges and solutions are well cataloged.

As a former commander of the 9th Air and Space Expeditionary Task Force–Afghanistan (9 AETF-A), I witnessed the impact of these challenges and implemented corrective actions. At the same time, I was proud to observe the determination and powerful capability of our JET and IA Airmen firsthand. The battlefield experiences of our Airmen are critical as we move forward into the next phase of the Afghanistan campaign.

Integration Begins with Training

Since JET and IA deployments are individually tasked and still not as widely understood as standard air expeditionary force deployments, it is necessary to discuss basic background information on the historical progression of JET deployments. The original JET Airmen filled "in lieu of" (ILO) taskings to solve US Army manpower shortfalls in support of Operation Iraqi Freedom in 2004. All of these ILO taskings required some level of predeployment training since the Airmen chosen had to conduct missions outside their basic core skills. Moreover, because the ILO Airmen had to integrate into Army units on the battlefield in Iraq, they needed to understand all of the unit differences between Air Force and Army operations. The Army was responsible for providing this training then and does so today.

In the chief of staff of the Air Force's memorandum "Joint Expeditionary Tasking Term" of 4 December 2008, Gen Norton Schwartz created the term *JET* and applied it to all Airmen who fill jointly sourced solution requests for forces to "emphasize our contribution to the fight with a single term that reflects our esprit and mission."[2] These JET and IA deployments have supported Operations Enduring Freedom, Iraqi Freedom, and New Dawn. However, key general characteristics of all of these deployments remained largely unchanged through the years. That is, as Airmen are individually tasked from across the Air Force, they attend predeployment training provided by the US Army for combat and mission skills. They then deploy and assimilate into joint or sister-service units widely dispersed across the battlefield. The commanders of these units exercise tactical control (TACON) of the JET and IA Airmen.

Deployment across the Area of Operations

At the height of operations, the Air Force had more than 4,200 JET and IA Airmen deployed to a large number of combat locations in Iraq and Afghanistan. Today, approximately 1,700 JET and IA Airmen are deployed in Afghanistan at more than 50 operating locations (see the figure below), with about one-third of those locations having fewer than five Airmen assigned. The challenge of commanding Airmen in such a low-density and scattered environment seems obvious, especially when depicted against the map of Afghanistan's sparse infrastructure. In addition, JET and IA Airmen are deployed throughout the US Central Command area of operations in support of other contingency operations; furthermore, if history is an indicator of the future, they will continue to deploy around the world in support of geographic combatant commanders.

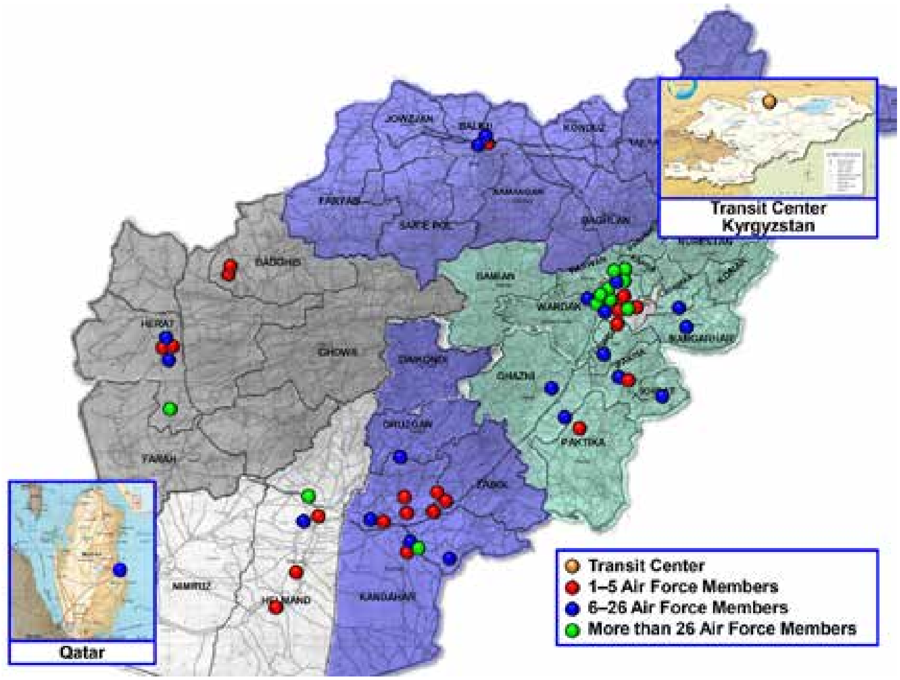


Figure. The primary challenge represented by the deployment of 1,667 JET and IA Airmen with 132 Air Force specialty codes in 54 locations—maintaining accountability. (From briefing to all JET/IA Airmen, 376th Air Expeditionary Wing Reception Center, subject: JET and IA Airmen Reception/Orientation, slide 14, 15 September 2013.)

As the commander in Afghanistan, I retained administrative control (ADCON) and operational control (OPCON) of all JET and IA Airmen assigned to US Air Forces Central Command (USAFCENT) in the Combined Joint Operating Area–Afghanistan. A basic responsibility of a commander is ensuring the well-being of his or her Airmen. The 9 AETF-A commander has command authority over all Airmen assigned, both standard and nonstandard forces.

Caring for and Tracking Airmen in the Fight

In a memorandum dated 31 May 2009, USAFCENT commander Gen Gary North established JET air expeditionary units in Afghanistan with the primary intent of providing specified ADCON over all deployed JET and IA Airmen.[3] Although not stated in the memo, his primary intent was to prevent the possibility of a "lost patrol." In other words, to ensure accountability, all Airmen would have and know the Air Force commander in their chain of command. In turn, all commanders would know and track the Airmen under their command.

By 2010 the 466th Air Expeditionary Group (466 AEG) and its three squadrons were activated to assume this responsibility in Afghanistan. However, when I assumed command of the 9 AETF-A in 2012, the 466 AEG had been scaled down to only one squadron—the 966th Air Expeditionary Squadron, which moved to the Transit Center at Manas, Kyrgyzstan, in an effort to reduce the footprint of Airmen in Afghanistan. This initiative, necessary at the time, significantly reduced the commander's battlefield circulation capability and degraded direct outreach to each JET and IA Airman.

Airmen's lack of direct access to their service's chain of command caused problems. The first indication of the difficulty was the increase in complaints made by Airmen after they had returned to their home stations. These complaints included incidents of basic and sexual assault. The fact they were not reported until after the Airmen redeployed was unacceptable and indicated a deficiency within the chain of command.

Two actions were taken to correct this deficiency. First, under the authority of the USAFCENT commander, I implemented what is now known as the Airman Blue Line Program (ABLP) as the primary mechanism to define the roles and responsibilities of the ADCON and OPCON command authority and to establish a clear chain of command for each JET and IA Airman.[4] The intent was to create an unbreakable but flexible "blue line" as a link between Airmen and the US Air Force while they were deployed to another service's unit.[5] The ABLP clearly assigned responsibilities of each participant at every level of command, from the Airman all the way to the USAFCENT commander. Today the ABLP is briefed to all JET and IA Airmen as they go through predeployment training and again when they in-process at deployed stations in-theater.

Second, I reactivated the 466 AEG and returned squadron-sized elements to Afghanistan. This action had multiple benefits. It not only enhanced unity of command and effort within the 9 AETF-A but also increased the number and effectiveness of routine battlefield circulations. Having a group in place allowed the O-6 commander to be on par with most of the commanders of the TACON units where the JET and IA Airmen were assigned.

The solutions to these challenges were found in basic Air Force doctrine and other guidance, but the lesson we learned is key for future operations. Moreover, the implementation required advocacy at the highest level since adding the manpower back on the books in Afghanistan was counter to the joint force commander's intent. Most importantly, the cost of inaction was not acceptable due to the potentially adverse impact on our Airmen.

CMSgt Frank Batten, 9 AETF-A command chief, acknowledges that one of the most significant limitations is how JET/IA requests for forces (RFF) are revalidated and/or turned off. He explained that after a position is validated (i.e., the Army has critically manned jobs versus

Air Force manning levels), recurring checks should ensure that the RFF is still valid according to the original criteria.

Further, as the TACON commander determines the end of mission, there is no automatic trigger to turn off the JET/IA RFF. During this transition, the Air Force must work with the requesting service to determine when to manage the revalidation and/or drawdown of the JET and IA positions. Additionally, OPCON responsibility currently does not allow the TACON authority to rerole/relocate JET/IA Airmen—potentially a problem if Airmen are being asked to perform a mission for which they are not trained or safely prepared.

Crucial Asset to Our Sister Services

Despite these challenges, our JET and IA Airmen continued to prove their superior capability and demonstrate the highest levels of flexibility as they contributed to the joint fighting team. During my many trips throughout the battlefield, I attempted to make contact with as many Airmen as possible. I was continually impressed with the capabilities of all of our JET and IA Airmen. The feedback I received from each of the TACONs was always positive. The most crucial consideration is that our Airmen were integral to supporting the joint force. A news article released by the Department of Defense notes that

> joint expeditionary tasked airmen have two commanders: an Army commander responsible for their day-to-day missions, and an Air Force commander responsible for their administrative and operational control.
>
> And both sing the praises of their Airmen.
>
> Army Lt. Col. Matt Smith, the [former] task force commander . . . [at Forward Operating Base Lightning in Afghanistan], said airmen are crucial in ensuring that the joint and combined services achieve their missions.
>
> "Airmen help fill a critical function in our headquarters and are doing an exceptional job—every one of them," he said. "One of my greatest fears is if the Air Force leaves us here; our operations run like a charm because of our Airmen."

> The wing commander responsible for all JET airmen in Afghanistan said airmen supporting the joint fight are examples of the Air Force's "all in" approach to the conflict.
>
> "Mentoring and partnering with the Army, Navy and Afghan forces are crucial to this war effort," said Air Force Brig. Gen. Steven L. Kwast, [former] 455th Air Expeditionary Wing commander. "Every airman has to be all in; you'll be more focused on the mission, and you'll ultimately be a better airman and person. Airmen will do anything [the joint community asks] of us, as long as we're trained to do the job correctly."[6]

Airmen in the Fight

These Airmen include MSgt Rebekah Virtue, an aerospace medical service technician assigned to a JET tasking with the 157th Combat Sustainment Support Battalion, Bagram Airfield, Afghanistan. As a convoy medic, Master Sergeant Virtue was appointed by the brigade commander to serve as the senior medic over all battalion medics after her leadership abilities and medical skills were highlighted by the battalion command sergeant major. Due to an absence of Army senior enlisted personnel, Master Sergeant Virtue was asked to take on the senior medic role, overseeing 18 combat medics. Her team aided in 175 convoys, expedited 45 aeromedical evacuations, and saw to the needs of 4,248 military members and civilians as well as 159 local nationals. During her deployment, Master Sergeant Virtue and her team provided medical escort coverage for 20,000 miles of outside-the-wire convoy movements and responded to 76 attacks by vehicle-borne improvised explosive devices, half of which resulted in multiple casualties. Master Sergeant Virtue exemplified all of the Air Force core values as a JET Airman, especially "service before self" and "excellence in all we do."[7]

Our Airmen also led provincial reconstruction teams (PRT), which supported reconstruction efforts and empowered local governments to govern their constituents more effectively. One such team in the region of Paktya, Afghanistan, was the US military's first PRT.[8] Team members not only assisted, advised, and mentored their provincial partners but also conducted counterinsurgency operations. This effectively culminated more than 10 years of PRT operations in Paktya, resulting in the administration of nearly $60 million in Commanders' Emergency Response Program funds, the construction of 38 health facilities, and an increase in schools from 24 to 518 and in agricultural projects from fewer than 10 during Taliban rule to over 68 provincewide today.[9] The Paktya area is now home to an estimated 1.2 million residents, up from fewer than 400,000 under Taliban rule.[10] Afghans the world over have returned home seeking a better life for their children and are credited not only with enduring hostile contact with insurgents but also with proudly completing the development of Afghanistan's first self-sufficient province.

The 466 AEG maintained accountability of all JETs/IAs in this area 24 hours a day, seven days a week. Deliberate efforts by the group to implement the ABLP made our Battlefield Airmen active sensors who relayed critical contact events back to the group—and thus the Air Force—without prompting and in real time. When one of our combat medics was critically wounded and being prepared for theater medevac without any notice to Air Force leadership, a JET Airman called the group to advise of the situation. As a result, the group was accountable for the Airman to Headquarters 9 AETF-A hour-by-hour with complete status and location as the medevac occurred. Furthermore, they simultaneously certified that both the Air Force Combat Action Medal and Purple Heart were awarded to our hero before leaving for the regional medical center in Germany.

From being entrusted to leading joint and coalition forces and securing hundreds of millions of dollars of equipment, US Air Force JET/IA Airmen—the most invaluable and dynamic aspect of airpower—provided the equivalent of a large combat air wing across the entire country of Afghanistan. These Airmen remain a critical manpower component for the future of the Resolute Support mission, just as they have during Operations Enduring Freedom, Iraqi Freedom, and New Dawn. They are an enduring feature of Air Force support to the joint force worldwide. Challenges remain to ensure the highest level of support to these nonstandard forces, especially as the operations tempo begins to decrease. It is important to continue identifying and understanding the lessons learned from this significant service effort and adapt the Airman Blue Line Program as needed. However, I feel certain that the outstanding individual contribution of these Airmen to the joint force around the globe will continue without fail. ✪

Notes

1. "NATO and Afghanistan," North Atlantic Treaty Organization, 18 June 2013, http://www.nato.int/cps/en/natolive/topics_8189.htm; and "Closing Press Conference by NATO Secretary General Anders Fogh Rasmussen Following the Meeting of NATO Defence Ministers," North Atlantic Treaty Organization, 5 June 2013, http://www.nato.int/cps/en/natolive/opinions_101215.htm.
2. "CSAF: Joint Expeditionary Tasking Term," Joint Base Elmendorf–Richardson, 17 December 2008, http://www.jber.af.mil/news/story.asp?id=123128629.
3. Gen Gary North, commander, US Air Forces Central Command, to Gen David D. McKiernan, commanding general, US Forces–Afghanistan, memorandum, 31 May 2009.
4. Richard Leech, USAFCENT A1 chief, Manpower and Personnel Readiness Division, "Airman Blue Line Program Concept of Operations," draft (Shaw AFB, SC: Headquarters USAFCENT, n.d.), 3.
5. Ibid.
6. Capt David Faggard, USAF, "Airmen Demonstrate Importance to Afghanistan," US Department of Defense, 9 September 2009, http://www.defense.gov/News/NewsArticle.aspx?ID=55769.
7. Col Panos Bakogiannis, USAF, e-mail correspondence, 20 October 2013—23 January 2014.
8. See Nima Abbaszadeh et al., *Provincial Reconstruction Teams: Lessons and Recommendations* (Princeton, NJ: Princeton University, Woodrow Wilson School of Public and International Affairs, January 2008), http://www.civilaffairsassoc.org/pdf/provincial_reconstruction_teams-lessons_and_recommendations.pdf.
9. Bakogiannis, e-mail, 2013–14.
10. Ibid., 2014.

Maj Gen Jake Polumbo, USAF

Major General Polumbo (USAFA; MS, Embry-Riddle Aeronautical University) is the commander of Ninth Air Force at Shaw AFB, South Carolina. Under his command, Ninth Air Force comprises eight active-duty wings and three direct-reporting units in the Southeastern United States with more than 400 aircraft and 29,000 active-duty and civilian personnel. Ninth Air Force is also responsible for the operational readiness of 16 Air Reserve Component wings. General Polumbo has commanded at the squadron, group, and three times at the wing level, including a yearlong deployment as commander of the 380th Air Expeditionary Wing, where he also led planning and deployment of the first US Army Patriot Battalion on his base in the area of responsibility. He most recently served as commander of the 9th Air and Space Expeditionary Task Force–Afghanistan; deputy commander–air, US Forces–Afghanistan; and deputy chief of staff–air, International Security Assistance Force Joint Command. In the latter assignment, he oversaw three air expeditionary air wings and three expeditionary groups consisting of more than 4,500 Airmen directly engaged in combat operations for Operation Enduring Freedom. He is a command pilot with 4,000 flying hours in all blocks of the F-16 Fighting Falcon, including combat sorties in Operation Northern Watch. He also holds the distinction of being the first Air Force general officer to fly the U-2S in combat and completed 21 operational U-2 missions in Operations Enduring Freedom and Iraqi Freedom. General Polumbo also flew combat missions in the MC-12W weapon system during Enduring Freedom.

Mr. Wesley Long

Mr. Long (BS, Citadel; MAS, Embry-Riddle Aeronautical University; MSS, Air War College) is the chief of US Air Forces Central Command's Air Advisory and Training Division at Shaw AFB, South Carolina. His division is the focal point for joint expeditionary tasked (JET) / individual augmentee (IA) expeditionary training requirements, combat skills development, and operational support for Airmen deployed to US Central Command's area of responsibility. He has deployed in a JET billet as an air adviser in Iraq and has conducted several deployed assessments in both Iraq and Afghanistan to develop training techniques and procedures for JET/IA Airmen.

Let us know what you think! Leave a comment!

http://www.airpower.au.af.mil

We encourage you to e-mail your comments to us at aspj@maxwell.af.mil. We reserve the right to edit your remarks.

A DIFFERENT AIR FORCE TIGER

I commend Lt Col Brian "Bingo" McLean, USAF, retired, on his article "Who's in Charge? Commander, Air Force Forces or Air Force Commander?" (November–December 2013). Bingo does an excellent job of explaining the role of Air Force commanders and of the commander, Air Force forces (COMAFFOR).

I especially liked his analogy that all tigers are cats but that not all cats are tigers. We understand from the analogy that the COMAFFOR is the tiger, uniquely authorized to function as the senior and single Air Force voice to the joint force commander. Brian's doctrinal explanation of COMAFFOR is spot on. However, in today's complex environment, there is usually another senior Air Force commander directly responsible to a joint force commander—the commander, Air Force special operations forces (COMAFSOF).

According to Air Force Doctrine "Annex 3-05, Special Operations," the COMAFSOF is normally under the operational control of the commander of the joint special operations component (a subunified command) to the joint task force. The COMAFSOF is frequently dual hatted as the joint special operations air component commander (JSOACC). The COMAFSOF/JSOACC is not normally assigned or subordinate to the COMAFFOR / joint force air component commander (JFACC).

The administrative control (ADCON) line runs from AFSOF through the senior Air Force Special Operations Command (AFSOC) officer in-theater, normally the COMAFSOF, to the COMAFSOC. When specified, ADCON may be shared with the Air Force service component commander or COMAFFOR.

AFSOF are an integral part of a subunified joint force; they prescribe to similar dictates of Air Force doctrinal principles and tenets. Many of the principles Bingo outlined for the COMAFFOR and his forces are equally true for AFSOF. Deployed AFSOF are normally presented under a single AFSOC Airman who reports to a joint force commander. In essence, there may be more than one Air Force tiger in-theater. The COMAFSOF is the single voice of AFSOF aviation but is known better as a Chindit than a tiger.

Brig Gen Buck Elton, USAF
Director of Strategic Plans, Programs, and Requirements
Headquarters Air Force Special Operations Command
Hurlburt Field, Florida

Peeling the Onion

Why Centralized Control / Decentralized Execution Works

Lt Col Alan Docauer, USAF

Understanding centralized control / decentralized execution has value because the concept links initiative at the tactical level to operational and strategic objectives in a way that is consistent with higher-level intent. For this reason, centralized control / decentralized execution can mitigate some of the joint-air command and control (C2) challenges posed by antiaccess / area denial that put traditional US space and cyber advantages at risk. This article "reblues" the reader regarding the nature of centralized control / decentralized execution, explores theory to determine why it works, and discusses examples and ideas for more effectively using it in future joint-air operations.

What Is Centralized Control / Decentralized Execution?

Emerging in the aftermath of the North African air campaign during World War II, centralized control / decentralized execution is a foundational concept found within current joint and US Air Force doctrine.[1] Field Manual 100-20, *Command and Employment of Airpower*, notes that "control of available airpower must be exercised through the Air Force commander if inherent flexibility and ability to deliver a decisive blow are to be fully exploited."[2] Furthermore, according to Air Force basic doctrine,

> *Centralized control is commanding airpower* and should be accomplished by an Airman at the air component commander level who maintains a broad focus on the joint force commander's (JFC's) objectives to direct, integrate, prioritize, plan, coordinate, and assess the use of air, space, and cyberspace assets in any contingency across the range of operations. *Centralized control empowers the air component commander to respond to changes in the operational environment and take advantage of fleeting opportunities.*[3] (emphasis in original)

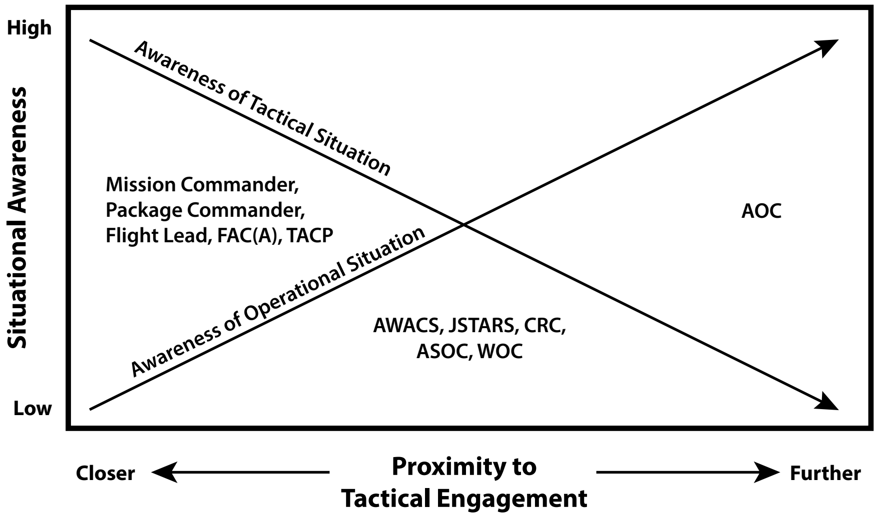
Centralized control enables an air component commander to plan, coordinate, and control the independent and direct-support actions of air forces in such a way that they meet the intent and objectives of the joint force commander.[4] Centralized planning of theater air operations provides a cohesive, integrated plan that meets combatant commander's objectives as part of the joint team. Centralized control supplies the theaterwide span of control necessary to exploit the speed, flexibility, and mass of air and space power to take advantage of unplanned and/or unanticipated opportunities (or vulnerabilities) whenever and wherever they emerge and as resources permit.

In contrast to centralized control, decentralized execution involves giving subordinate commanders the initiative to make decisions based on the best available information, informed by the air component commander's guidance, directives, and rules of engagement (ROE): "Execution should be decentralized within a command and control architecture that exploits the ability of front-line decision makers (such as strike package leaders, air battle managers, forward air controllers) to make on-scene decisions during complex, rapidly unfolding operations."[5]

Although the line between centralized control and decentralized execution may seem clear, it can quickly blur. That said, what allows this concept to work if the distinction is less clear than first appears in the black and white of doctrine? Exploring the importance of situational awareness (SA) offers a good starting point for answering that question.

The Importance of Situational Awareness to Shared Understanding of the Battlespace

The ability of technology to seemingly enhance SA and inform decision making has increased exponentially over the past decade. Data links, Internet relay chat, satellite communications, and full-motion video feeds are among some of the tools available to commanders at all levels. Although technology has placed additional information and options at the fingertips of leaders, it hasn't changed an anecdotal truth: *In general*, SA of what occurs in a tactical engagement is higher for those actually involved in it than for those who monitor it at an operational command center. Inversely, awareness of how an engagement fits into the larger scheme of operational art and strategy is higher at the operational level than at the tactical (fig. 1).[6]



AOC - air and space operations center	FAC(A) - forward air controller (airborne)
ASOC - air support operations center	JSTARS - Joint Surveillance Target Attack Radar System
AWACS - Airborne Warning and Control System	TACP - tactical air control party
CRC - control and reporting center	WOC - wing operations center

Figure 1. Situational awareness matrix. (From Lt Col Paul Maykish, used with permission.)

Bridging the SA gap between operational C2, which for the Air Force resides at the air and space operations center (AOC), and the tactical edge are battle-management C2 nodes such as the E-3 Airborne Warning and Control System (AWACS) and E-8C Joint Surveillance Target Attack Radar System. *In general*, these nodes have higher SA of what happens in a tactical engagement than operational C2 because they are closer and more involved in directly supporting the engagement and at times have as much or more SA than the shooter. Battle-management C2 actions are informed by published guidance, directives, orders, and direction from operational C2 during mission execution. The epitome of decentralized execution rests with the mission commander, package commander, flight lead, and terminal attack controller. For them, SA over their individual tactical engagement is very high. But how that action fits into the theaterwide perspective of air operations is understandably limited. Figure 1 generally shows the relationship of SA and proximity to the tactical engagement—it is not all encompassing. For example, a predator feed may serve tactical, operational, and strategic SA simultaneously. However, knowing where SA of the tactical, operational, and strategic situation is highest at a given time would prove helpful to understanding the value of centralized control / decentralized execution.

For instance, consider a notional mission tasked to attack a C2 communications bunker defended by enemy surface-to-air missiles and aircraft as part of an ongoing air campaign. To support the attack, the mission package includes B-1s to strike the target, F-15Cs for offensive counterair sweep, F-16s for suppression of enemy air defenses, and an EA-6B for electronic warfare support. C2 support includes the AOC and an E-3C AWACS. As the mission package begins to marshal for the attack, SA of the battlespace is enhanced by threat updates from the E-3C and an RC-135. In addition to this strike, four other air interdiction missions are under way elsewhere in the battlespace. Moreover, there is an ongoing dynamic targeting effort against theater ballistic missiles.

To the mission commander on the B-1, focused on the tactical objectives of conducting an attack to destroy the bunker, the battlespace encompasses the area immediately surrounding the target, enemy, and friendly assets. The mission commander understands the locations of the target in relation to the air-to-surface threats and has coordinated to suppress them. Based on the situation updates from the E-3C, he coordinates a delayed push by the B-1s to give the F-15Cs time to complete their work. His SA of the upcoming tactical engagement is high due to the proximity to the engagement. However, the mission commander's SA of other interdiction and dynamic targeting missions in the battlespace is understandably limited because of his tactical concentration on issues related to destroying the target.

To the crew of the E-3C, intent on bridging tactical action with operational objectives, the battlespace encompasses the platform's assigned battle-management area, which is broad because of the E-3's large sensor and communication footprint. Within the area controlled by the E-3C, two other interdiction strikes are occurring elsewhere in the battlespace; furthermore, in addition to the mission to strike the C2 bunker, it is coordinating the search for theater ballistic missiles. The AWACS also provides high-value airborne-asset control, protection, and deconfliction for tankers; intelligence, surveillance, and reconnaissance; and electronic warfare aircraft. Finally, several tankers are airborne with the E-3C controlling the refueling tracks and coordinating the effort with the AOC.

The E-3C crew's awareness of the tactical situation is high because controllers directly support the mission/package commanders. The crew knows about the air threat and the plan to counter it as well as the surface threats. However, their SA is not as high as that of the mission commander on the B-1. A system malfunction prevents one of the B-1s en route to the target from dropping its weapons. During planning, the mission commander developed a contingency plan to prioritize a single B-1's weapons against the priority impact points, leaving lower-priority points intact and the target only partially destroyed. With the attack in progress, the commander does not have time to notify the E-3 of the situation. Because the E-3 strike controller monitors the B-1's communications, though, SA exists regarding the impact points that were not attacked. Understanding the operational priorities, the E-3 mission crew commander reports the mission limitation to the AOC so it can decide whether to rerole assets from other missions to the surviving impact points or to attack them another day.

To the combat operations division of the AOC, concerned with linking strategy to task, the battlespace includes the entire theater. The AOC monitors all four interdiction strikes and the ongoing dynamic targeting effort; it also maintains awareness through updates from battle-management C2 and the common operational picture. Many actions occur simultaneously. During the attack on the C2 bunker, the AOC reacts and responds to a missile strike on a friendly air base and tries to decide whether to launch an alert tanker to replace one whose launch aborted on the ground. As the single air manager in-theater, the AOC maintains a theater perspective rather than focusing on individual engagements. When the E-3 reports that part of the C2 bunker remains intact, the AOC understands that the bunker is a critical vulnerability of the enemy's integrated air defense system. However, given the report of successful strikes against the highest-priority impact points, the AOC decides for the moment to attack the remaining points later. A theater focus limits the SA of what transpired at the C2 bunker to reporting by the E-3. However, understanding how the attack factored into the bigger picture of operational art remains very high.

In this example, the mission commander on the B-1, the E-3 AWACS crew, and the AOC had SA that matched their emphasis on the tactical, operational, and strategic mission. Although the SA of these three entities differed, they all contributed to an overall mutual understanding that enabled attainment of the objectives tying strategy to task for this one mission. But why does it work? In doctrine, clear lines exist between centralized control and decentralized execution. However, during operations, they tend to blur. Recently, Lt Gen Ralph Jodice, USAF, retired, the former combined force air component commander (CFACC) of Operation Unified Protector, discussed the importance of the AOC and the ability to move quickly between the levels of war (see the table below) "in order to connect strategy to task, task to strategy, and everything in between" since tactical actions can yield strategic effects—as occurred in our example.[7] The next section explores why this works by looking at centralized control / decentralized execution through the lens of C2 theory.

Table. Levels of war

Levels of War	*Definition*	*Examples*
Strategic	Employment of the instruments of national power in a synchronized and integrated fashion to achieve theater, national, and/or multinational objectives	President and Secretary of Defense, Combatant Commander
Operational	Linkage of the tactical employment of forces to national and military strategic objectives	Joint Force Commander, Air and Space Operations Center
Tactical	The employment and ordered arrangement of forces in relation to each other. Joint doctrine focuses this term on planning and executing battles, engagements, and activities at the tactical level to achieve military objectives assigned to tactical units or task forces.	AWACS, JSTARS, Control and Reporting Center, Air Support Operations Center, E-2D Hawkeye, AEGIS Combat System, Wing Operations Center

Source: Compiled by the author. For definitions, see Joint Publication 3-0, *Joint Operations*, 11 August 2011, 36, http://www.dtic.mil/doctrine/new_pubs/jp3_0.pdf.

Exploring Theory: Why Centralized Control / Decentralized Execution Works

In joint-air C2 with shared understanding, the components should function as a system instead of as individual parts functioning separately. Discussing the issue of centralized control / decentralized execution without a holistic perspective equates to a "corps commander telling a sergeant how to put his troops in a foxhole"—probably not the most efficient way to fight.[8] This occurs not because the corps commander has nothing better to do but because the system lacks enough adaptability and flexibility to offer any perceived options.[9] Instead, joint-air C2 should be flexible enough to reposture quickly and/or effectively across the levels of war, depending on the situation, and regain shared understanding rapidly.[10]

So what are we really talking about? Enabling SA to affect shared understanding in a system flexible enough to reposture quickly at the tactical, operational, and strategic levels demands that those with the best SA orient, reorient, and take action appropriate to the situation. To discover how this works, we would do well to reexamine the relevance of Col John Boyd's theories of the observe, orient, decide, act (OODA) loop (fig. 2).

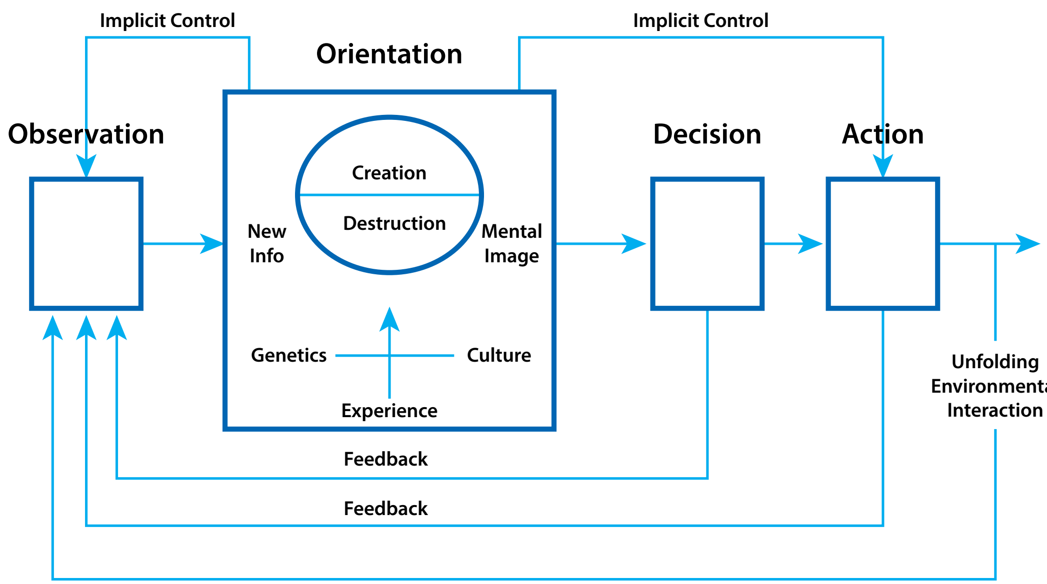


Figure 2. John Boyd's OODA loop. (Reprinted from Lt Col David S. Fadok, "John Boyd and John Warden: Airpower's Quest for Strategic Paralysis," in *The Paths of Heaven: The Evolution of Airpower Theory*, ed. Col Phillip S. Meilinger [Maxwell AFB, AL: Air University Press, 1997], 366.)

Some people criticize the OODA loop as overly simplistic—success on the battlefield simply involves "getting inside an adversary's OODA loop and staying there."[11] The loop lent itself as a model to net-centric warfare (NCW) insofar as both contained the idea that decision-cycle rapidity holds the key to generating enough friction to cause the enemy to look inside, leading to system paralysis.[12] NCW documents make "explicit reference" to the OODA loop, emphasizing the importance of obtaining and exploiting an information advantage.[13] In the 1990s, when the idea of NCW was taking shape, the concepts of swarming and information dominance inherent in Colonel Boyd's thinking resonated with NCW proponents, and the OODA loop offered an easy way to capture the ideas as a bumper sticker for NCW as a whole. The perceived tie between the loop and rapidity is understandable, given the context of the environment that shaped Boyd's ideas. The latter grew during the post-Vietnam environment of change as the US military turned its attention to winning a war in Western Europe. Perhaps unsurprisingly, Boyd's ideas influenced maneuver warfare and later NCW. Like an overidentified brand name, the OODA loop became synonymous with high-intensity conflict. The authors of an *Armed Forces Journal* article observe that

> the unemployment theory fit our understanding of the problem and, while incorrect, was coherent with an OODA Loop approach. We observed lots of unemployed Sunni in the streets and knew that the same cohort provided manpower for the insurgency. We oriented to the reality that coalition decisions had put them out of work. We decided that works projects would give them employment and take them off the streets. We acted by spending huge amounts of money on projects that were largely ineffectual in fixing the infrastructure or reducing the insurgency. Our mistake was in thinking a fundamentally complex problem—one with so many seen and unseen variables that there are no longer direct correlations between action and outcome—was merely a complicated one, with direct linkages between cause and effect.[14]

Their criticism is consistent with a simplistic view of the OODA loop. However, as a model for learning and adaptation over time, it is only as good as the orientation that informed the decisions and actions. How so? The key to effective orientation involves understanding the complexities of the operating environment, including the cultural/genetic factors, previous experiences, and analysis and synthesis that form the destruction of the various parts contained in disparate information. This is followed by re-creation through synthesis of the various parts into orientation on the accurate whole. In this case, the model failed because a lack of understanding of the operational environment (poor mission analysis) and cultural/genetic factors (limited education/experience with Iraqi culture) resulted in an ill-informed orientation and, consequently, poor decisions and actions. Boyd might argue that the OODA loop is just as relevant today if properly applied. However, he might use the word *persistence* instead of *rapidity* in the context of irregular warfare. Consider the mission of Constant Hawk in Iraq where postmission forensic analysis of collected data and fusion with other intelligence sources resulted in disruption of criminal and insurgent networks.[15] Information developed by Constant Hawk proved invaluable in preventing future attacks by enabling effective orientation and disruption of the enemy. It wasn't rapid, but it was persistent and effective. For this reason, the OODA loop—properly understood—may be a viable model across the spectrum of conflict. It is also a viable model at all levels of war since the need to orient exists there as well—from a CFACC to a mission commander. In the words of Frans Osinga, "We need to move well beyond the narrow 'rapid-OODA loop' concept."[16]

Accounting for Friction: Toward More Effective C2 Interaction

It is not enough to assume that one's SA and ability to observe, orient, decide, and act will bridge strategic to tactical objectives. Something has to link initiative at the tactical, operational, and strategic levels to ensure that actions taken are consistent with higher-level intent and objectives. So what are those linkages, and how do they work? Another of Boyd's ideas, the "Organic Design for Command and Control," builds on the ideas of destruction and creation and patterns of conflict to create a framework that inflicts paralysis on the enemy.[17] Boyd articulated four key points during a series of briefings on the subject:

1. The atmosphere of war is friction.
2. Friction is generated and magnified by menace, ambiguity, deception, rapidity, uncertainty, mistrust, etc.
3. Friction is diminished by implicit understanding, trust, cooperation, simplicity, focus, etc.
4. In this sense, variety and rapidity tend to magnify friction, while harmony and initiative tend to diminish friction.[18]

Referring to friction in war, Carl von Clausewitz declares that "everything in war is very simple, but the simplest thing is difficult." He goes on to write that "countless minor incidents—the kind you can never really foresee—combine to lower the general level of performance."[19] The key to Boyd's idea is friction—how to magnify friction for the enemy and diminish it for our side. According to Boyd, a relationship exists between generating enemy friction and maintaining harmony and initiative. In other words, how does a force "generate harmony and initiative in order to exploit variety and rapidity"?[20] A C2 system creates these two elements through interactions that minimize friction and maximize learning and adaptation. Positive interaction mitigates friction while negative interaction induces friction. However, effective orientation does not assure the ability to exploit variety and rapidity. Rather, one must have a system in which implicit trust allows exploitation of what is not explicitly communicated, enabling lower-level initiative to "reduce friction and compress time."[21]

To gain an understanding of how friction occurs and how to mitigate it, one must look at what occurs when the levels of war overlap. These points of overlap are potential friction points resulting from a lack of shared understanding driven by differing SA. For example, an AWACS operator at the tactical level who has better proximity to the engagement may not understand the intent of an AOC operator who coordinates at the tactical level. That operator, who possesses higher operational SA, knows why they are coordinating at the tactical level but has a lower overall awareness of the tactical engagement than the AWACS operator. This disconnect between echelons induces friction, resulting in increased coordination as each strives to gain shared understanding. Upon attainment of the latter, the AOC operator understands what is possible, and the tactical C2 operator understands what is needed.

Shared understanding is the key to linking actions across the levels of war, and implicit controls are essential to such understanding. These controls (e.g., the air tasking order, air operations directive, and ROEs) help align tactical action with operational intent. Further, they ensure that the actions of battle managers and mission commanders are nested with operational intent. According to Boyd, the payoff is a "command and control system, whose secret lies in what's unstated or not communicated to one another (in an explicit sense) in order to exploit lower-level initiative yet realize higher-level intent, thereby diminish friction and compress time, hence gain."[22] Here, he refers to the implicit controls that bind strategy to task and enable shared understanding of operational intent in time and space. To attain the payoff that Boyd alludes to requires effective integration of implicit controls in higher-level guidance such as the joint air operations plan that considers operational flexibility and risk management.

Flexibility in Action: The Future of Centralized Control / Decentralized Execution

Operational flexibility is a relatively new term.[23] For the purposes of this article, it denotes harmonizing operations to maximize the effectiveness of airpower through the range of military operations. A case in point is the assignment of an air and space expeditionary task force (AETF) commander in Afghanistan as an additive C2 echelon to the theater CFACC. This provides the joint task force (JTF) commander in Afghanistan an air commander with authority over air assets, thus greatly aiding unity of effort by giving the JTF commander a voice. The AETF commander is naturally positioned to harmonize C2 within Afghanistan because of the commander's proximity to the fight.[24]

The concept of the AETF commander lies at the heart of a discussion of C2. The question has to do with when it is appropriate to decentralize control from the theater CFACC in order to better support JTF commanders.[25] In this case, decentralization is necessary to mitigate seams created by the mismatch of centralized planning and control in a theater AOC versus the needs of JTF commanders for decentralized control and execution in a conflict with multiple JTFs.[26]

In contrast, during high-intensity conflict, more centralized control may be required to maintain a theater perspective and to take advantage of airpower's attributes of speed, flexibility, and mass.[27] Similarly, more centralization may prove necessary in operations with strategic impact, especially when political issues demand that operational and strategic decision makers maintain flexibility or mitigate risk.[28] In contrast, more decentralization might accommodate highly intense conflicts that pose substantial risk to forces, the unavailability of or risk to linkages needed for higher-level decision making, or the existence of a decision cycle driven by enemy or friendly tempo that occurs faster than the time available for coordination up and down the chain. Take for example the concept of centralized command / distributed control / decentralized execution. In the end, the nature of the conflict, the need for flexibility, and C2 capacity are considerations for the degree of centralization/decentralization.[29] No finite answers exist; ultimately, the situation will dictate the nature and shape of operational flexibility.

The following illustrates the hazard of failure to apply operational flexibility. During Operation Anaconda—an effort to destroy al-Qaeda and Taliban forces in Afghanistan—the air component was not effectively integrated into planning, thereby leaving it unprepared.[30] The C2 structure at the time involved a theater AOC supporting Operation Enduring Freedom, Operation Southern Watch, and operations in the horn of Africa. Elements of battle-management C2 included AWACS and E-2 aircraft as well as joint terminal attack controllers embedded with land forces. An air liaison officer represented the air component in planning but "did not exert a great deal of influence over the plan."[31]

Consequently, a chaotic, poorly coordinated air effort ensued. The air component rebounded and proved decisive in the end, but lessons of the need for operational flexibility were clear. In the aftermath, the CFACC assigned an air component coordination element to Afghanistan to ensure the unified planning of air operations.[32]

How can we apply operational flexibility in future conflicts? According to Benjamin Lambeth, this process involves enabling lower-level initiative when centralization of execution "would be impossible in a larger war requiring a thousand or more combat sorties and weapon aim points a day."[33] In addition, at a time when assured access to information dominance enabled by space and cyber is at risk—coupled with long distances in certain areas that require distributed operations using beyond-line-of-sight communications—we have created an exploitable vulnerability. Command and control of air operations involves developing a C2 structure that exploits operational flexibility to allow C2 to continue functioning (what Boyd would call a noncooperative center of gravity for the enemy) even when our traditional advantages degrade.[34]

Operational flexibility is only part of the equation. Implicit controls also include risk assessment and products that facilitate shared understanding. Assessment, which can help determine the need for decentralization, is part of the joint operations planning process for air and continues in execution as part of the joint air tasking cycle.[35] During planning, risk is identified during mission analysis and characterized in terms of its severity and the frequency with which it manifests. Course-of-action development further refines risk and identifies mitigation measures. Within the joint air tasking cycle, risk assessment remains an ongoing function of the development of an air operations directive in the AOC's strategy division. Characterizing risk as it applies to decentralization and, more specifically, as it relates to implicit controls is a factor of both ROEs and risk to force.

Generally, an inverse relationship exists between decentralization and ROEs. The more restrictive the rules, the less likely that tasks related to engaging the enemy will be decentralized. Contrastingly, the less restrictive the ROEs, the more likely the tasks related to engaging the enemy will be decentralized.[36] Unlike irregular warfare, in a high-end fight against a peer adversary, decentralization as a risk-mitigation measure may be needed in a conflict in which an advanced enemy can challenge decision making by denying assured access to distributed communications and battlespace awareness. In a conflict of this nature, decentralization of C2 may prove critical to victory, and it is one of many reasons that battle-management C2 has value near the tactical edge. Although the effort to characterize and mitigate risk occurs in planning, it should be systematically reevaluated during execution. Doing so ensures the flexibility to adjust course and become more or less restrictive in the decentralization of C2 should the nature, phase, or constraints of the conflict require.

Another risk-management consideration concerns the risk to forces. Decentralization of C2 during a peer conflict offers a way of mitigating risk to forces and continuing the fight should critical linkages be lost, as well as a way of countering the enemy's pace and initiative. Decentralization includes risk-mitigation measures and operational flexibility that shape the nature of the products of implicit control.

Several of these products enable joint-air C2, including a joint air operations plan, an air operations directive, an area air defense plan, ROEs, an air tasking order, and so forth. Embedded within them are the guidance, direction, and details necessary for shared understanding between echelons of the commander's intent and objectives together with the game plan to make it happen—operational art. However, despite these implicit controls, friction remains. To reduce it, we need a flexible process that details levels of decentralization and is adaptable to changing situations. During development of this matrix (fig. 3), planners should consider the operational environment, including the commander's intent, threat, mission, risk to forces, and ROEs.

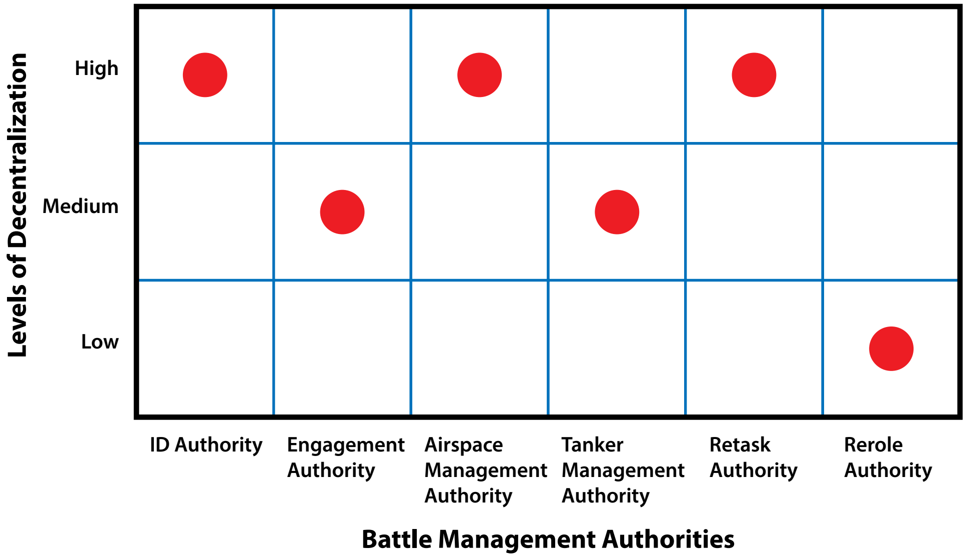


Figure 3. Sample tactical C2 decentralization matrix

Development of the matrix calls for a three-phase process resulting in published guidance. First, air component campaign planners should develop a by-phase matrix included in the C2 annex of the joint air operations plan. Second, matrix refinement should be part of the normal joint air tasking cycle. The risk assessment for the air operations directive, produced by the AOC's strategy division, should form the baseline for determining levels of decentralization that can be further refined by the combat plans division and then be promulgated in the air tasking order's special instructions. Finally, the AOC's combat operations division should use the matrix to adjust levels of decentralization based on unfolding circumstances and to provide guidance for battle-management C2 or mission commanders in the event of loss or denial of communication with the AOC. This matrix should reduce friction by improving adaptability and should facilitate shared understanding in joint air operations.

A case study of airspace challenges during Operation Anaconda illustrates the importance of implicit control, noting that the airspace structure could not support the pace of operations and amount of air activity. This situation compromised safety for the combatants on the ground, aircrews, and civilian airliners operating on an air route above the valley.[37] According to an Air Force doctrine publication, the problem stemmed from a lack of planning: "Normal airspace planning would have accounted for this earlier."[38] However, how would normal planning have helped? The air component did not even know that it needed to plan because implicit control was absent, creating friction as the operation unfolded due to a lack of shared understanding. Applying operational flexibility, including assignment of an air component coordination element as soon as the JTF commander was on the ground in Afghanistan, would have enabled adequate allocation of forces for planning. Furthermore, a risk assessment that balanced ROEs with risk to force would have produced decentralization of airspace management to battle-management C2. Finally, it would have led to the development of products that support shared understanding, including an airspace control plan/order, clear priorities and intent of an air operations directive, and so forth. Mission-type orders, an additional method of implicit control effectively utilized in recent decentralized ISR operations, contribute to successful missions.

Conclusion

A winning formula for joint-air C2 in antiaccess / area denial involves a system with the initiative to act at the tactical level, based on SA linked to higher-level intent by effective, implicit controls. Further, refining such C2 through the application of operational flexibility can optimize the system for the operational environment and enable its reposturing as events warrant. This article has addressed the nature of centralized control / decentralized execution, explored theory to reveal the way it works, and discussed ideas for its effective use in future joint air operations.

Notes

1. Curtis E. LeMay Center for Doctrine Development and Education, *Volume I, Basic Doctrine*, 14 October 2011, 59–60, https://doctrine.af.mil/download.jsp?filename=Volume-1-Basic-Doctrine.pdf (hereafter *Basic Doctrine*); and JP 3-30, *Command and Control for Joint Air Operations*, January 2010, 26.
2. Field Manual 100-20, *Command and Employment of Airpower*, 21 July 1943, 53.
3. *Basic Doctrine*, 59.
4. Col Edward C. Mann III, *Thunder and Lightning: Desert Storm and the Airpower Debates* (Maxwell AFB, AL: Air University Press, 1995), 53–54, http://www.au.af.mil/au/awc/awcgate/au/mann.pdf.
5. *Basic Doctrine*, 60.
6. During a white-board presentation by Lt Col Paul Maykish, he offered a simple method of discussing SA at various levels. I have used it in a number of forums over the years and have found it an effective way of quickly communicating the variance in SA among different echelons.
7. Lt Gen Ralph Jodice (speech to Air Command and Staff College, Maxwell AFB, AL, 29 February 2012) (used with permission).
8. Col Luke Grossman, interview by the author, 16 December 2012 (used with permission). Colonel Grossman was assigned to the equivalent of the combat operations division in the AOC during Operation Allied Force. He also served as vice-commander of the 332nd Air Expeditionary Wing at Balad AB, Iraq, from 2009 to 2010.
9. Ibid.
10. Ibid.
11. Lt Col David S. Fadok, "John Boyd and John Warden: Airpower's Quest for Strategic Paralysis," in *The Paths of Heaven: The Evolution of Airpower Theory*, ed. Col Phillip S. Meilinger (Maxwell AFB, AL: Air University Press, 1997), 367.
12. Frans Osinga, "John Boyd and Strategic Theory in the Postmodern Era," [2007], 1, http://www.au.af.mil/au/awc/awcgate/boyd/osinga_boyd_postmod_copyright2007.pdf.
13. Ibid., 5.
14. Col Kevin Benson and Col Steven Rotkoff, "Goodbye, OODA Loop," *Armed Forces Journal* 149, no. 3 (October 2011), http://www.armedforcesjournal.com/goodbye-ooda-loop/.
15. Constant Hawk was an airborne, persistent, wide-area surveillance capability employed in Iraq.
16. Osinga, "John Boyd and Strategic Theory," 12 (see note 18).
17. John Boyd, "Organic Design for Command and Control" (PowerPoint re-creation of original briefings), http://www.ausairpower.net/JRB/organic_design.ppt.
18. Ibid., 8.
19. Carl von Clausewitz, *On War*, ed. and trans. Michael Howard and Peter Paret (Princeton, NJ: Princeton University Press, 1976,) 119.
20. Boyd, "Organic Design," 9.
21. Ibid., 18.
22. Ibid., 17.

23. This idea was first articulated to me by Mr. Richard Perry during a discussion about the cross domain operator on US Air Force C2.

24. Ibid.

25. Lt Col Jeffrey Hukill, USAF, retired, and Dr. Daniel R. Mortensen, "Developing Flexible Command and Control of Airpower," *Air and Space Power Journal* 25, no. 1 (Spring 2011): 54, http://www.airpower.maxwell.af.mil/airchronicles/apj/2011/2011-1/2011_1_03_hukill_mortensen.pdf.

26. Ibid.

27. Ibid., 57.

28. Lt Col Clint Hinote, *Centralized Control and Decentralized Execution: A Catchphrase in Crisis?* Research Paper 2009-1 (Maxwell AFB, AL: Air Force Research Institute, 2009,) 59–61.

29. Ibid.

30. Benjamin S. Lambeth, "Operation Enduring Freedom, 2001," in *A History of Air Warfare*, ed. John Andreas Olsen (Washington, DC: Potomac Books, 2010), 269.

31. Richard Kuglar, *Operation* Anaconda *in Afghanistan*: *A Case Study of Adaptation in Battle*, Case Studies in Defense Transformation no. 5 (Fort Lesley J. McNair, DC: National Defense University Center for Technology and National Security Policy, 2007), 13, http://www.dtic.mil/cgi-bin/GetTRDoc?AD=ADA463075.

32. The "air component coordination element" is now known as the "joint air component coordination element."

33. Lambeth, "Operation Enduring Freedom, 2001," 275.

34. Boyd, "Organic Design."

35. Curtis E. LeMay Center for Doctrine Development and Education, *Volume 4, Operations*, 5 June 2013, 6–7, https://doctrine.af.mil/download.jsp?filename=Volume-4-Operations.pdf.

36. Hinote, *Centralized Control and Decentralized Execution*, 60–61.

37. Curtis E. LeMay Center for Doctrine Development and Education, "Annex 3-52, Airspace Control," 2 February 2011, 14, https://doctrine.af.mil/download.jsp?filename=3-52-Annex-AIRSPACE-CONTROL.pdf.

38. Ibid.

Lt Col Alan Docauer, USAF

Lieutenant Colonel Docauer (BS, Mount Olive College; MA, University of Oklahoma; MS, Air University) is chief of the Command and Control Branch, Command and Control and Global Intelligence, Surveillance, and Reconnaissance Panel, Headquarters, US Air Force Directorate of Strategic Plans and Programs. He is responsible for synthesizing defense and Air Force strategy, command and control (C2) service core function strategy, Air Force budget guidance, C2 program requirements, and combatant commander priorities into an annual C2 budget submission for deliberation by the Air Force corporate structure. A former US Air Force Weapons School instructor, he is a senior air battle manager with combat experience in the E-3 Airborne Warning and Control System, E-8C Joint Surveillance Target Attack Radar System, and the control and reporting center.

The Joint Strike Fighter / F-35 Program

A Canadian Technology Policy Perspective

Dr. Danny Lam
Dr. Brian Paul Cozzarin*

The Canadian F-35 procurement represents the largest peacetime acquisition of new aircraft for Canadian forces since the Korean War. Securing industrial benefits from military procurement is essential for advanced industrialized nations, and it has long been Canadian industrial policy to do so. For the CF-18 program, "offset" contracts were negotiated, valued at 2.7 billion Canadian dollars (CAD) or 110 percent of the worth of the initial contract.

*The authors are grateful for insights from Dr. Robbin Laird. An anonymous referee provided excellent feedback on an earlier draft of the article, and Dr. Marvin Bassett, a research and writing specialist at the Air Force Research Institute, provided very detailed editorial questions that improved the accuracy and intent of the article. Any errors remain our own.

According to the US Department of Defense (DOD), Canadian participation in the Joint Strike Fighter (JSF) program offered the promise of leveraging an investment of US $150 million into $8–10 billion of incremental revenues for Canadian industry over the life of the program. However, procurement of the F-35 was a "no bid" sole-source contract that precluded any possibility of bargaining both for price and industrial benefits under the offset model.

Issues that resulted in the DOD structuring of the JSF program to preclude traditional offsets include recognition of the nonmarket nature of defense procurement in the context of acquisition reform and the changing nature of defense systems. Partners like the United Kingdom, Israel, and Norway adapted to this new "no offset" model in securing industrial benefits. As of 2012, Canada has considerable incremental opportunities to develop similar programs that will enhance industrial and regional benefits from the JSF program as long as the offset model is not considered the norm for twenty-first-century programs. We try to address the issue in terms of how a country that lived comfortably under the US North Atlantic Treaty Organization (NATO) umbrella since World War II with limited obligations can rebuild a drastically downsized defense capability after the end of the Cold War. Canadians have only a limited sense of awareness of the need for military capabilities for the Arctic and a very limited understanding of the importance of military power.

Program History

Canada's procurement of the JSF (F-35 Lighting II) is a controversial program in Canada, a country notable for controversial defense procurement programs. The acquisition began with Canada as a participant in the development. Beginning in 1997, Canada invested US $10 million to participate in the concept demonstration phase, which resulted in the selection of Lockheed Martin as the winner in 2001. This was followed by an investment of US $100 million plus an additional US $50 million in federally funded Canadian technology programs.

Canada signed on to the JSF Production, Sustainment, and Follow-on Development Memorandum of Understanding (MOU) with an additional investment of US $551 million to be spent between 2007 and 2051. In 2008 Canada announced its intention to acquire the JSF to replace the CF-18, with the government of Canada exercising its option under the MOU and committing roughly CAD 9 billion to acquire a fleet of 65 aircraft, weapons, support, spares, and operating costs in accordance with the Canada First Defense Strategy.

As of this writing, several embarrassing controversies have occurred, including an auditor general's *2012 Spring Report* that raised concerns about the no-bid/sole-source contract and many other issues, such as escalating costs. In light of these findings, the government of Stephen Harper established a Seven Point Plan that included creation of the National Fighter Procurement Secretariat, tasked with "ensur[ing] that the Royal Canadian Air Force acquires the fighter aircraft it needs to complete the missions asked of it by the Government, and that Parliament and the Canadian public have confidence in the open and transparent acquisition process that will be used to replace the CF-18 fleet."[1] As a part of this process, the secretariat issued new "terms of reference" in December 2012 for the evaluation of alternative aircraft to the F-35 and commissioned independent reviews of costs for the program.[2] Behind these concerns are the apparent lack of industrial benefits from what amounts to one of the largest Canadian defense procurements in decades as well as the decision makers' and general public's lack of understanding and perceived need for the increase in defense capability offered by the JSF. Significantly, there is little understanding of how peer nations like Norway, Israel, Singapore, and so forth, have been able to "plug in" to the JSF program to extract industrial benefits.[3]

The JSF program originated in the merger of two major programs: the Common Affordable Lightweight Fighter and the Joint Advanced Strike Technology, which emerged in 1993 to develop a replacement for the F-16, F/A-18, Harrier, and other programs. The ideas involved creating a common platform formerly served by three distinct platforms: the F-16 as a multirole light fighter; the F-18 carrier-based, multirole fighter; and the Harrier as a short takeoff and vertical landing (STOVL) craft.[4] Other aircraft programs were consolidated into the JSF program around 1994.[5] The rationale for this consolidation of many aircraft types from the Navy and Air Force into one was the combining of the US defense industry after the end of the Cold War. The latter action resulted in the merger of many defense firms, virtually eliminating competitive forces from a market inherently not driven by market forces.[6] Three firms entered the competition for the JSF: Lockheed Martin, Boeing, and McDonnell Douglas. The latter's early elimination and the disbanding of its design team left the former two companies to field concept demonstration aircraft.[7] In 2001 came the decision to select the Lockheed Martin entry and proceed to the system development and demonstration phase with Lockheed Martin, Northrop Grumman, and BAE.[8]

The idea called for building a common airframe with shared combat systems that would be customized to fulfill many roles for the purpose of gaining economies of scale and logistical simplicity with interchangeable and common stockpiles of parts (70–90 percent) among all participants of the program.[9] Allied nations were invited to formally participate in the program beginning in 2001, when the United Kingdom signed an MOU that built on that country's support of the concept phase nearly a decade earlier.[10] Other nations participated as follows: Canada joined the JSF program on 7 February 2002, committing $150 million to become a level III partner. The United Kingdom is the only level l partner. The Netherlands and Italy are level II partners. Other level III partners include Australia, Norway, Turkey, and Denmark (fig. 1). Levels are primarily based on financial contributions, with between $750 million to $1 billion expected for a level II partner. However, Israel and Singapore, both with limited populations and relatively small defense budgets, became security cooperative partners with considerably smaller contributions in cash but significant contributions in expertise, technologies, and unique know-how. The original total US JSF program budget amounted to about US $200 billion for 3,000 aircraft.[11] Increases, though, have caused project costs to balloon, some projections reaching over US $1 trillion.[12]

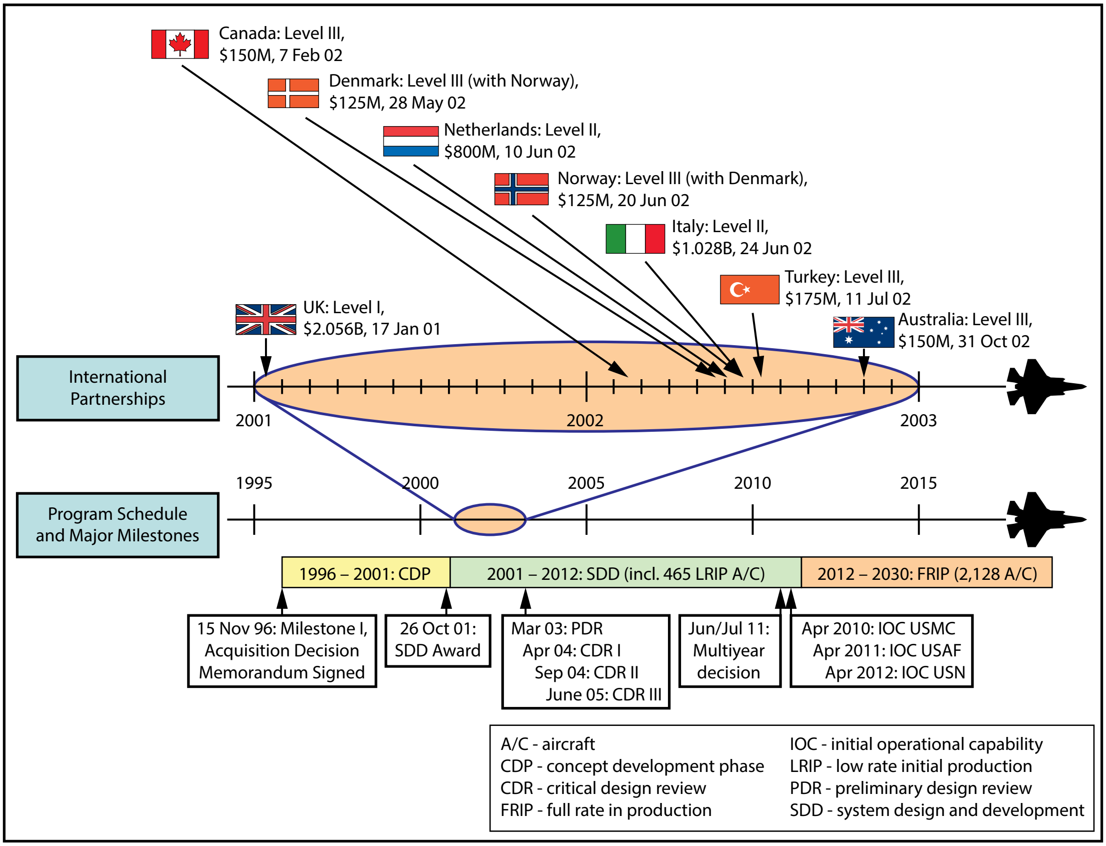


Figure 1. JSF timeline. (From Office of the Deputy Under Secretary of Defense [Industrial Policy], *JSF International Industrial Participation: A Study of Country Approaches and Financial Impacts on Foreign Suppliers* [Washington, DC: Office of the Deputy Under Secretary of Defense (Industrial Policy), June 2003], 3, http://www.ledevoir.com/documents/pdf/etude_internationale_defense_americaine.pdf.)

Controversy

Defense capital programs in Canada traditionally have been controversial for many reasons.[13] Historically, Canadian forces have found themselves underfunded relative to NATO expectations of 2 percent of gross domestic product (GDP). After the Cold War, defense spending was slashed in 1990 from just below 2 percent of GDP to 1 percent between 1998 and 2009 (fig. 2).[14] Canada made a major commitment after 9/11 that deployed its forces to Afghanistan under NATO that would have stressed the defense budget had expenditures remained at 1 percent of GDP. Consequently, by the end of the first decade of the twenty-first century, Canadian forces were severely underfunded. Estimates show that the Afghanistan conflict cost CAD 18 billion—a figure that may understate the cost to replace worn-out equipment from that conflict.[15] By 2008 politicians recognized the underfunding of Canadian forces and gradually increased the budget to its present level of about 1.5 percent of GDP.

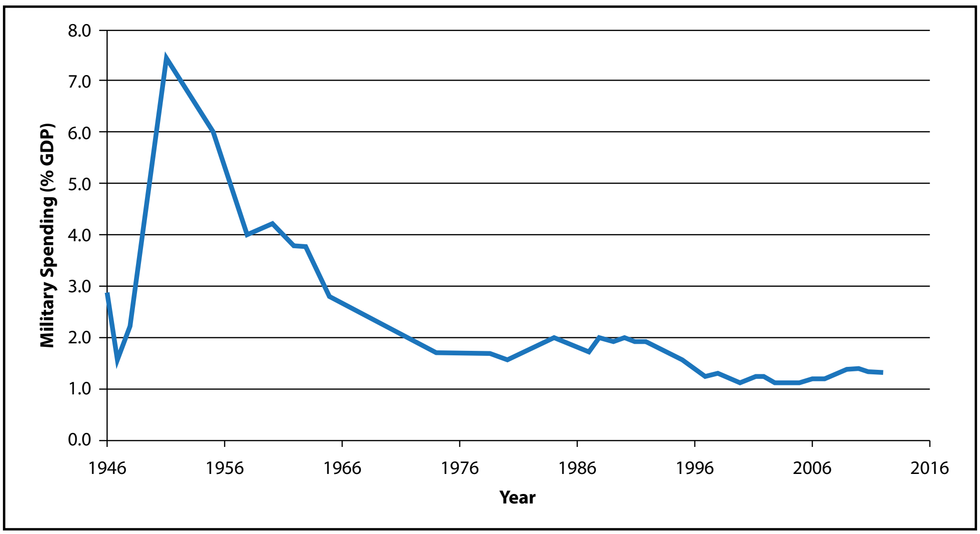


Figure 2. Canada's military spending. (From *SIPRI Yearbook, 2013*, Stockholm International Peace Research Institute, accessed 7 February 2014, http://www.sipri.org/research/armaments/milex/milex_database.)

The post-2008 fiscal climate worsened considerably with the federal budget in deficit from the stimulus program, and provinces like Ontario faced severe fiscal constraints. Because of the pressure, a program deemed essential—the replacement of military trucks—was recently cancelled days before the deadline for bidders.[16] Furthermore, the multibillion-dollar purchase of 28 CH-148 Cyclone helicopters is in jeopardy due to cost overruns and delays.[17]

Other countries such as the Netherlands are facing fiscal constraints. A general dissatisfaction with delays and cost increases that could scrap the program also exists.[18] Japan has decided to buy 42 F-35s while South Korea just vetoed what was thought to be a solid decision to buy F-15 Silent Eagles from Boeing. The South Korean government has concluded that a fifth-generation fighter is necessary to counter North Korea's arsenal, and it appears that the F-35 is the only contender for the $7.2 billion contract.[19]

Canada's budget issue, like that of most other countries, is exacerbated by the politicization of defense procurement which, for example, resulted in the Liberal Party under Jean Chrétien threatening cancellation of the EH-101 "Cadillac" helicopter during the 1993 federal election campaign. The EH-101 was chosen as a successor to the then-30-year-old Sea King helicopter. Upon taking office, Prime Minister Chrétien cancelled the contract and paid the penalty of CAD 500 million for doing so to Augusta Westland.[20] Department of National Defense (DND) officials objected strenuously but without effect.[21] With this recent historical precedent and deep cuts in defense spending under Chrétien, the DND was precluded from becoming a major partner in the JSF program.[22] The DND, though, managed to contribute CAD 10 million in 1997 to become an informed partner.[23] This initial contribution was followed by the Chrétien Cabinet's approval of an MOU on 7 February 2002 that committed Canada to a total of US $150 million, two-thirds from the DND and one-third from Industry Canada.[24] This decision set Canada down the path toward a no-bid contract for purchasing the JSF. An actual signed contract for the JSF did not emerge until 2010. However, at this time Canada is indeed a level III partner.[25]

Leveraging Industry Benefits

National defense and defense procurement are a core function of a modern state. Decision makers involved in this process commonly attempt to leverage these programs for benefits.[26] This policy is executed in Canada via Industry Canada's Industry and Regional Benefits Policy.[27] Traditionally, Canada utilized a benefits model based on the maximum use of domestic Canadian contractors for capital projects like vessels and so forth, which served both to stimulate industrial development and ensure that Canada was not held hostage to foreign suppliers for essential maintenance and repair over the life of the equipment. Yet, given the fact that the life-cycle maintenance of the CF-18 has already been very dependent on the United States, we can expect such dependence to increase with the JSF.

Moreover, modern military equipment is so complex that it is neither practical nor possible for Canadian industry to build many of the systems indigenously. This fact was reinforced by the historical precedent of the Avro Canada CF-105 Arrow project, cancelled on 20 February 1959. Since that time, Canada has had to rely on foreign suppliers for frontline fighter aircraft. The last major purchase took place in 1980 after pitting the F-16, F-18A/B, and F-14 against each other in the New Fighter Aircraft Competition—one that saw the F-16 eliminated due to a lack of engine redundancy as well as limited range and the F-14 eliminated because of cost. However, a combination of reasons, including technological change and policy changes under acquisition reform at the DOD in the 1990s, resulted in the United States not offering the offset or "coproduction" model for the JSF program. In lieu of traditional offsets, participants in the JSF program were offered the chance to competitively bid for contracts for the entire program. The following section discusses the benefits models.

Coproduction / License Production Model

The decision by the government of John Diefenbaker to exit from indigenously producing first-line fighter aircraft in 1959 was a watershed event in Canadian aviation history. From that day onwards, Canada had limited options for meeting the needs for fighter aircraft—namely, straight purchase, a model most often used by smaller or less developed nations; coproduction, used by many advanced industrialized nations like Japan and the United Kingdom; membership as a partner in a consortium such as the European Aeronautic Defence and Space Company; or a deal with a quasi-independent producer like Saab. As a NATO member, Canada does not have the option to purchase from sources outside alliance suppliers, such as Russian manufacturer Sukhoi, or to acquire equipment like the Chengdu J-20 from China, regardless of the "deal" offered.[28] Only one non-NATO option credibly exists, and that is a deal with Sweden that would have coproduced or jointly developed a new variant of the Saab JAS 39 Gripen.[29] The question is, how is Saab, with its comparatively low volumes and defense budget, able to keep the Gripen fighter viable in view of the historical rise in technological complexity and costs? It does so by in effect building a "kit plane" that heavily relies on components, systems, and subsystems manufactured by other nations.

The option to coproduce under license aircraft whose architecture was designed by another nation is "on the table" for all but the leading-edge aircraft (e.g., the F-35). For the right price, Canada could have asked for such an arrangement though it is generally acknowledged that coproduction of very small volumes of aircraft for a Canadian order would have added considerably to the cost without any obvious offsetting benefits over the long term. During the awarding of the CF-18 contract, coproduction was in fact offered and declined for these reasons.[30]

Offset Contracts

Offset contracts are the primary means of securing industrial benefits. In essence, rather than Canada choosing a colicense to produce small numbers that will have no economies of scale, the idea is that Canadian contractors will be guaranteed a share of the work as subcontractors for the aircraft. When Canada turns to foreign suppliers for major military systems, it is routine for offset deals to be negotiated by Industry Canada as a normal part of any defense competition. The Maritime Helicopter Program reputedly obtained CAD 2 billon in offsets for a contract valued at CAD 1.8 billion.[31] For the CF-18 program, the offset contract proposal in fact exceeded the value of the deal by 10 percent, providing CAD 2.7 billion over 15 years—110 percent of the value of the contract that McDonnell Douglas received. Prime and major subcontractors like McDonnell Douglas, General Electric, and Hughes fanned out in Canada to identify qualified suppliers and provide them with contracts. The contracts stimulated development and enhanced Canadian industry although one should note that some of these deals would have happened without the offset contracts.[32] The offset model is widely used on many programs.[33]

How does a defense contractor address demands for offsets that are larger than the value of the deal? Most defense contracts are deals made for capital equipment that have a long lifetime, and during the life of the equipment, a steady stream of maintenance, support, upgrades, or replacements is required. The offset amount initially demanded may appear large, but the follow-on contracts are even larger when the customer is in a weak bargaining (or no-bargaining) position. Typically, the initial contract to purchase and support a major system represents $1 against $5 to $10 of future noncompetitive or limited competition deals for items such as maintenance, support, upgrades, and so forth. (A one-to-five-and-beyond ratio might be possible if inflation is taken into account and issues such as fuel consumption are considered. However, such broad figures should be critically examined or put into context.)

Thus, manufacturers have an incentive to do whatever is necessary to win the deal and lock in a long-term customer in a monopolistic seller relationship for the future. Negotiating for a favorable offset deal from the perspective of the buying government is not necessarily an assurance that the entire package (over a program life that can span a half century or more) is a good deal, but it does offer the *appearance* of officials driving a hard bargain—an essential component to promotions in a merit-based bureaucracy of a modern nation in the Organization for Economic Cooperation and Development. When purchased systems either far exceed career lifetimes or key officials' duration at one post or politicians making decisions, it is not at all clear that such a system will deliver a good outcome for the nation on a life-cycle total-cost-of-ownership basis.[34] Despite these known shortcomings, the industrial offset model is tried, proven, and known to be viable as well as supported by bureaucratic momentum and routines in many nations. The question becomes why it was not offered as an option on the JSF program by the US government when the program was conceived in the 1990s.

The Current Situation

Normally, American defense firms do not offer others the opportunity to participate early in a defense program, when most of the major decisions with respect to prime contractors and major performance parameters are made. Prior to the JSF, this collaborative approach was used primarily by Europeans who developed the Panavia Tornado, Eurofighter, Eurocopter Tiger, A400M, and so forth, with this model. By engaging allies and potential customers early in the design process and offering a "buy in," the model enabled partners to divide shares of the work from the program equitably. The American model differed in that the United States was, by far, the lead partner, expected to purchase more than 50 percent of the total units sold for the Air Force, Navy, and Marine Corps versions. Partners were not committed to purchase the aircraft; rather, they had to contribute development money, and then firms from partner countries could bid competitively on contracts.

However, in Canada's case, the DND could withdraw from the MOU if industrial benefits proved insufficient.[35] At that time, the F-35 was expected to have a "flyaway" cost of US $37–47 million per unit (in retrospect, overly optimistic).[36] This figure compared favorably with that for the F/A-18E/F, which at initial operational capability in 2000, cost about US $55 million a copy.[37] What did the politicians expect as benefits in 2001 upon agreeing to the MOU? Art Eggleton, Canada's minister of national defense, stated on 6 December 2001 that the JSF program "could result in some $350 to $450 million in contracts for Canadian companies and generate 3,500 to 5,000 person-years of employment. Over the life of the project, it is estimated that Canadian companies could potentially obtain between $8 to $10 billion worth of contracts resulting in 50,000 to 65,000 person-years of employment."[38]

That would appear to be a very good return for a commitment of approximately $150 million in research and development funds, a $10 million "informed partner" fee, and unspecified amounts of use of Canadian facilities and limited staff support during the developmental process. This view was echoed by the DOD, which independently conducted a study for major participant countries published in June 2003, concluding that

> JSF Canada estimates a potential for $4.4 billion to 6.3 billion of revenues for Canadian industry over the life of the JSF program; our estimate is $3.9 billion. . . . The sheer magnitude of the revenues combined with a relatively low level of SDD [system design and development] and TPC [Technology Partnerships Canada] investment is expected to translate into returns of approximately 4117%—a nominal payback of over $41.00 per $1.00 invested into the program. . . . This translates to an annual compounded rate of return of nearly 67%.[39]

This assessment is regarded as conservative compared to the figures cited by Defense Minister Eggleton although it counted only direct investment to the United States of US $95 million rather than the total committed, including loans through Technology Partnerships Canada for Canadian industry.[40] The DOD stated its case succinctly (see the table below).

Table. Potential impact of the JSF

	Revenues	*EBIT*	*EBIT Margin*
	($US million current)		
	2012–26	2012–26	2012–26
CaseBank Technologies	$266.8	$66.7	25.0%
GasTOPS Ltd.	15.9	1.9	12.0%
Héroux-Devtek	255.2	16.4	6.4%
Magellan Aerospace	319.6	33.1	10.4%
Pratt & Whitney Canada	70.6	8.4	11.8%
Others	1,888.9	257.5	12.5%
Total	$2,817.0	$384.0	12.6%

Source: Adapted from Office of the Deputy Under Secretary of Defense (Industrial Policy), *JSF International Industrial Participation: A Study of Country Approaches and Financial Impacts on Foreign Suppliers* (Washington, DC: Office of the Deputy Under Secretary of Defense [Industrial Policy], June 2003), 50, http://www.ledevoir.com/documents/pdf/etude_internationale_defense_americaine.pdf.

EBIT - earnings before interest and taxes

This estimation of benefits is troubling for many reasons. The government of Canada effectively wrote a check ranging from $100 million to $160 million for the program. Although there is no dispute that the return on gross revenues will be large, that may not be a good perspective for understanding gains. A more plausible method might involve summing up the EBIT for the program ($110 million [2002–11] plus $384 million [2012–26] equals $494 million over the life of the program in incremental EBIT earnings by Canadian firms). That may reflect favorably on a taxpayer-funded investment that is three to five times the initial investment, but such a calculation is fraught with risks and pitfalls.

Cost and Schedule Slippages and Allied Partners

Growth of program cost is the norm in military programs. It comes from the tendency of defense procurement to focus on the "best" without regard to costs, simultaneously requiring relatively small quantities compared with many mass-produced civilian products. At the same time, considerations of logistics and the security of the supply chain sharply raise the cost of many components.[41]

The program-cost growth for the JSF program, however, is both predictable and entirely foreseeable based on the history of military aircraft programs. The cost of fighter aircraft has steadily risen since World War II as aircraft became more capable. A retroactive look at expenses by Norman Augustine shows cost growth from initial estimate to initial operational capability (fig. 3).[42] Parsing this data, one notes that the early versions (e.g., F-15A/B, F-14, F-22) tend to lie above the trend line. Programs that are extensions or elaborations of existing programs have the best chance of staying at or below this line. The Parliamentary Budget Office came to substantially the same conclusion using trend lines in the historical cost growth of strike fighters and based on the weight of the airframe.[43] Regardless of the methodologies chosen, it is clear that the life-cycle cost of ownership of the F-35s will be substantially higher than the projection by Canadian DND officials.

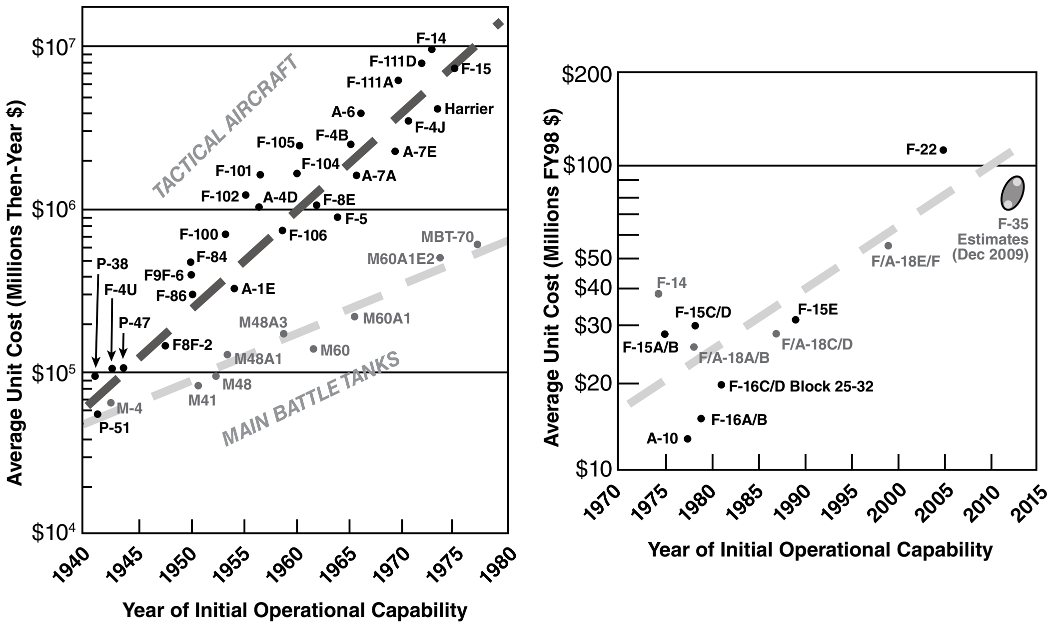


Figure 3. Average unit costs. (From Barry D. Watts and Todd Harrison, *Sustaining Critical Sectors of the U.S. Defense Industrial Base* [Washington, DC: Center for Strategic and Budgetary Assessments, 2011], 20.)

The above discussion suggests that cost and schedule slippages in the JSF program are quite normal and lie within the realm of reason and historical experience. The problem, accordingly, arises not so much from the cost/schedule slippage itself but from the desire by Canadian DND officials to paint the most optimistic picture of costs for their political masters without regard for readily obtainable data of past program experience. Although other partners have grumbled about rising costs in the aftermath of the 2008 economic crash, the vociferousness of the complaints in Canada is notable for the degree to which it has contributed to political discord there. That is a function of the political establishment, Industry Canada, and—more recently—the auditor general expressing considerable dismay at how the DND was talked into the program, apparently in violation of the industrial and regional benefits normally expected by the government of Canada and politicians.

The question then becomes one of whether a viable alternative to the F-35 did in fact exist. There is a viable stopgap that any modern fighter could fill—one that would be good for about 10–20 years. The Australians think they have a gap, and they bought F-18s to plug it. As for costs, they are irrelevant in terms of a stopgap airplane since it will be obsolete before reaching its designed life span.

Decision-Making Power

From the inception of the JSF program, the lion's share of the decision-making power and authority rested with the DoD. No matter how optimistic the projections, the largest single buyer was obviously the DOD to fill requirements for the Air Force, Navy, and Marine Corps. Their needs dictated the architecture of the craft, and their priorities drove the needs of the program far above those of the industrial partners. The only major exception was the United Kingdom, which leveraged its expertise and capabilities in vertical and/or short takeoff and landing acquired through the Harrier program to a privileged place both as a supplier and major customer for the STOVL version F-35B. Even then, the United Kingdom experienced considerable difficulty securing commitments from the United States with respect to accessing the software code. This is a critical issue for the program in many ways, including the matter of leveraging industrial benefits. With the United States as the dominant partner, participants—let alone customers—have scant opportunity to make material changes in the package.

One must also note that the "prime" contractor for the F-35, Lockheed Martin, is a 30 percent stakeholder in the program, with other key companies providing the rest of the capability—notably with regard to the combat systems. The latter represent the element of greatest value in the aircraft and will be updated over time because the platform is software upgradeable. A substantial number of elements of the aircraft are being produced by a global supply chain; currently, upwards of 20 percent of the entire supply chain is foreign.[44]

Joint Strike Fighter Systems

Software

Defense equipment has fundamentally changed from the 1970s and 80s. Most defense systems' added value is no longer in the hardware but overwhelmingly in the software. Given the growing complexity of software, cost and schedule overruns escalated and, with them, the cost not only to develop but also to maintain the software during the life of the system. A common rule of thumb holds that maintenance of the software will require about 40 percent of the cost to develop it, assuming the addition of no major new capabilities.[45] Furthermore, although estimating the added value of software versus hardware in the JSF program lies beyond the scope of this article, a plausible guess is that it cannot be lower than the F/A-18 at over 50 percent software and likely is in the 80–90 percent range or higher, depending on the value of the reused code modules from previous programs and the cost of writing DO-178x-certified code.[46] Once the United States made the policy decision that it would not share the source code (not even at the modules level) with the largest partner and biggest contributor to the program (the United Kingdom), it became clear that such a policy effectively locks out partners from all but a very small amount of the added value in the entire program, no matter how many industrial benefits the DOD may claim for the partners. The question then becomes, how can one leverage benefits from such a model imposed by the DOD?

Britain initially sought to have source-code access to the JSF software as befitting the sole level I partner of the program. The United States, however, refused the request. Ultimately, Britain applied considerable pressure up to and including a threat to pull out of the JSF program and obtained an agreement in 2006. According to President G. W. Bush and Prime Minister Tony Blair, "Both governments agree that the UK will have the ability to successfully operate, upgrade, employ and maintain the Joint Strike Fighter such that the UK retains operational sovereignty over the aircraft."[47] The specifics and details remain classified, but it is believed that the United States in fact did not transfer the source code but gave the United Kingdom priority and assurance that its needs would be met by timely American-engineered upgrades.[48] Why is control of the software so important?

Technologically, functionality has steadily migrated from hardware to software ever since creation of the first vacuum tube electronic device. Added value has steadily moved away from making physical things to designing software that made the devices more useful. During World War II, a major Allied innovation was the invention of the proximity fuse, a miniaturized radar transceiver that triggered the explosion of an artillery shell near a target, enabling the use of airbursts of shrapnel against difficult-to-hit targets such as aircraft. This progress continued the use of hard-wired electronics until the recognition that in the 1973 Arab-Israeli war, such electronics enabled the jamming of Israeli systems and led to the development of reprogrammable radar and electronics. The F/A-18 was the first aircraft of its kind to be equipped with a programmable radar having a one-kilobyte hard drive on board. This radar allowed dynamic reconfiguration of the F/A-18 in flight, switching from air-to-air combat mode to ground-attack mode, making the aircraft the world's first truly multirole fighter. It was also the first major defense program in which the cost of developing the software exceeded the development budget for the hardware. Since that time, on every major program, software costs have exceeded those for hardware.

The importance of software in increasing the capabilities and lethality of military systems is now central. For instance, software lines of code (SLOC) for all F/A-18 variants are as follows: A/B model was 943,000 (943K), C/D (2,130K), Night Attack (3,054K), C/D XN-8 (6,629K), C/D SMUG/RUG (14,268K), and E/F (17,101K).[49] As "smartness" of weapons increased, productivity improved. During the first Gulf War, although the tonnage of "smart" bombs was relatively small, they demonstrated to the world that a few precision targeted bombs could accomplish what formerly required large fleets of bomber aircraft carrying "dumb" bombs. This brings up the issue of productivity or lethality of the JSF versus that of the alternatives.

As the largest contributor, the United Kingdom solved the problem by leveraging a technology that it historically controlled into STOVL technology, ensuring that not only the manufacturing of the physical parts but also the software developed for that portion of the JSF stayed in the United Kingdom. Norway, on the other hand, lobbied the United States successfully for a commitment to integrate the Norwegian-made Joint Strike Missile (JSM) into the F-35, which will likely have many customers—including the US Navy. Norway estimated that the JSM will probably result in $3.3 billion to $4.2 billion in revenues.[50] In a similar fashion, Israel, one of America's closest allies, got a commitment from the United States for "plug and play" compatibility for a range of Israeli-made electronic warfare and other systems.[51]

All of these models did not require the United States to compromise on its insistence on sole control of the F-35 source code. At present, it remains unknown whether Canada, as a part of the Canadian JSF program, has crafted or is crafting a complementary program to develop and field a JSF-compatible product that fits with particular Canadian needs and that potentially has an export market to all JSF customers, including the DOD. Given the size and scope of Canada's commitment to the JSF program and that country's long-standing status as a reliable ally, it is within the realm of possibility to ask the United States for at least a deal comparable to Norway's and Israel's.[52]

Lethality and Productivity: Automated Warfare

One of the least understood aspects of the JSF program concerns the reason why this aircraft is so different from its predecessors. Side-by-side comparisons that utilize published specifications cited by aviation enthusiasts reveal an aircraft inferior in many respects to the best Russian craft being exported. Indeed, Australian Airpower, an independent air defense think tank staffed by former Royal Australian Air

Force pilots, published many studies that showed the F-35's technical inferiority.[53] When experienced veteran pilots of close US allies are so negative, it raises the question of why the benefits of the JSF program were not effectively communicated. From the first day of flight, aircraft have become gradually more automated, and as automation enhanced function, crew workloads gradually declined, resulting in smaller crews doing more. Figure 4 illustrates the trend of increasing automation in the cockpit.

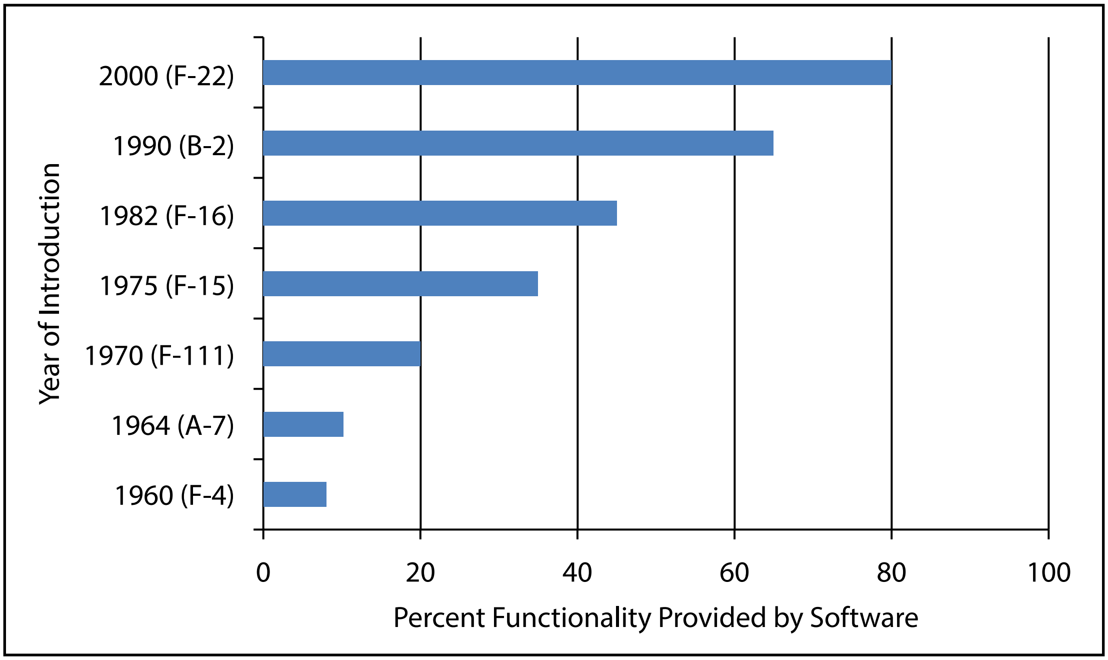


Figure 4. Growth in software functionality of military aircraft software. (Adapted from Daniel L. Dvorak, ed., *NASA Study on Flight Software Complexity* [Washington, DC: NASA Office of Chief Engineer, 2009], 30, http://www.nasa.gov/pdf/418878main_FSWC_Final_Report.pdf.)

The size of cockpit crews has steadily declined even as the platforms became more capable. The CF-18s were primarily single-seat A models, but the B models were built with a second seat for the weapons systems officer, in line with the now-retired F-14 of the same vintage that required a crew of two. With automation and considerable attention to reducing pilot workload, modern aircraft have made two seats unnecessary, just as improvements in reliability have made two engines unnecessary.[54] Both of these developments are the direct product of improved software—the former from cockpit automation and the latter from the monitoring of engines and preemptive maintenance to reduce the chances of in-flight failure. Critics have observed that the F-35 is a single-engine craft unable to "supercruise" like the apparently more advanced F-22.[55]

With the increase in software functionality have come improvements in platform reliability, the active management of a system's performance, the tracking and logging of data, and, finally, the use of the data itself.[56] In other words, all data from every program participant is pooled together. This enables the building of a large database that, in turn, permits identifying and proactively addressing issues before the actual point of failure (see the system for engine health management, below).[57] Because of these changes, the reliability of a single-engine craft can approach and, in fact, exceed the reliability of twin-engine craft that have less sophisticated onboard management systems, such as the F/A-18A/B currently in the Canadian inventory.[58]

Additional features on the F-35 that set it entirely apart from any previous aircraft except the F-22 include a limited amount of stealthiness, passive conformal sensors, and a helmet display that greatly reduces the pilot's workload.[59] The F-35's stealthiness against radar is designed to reduce its signature, primarily at the X band but not the L band or other VHF band radars. Infrared signature is produced by designing the airframe to limit hot spots and blending hot exhaust gases to reduce the signature. However, no matter what one does to reduce the signature, emerging technologies—including networked sensor technologies based on optics—can render the issue moot.[60] A major improvement initiated in the F-22 and publicly disclosed in the F-35 is the use of conformal passive sensors and difficult-to-detect distributed aperture radar.[61] However, these improvements are still single-platform enhancements. Signature reduction is an evolving challenge with emerging sensor technologies that make older generations of stealth technology obsolete.

Automation to Network-Centric Warfare

Communications have always been central to warfare. From the earliest days of fighting, combatants were trained to use and follow what ultimately evolved into an elaborate system of commands and controls. The key to the increased lethality of modern weapons platforms is the move toward network-centric as opposed to platform-centric approaches of the past. As part of acquisition reforms in the 1990s, individual platform-specific systems were gradually phased out and replaced with platforms interoperable with architecture designed to share data. Beginning in the 1990s, the idea of data fusion, whereby data from platforms could be electronically accessed by other platforms, became an aspiration for all defense systems.[62] This contrasts historical models whose sensor data (e.g., from the Airborne Warning and Control System platform) must be interpreted; only then can a controller manually vector an aircraft to the threat.[63] The F-35 is the first major platform that can not only access sensor data but also seamlessly operate a fleet of remotely piloted assets in its vicinity. SLOCs illustrate the complexity of network-centric software in the F-35 and its expansion through generations of aircraft.

Complexity in software expanded sharply between the relatively new F-22 program (1.9 million SLOCs) to more than 9.5 million SLOCs in the F-35 for the aircraft portion of the code. Additional code not on board the F-35 totals over 24 million SLOCs.[64] The 2012 Government Accountability Office review notes that

> the lines of code necessary for the JSF's capabilities have now grown to over 24 million—9.5 million on board the aircraft. By comparison, JSF has about 3 times more on-board software lines of code than the F-22A Raptor and 6 times more than the F/A-18 E/F Super Hornet. This has added work and increased the overall complexity of the effort. The software on-board the aircraft and needed for operations has grown 37 percent since

> the critical design review in 2005. . . . JSF software growth is not much different than other recent defense acquisitions which have experienced from 30 to 100 percent growth in software code over time. However, the sheer number of lines of code for the JSF makes the growth a notable cost and schedule challenge.[65]

Lethality Multiplication

What caused this drastic increase in software complexity with the F-35? The maturation of first-generation remotely piloted platforms and the US Air Force's change of heart toward remotely piloted versus manned represent the major change from 1990s when the program was conceived for the twenty-first century. The growing legitimacy of remotely piloted assets in the US Air Force resulted in substantial increases in requirements for software for the F-35, no longer viewed as a conventional fighter aircraft. This revised concept addressed many concerns about the F-35, including its relatively undistinguished performance in conventional air-to-air combat roles, noted by independent studies.[66]

Appraisals of F-35 lethality fail to recognize that as a stand-alone platform, it is as vulnerable as they claim. But the US Air Force has moved far beyond deploying the F-35 in the conventional role of a strike fighter. A new generation of remotely piloted aircraft (RPA) has architecture from the ground up to operate semiautonomously without the need for a ground controller to "fly" them; the present generation of RPAs, such as the Predator MQ-1, is being tested and "mated" to the F-35 as a strike package.[67] These new swarms will both address these concerns and give the F-35 a capability that effectively multiplies its lethality—though the exact degree of multiplication has yet to be proven in combat. Fusion of the combat system is more important than RPAs, which are very vulnerable assets. The ability to deliver data throughout the fleet with these common combat systems, for electronic warfare and cyber war, is crucial as well.

Given this major increase in capability, one question that needs to be raised is whether the original DND statement of requirements that specified 65 aircraft remains relevant when the F-35 is used as presently designed in conjunction with semiautonomous, remotely piloted assets. Another major question has to do with why Canadian forces have lagged in adopting and developing remotely piloted technologies.[68]

Conclusion

The dominant industrial and regional benefits offset model was historically a good one for much of the twentieth century. It remains an excellent mechanism to secure economic benefits and technology transfer from a prime or major subcontractor to Canadian industry and to ensure some degree of control by Canada over security of supply for logistical purposes in the event of war. However, as the proportion of software grew in terms of total value, the most critical element became not the making of the physical product but access to the system software. The DOD has made it amply clear that such access will not be granted in a meaningful fashion, even to the closest allies. Under such circumstances, even if Canada hypothetically were able to secure the production contract for the entire JSF program (US and foreign combined), the benefits would (a) remain well below 50 percent of the total value of the program and (b) not materially improve Canada's position of dependence on the United States to provide the software. No JSF can fly without the software, and it is not within the capabilities of anyone other than a consortium of the European Union to develop an alternative software suite independent of the United States.

As the largest and closest ally of the United States in the JSF program, the United Kingdom in effect secured the majority of the manufacturing and some of the software work specific to the F-35(B) STOVL version. Even then, the deal left it dependent upon America for most software modules. Both Israel and Norway, relatively small players, leveraged "plug compatibility" for major additions to the F-35. Norway will implement the Joint Direct Missile Program, and Israel will implement its own equipment and weapons into the JSF.[69]

The Canadian armed forces and Industry Canada could have used the Norwegian, Israeli, Singaporean, and UK programs as templates to produce the architecture for a set of complementary products and services that would meet unique Canadian needs and potentially have a large export market by securing from the United States the assurance of plug compatibility on the F-35 platform. As of the date of this publication, the opportunity to leverage the Canadian JSF procurement into a set of complementary programs with substantial industrial and regional benefits—while addressing pressing Canadian priorities such as Arctic sovereignty / resource and environmental management—is still open. ✪

Notes

1. "National Fighter Procurement Secretariat (NFPS)," Public Works and Government Services Canada, 11 December 2013, http://www.tpsgc-pwgsc.gc.ca/app-acq/stamgp-lamsmp/snac-nfps-eng.html.
2. Carlo Muñoz, "Canada Begins Search for Joint Strike Fighter Replacement," *The Hill* (blog), 12 December 2012, http://thehill.com/blogs/defcon-hill/procurement/272633-canada-begins-search-for-jsf-replacement-.
3. "Chapter 2, Replacing Canada's Fighter Jets," in *Report of the Auditor General of Canada to the House of Commons* (Ottawa: Office of the Auditor General of Canada, Spring 2012), http://www.oag-bvg.gc.ca/internet/docs/parl_oag_201204_02_e.pdf; and "Canada's Next Generation Fighter Capability: The Joint Strike Fighter F-35 Lightning II," Government of Canada, 16 July 2010, http://news.gc.ca/web/article-eng.do?m=/index&nid=548059.
4. "Program Overview," F-35 Lightning II Program, accessed 15 January 2014, http://www.jsf.mil/program/. The article's focus is primarily on the issue of leveraging industrial benefits from the program, given the way it is structured by the DOD.
5. "Pre JAST: History," F-35 Lightning II Program, accessed 15 January 2014, http://www.jsf.mil/history/his_prejast.htm#ASTOVL.
6. See Jacques S. Gansler, *Democracy's Arsenal: Creating a Twenty-First-Century Defense Industry* (Cambridge, MA: MIT Press, 2011).
7. "JSF: History," F-35 Lightning II Program, accessed 15 January 2014, http://www.jsf.mil/history/his_jsf.htm.
8. Ibid.
9. "Program Overview." This is believed to apply to the commonality of hardware parts, not software.

10. "International Participation: Program," F-35 Lightning II Program, accessed 15 January 2014, http://www.jsf.mil/program/prog_intl.htm.

11. Leslie Wayne, "One Fighter, 11 Nations and Building Problems," *New York Times*, 22 July 2004, http://www.nytimes.com/2004/07/22/business/one-fighter-11-nations-and-building-problems.html.

12. This is a conservative estimate. A more aggressive one by the DOD's Cost Assessment and Program Evaluation Office put the cost at US $1.45 trillion over the life of the program. See Andrea Shalal-Esa, "JSF Lifetime Cost Hits $1.45T: Reuters," *Aviation Week Intelligence Network*, 29 March 2012.

13. See the special issue on the Canadian F-35 program in the *Canadian Foreign Policy Journal*, Special Issue 13, no. 3 (September 2007); and an overview in Srdjan Vucetic, "Canada and the F-35: What's at Stake?," *Canadian Foreign Policy Journal* 17, no. 3 (September 2011): 196–203. Perspectives generally supportive of the program include James Fergusson, "The Right Debate: Airpower, the Future of War, Canadian Strategic Interests, and the JSF Decision," *Canadian Foreign Policy Journal* 17, no. 3 (September 2011): 204–16; and Paul T. Mitchell, "Lightning in a Bottle: The F-35 and the Bankruptcy of Modern Warfare," *Canadian Foreign Policy Journal* 17, no. 3 (September 2011): 193–95. For opposition to the program, see Michael Byers and Stewart Webb, "Canada's F-35 Purchase Is a Costly Mistake," *Canadian Foreign Policy Journal* 17, no. 3 (September 2011): 217–27; and Anton Bezglasnyy and Douglas Alan Ross, "Strategically Superfluous, Unacceptably Overpriced: The Case against Canada's F-35A Lightning II Acquisition," *Canadian Foreign Policy Journal* 17, no. 3 (September 2011): 239–50.

14. "Mark Collins—Canada's Declining Defence Budget as Percentage of GDP," *3Ds Blog*, Canadian Defence and Foreign Affairs Institute, accessed 11 November 2013, http://www.cdfai.org/the3dsblog/?p=1197.

15. Ramnarayanan Mathilakath, Ashutosh Rajekar, and Sahir Khan, *Fiscal Impact of the Canadian Mission in Afghanistan* (Ottawa: Office of the Parliamentary Budget Officer, 2008), 8, http://celarc.ca/cppc/219/219354.pdf.

16. Canadian Press, "Military Truck Purchase Cancelled Due to Cost Concerns," *CBC News*, 12 July 2012, http://www.cbc.ca/news/canada/story/2012/07/11/military-truck-purchase-halted.html.

17. Kathleen Harris, "Cyclone Helicopter Contract Revisions Urged by Report," *CBC News*, 4 September 2013, http://www.cbc.ca/news/politics/cyclone-helicopter-contract-revisions-urged-by-report-1.1378318.

18. "Dutch Plans to Buy F-35 Fighter Jets in Doubt," Reuters, 5 July 2012, http://it.reuters.com/article/idUKBRE8640X620120705.

19. Jung Sung-Ki, "F-35 Back in S. Korea Fighter Contest," *Defense News*, 28 September 2013, http://www.defensenews.com/article/20130928DEFREG/309280008/F-35-Back-S-Korea-Fighter-Contest.

20. "Requiem for the Sea King," *CBC News*, February 2006, http://www.cbc.ca/news2/background/cdnmilitary/seaking.html.

21. Except for the Arrow, a developmental versus acquisition program, Canada did not cancel a major defense capital acquisition program in recent history before the EH-101 deal.

22. Note that smaller countries contributed sums disproportionate to the size of their economies.

23. Michel Rossignol, *The Joint Strike Fighter Project* (Ottawa: Library of Parliament, Parliamentary Research Branch, 15 July 2002, rev. 19 February 2003), 3, http://publications.gc.ca/collections/Collection-R/LoPBdP/PRB-e/PRB0207-e.pdf.

24. Ibid. Note that the figures are different by source. Office of the Deputy Under Secretary of Defense (Industrial Policy), *JSF International Industrial Participation: A Study of Country Approaches and Financial Impacts on Foreign Suppliers* (Washington, DC: Office of the Deputy Under Secretary of Defense [Industrial Policy], June 2003), 3, http://www.ledevoir.com/documents/pdf/etude_internationale_defense_americaine.pdf.

25. David Ljunggren, "Canada to Buy 65 F-35 Jet Fighters in C$9 Bln Deal," Reuters, 16 July 2010, http://www.reuters.com/article/2010/07/16/canada-fighters-idUSN1611146620100716. See also "F-35 Joint Strike Fighter (JSF) Lightning II," GlobalSecurity.org, accessed 15 January 2014, http://www.globalsecurity.org/military/systems/aircraft/f-35-int.htm.

26. Corruption in military procurement is legendary. A well-known fable about a businessman who paid many bribes to obtain an order for tents from the tsar in Russia was asked for a final, very large bribe for the approval. He complained that he would not be able to deliver the goods and was reputedly told by the courtier, "Why deliver the tents?"

27. Industry Canada is a federal department that overseas industrial development policy for the benefit of Canadians. The Industrial and Regional Benefits Policy goes further in that it requires companies that secure military contracts with Canada to spend 100 percent of the contract value in Canada. See "What Is the IRB Policy?," Industry Canada, 11 October 2013, http://www.ic.gc.ca/eic/site/042.nsf/eng/h_00016.html.

28. Integration of equipment from suppliers within a single nation (e.g., the United States) is a nontrivial issue. Such integration between existing Canadian inventories and newer equipment from different NATO suppliers is a sizable issue due to the different architectures and the difficulties working with legacy equipment. Furthermore, had a nontraditional supplier like Sukhoi been used, there would likely be no support from the United States for integrating it into a usable system with existing equipment. Considerable nonrecurring engineering costs will be necessary to make it work even at a minimal level.

29. Sweden, Saab's home nation, is unusual in having a close security relationship with NATO but is not a member. See "NATO's Relations with Sweden," North Atlantic Treaty Organization, accessed 15 January 2014, http://www.nato.int/cps/en/natolive/topics_52535.htm.

30. Office of Management and Budget, "F/A-18 Aircraft Sales to Canada, Australia, and Spain: A Case Study of Offsets," *DISAM [Defense Institute of Security Assistance Management] Journal* 13, no. 1, (Fall 1990): 32–46.

31. "Maritime Helicopter Project (MHP)," Industry Canada, 6 February 2012, http://www.ic.gc.ca/eic/site/043.nsf/eng/00004.html. See also Canada Department of National Defence, "Canada—Maritime Helicopter Project: Status—Streitkräfte der Welt World's Armed Forces," GlobalDefence.net, accessed 7 February 2014, http://www.globaldefence.net/defence-news/21510-canada-maritime-helicopter-project-status.html.

32. Office of Management and Budget, "F/A-18 Aircraft Sales to Canada, Australia, and Spain: A Case Study of Offsets," *DISAM Journal* 13, no. 1 (Fall 1990): 36, http://www.disam.dsca.mil/pubs/Vol%2013_1/OMB.pdf.

33. For a list of recent procurements under industrial and regional benefits, see "List of Procurements and their IRB Managers," Industry Canada, 11 October 2013, http://www.ic.gc.ca/eic/site/042.nsf/eng/h_00017.html.

34. Life-cycle cost of ownership is not traditionally used in many procurement decisions. Credible estimates have to deal with considerable uncertainties, including the possibility that equipment lasts either not as long (often due to obsolescence) or much longer than originally intended.

35. Rossignol, *Joint Strike Fighter Project*, 4.

36. Ibid.

37. Barry D. Watts and Todd Harrison, *Sustaining Critical Sectors of the U.S. Defense Industrial Base* (Washington, DC: Center for Strategic and Budgetary Assessments, 2011), 20.

38. Rossignol, *Joint Strike Fighter Project*, 3.

39. Office of the Deputy Under Secretary of Defense (Industrial Policy), *JSF International Industrial Participation*, 50–51. Please note that the dollar estimates are nominal dollars and that the rate-of-return estimates are nominal as well.

40. Ibid. The minor differences in calculation do not alter the main finding. That is, the Technology Partnerships Canada funds were variously quoted as being $50 million to $75 million in the above study.

41. For example, digital electronic components can rapidly become obsolete, often on an 18-month product life cycle based on Moore's law. After as little as a decade, the device may no longer be available if the supplier has shut down production of the line and the line could not be reopened without considerable sunk cost. The default solution calls for the Pentagon to stockpile parts expected to be required during the life of the system. However, it is not anticipated that most allies or customers of the system would have their independent stockpiles but would rely on the Pentagon for supply as needed.

42. See the classic "Augustine's Laws" about the history of cost and schedule in defense procurement. Augustine offers an example of an arms maker given a contract for rifles for the American revolutionary war—one that was delayed and over budget. Norman R. Augustine, *Augustine's Laws / Norman R. Augustine*, rev. and expanded ed. (New York: Viking, 1986). Initial operational capability is a standard program milestone whereby a system meets a minimum criterion.

43. See Tolga R. Yalkin and Peter Weltman, *An Estimate of the Fiscal Impact of Canada's Proposed Acquisition of the F-35 Lightning II Joint Strike Fighter* (Ottawa: Office of the Parliamentary Budget Officer, 10 March 2011), 36, http://publications.gc.ca/collections/collection_2011/dpb-pbo/YN5-31-2011-eng.pdf.

44. Jeremiah Gertler, *F-35 Joint Strike Fighter (JSF) Program: Background and Issues for Congress*, CRS Report for Congress RL30563 (Washington, DC: Congressional Research Service, 26 April 2011), 17.

45. The historical cost estimates of sustainment costs based on the CF-18A/B may not be applicable given the differences in the software suite. The JSF may have a cost structure resembling a major software system like SAP or Oracle, wherein maintenance costs can well exceed the cost of the initial purchase.

46. DO-178x is the standard for aerospace-grade software code. See "DO-178B Industry Group for Engineers," accessed 15 January 2014, http://www.do178site.com/.

47. "UK Offered 'Operational Sovereignty' over Lockheed Martin F-35 Joint Strike Fighter, Diffusing Technology Transfer Row," Flightglobal, 31 May 2006, http://www.flight global.com/news/articles/uk-offered-39operational-sovereignty39-over-lockheed-martin -f-35-joint-strike-fighter-206979/.

48. Colin Clark, "US Guards JSF Crown Jewels," *DoD Buzz*, 24 November 2009, http:// www.dodbuzz.com/2009/11/24/us-guards-jsf-software-crown-jewels/.

49. Mike Philips, "Toward Efficient and Effective Software Sustainment," *SEI Blog*, 27 February 2012, http://blog.sei.cmu.edu/post.cfm/toward-efficient-and-effective-software -sustainment.

50. Robert Wall, "Norway's JSF Deal Bolsters JSM Missile," *Aviation Week*, 25 June 2012, http:// www.aviationweek.com/Article.aspx?id=/article-xml/AW_06_25_2012_p32-469614.xml.

51. "Israeli Plans to Buy F-35s Moving Forward," *Defense Industry Daily*, 25 April 2012, http://www.defenseindustrydaily.com/israel-plans-to-buy-over-100-f35s-02381/.

52. New weapons that will work with the F-35 are more like applications derived from common software code (i.e., like apps that work with Android). It should be possible, therefore, for foreign missile manufacturers to make plug-compatible weapons, and for the first time they will be able to access a global market. One criticism of US missile manufacturers is that they are disadvantaged by the global common fleet, which creates a different playing field. US firms do not like the globalism of the aircraft delivered through a software-upgradeable platform whereby the partners can create caucuses to shape evolution and then leverage the global market. Lockheed Martin's role is simply to incorporate the applications into stable software code.

53. Wing Cdr Chris Mills, RAAF, Retired, "How? The Deadly Question for the F-35 Joint Strike Fighter," Air Power Australia, 5 July 2010, http://www.ausairpower.net/APA-NO TAM-05072010-1.html; and "RAAF vs F-35 Lightning II Joint Strike Fighter," Air Power Australia, accessed 16 January 2014, http://www.ausairpower.net/jsf.html.

54. There is no readily available public data on the reliability of small-diameter (military) jet engines, but that on the reliability of civilian engines can be tracked and is roughly comparable. Boeing now offers 330 minutes of extended operations on the 777. See Geoffrey Thomas, "FAA Extends 777 ETOPS Approval to 330-Min," Air Transport World, 13 December 2011, http://atwonline.com/aircraft-amp-engines/faa-extends-777-etops-approval-330-min.

55. *Supercruise* refers to the ability to fly at supersonic speeds with a useful payload without the use of afterburners. Dr. Carlo Kop is a strong critic who unsuccessfully advocated the purchase of the F-22 for the Royal Australian Air Force. See Carlo Kopp, "Just How Good Is the F-22 Raptor? Carlo Kopp interviews F-22 Chief Test Pilot, Paul Metz," *Air Power International* 4, no. 3 (September 1998), http://www.ausairpower.net/API-Metz-Interview.html.

56. Lars Seumenicht, "New Developments for Military Jet Engines" (presentation at the Seventh Israeli Symposium on Jet Engines, Technion-Israel Institute of Technology, Haifa, Israel, 6 November 2008, Rolls-Royce Deutschland, Germany), http://jet-engine-lab.technion .ac.il/7AIJESpresent/1.-LARS.pdf.

57. This same concept is now widely used for commercial aircraft and increasingly in modem autos as well as many other systems, even individual machine tools. In effect, the original equipment manufacturer pretty much knows what the customer is doing with their equipment, nearly in real time.

58. The debate over one versus two engines in Canada is rather quaint. It is mostly conducted by those who are not aware of the technical advances in software-based engine management and its contribution to reliability and the avoidance of catastrophic failures that will almost certainly result in the loss of hull in a single-engine craft.

59. A passive conformal sensor is a radar receiver that is blended into the airframe/wing /body (conformal) and only receives (does not send out) signals, making it difficult to detect. It lets something else (RPA-borne radar transmitter or a ship-based radar) light the target, but the reception and processing of the signal occurs on board the JSF, allowing it to see but not be the source of the light. Older fighters must rely on their onboard radar to guide them to the target and shoot once they are vectored to the general vicinity by a platform like the Airborne Warning and Control System or shipboard radar like Aegis.

60. The US Air Force has more experience operating stealth fighters and bombers than any other service. The step back from stealthiness occurs for many reasons but is primarily driven by the ease with which stealth can be defeated by a technologically sophisticated adversary. See the Rand presentation by John Stillion and Scott Perdue, "Air Combat Past, Present and Future," Project Air Force briefing, Rand Corporation, August 2008, http://www.scribd.com/doc/7774389/Rand-StudyFuture-fo-Air-Combat.

61. See "AN/APG-81 AESA Radar," Northrop Grumman, accessed 15 January 2014, http://www.northropgrumman.com/Capabilities/ANAPG81AESARadar/Pages/default.aspx; and Wing Cdr Chris Mills, "F-35 Joint Strike Fighter vs Russia's New Airborne Counter-Stealth Radars," Air Power Australia, 14 September 2009, http://www.ausairpower.net/APA-NOTAM-140909-1.html.

62. See D. L. Hall, "An Introduction to Multisensor Data Fusion," *Proceedings of the IEEE* 85, no. 1 (January 1997): 6–23.

63. The issue of communications systems complexity is central to a modern command and control system. During the 1990s, a major air force purchased aircraft from three different sources and ended with a nightmare when the only way to pass commands and communications between them called for going through ground controllers to relay the messages! This matter of compatibility and communications upgrades is one of the major issues addressed in the CF-18 incremental modernization program. See Allan Ng, "The CF18 Incremental Modernization Program—in Detail," *Canadian American Strategic Review*, December 2003, http://www.casr.ca/id-cf18-3-1.htm.

64. House, "*Joint Strike Fighter: Restructuring Added Resources and Reduced Risk, but Concurrency Is Still a Major Concern," Statement of Michael J. Sullivan, Director, Acquisition and Sourcing Management, Testimony before the Subcommittee on Tactical Air and Land Forces, Committee on Armed Services, House of Representatives*, 112th Cong., 2nd sess. (Washington, DC: Government Accountability Office, 20 March 2012), 11, http://www.gao.gov/assets/590/589454.pdf.

65. Ibid.

66. For example, see the 2008 Rand study by Stillion and Perdue, "Air Combat Past, Present and Future," which generated intense controversy and resulted in Rand issuing the following "clarification": Andrew Hoehn, "Statement Regarding Media Coverage of F-35 Joint Strike Fighter," Rand Corporation, 25 September 2008, http://www.rand.org/news/press/2008/09/25.html. This did not stop the Australians from extending the study to show the F-35's vulnerability: "Australian Committee Hearing Reveals Details of F-35 Performance

in Wargame," Defense-Aerospace, 6 March 2012, http://www.defense-aerospace.com/article-view/verbatim/133273/f_35-fares-worse-in-rand-wargame.html.

67. Predator MQ-1s are remotely piloted but for practical purposes, remotely manned. Remote operators "fly" them via a satellite link and control everything they do—hence the need for large amounts of satellite bandwidth whenever they are deployed. See Peter B. de Selding, "Troop Drawdown Won't Crimp Bandwidth Demand, Officials Say," *SpaceNews*, 2 December 2011, http://www.spacenews.com/article/troop-drawdown-wont-crimp-bandwidth-demand-officials-say.

68. Canadians' interest in RPAs dates from the early 2000s. They were flying SAGEM CU-161 Sperwer tactical RPAs in Afghanistan from 2003 onwards. See "Canada Crafting High-End UAV Requirements," *Defense Industry Daily*, 19 December 2005, http://www.defenseindustrydaily.com/canada-crafting-highend-uav-requirements-01640/.

69. "Israeli Plans to Buy F-35s Moving Forward," *Defense Industry Daily*, 25 April 2013, http://www.defenseindustrydaily.com/israel-plans-to-buy-over-100-f35s-02381/.

Dr. Danny Lam

Dr. Lam (BA, University of Waterloo; MBA, Richard Ivey School of Business, University of Western Ontario; PhD, Carleton University) is a graduate student in civil and environmental engineering at the University of Waterloo, where he is completing a thesis on "Defense Energy Systems for the 21st Century." Before he returned to school, he had a 25-year career in microelectronics and technology that included stints in industry and academe. His research and analysis, which appeared on *CNBC* and in the *Wall Street Journal*, include a chapter in the *Handbook of Technology Management* (McGraw Hill, 1996). Danny has published articles in *Semiconductor International* as well.

Dr. Brian Paul Cozzarin

Dr. Cozzarin (BA, MSc, University of Guelph; PhD, University of Illinois–Urbana-Champaign) is an associate professor in the Department of Management Sciences, Faculty of Engineering, University of Waterloo, Waterloo, Ontario. He teaches an undergraduate course in finance for engineers as well as graduate courses in the economics of innovation and technological change and strategic management of technology. His research interests include the economics of technology policy, government program evaluation, entrepreneurship, and private equity.

Let us know what you think! Leave a comment!

How LeMay Transformed Strategic Air Command

Col Phillip S. Meilinger, USAF, Retired*

When the Soviets blockaded Berlin in June 1948 and war seemed imminent, the Joint Chiefs of Staff asked the commander of Strategic Air Command (SAC), Gen George Kenney, to brief them on his unit's readiness. The briefing did not go well: Kenney appeared ill informed. The Air Force chief of staff, Gen Hoyt Vandenberg, then asked an old friend, Charles Lindbergh, to inspect SAC and evaluate its competence and abilities. Two weeks later, Lindbergh reported that SAC was unprepared and lacking in basic skills: "Personnel are not sufficiently experienced in their primary mission."[1] Vandenberg relieved Kenney and replaced him with Lt Gen Curtis E. LeMay.

The Man

Born in Columbus, Ohio, LeMay was commissioned through the Reserve Officer Training Corps in 1928 as he worked toward an engineering degree at Ohio State University. He won his wings the following year and in 1936 arrived at the 2nd Bombardment Group at the same time as the new YB-17s. Over the next decade, he became known as one of the best navigators and pilots in the Air Corps. In 1937 he located the battleship *Utah* in exercises off California and "bombed" it with water canisters. The following year, he navigated B-17s 600 miles out to sea to intercept the ocean liner Rex, illustrating airpower's abil-

*This article is adapted from the author's book *Bomber: The Formation and Early Years of Strategic Air Command* (Maxwell AFB, AL: Air University Press, 2012).

ity to defend American coasts. In 1938 LeMay led B-17s to South America to display airpower's role in hemisphere defense. War brought rapid promotion.

At the beginning of World War II, LeMay served as a group commander in the Eighth Air Force but in 18 months had progressed to major general. He led from the front while also earning a reputation as an innovative tactician and problem solver. In December 1944, LeMay took over XXI Bomber Command in the Mariana Islands. From there, he planned and conducted the decisive B-29 bombing campaign against Japan.

When the war ended, LeMay served on the Air Staff as the deputy chief of staff for research and development. He then moved to Germany to become commander of United States Air Forces in Europe, where he was at the time of the Berlin blockade. Vandenberg was impressed by LeMay's ability to get things done. When the chief needed a new leader at SAC, LeMay was the obvious choice; he possessed an indomitable will and an unshakeable faith in the efficacy of strategic airpower.

LeMay's personality was the subject of frequent caricature. Yes, he was unsophisticated, taciturn, and tactless, but he was also hard working and courageous. He led his bomb group on the bloody Schweinfurt-Regensburg mission of August 1943, and during his tenure as SAC commander, he stated that if his men went to war, then he would be in the first plane. At the same time, he was sincerely concerned about his troops and labored to improve their food, housing, and recreation facilities. In the austere areas where many SAC bases were located, these amenities were important. In one letter, LeMay noted that "pay alone is not a primary incentive. . . . There must be a vital concern throughout SAC [for] individual consideration and firm personal guidance for our airmen."[2]

LeMay believed that people wanted to work hard but needed encouragement and recreational opportunities to recharge their batteries. For his part, he loved hunting, fishing, and working on cars. He wanted all SAC bases to have an auto hobby shop for the benefit of others like him who found relaxation in overhauling a car engine. LeMay also pushed hard for better housing.

Although hundreds of air bases had been built during the war, these temporary facilities were of substandard construction. To him, open-bay barracks for enlisted troops were an outdated concept; he wanted Airmen in dormitories—two to a room—to give them a better lifestyle. When the Corps of Engineers objected, LeMay hired local contractors to build them. He asked a group of wives to select colors, drapes, and furniture to make the dorms more livable. For married families, LeMay worked with Senators Kenneth Wherry and Homer Capehart to fund low-cost base housing.

Although LeMay seemed tough and uncompromising, those who knew him best said he had a soft heart. He seldom became visibly angry or raised his voice. He cared about people and their welfare—but the mission came first. One of LeMay's comments regarding someone relieved because of an unfortunate accident was typical: "I can't tell the difference between unlucky and unskilled because the results are the same."[3] Above all, he demanded results.

LeMay used his staff effectively, seldom giving detailed directives but providing subordinates the authority to use their own judgment. The operations analysis chief at SAC watched him for nine years and concluded that his management style worked:

> LeMay's reliance on the people he selected for senior positions [allowed] him time to be available on short notice. By concentrating on basic strategies and major decisions, while depending on his staff to formulate them, he escaped the trap of a bulging schedule that would have made mature planning difficult. As a result, he was able to stay in complete control of SAC's operations, while being one of the most available persons in the headquarters.[4]

The stories told of LeMay and quotations attributed to him are legion. Although most are apocryphal, they were widely circulated and added to his mystique. He once entered a hangar and found it guarded only by an Airman with a ham sandwich. He drove through a gate at one SAC base without stopping; the gate guard pulled out his sidearm and shot at the car. LeMay slammed on the brakes, got out, and berated the cop—for missing. One day he grew suspicious of a telephone repairman in his office; he pulled out his .45 and held the man prisoner until the air police arrived. At one of his bases, a guard found an intruder in the nuclear weapons storage area, ordered him to halt, and then fired a warning shot. When the individual kept running, he shot and killed the man. The wing commander called LeMay and asked for guidance on how to handle the situation. LeMay told him to make the sky cop pay for the bullet he wasted on the warning shot. When asked whom he favored in the upcoming Army-Navy football game, he growled, "I hope they both lose." A cigar became his trademark. (LeMay had Bell's palsy, a malady that affects the facial muscles, making it difficult to keep the mouth from sagging. He usually had a cigar in his mouth to help strengthen those muscles.) While the general was standing next to a bomber being refueled, a maintenance officer asked him to extinguish his stogie before it blew up the entire base. LeMay's reply: "It wouldn't dare." When someone called him a tough guy, he retorted that he didn't mind: he found that in his business, the tough guys led the survivors. He needed to be tough to deal with the many challenges facing his command.

Reforging the Weapon

One LeMay legend concerns "the attack on Dayton." After taking over at SAC, he met with his commanders and staff and realized they "weren't worth a damn." He announced an alert—a maximum effort of all bombers to carry out a simulated attack on Dayton, Ohio. The strike would occur from high altitude, at night, using radar bombing techniques. According to LeMay, not one aircraft completed the mission as briefed.[5] The SAC history is not quite that damning, but it notes that the results of the mock attack were poor: of 15 B-36s scheduled in one bomb group, six aborted and three others failed to "drop" over the target due to radar malfunctions. The story was the same in other groups. Bombing accuracy was awful, with an average miss distance of two miles.[6] LeMay had made his point.

The general then began to strip down the command and remake it, reshuffling the three numbered air forces. It made no sense to have a bomb wing in Florida assigned to Fifteenth Air Force, headquartered in California. The air forces also had been organized along functional lines: the Eighth had mostly B-50s while the Fifteenth primarily flew B-29s; Second Air Force contained reconnaissance assets. LeMay transformed all three into composite units with a mix of very heavy bombers (the new B-36s coming online), mediums (B-29s and B-50s), a reconnaissance wing, and fighter escorts. This commonsense reorganization saved money, cut communication and travel time, and allowed better training.

Bombing accuracy was a major concern. LeMay directed that exercise targets be changed frequently—as were aim points, altitudes, and run-in headings—to prevent crews from becoming too familiar with training routines and thereby inflating bomb scores. Radar reflectors to aid bombardiers were prohibited. At the same time, crews used detailed radar surveys of US cities as training guides.

Radar bomb-scoring (RBS) detachments were deployed throughout the United States using sophisticated wind-measuring instruments and radar to determine the accuracy of simulated bomb drops. The use of RBS increased dramatically under LeMay: in 1946 SAC logged 888 radar bomb runs; in 1950 that number leapt to 43,722. The radar specialists also realized they could do more than measure results; they could assist a crew's bombing effort. During the Korean War, these teams deployed to Korea to aid B-29s on their bombing missions.

Readiness tests had been instituted in early 1948, but LeMay refocused them to emphasize flying, radar bombing, the in-commission rate of aircraft, and the ability to sustain a maximum effort over a period of several days. This marked the birth of the dreaded operational readiness inspections (ORI), during which teams would fly into a SAC base unannounced and tell the wing commander to assume that war had broken out and to execute the war plan. In addition, bombing competitions were held annually. Crews from each bomb group would drop a series of simulated bombs from high altitude using radar. The winning crews returned home as heroes. Rivalry between the wings grew, and so did morale.

One initiative, the Lead Crew School, sought to improve SAC bombing accuracy. LeMay had instituted such programs during World War II and decided to replicate the practice in SAC. In June 1949, he established SAC's Lead Crew School at Walker AFB in New Mexico. There, crews trained together in a standardized and uniform pattern. Each wing sent three crews to each class, and the school soon established an excellent reputation—after eight cycles, bomb scores had improved by more than 50 percent. These crews then returned to their units to instruct the other crews on what they had learned, slowly but noticeably improving the performance of the entire command.

In December 1949, LeMay pushed through another radical idea—spot promotions. He met with Gen Idwal H. Edwards (deputy chief of staff for personnel) and General Vandenberg, convincing them to allow him to promote lead crew members "on the spot" to the next grade. Crews that won bomb competitions would receive promotions as well. LeMay intended to improve morale, give everyone a heightened sense of purpose and competition, and validate SAC as the premier organization in the Air Force. He recognized that this practice would cause irritation outside SAC, so he made it clear that spot promotions would be based on merit and *continued* outstanding performance: "I intend to make an example of the first officer I find who has relaxed now that he has made temporary captain as a crew member." If someone failed a check flight, then all crew members would lose their spot promotions.[7]

Studies of war plans that assumed a major conflict with the Soviet Union spearheaded by an atomic strike employing SAC bombers raised the question of covering the long ranges to and from targets deep in Russia. Other investigations showed that bases in Europe were highly vulnerable to a Soviet first strike. Instead, LeMay pushed hard for air refueling. Based on his experience in research and development after the war, the general became a firm believer in advanced technologies. He wanted the jet-powered, long-range B-52s. But even these aircraft would need air refueling to reach their targets and return. B-29s and C-97s were modified to serve as tankers, but as the new jet bombers came online, these piston-driven tankers could not keep up. The Boeing KC-135 offered a solution, and LeMay ordered more than 700 of these "Stratotankers," hundreds of which are still in service.

The Leader

Contrary to some depictions, Curtis LeMay neither rejected scientific thinking nor resented the introduction of civilian academics into what had been the military's preserve. Indeed, because of his support in this area, one historian refers to him as the "godfather" of RAND—the California-based think tank that to this day performs important work for the Air Force.[8]

The nuclear war theorists used impeccable logic in devising their scenarios regarding deterrence, assured destruction, and related concepts. To LeMay, such theories were of limited use. War had its own logic, and it was not as predictable as civilian academics believed. If logic were the key to strategy, then the Japanese would never have been so foolish as to attack Pearl Harbor in 1941.

LeMay appreciated the efforts of these academics but realized that he, as the commander, was responsible for results. The professors at RAND and elsewhere could provide some good ideas—but the buck stopped at SAC. It would be the unit going to war, and LeMay never forgot that.

By the mid-1950s, SAC had reinvented itself, and over it all stood Curtis LeMay. He pinned on his fourth star in 1951, one month prior to his 45th birthday (the second-youngest full general in American history behind U. S. Grant). His insistence on performance and professionalism put great pressure on his command. LeMay knew that but considered the stakes too high to demand anything less. He remembered the two decades between the world wars when the Air Corps suffered with a budget barely 12 percent of the Army total. Consequently, the air arm entered the war unprepared. He would not let that happen on his watch. The general understood the burdens he imposed; thus, his spot promotion system, lead crews, and emphasis on better housing and facilities helped make it all bearable.

Professionalism and an emphasis on people were two aspects of the cultural change that LeMay brought to SAC. Another closely related facet was his insistence that the command consider itself on a perpetual war footing. From Hiroshima onward, Air Force leaders stressed that the atomic age had eliminated the time-honored American tradition of unpreparedness for war. The problems that he confronted in 1942 when he had no aircraft, equipment, or trained personnel had affected him profoundly. Good men had died because of unreadiness—but no more. Leaders often raised the specter of an "atomic Pearl Harbor" to stress the need for an Air Force-in-being, ready at the outset of hostilities to fight decisively. LeMay embraced that concept, constantly telling members of his command to act like they were already at war. He did not want competent performance to occur weeks or months after war began but immediately. When LeMay assumed command, such ideas were fanciful, but from his first days in office he inculcated that belief throughout the organization.

The general began with training—his crews *would* launch on time, find their targets anywhere in the world, and then destroy them. LeMay's emphasis on standardization and top performance was reflected in his ORI mentality: no warning and no chance to get things in order. Real war would come without such niceties, and he was determined to ensure that SAC would be prepared if the unexpected occurred. Similarly, base security was legendary around the Air Force. LeMay wanted his personnel to *assume* that they were targets—always. Therefore, they must be ready.

As the Cold War deepened, LeMay took matters to a higher level, building dispersal bases and deploying bombers and tankers there to complicate a possible enemy attack. The advent of ballistic missiles meant that warning time would be measured in minutes, not hours. Beginning in late 1956, SAC placed bombers and tankers on continuous alert. If the Klaxon sounded, crews rushed to their aircraft and launched. At some point, they were told that it was an exercise and that they could return to quarters. The crews never knew: sometimes they would be recalled as they started engines or taxied out; at other times, they launched, climbed to altitude, refueled, and proceeded toward their targets on the other side of the globe.

In all of this, LeMay sought to develop within SAC a unique and definable military culture of seriousness and purpose. Over the four-plus decades of the command's existence, this culture was sometimes derided by those in other Air Force commands who had no such immediacy in their mission. At times, even SAC personnel grew resentful and weary of the never-ending insistence on perfection and instantaneous response. Nonetheless, the culture existed throughout the life of the command, imposed by the iron will and determination of Curtis LeMay and those who followed him. SAC veterans claim that the culture of professionalism within the command was one of its greatest strengths and that the Air Force lost much when SAC and its distinctive ethos ended in June 1992.

Curtis LeMay had performed his task well. By the end of his nine-year tenure at Offutt AFB, Nebraska, in July 1957, SAC had developed into an organization of renowned professionalism and precision. By that point, it received one-third of the Air Force budget, which garnered nearly half of the entire defense budget. As the key to the US nuclear deterrent, SAC kept the peace because it trained so unremittingly for war. ✪

Notes

1. "Lindbergh Report," 14 September 1948, LeMay papers, box 61, Library of Congress.
2. Gen Curtis E. LeMay to Gen Emmett O'Donnell, letter, 9 February 1949, in Official History, Strategic Air Command, 1949, vol. 2, exhibit 20.
3. Gen Paul K. Carlton, interview by Cargill Hall, 30 September 1980, 79.
4. Carroll L. Zimmerman, *Insider at SAC: Operations Analysis under General LeMay* (Manhattan, KS: Sunflower Press, 1988), 34.
5. Gen Curtis E. LeMay, interview by John T. Bohn, 9 March 1971, 37; and Curtis E. LeMay with MacKinlay Kantor, *Mission with LeMay: My Story* (Garden City, NY: Doubleday, 1965), 432–33.
6. Official History, Strategic Air Command, 1950, vol. 1, 76; and Clark to 7BW [7th Bomb Wing], letter, 17 January 1949, in ibid., vol. 4, exhibit 3.
7. Official History, Strategic Air Command, 1949, vol. 1, 16.
8. Alex Abella, *Soldiers of Reason: The RAND Corporation and the Rise of the American Empire* (Orlando: Harcourt, 2008), 15.

Col Phillip S. Meilinger, USAF, Retired

Colonel Meilinger (USAFA; MA, University of Colorado; PhD, University of Michigan) served 30 years in uniform as a command pilot, staff officer, and educator. He flew C-130s and HC-130s in Europe and the Pacific and served as a staff officer in the Pacific Airlift Control Center. During Operation Desert Storm, he was a planner on the Air Staff in the Pentagon while also serving as chief of the Air Force Doctrine section. He taught at the Air Force Academy and Naval War College and served as dean of the School of Advanced Airpower Studies (now the School of Advanced Air and Space Studies)—the Air Force's only accredited graduate school for the education of future strategists. After retiring from the Air Force, he worked as a defense analyst for six years in the Washington, DC, area. The author of 10 books and more than 100 articles on airpower, military operations, and military/airpower theory and doctrine, Dr. Meilinger has lectured at military and civilian venues all over the world. His most recent book is *Bomber: The Formation and Early Years of Strategic Air Command* (Air University Press, 2012).

Let us know what you think! Leave a comment!

http://www.airpower.au.af.mil

Nuclear Deterrence and Cyber

The Quest for Concept

Dr. Stephen J. Cimbala

Nuclear deterrence is not what it used to be. Theorists, policy makers, and military planners have arrived at the place that noted physicist Freeman Dyson referred to as "The Quest for Concept."[1] One aspect of this change is that uses of nuclear weapons for deterrence or other missions will take place in a post-Internet, cyber-ready world. This is the international system defined not only by Hobbes but also by Jobs. Governments and their armed forces will have to adapt their bureaucratic hierarchies to the demands for faster and more flexible decision making and force application. In so doing, they will become progressively more cyber implicated, cyber dependent, and cyber vulnerable.[2]

That this is so is already acknowledged in US military organization. The Department of Defense (DOD) established US Cyber Command (USCYBERCOM) as a subunified command of US Strategic Command, and USCYBERCOM coordinates across the relevant military branches (US Army Cyber Command, US Fleet Cyber Command / US Tenth Fleet, Twenty-Fourth Air Force, US Marine Corps Forces Cyber Command, and US Coast Guard Cyber Command). Colocated with the National Security Agency, USCYBERCOM is headed by the same director.[3] Yet, for the most part, nuclear deterrence and cyber warfare issues are treated as separate and distinct compartments. This cyber-nuclear separatism is understandable as a matter of division of labor among experts, but it casts a shadow over the reality of nuclear deterrence or crisis management under cyber-intensive conditions.

In the discussion that follows, we first examine some of the broader theoretical implications of the nuclear-cyber nexus for students of national security policy and warfare. Second, we comment on the apparent significance of cyber and information wars, albeit with caveats not always recognized. Third, we consider how missile defenses, posing cyber challenges of their own, might complicate US-Russian political relations and nuclear arms reductions. No implication is intended that the US-Russia deterrence relationship is illustrative of other arms control and proliferation issues; indeed, we will see below that just the opposite is true. Nevertheless, some enduring realities of nuclear force exchanges merit recall as we move further away from the precyber and into the postcyber nuclear age. Fourth, we analyze how the combination of nuclear offenses and more advanced missile defenses might play out for deterrence stability, especially within the contentious US-Russian context. Finally, we draw pertinent conclusions about the nuclear-cyber interface insofar as it might pertain to future arms control, nonproliferation, and deterrence.

Nuclear and Cyber: Together or Apart?

What are the implications of potential overlap between concepts or practices for cyber war and for nuclear deterrence?[4] Cyber war and nuclear weapons seem worlds apart. Cyber weapons should appeal to those who prefer a nonnuclear or even a postnuclear military-technical arc of development. War in the digital domain offers, at least in theory, a possible means of crippling or disabling enemy assets without the need for kinetic attack or while minimizing physical destruction.[5] Nuclear weapons, on the other hand, are the very epitome of "mass" destruction, such that their use for deterrence or the avoidance of war by the manipulation of risk is preferred to the actual firing of same. Unfortunately, neither nuclear deterrence nor cyber war will be able to live in distinct policy universes for the near or distant future.

Nuclear weapons, whether held back for deterrence or fired in anger, must be incorporated into systems for command, control, communications, computers, intelligence, surveillance, and reconnaissance (C4ISR). The weapons and their C4ISR systems must be protected from attacks both kinetic and digital in nature. In addition, the decision makers who have to manage nuclear forces during a crisis should ideally have the best possible information about the status of their own nuclear and cyber forces and command systems, about the forces and C4ISR of possible attackers, and about the probable intentions and risk acceptance of possible opponents. In short, the task of managing a nuclear crisis demands clear thinking and good information. But the employment of cyber weapons in the early stages of a crisis could impede clear assessment by creating confusion in networks and the action channels that depend upon those networks.[6] The temptation for early cyber preemption might "succeed" to the point at which nuclear crisis management becomes weaker instead of stronger.

Ironically, the downsizing of US and post-Soviet Russian strategic nuclear arsenals since the end of the Cold War, while a positive development from the perspectives of nuclear arms control and nonproliferation, makes the concurrence of cyber and nuclear attack capabilities more alarming. The supersized deployments of missiles and bombers and expansive numbers of weapons deployed by the Cold War Americans and Soviets had at least one virtue. Those arsenals provided so much redundancy against first-strike vulnerability that relatively linear systems for nuclear attack warning, command and control, and responsive launch under—or after—attack sufficed. At the same time, Cold War tools for military cyber mischief were primitive compared to those available now. In addition, countries and their armed forces were less dependent on the fidelity of their information systems for national security. Thus the reduction of US, Russian, and possibly other forces to the size of "minimum deterrents" might compromise nuclear flexibility and resilience in the face of kinetic attacks preceded or accompanied by cyber war.[7]

Offensive and defensive information warfare as well as other cyber-related activities is obviously very much on the minds of US military leaders and others in the American and allied national security establishments.[8] Russia has also been explicit about its cyber-related concerns. President Vladimir Putin urged the Russian Security Council in early July 2013 to improve state security against cyber attacks.[9] Russian security expert Vladimir Batyuk, commenting favorably on a June 2013 US-Russian agreement for protection, control, and accounting of nuclear materials (a successor to the recently expired Nunn-Lugar agreement on nuclear risk reduction), warned that pledges by Presidents Putin and Barack Obama for cooperation on cybersecurity were even more important: "Nuclear weapons are a legacy of the 20th century. The challenge of the 21st century is cybersecurity."[10] On the other hand, arms control for cyber is apt to run into daunting security and technical issues, even assuming a successful navigation of political trust for matters as sensitive as these. Of special significance is whether cyber arms-control negotiators can certify that hackers within their own states are sufficiently under control for cyber verification and transparency.

The cyber domain cuts across the other geostrategic domains for warfare as well: land, sea, air, and space. However, the cyber domain, compared to the others, suffers from the lack of a historical perspective. One author argues that the cyber domain "has been created in a short time and has not had the same level of scrutiny as other battle domains."[11] What this might mean for the cyber-nuclear intersection is far from obvious. Table 1 summarizes some of the major attributes that distinguish nuclear deterrence from cyber war, according to experts, but the differences between nuclear and cyber listed here do not contradict the prior observation that cyber and nuclear domains inevitably interact in practice. According to research professors Panayotis A. Yannakogeorgos and Adam B. Lowther at the US Air Force Research Institute, "As airmen move toward the future, the force structure—and, consequently, force-development programs—must change to emphasize the integration of manned and remotely piloted aircraft, space, and cyber-power projection capabilities."[12]

Table 1. Comparative attributes of cyber war and nuclear deterrence

Cyber War	*Nuclear Deterrence*
Source of attack may be ambiguous—third-party intrusions masquerading as other actors are possible.	Source of attack is almost certain to be identified if the attacker is a state, and even terrorist attackers' nuclear materials may be traceable.
Damage mostly to information systems, networks, and their messaging contents although these might have spillover effects to the operations of military combat systems, economy, and social infrastructure.	Failure of deterrence can lead to historically unprecedented and socially catastrophic damage even in the case of a "limited" nuclear war by Cold War standards.
Denial of the attacker's objectives is feasible if defenses are sufficiently robust and/or penetrations can be repaired in good time.	Deterrence by means of threat to deny the attacker its objectives is less credible than the threat of punishment by assured retaliation (although improved missile defenses seek to change this).
The objective of cyber attacks is typically disruption or confusion rather than destruction per se.	Nuclear deterrence has rested for the most part on the credible threat of massive, prompt destruction of physical assets and populations.
Cyber war and information attacks can continue over an extended period of time without being detected and sometimes without doing obvious or significant damage—some are not even reported after having been detected.	The first use of a nuclear weapon since 1945 by a state or nonstate actor for a hostile purpose (other than a test) would be a game-changing event in world politics, regardless of the size of the explosion and the immediate consequences.
The price of entry to the games table for cyber war is comparatively low—actors from individual hackers to state entities can play.	Building and operating a second-strike nuclear deterrent requires a state-supported infrastructure, scientific and technical expertise on a large scale, and long-term financial commitments.

Source: The author. See also Timothy L. Thomas, *Three Faces of the Cyber Dragon: Cyber Peace Activist, Spook, Attacker* (Ft. Leavenworth, KS: Foreign Military Studies Institute, 2012), 60–66; and Martin C. Libicki, *Cyberdeterrence and Cyberwar* (Santa Monica, CA: RAND Corporation, 2009), 27–28 and passim.

Cyber Attacks and Information Wars: How Significant?

The DOD and other government agencies, together with military and information technology experts, anticipate that future interstate conflict will include cyber attacks and information wars.[13] But the term *cyber war* may be misleading since attacks on computers and networks are only one means of accomplishing the objective of neutralizing the enemy's critical infrastructures.[14] As Joel Brenner has noted,

> The U.S. Navy spent about $5 billion to develop a quiet electric drive for its submarines and ships so they'd be silent and hard to track. Chinese spies stole it. The navy spent billions more to develop new radar for their top-of-the-line Aegis Cruiser. Chinese spies stole that, too. The electronic intelligence services of the Chinese and the Russians are working us over—taking advantage of our porous networks and indifference to security to steal billions of dollars' worth of military and commercial secrets. Some of our allies, like the French and the Israelis, have tried it too.[15]

One purpose for activity that the DOD refers to as information and infrastructure operations would not be mass destruction (although destructive secondary effects are possible) but mass and/or precision *disruption*.[16] According to Robert A. Miller, Daniel T. Kuehl, and Irving Lachow, the purpose of an information and infrastructure operation would be to "disrupt, confuse, demoralize, distract, and ultimately diminish the capability of the other side."[17] This concept lends itself to consideration for a deterrent mission based on the credible threat of conventional or nuclear response. One must always remember, however, that the unique, prompt lethality of nuclear weapons creates a separate grammar for the conduct of nuclear war even if such a war would remain within the boundaries of strategic logic.[18] As Colin Gray has warned,

> First, except for highly unusual cases, cyber power is confined in its damaging effects to cyberspace. This is not to understate the problems that can be caused by cyber attack, but it is to claim firmly that the kind of damage and disruption that cyber might affect [*sic*] cannot compare with the immediate and more lasting harm that nuclear weapons certainly would cause.[19]

It merits emphasis that cyber war, or deterrence primarily exercised in cyberspace, is emphatically cognitive in its epistemic center of gravity. However, for cyber war (or deterrence) to be of significant interest to strategists, it must also find meaningful application to the strategic and tactical problems that analysts and war fighters are expected to solve. In this regard, theories of cyber war or deterrence raise some of the same concerns that nuclear deterrence theories have done. In both cases, the theorist risks giving way to the temptation of putting forward elegant conceptual architectures for which pertinent applications are remotely visible, if at all. One must be alert to the possible distraction of nuclear or cyber versions of the Schlieffen plan.

Missile Defenses: Prophecy or Problem?

Technical Uncertainties

The cyber aspects of nuclear deterrence intersect with those pertinent to missile defense. Missile defenses, if successful, offer the possibility that deterrence by threat of unacceptable retaliation could be supported by deterrence based on denial of the attacker's objectives.[20] Today, missile defenses remain technologically and politically contentious. Russian objections to the European Phased Adaptive Approach (EPAA) to missile defenses proposed by the United States and North Atlantic Treaty Organization (NATO) remained emphatic even as reportedly secret DOD studies cast doubt on the technical proficiency of the proposed components for the European ballistic missile defense (BMD) systems.[21] A study by the US National Academy of Sciences on missile defense technologies called into question some of the thinking of the Obama administration and the US Missile Defense Agency about the priority of certain missions and technologies for BMD.[22] On the other hand, other expert scientists criticized the aforementioned study as containing "numerous flawed assumptions, analytical oversights, and internal inconsistencies" leading to "fundamental errors in many of the report's most important findings and recommendations" and as undermining its scientific credibility.[23] Future technology challenges to the development and deployment of missile defenses will have more to do with the "arbitrary complexity" of software engineering for multiple contingencies and players, compared to the bipolar and physics-centric context of the High Cold War.[24] Suffice it to say that the academic and policy arguments continue as to the feasibility and desirability of building missile defenses, alongside the inertial pull of research and development funding in this direction since the Reagan administration's Strategic Defense Initiative.[25]

Political Pitfalls

If the linkage between US and NATO plans for European missile defenses and further progress in US-Russian strategic nuclear arms reductions was not yet a hostage relationship, it was clearly a problematical connection.[26] The New Strategic Arms Reduction Treaty (START) agreement does not preclude the United States from deploying future missile defenses despite Russian efforts during the negotiating process to restrict American degrees of freedom in this regard.[27] But then Russian president Dmitry Medvedev and his predecessor-successor Putin have made it clear that Russia's geostrategic perspective links US and NATO missile defenses to cooperation on other arms control issues. Meanwhile the United States and NATO in 2011 moved forward with the first phase of a four-phase deployment of the EPAA for missile defenses.[28] In March 2013, Secretary of Defense Chuck Hagel announced plans to modify the original plan for the EPAA by abandoning the originally planned deployments of SM-3 IIB interceptor missiles in Poland by 2022. Nevertheless, this step failed to reassure Russian doubters about the US and NATO claims that their regional and global missile defenses were not oriented against Russia. Russian officials frequently reiterate demands for a legally binding guarantee from the United States and NATO that Russian strategic nuclear forces would not be targeted or affected by the system.[29] Table 2 summarizes the status of the EPAA BMD as of autumn 2013.

Table 2. European Phased Adaptive Approach to missile defense

	Phase I	*Phase II*	*Phase III*	*Phase IV (canceled March 2013)*
Time Frame	*2011*	*2015*	*2018*	*2020*
Capability	Deploying today's capability	Enhancing medium-range missile defense	Enhancing intermediate-range missile defense	Early intercept of MRBMs, IRBMs, and ICBMs
Threat/ Mission	Address regional ballistic missile threats to Europe and deployed US personnel.	Expand defended area against short- and medium-range missile threats to Southern Europe.	Counter short-, medium-, and intermediate-range missile threats to include all of Europe.	Cope with MRBMs, IRBMs, and potential future ICBM threats to the United States.
Components	AN/TPY-2 (FBM) in Kurecik, Turkey; C2BMC in Ramstein, Germany; Aegis BMD ships with SM-3 IA off the coast of Spain	AN/TPY-2 (FBM) in Kurecik, Turkey; C2BMC in Ramstein, Germany; Aegis BMD ships with SM-3 IB off the coast of Spain; Aegis Ashore with SM-3 1B in Romania	AN/TPY-2 (FBM) in Kurecik, Turkey; C2BMC in Ramstein, Germany; Aegis BMD ships with SM-3 IIA off the coast of Spain; Aegis Ashore with SM-3 IB/IIA in Romania and Poland	AN/TPY-2 (FBM) in Kurecik, Turkey; C2BMC in Ramstein, Germany; Aegis BMD ships with SM-3 IIA off the coast of Spain; Aegis Ashore with SM-3 IIB in Romania and Poland
Technology	Exists	In testing	Under development	In conceptual stage when canceled
Locations	Turkey, Germany, ships off the coast of Spain	Turkey, Germany, ships off the coast of Spain, ashore in Romania	Turkey, Germany, ships off the coast of Spain, ashore in Romania and Poland	Turkey, Germany, ships off the coast of Spain, ashore in Romania and Poland

Source: Karen Kaya, "NATO Missile Defense and the View from the Front Line," *Joint Force Quarterly*, issue 71 (4th Quarter 2013): 86. For pertinent technical challenges relative to target acquisition, discrimination, interception, and data networking, see Steven J. Whitmore and John R. Deni, *NATO Missile Defense and the European Phased Adaptive Approach: The Implications of Burden Sharing and the Underappreciated Role of the U.S. Army* (Carlisle, PA: US Army War College, October 2013), 11–17.

Note: Separate national contributions to the mission of European BMD have been announced by the Netherlands and France.

Aegis Ashore - land-based component of the Aegis BMD system
AN/TPY-2 (FBM) - Army-Navy / Transportable Radar Surveillance, Model 2 (forward-based mode)
BMD - ballistic missile defense
C2BMC - command, control, battle management, and communications
ICBM - intercontinental ballistic missile
IRBM - intermediate-range ballistic missile
MRBM - medium-range ballistic missile

Although the prospects for US-Russian or NATO-Russian agreement on European missile defenses might seem challenging at this writing, the prospects for US cooperation with allies and partners outside Europe on regional missile defenses are more favorable. The potential bull market for missile defenses lies in Asia, including prompts from Sino-Japanese rivalry, North Korean threats and missile tests, and deterrence challenges between India and Pakistan. From the standpoint of military modernization, both conventional and nuclear, as well as the expectation of future war, Europe is a relatively pacific security community compared to turbulent Asia. Should deterrence fail, missile defenses might appeal to states in Asia as supports for deterrence by denial-of-enemy-attack objectives and as means of damage limitation. Missile defenses for some US allies and partners might also reinforce US security guarantees based on the American nuclear umbrella and consequently reduce the incentives for those states to develop their own nuclear arsenals.[30]

Arms Reductions: Analysis

Force Exchange Models

The New START agreement of 2010 mandates modest reductions in the numbers of deployed strategic weapons and launchers, building on the Strategic Offensive Reductions Treaty reached earlier between the United States and Russia during the George W. Bush administration. In his Berlin speech of 19 June 2013, President Obama indicated US interest in post–New START reductions of about one-third in the numbers of Russian and American deployed intercontinental weapons.[31]

Could the United States and Russia safely take the step, from the New START maximum limit of 1,550 to roughly 1,000 operationally deployed nuclear warheads on intercontinental missiles and heavy bombers while preserving deterrence and arms control stability? The analysis that follows uses summary figures to interrogate that issue.[32]

New START and lower-limit force structures are projected based on various expert assessments and are tested by our model for their nuclear exchange outcomes.[33]

Figures 1 and 2 summarize the outcomes of US-Russian strategic nuclear exchanges, assuming a New START–compliant limit of 1,550 or 1,000 operationally deployed warheads on intercontinental launchers for each state. Figure 1 displays the numbers of second-strike surviving and retaliating warheads for each state under a deployment ceiling of 1,550 weapons, and figure 2 provides similar information for the case of 1,000 deployed weapons. In figures 3 and 4, respectively, we introduce antimissile and air defenses (combined) into the equation for each state, providing a variable range of possible performances against second-strike retaliating weapons: phase I defenses successfully intercept at least 20 percent of the second-strike retaliating warheads; phase II defenses, at least 40 percent; phase III defenses, at least 60 percent; and phase IV defenses, at least 80 percent.

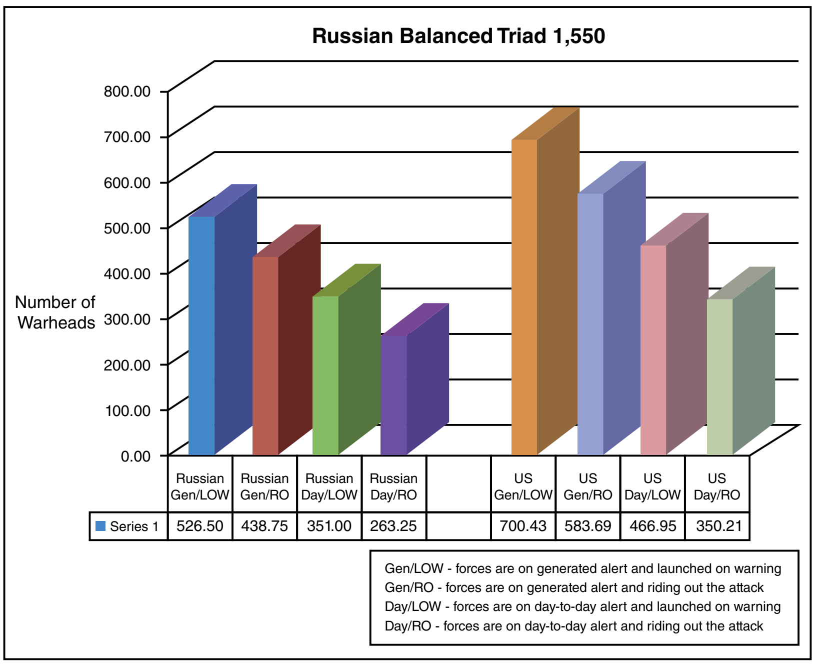


Figure 1. US-Russia surviving and retaliating warheads (1,550 deployment limit)

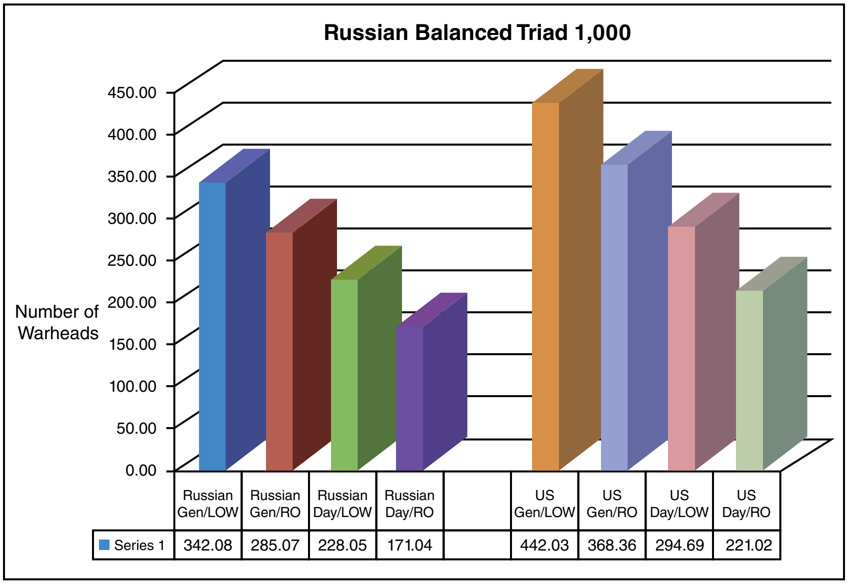


Figure 2. US-Russia surviving and retaliating warheads (1,000 deployment limit)

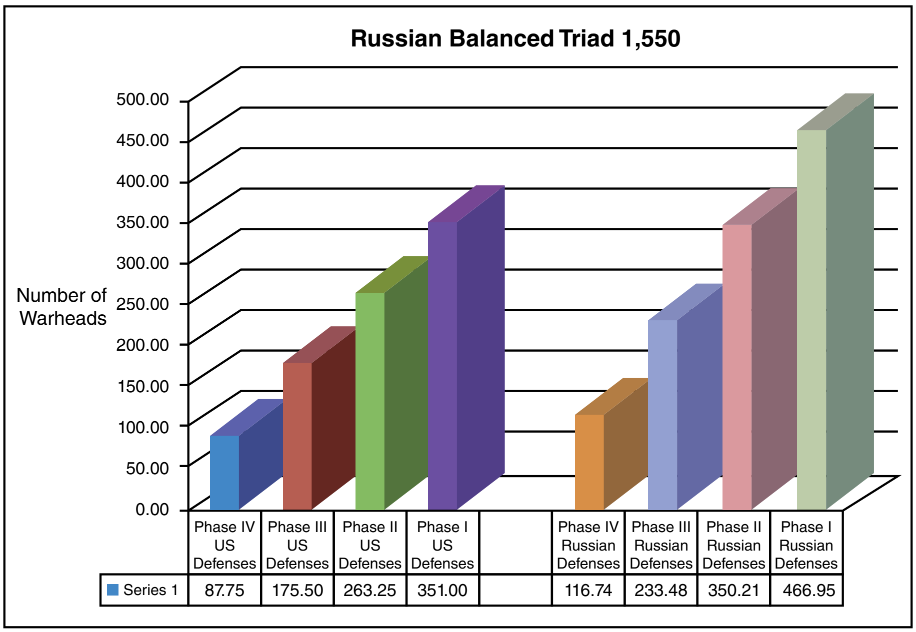


Figure 3. US-Russia surviving and retaliating warheads versus defenses (1,550 deployment limit)

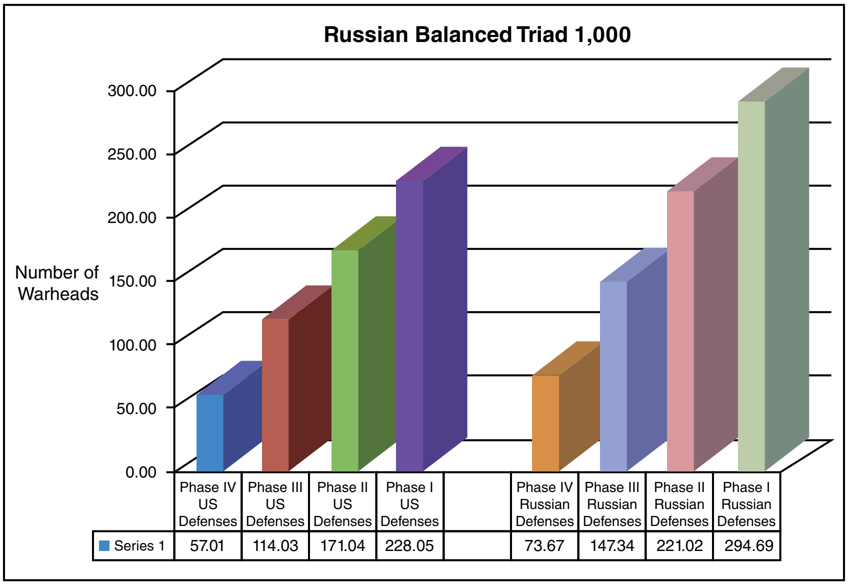


Figure 4. US-Russia surviving and retaliating warheads versus defenses (1,000 deployment limit)

Results and Implications

The preceding figures appear to show that each state has numbers of surviving and retaliating weapons sufficient to satisfy the criterion of "unacceptable damage" in a second strike so long as unacceptable damage is defined by traditional US political and military standards.[34] However, the assumptions about rationality or reasonableness on which traditional models of deterrence have rested may be misleading. As Keith B. Payne has noted in arguing for a more empirical approach to deterrence,

> Attempting to become familiar with the decision-making dynamics of foreign leaders, for the purpose of establishing an informed basis for deterring and coercing them, is not a trivial undertaking. And, it must be acknowledged that even extensive efforts at acquiring information concerning the factors underlying a challenger's decision-making will not preclude surprising, unpredictable behavior based on unfamiliar or wholly obscure motives, goals, and values.[35]

For example, some expert analysts have suggested that improving accuracies for delivering nuclear and conventional weapons may make counterforce strategies attractive to some states, including nuclear weapons states other than the United States and Russia.[36] In contrast, other researchers have warned that even nuclear wars smaller than those involving those two countries, such as a future nuclear conflict between Israel and Iran, could result in historically unprecedented and socially unmanageable consequences for both sides (in addition to uncertain side effects for the rest of the region).[37]

Thus the appeal of nonnuclear systems, including cyber weapons, for prospective attackers rests in part on their putative capacity for *calculated deception* combined with *precise lethality*. On this very point, Russian deputy prime minister Dmitry Rogozin has warned that information weapons are becoming first-strike weapons against enemy political, military, and industrial centers. Rogozin also claimed that Pentagon computer games showed that strikes by some 3,000–4,000 precision-guided munitions could destroy as much as 80–90 percent of Russia's nuclear potential.[38] Of course a US attack of this scale on Russia and Russia's probable responses would destroy political stability and economic viability in much of Europe and Central Eurasia in addition to whatever damage was caused to their respective state territories. Deterrence failure remains a dead end to be avoided; relative advantage is a cruel hoax.

Another challenge for the Obama administration is the potential for conflict between its objectives for achieving global denuclearization and for reducing the role of nuclear weapons in US military strategy on the one hand and for promoting advanced conventional weapons, including missile defenses and offensive weapons for precision global strike (PGS), on the other. For example, China's putative posture of minimum deterrence with respect to its numbers of deployed strategic weapons assumes a minimum second-strike capability relative to the United States that might be threatened by enhanced missile defenses and/or PGS weapons.[39] Furthermore, as previously noted, Russia has also warned that US missile defenses nominally aimed at Iran might eventually pose a threat to Russia's strategic nuclear deterrent.[40]

Conclusions

Nuclear weapons find themselves anomalies in a post–Cold War world in which they have become detached from their origins in a US-Soviet global rivalry. They still command respect for their unique ability to cause unprecedented mass destruction in a short time and to create long-term lethal effects. However, the environment for strategy-making and policy-relevant nuclear deterrence, arms control, and disarmament analysis has already changed profoundly—and more changes are ahead. Changes in technology are the most visible, but their impact extends beyond nuts and bolts. The diversification of offensive strike platforms, the development of improved antimissile and antiair defenses, and the increasing importance of cyber, including offensive and defensive information warfare, could combine to create a paradigm shift in the thinking about major war in advanced countries. The preceding discussion at best scratches the surface of this possibly tectonic change.

One paradox of the nuclear-cyber age is that the ability of the nuclear great powers to deter one another might encourage an undeserved complacency as to the substructure of regional nuclear deterrence, especially among existing and nuclear-aspirational powers in the Middle East and South and East Asia.[41] A multipolar nuclear power system outside Europe creates potential instabilities that will challenge existing notions of deterrence rationality as well as the endurance of the nonproliferation regime. US and allied planning for nuclear crises will have to take into account the possibility of scenarios with plot lines unscripted in past war games, including cases of ambiguity about whether "nuclear" use had actually occurred.[42] For these reasons, the two-dimensional analysis offered here, relative to US-Russian nuclear dynamics, overlaps inescapably and inevitably with the emerging multipolar nuclear power system of which it is a part. But now the United

States and Russia have the incentives and opportunities, unlike the Cold War Americans and Soviets, to pursue multilevel-system crisis management and shared nonproliferation objectives without a presumption of ideological hostility. The system "default" is to more nuclear initiative from the regions and (hopefully) to multilateral arms reductions beyond the precedents set by New START and any follow-ons.

The relationship between offensive nuclear force reductions and missile defenses (with or without cyber in the mix) is a complicated one. Missile defenses are more promising technologies than they were in the previous century. Expert studies, however, suggest that anti-BMDs are much more viable prospects against small attacks by regional foes than they are strategic counterweights to massive long-range missile attacks.[43] There is room for security cooperation in missile defense by NATO and Russia against possible threats posed by Middle Eastern or other nuclear capabilities. But the effects of nuclear weapons spread in the Middle East or additional proliferation in Asia cannot be precluded only by missile defenses or even by solely military responses. Smart diplomacy combined with limited regional missile defenses might buy time for more ambitious nonproliferation and counterproliferation initiatives to work.[44] ✪

Notes

1. Freeman Dyson, *Weapons and Hope* (New York: Harper and Row, 1984), 223–38.
2. According to information security and intelligence expert Joel Brenner, the US military-industrial complex is the world's "fattest espionage target"; moreover, the assault on our national defense establishment "is constant, it is relentless, and it is coming from all points on the compass in ways both old and new." Brenner, *Glass Houses: Privacy, Secrecy, and Cyber Insecurity in a Transparent World* (New York: Penguin Books, 2013), 73.
3. Thomas M. Chen, *An Assessment of the Department of Defense Strategy for Operating in Cyberspace* (Carlisle Barracks, PA: Strategic Studies Institute, US Army War College, September 2013), 9–10 and passim.
4. Insightful analyses pertinent to this topic include Colin S. Gray, *Making Strategic Sense of Cyber Power: Why the Sky Is Not Falling* (Carlisle Barracks, PA: Strategic Studies Institute, US Army War College, April 2013); Kamaal T. Jabbour and E. Paul Ratazzi, "Does the United States Need a New Model for Cyber Deterrence?," in *Deterrence: Rising Powers, Rogue Re-*

gimes, and Terrorism in the Twenty-First Century*, ed. Adam B. Lowther (New York: Palgrave-Macmillan, 2012), 33–45; and Martin C. Libicki, *Cyberdeterrence and Cyberwar* (Santa Monica, CA: RAND, 2009). Other references on this topic appear in later notes. The chronology of key government documents pertinent to cyberspace and US national security strategy is nicely summarized in Chen, *Assessment*, appendix, 45–46.

5. On the information operations concepts of major powers, see Timothy L. Thomas, *Cyber Silhouettes: Shadows over Information Operations* (Ft. Leavenworth, KS: Foreign Military Studies Office, 2005), chaps. 5–6, 10, 14, and passim. See also Pavel Koshkin, "Are Cyberwars between Major Powers Possible? A Group of Russian Cybersecurity Experts Debate [*sic*] the Likelihood of a Cyberwar Involving the U.S., Russia or China," *Russia Direct*, 1 August 2013, http://russia-direct.org, in *Johnson's Russia List 2013*, no. 143 (6 August 2013), davidjohnson@starpower.net.

6. Cyber weapons are not necessarily easy to use effectively as enabling instruments for operational-tactical or strategic effect. See Martin C. Libicki, *Conquest in Cyberspace: National Security and Information Warfare* (Cambridge, UK: Cambridge University Press, 2007), especially chaps. 4–5.

7. An expert critique of proposals for minimum deterrence for US nuclear forces appears in Dr. Keith B. Payne, study director, and Hon. James Schlesinger, chairman, Senior Review Group, *Minimum Deterrence: Examining the Evidence* (Fairfax, VA: National Institute for Public Policy, National Institute Press, 2013). For a favorable expert assessment of the prospects for minimum deterrence, see James Wood Forsyth Jr., Col B. Chance Saltzman, and Gary Schaub Jr., "Remembrance of Things Past: The Enduring Value of Nuclear Weapons," *Strategic Studies Quarterly* 4, no. 1 (Spring 2010): 74–90.

8. USCYBERCOM plans for the equivalent of a "Star Wars" cyber defense against attacks on computer networks and other targets might be delayed or diverted by political controversy over National Security Agency surveillance. See David E. Sanger, "N.S.A. Leaks Make Plan for Cyberdefense Unlikely," *New York Times*, 12 August 2013, http://www.nytimes.com/2013/08/13/us/nsa-leaks-make-plan-for-cyberdefense-unlikely.html.

9. "Putin Calls to Strengthen Protection against Cyber Attacks," *Itar-Tass*, 5 July 2013, in *Johnson's Russia List 2013*, no. 122 (5 July 2013), davidjohnson@starpower.net.

10. Cited in Jonathan Earle, "U.S. and Russia Sign New Anti-Proliferation Deal," *Moscow Times*, 19 June 2013, in *Johnson's Russia List 2013*, no. 111 (19 June 2013), davidjohnson@starpower.net.

11. Clifford S. Magee, "Awaiting Cyber 9/11," *Joint Force Quarterly*, issue 70 (3rd Quarter 2013): 76.

12. Dr. Panayotis A. Yannakogeorgos and Dr. Adam B. Lowther, "Saving NATO with Airpower," *Royal Canadian Air Force Journal* 2, no. 1 (Winter 2013): 70.

13. See, for example, Chen, *Assessment*, 10–11 and passim; Brenner, *Glass Houses*, especially chaps. 6–7; Timothy L. Thomas, *Three Faces of the Dragon: Cyber Peace Activist, Spook, Attacker* (Ft. Leavenworth, KS: Foreign Military Studies Office, 2012); and Timothy L. Thomas, *Recasting the Red Star: Russia Forges Tradition and Technology through Toughness* (Ft. Leavenworth, KS: Foreign Military Studies Office, 2011). See also Department of Defense, *Department of Defense Strategy for Operating in Cyberspace* (Washington, DC: Department of Defense, July 2011), http://www.defense.gov/news/d20110714cyber.pdf; White House, *International Strategy for Cyberspace: Prosperity, Security, and Openness in a Networked World* (Washington, DC: White House, May 2011), http://www.whitehouse.gov/sites/default/files

/rss_viewer/international_strategy_for_cyberspace.pdf; Colin S. Gray, *Making Strategic Sense of Cyber Power: Why the Sky Is Not Falling* (Carlisle Barracks, PA: Strategic Studies Institute and US Army War College Press, April 2013), 8, http://www.strategicstudiesinstitute.army.mil/pubs/download.cfm?q=1147; Robert A. Miller, Daniel T. Kuehl, and Irving Lachow, "Cyber War: Issues in Attack and Defense," *Joint Force Quarterly*, issue 61 (2nd Quarter 2011): 18–23; Libicki, *Cyberdeterrence and Cyberwar*; P. W. Singer, *Wired for War: The Robotics Revolution and Conflict in the Twenty-First Century* (New York: Penguin Books, 2009); John Arquilla, *Worst Enemy: The Reluctant Transformation of the American Military* (Chicago: Ivan R. Dee, 2008), especially chaps. 6–7; and Libicki, *Conquest in Cyberspace*, especially 15–31.

14. Miller, Kuehl, and Lachow, "Cyber War."

15. Brenner, *Glass Houses*, 3.

16. An example of such an attack was provided by the Stuxnet "worm" used to attack Iran's centrifuges as part of its nuclear program. Reportedly, some 1,000 of 5,000 centrifuges were temporarily disabled by the United States and Israel as part of a US program called Olympic Games that began under George W. Bush and continued into the Obama administration. See David E. Sanger, "Obama Order Sped Up Wave of Cyberattacks against Iran," *New York Times*, 1 June 2012, http://www.nytimes.com/2012/06/01/world/middleeast/obama-ordered-wave-of-cyberattacks-against-iran.html?_r=0.

17. Miller, Kuehl, and Lachow, "Cyber War," 19. Some of these objectives might also be accomplished by "friendly conquest" as opposed to "hostile conquest" in cyberspace. See Libicki, *Conquest in Cyberspace*, 125–26, for contrasting definitions and the remainder of chap. 6 for pertinent discussion.

18. Patrick M. Morgan discusses the relationship between reexamination of deterrence theory and practice and cybersecurity in his article "The State of Deterrence in International Politics Today," *Contemporary Security Policy* 33, no. 1 (April 2012): 85–107, especially 101–3.

19. Gray, *Making Strategic Sense of Cyber Power*, 36.

20. According to Adam B. Lowther, deterrence can be conceptualized as a continuous spectrum with three components: deterrence by dissuasion, deterrence by denial, and deterrence by threat. Moving across the spectrum, from dissuasion through denial to threat, increases the level of action by the state attempting to deter. See Lowther, "How Can the United States Deter Nonstate Actors?," in Lowther, *Deterrence: Rising Powers*, 163–82, especially 166–67.

21. Desmond Butler, "Flaws Found in U.S. Missile Shield for Europe," *Army Times*, 9 February 2013, http://www.armytimes.com/article/20130209/NEWS/302090305/Flaws-found-in-U-S-missile-shield-for-Europe. See also "US Missile Defense Shield Flawed—Classified Studies," *Russia Today*, 11 February 2013, http://rt.com/usa/us-missile-defense-flaws-811/.

22. National Research Council, *Making Sense of Ballistic Missile Defense: An Assessment of Concepts and Systems for U.S. Boost-Phase Missile Defense in Comparison to Other Alternatives* (Washington, DC: National Research Council, National Academy of Sciences, National Academies Press, 2012), prepublication copy, accessed 17 September 2012, http://www.nap.edu.

23. George N. Lewis and Theodore A. Postol, "The Astonishing National Academy of Sciences Missile Defense Report," *Bulletin of the Atomic Scientists*, 20 September 2012, http://thebulletin.org/astonishing-national-academy-sciences-missile-defense-report-0.

24. Rebecca Slayton, *Arguments That Count: Physics, Computing, and Missile Defense, 1949–2012* (Cambridge, MA: MIT Press, 2013).

25. Superior treatment of technical, political, and economic challenges to US and NATO plans for European missile defenses is provided in Steven J. Whitmore and John R. Deni, *NATO Missile Defense and the European Phased Adaptive Approach: The Implications of Burden Sharing and the Underappreciated Role of the U.S. Army* (Carlisle Barracks, PA: Strategic Studies Institute and US Army War College Press, October 2013).

26. For US and NATO missile defense plans, see LTG Patrick J. O'Reilly, USA, director, Missile Defense Agency, "Ballistic Missile Defense Overview," 12-MDA-6631 (briefing presented to the 10th Annual Missile Defense Conference, Department of Defense, Washington, DC, 26 March 2012), http://mostlymissiledefense.files.wordpress.com/2013/06/bmd-update-oreilly-march-2012.pdf.

27. *Treaty between the United States of America and the Russian Federation on Measures for the Further Reduction and Limitation of Strategic Offensive Arms* (Washington, DC: Department of State, 8 April 2010), http://www.state.gov/documents/organization/140035.pdf.

28. The Obama Phased Adaptive Approach to missile defense will retain and improve some technologies deployed by the George W. Bush administration but shift emphasis to other interceptors supported by improved battle management command, control, and communications (BMC3) systems and launch detection and tracking. See Karen Kaya, "NATO Missile Defense and the View from the Front Line," *Joint Force Quarterly*, issue 71 (4th Quarter 2013): 84–89; John F. Morton and George Galdorisi, "Any Sensor, Any Shooter: Toward an Aegis BMD Global Enterprise," *Joint Force Quarterly*, issue 67 (4th Quarter 2012): 85–90; and Frank A. Rose, deputy assistant secretary, Bureau of Arms Control, Verification and Compliance, "Growing Global Cooperation on Ballistic Missile Defense" (remarks as prepared, Berlin, Germany, 10 September 2012), http://www.state.gov/t/avc/rls/197547.htm.

29. For example, see "Moscow Needs More 'Predictability' in NATO Missile Defense Plans," *RIA Novosti*, 23 October 2013, in *Johnson's Russia List 2013*, no. 191 (24 October 2013), davidjohnson@starpower.net.

30. For pertinent discussion, see the essays in Dr. Adam Lowther, ed., *The Asia-Pacific Century: Challenges and Opportunities* (Maxwell AFB, AL: Air University Press, Air Force Research Institute, April 2013).

31. Peter Baker and David E. Sanger, "Obama Has Plans to Cut U.S. Nuclear Arsenal, If Russia Reciprocates," *New York Times*, 18 June 2013, http://www.nytimes.com/2013/06/19/world/obama-has-plans-to-cut-us-nuclear-arsenal-if-russia-reciprocates.html?_r=0. See also Roberts Rampton and Stephen Brown, "Obama Challenges Russia to Agree to Deeper Nuclear Weapon Cuts," Reuters, 20 June 2013, in *Johnson's Russia List 2013*, no. 212 (20 June 2013), davidjohnson@starpower.net.

32. The author gratefully acknowledges that figures 1–4 are based on a model originally developed by Dr. James J. Tritten, who is not responsible for its use here or for any arguments or opinions in this article.

33. Force structures in the analysis are notional and not necessarily predictive of actual deployments. For expert appraisal, see Hans M. Kristensen, *Trimming Nuclear Excess: Options for Further Reductions of U.S. and Russian Nuclear Forces*, Special Report no. 5 (Washington, DC: Federation of American Scientists, December 2012), http://www.fas.org/programs/ssp/nukes/publications1/TrimmingNuclearExcess.pdf; Gen James Cartwright, retired, chair, *Global Zero U.S. Nuclear Policy Commission Report: Modernizing U.S. Nuclear Strategy, Force Structure and Posture* (Washington, DC: Global Zero, May 2012), http://www.globalzero.org/files/gz_us_nuclear_policy_commission_report.pdf; Pavel Podvig, "New START Treaty

in Numbers," *Russian Strategic Nuclear Forces* (blog), 9 April 2010, http://russianforces.org/blog/2010/03/new_start_treaty_in_numbers.shtml. See also Joseph Cirincione, "Strategic Turn: New U.S. and Russian Views on Nuclear Weapons," New America Foundation, 29 June 2011, http://newamerica.net/publications/policy/strategic_turn; and "U.S. Strategic Nuclear Forces under New START," Arms Control Association, July 2013, http://www.armscontrol.org/factsheets/USStratNukeForceNewSTART.

34. According to some experts, the United States could conceivably satisfy its requirements for strategic nuclear deterrence with fewer than 400 deployed warheads on intercontinental launchers. See James Wood Forsyth Jr., B. Chance Saltzman, and Gary Schaub Jr., "Minimum Deterrence and Its Critics," *Strategic Studies Quarterly* 4, no. 4 (Winter 2010): 3–12. Counterarguments appear in Payne and Schlesinger, *Minimum Deterrence: Examining the Evidence*, passim, especially 65–70.

35. Keith B. Payne, *The Fallacies of Cold War Deterrence and a New Direction* (Lexington: University Press of Kentucky, 2001), 101.

36. For example, see Keir A. Lieber and Daryl G. Press, "The New Era of Nuclear Weapons, Deterrence, and Conflict," *Strategic Studies Quarterly* 7, no. 1 (Spring 2013): 3–14.

37. Cham E. Dallas et al., "Nuclear War between Israel and Iran: Lethality beyond the Pale," *Conflict and Health*, 10 May 2013, via BioMed Central, accessed 15 May 2013, http://www.conflictandhealth.com/content/7/1/10. See also Anthony H. Cordesman, *Iran, Israel, and Nuclear War: An Illustrative Scenario Analysis* (Washington, DC: Center for Strategic and International Studies, 19 November 2007), http://csis.org/files/media/csis/pubs/071119_iran.is&nuclearwar.pdf; and US Congress, Office of Technology Assessment, *The Effects of Nuclear War* (Washington, DC: Government Printing Office, May 1979), especially 27–44 for case studies of attacks on a single city. The Office of Technology Assessment cautions that the effects of even a small or limited nuclear attack would be "enormous" (p. 4).

38. Cited in Ilya Maksimov and Sergey Kuksin, "Russia Will Not Be a Bystander in the Arms Race," *Rossiyskaya Gazeta*, 28 June 2013, in *Johnson's Russia List 2013*, no. 122 (5 July 2013), davidjohnson@starpower.net.

39. Lora Saalman, "How Chinese Analysts View Arms Control, Disarmament, and Nuclear Deterrence after the Cold War," in *Engaging China and Russia on Nuclear Disarmament*, Occasional Paper no. 15, ed. Cristina Hansell and William C. Potter (Monterey, CA: James Martin Center for Nonproliferation Studies, April 2009), 47–71.

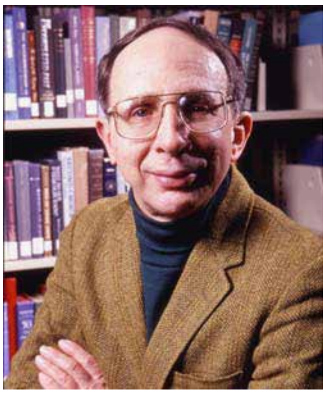
40. For an expansion of the point about the possible conflict between Obama nuclear disarmament and advanced conventional weapons modernization goals, see Andrew Futter and Benjamin Zala, "Advanced US Conventional Weapons and Nuclear Disarmament: Why the Obama Plan Won't Work," *Nonproliferation Review* 20, no. 1 (2013): 107–22, http://dx.doi.org/10.1080/10736700.2012.761790.

41. Paul Bracken, *The Second Nuclear Age: Strategy, Danger, and the New Power Politics* (New York: Henry Holt, 2012), especially 215–20 and 267–70. For additional perspective on the second nuclear age, see Lowther, *Deterrence: Rising Powers*; Paul K. Davis, *Structuring Analysis to Support Future Decisions about Nuclear Forces and Postures*, Working Paper WR-878-OSD (Santa Monica, CA: RAND National Defense Research Institute, September 2011); Michael Krepon, *Better Safe Than Sorry: The Ironies of Living with the Bomb* (Stanford, CA: Stanford University Press, 2009), especially 94–132; and Colin S. Gray, *The Second Nuclear Age* (Boulder, CO: Lynne Rienner Publishers, 1999).

42. For some interesting possibilities in this regard, see George H. Quester, *Nuclear First Strike: Consequences of a Broken Taboo* (Baltimore: Johns Hopkins University Press, 2006), 24–52, especially 25–30. This author road tests some models for multipolar nuclear power systems in "Anticipatory Attack," his working paper in progress, available upon request.

43. National Research Council, *Making Sense of Ballistic Missile Defense*.

44. Sources of instability in the second nuclear age will include major powers, secondary powers, and groups sometimes making creative political uses of nuclear weapons short of war, overlaid by great-power competition within a multipolar nuclear system. See Bracken, *Second Nuclear Age*, especially 93–126; James E. Goodby, "The End of a Nuclear Era," *New York Times*, 14 August 2013, http://www.nytimes.com/2013/08/15/opinion/global/the-end-of-a-nuclear-era.html?_r=0; and C. Dale Walton and Colin S. Gray, "The Geopolitics of Strategic Stability: Looking Beyond Cold Warriors and Nuclear Weapons," in *Strategic Stability: Contending Interpretations*, ed. Elbridge A. Colby and Michael S. Gerson (Carlisle Barracks, PA: Strategic Studies Institute and US Army War College Press, 2013), 85–115.



Dr. Stephen J. Cimbala

Dr. Cimbala (BA, Penn State; MA, PhD, University of Wisconsin–Madison) is Distinguished Professor of Political Science at Penn State–Brandywine and the author of numerous works in the fields of US national security, nuclear arms control, and other topics. He is an award-winning Penn State teacher, and his recent publications include *Arms for Uncertainty: Nuclear Weapons in US and Russian Security Policy* (Ashgate, 2013) and *US National Security: Policymakers, Processes and Politics* (with Sam C. Sarkesian and John Allen Williams) (Lynne Rienner, 2013).

Let us know what you think! Leave a comment!

Slinging the Bull in Korea: An Adventure in Psychological Warfare by John Martin Campbell. University of New Mexico Press (http://www.unmpress.com/), 1717 Roma Avenue NE, Albuquerque, New Mexico 87106, 2010, 192 pages, $34.95 (hardcover), ISBN 978-0-8263-4876-0.

Korea, "the forgotten war," remains underrepresented on the list of popular subjects in military history. Moreover, although other books have covered conventional operations in that conflict, *Slinging the Bull in Korea*, as its name might imply, delves into one of the lesser-known areas of a less-studied war—that of psychological warfare. A combination history and wartime memoir, this book tells the story of US psychological warfare operations in Korea and, more specifically, that of the Air Resupply and Communications Service, the rather nondescriptive name of the organizations charged with this mission. This service worked both "white" and "black" operations, but author John Campbell sticks to his personal experience in white operations, limiting his description of black operations to recalling that they involved all manner of skullduggery.

White operations, mostly in the propaganda field, consisted of truthful leaflets and radio broadcasts to both allied and communist forces. The focus on allied forces, especially early in the war, sought to bolster resolve and fighting spirit; against communist forces, the goal involved destroying morale and convincing soldiers either to stop fighting or to defect.

Slinging the Bull in Korea benefits from a short (21 pages) introduction by Katherine Kallestad, a military history and psychological operations author, that not only offers a quick overview of events leading up to and during the Korean War but also sets the stage for psychological warfare operations and the agencies which operated in that realm. Although the book is not so much an in-depth history as a personal journal, it does include some interesting tidbits, such as the tale of "Madam Rhee's theaters arts circle": ladies who parachuted into North Korea to work their wiles on communist officers and leaders and then sneak back into the South with whatever information they could gain (pp. 71–72). The 54 pages of photos reproducing the various pamphlets and psychological warfare flyers, especially those produced by the communists for use against allied forces, are another highlight and make for interesting reading. The 33 different images vividly illustrate what each side was trying to convey, as well as the target audiences.

As the author observes, "Ordinarily, there is so little glamour attached to white-hat activities that few historians care to write about them" (p. 40). That fact alone makes *Slinging the Bull in Korea* worth reading. It does, however, seem more akin to a robust research paper (with numerous notes and references), combined with a fair amount of reminiscing, than a substantial military history.

Lt Col Aaron Burgstein, USAF
Washington, DC

Saving Big Ben: The USS *Franklin* and Father Joseph T. O'Callahan by John R. Satterfield. Naval Institute Press (http://www.usni.org/navalinstitutepress), 291 Wood Road, Annapolis, Maryland 21402, 2011, 208 pages, $34.95 (hardcover), ISBN 978-1-59114-808-1.

On 19 March 1945, hundreds of US naval vessels were arrayed in waters surrounding the Japanese home island of Okinawa. The final battles in preparation for the ultimate invasion of mainland Japan had begun. Desperate to protect the homeland, Japan resorted to suicide tactics in the hopes of inflicting unacceptable losses on US forces. In the dawn sky, a lone Japanese D4Y3 Suisei (Comet) dive-bomber acquired a target—the USS *Franklin* CV-13, an *Essex*-class carrier. The Comet dove out of the clouds, streaked across the carrier's deck, and released two bombs that found their mark deep below deck before pursuing American fighters blasted it out of the sky.

The explosions instantly killed hundreds of the *Franklin*'s crew and crippled the ship just 60 miles from Japan. Ultimately, more than 800 sailors—approximately 25 percent of the crew—died in that attack. The dazed and wounded survivors now had a new battle—one to save the dying ship. Heroism was the order of the day, especially that of the *Franklin*'s chaplain, Fr. Joseph T. O'Callahan.

Father O'Callahan, a first-generation Irish-American, was well into life as a Jesuit priest, teaching math at Holy Cross College with war looming on the horizon. His sense of duty motivated him to petition his Order for permission to join the Navy as a chaplain. After receiving it, he moved through a series of land and sea assignments before joining the crew of the *Franklin*. In the fight to save the ship, Father O'Callahan stood out among the company of heroes, ministering to the dead, dying, and wounded, while simultaneously pitching in to save the ship during that harrowing day. Through the flames and smoke, the white cross on his helmet was visible from the *Franklin*'s bridge as he moved on the listing deck, seemingly unconcerned for his own safety. The *Franklin*'s commanding officer, Capt Leslie E. Gehres, not a religious man, was so impressed that he recommended Father O'Callahan for the Medal of Honor—one of only two awarded for actions on that day.

Saving Big Ben is the narrative of the ship, attack, and battle to save her, told within the story of the first Jesuit military chaplain who became the first Navy chaplain to receive the Medal of Honor. This well-written, entertaining volume is surprisingly comprehensive despite its brevity. Author John R. Satterfield adequately covers Father O'Callahan's early life and priesthood, together with his assignments before and after the *Franklin*, including his service aboard the *Ranger.* He balances the tale of the ship with that of the man by including *Franklin*'s first cruise before Father O'Callahan joined her crew. He objectively details the controversy surrounding Father O'Callahan's receipt of the Medal of Honor and provides a sad portrait of the postwar years leading up to his painful health problems and premature death.

The USS *Franklin*, the most damaged American carrier to survive the war, boasted the most decorated crew. Any student of American military history should know her story and that of the crew, especially the chaplain's. They offer examples of dedication and courage born of crisis that will serve all readers well. I highly recommend *Saving Big Ben: The USS Franklin and Father Joseph T. O'Callahan*.

CSM James H. Clifford, USA, Retired
Robins AFB, Georgia

Allied Fighters, 1939–45: The Essential Aircraft Identification Guide by Chris Chant. Zenith Press (http://www.zenithbooks.com), 400 First Avenue North, Suite 300, Minneapolis, Minnesota 55401, 2008, 192 pages, $19.95 (softcover), ISBN 978-0-7603-3451-5.

Allied Fighters 1939–45 is but one of a number of books comprising *The Essential Aircraft Identification Guide*. Though claiming to include all major fighters of World War II, the book focuses solely on the European and North African theatres of operations, with little, if any, mention of the Pacific theatre. It is penned by Chris Chant, author of its counterpart *Allied Bombers, 1939–45*, in addition to a number of other books on airpower.

The book begins with a short history of the predominant tactics that would define the war. It then provides short histories of the French, British, and American air forces, divided by their fighter commands. The other sections, comprising the Soviet Union and smaller nations such as Denmark, Norway, and Yugoslavia, are organized by major events. The book concentrates largely upon the United Kingdom, which receives a total of 81 pages; the Soviet Union is summarized in 19.

Embedded in the history are pictures of the fighters, their variants, and relevant statistics such as power plant, speed, range, weight, and weaponry. However, it omits maneuverability statistics as well as detailed comparisons with enemy aircraft of the period.

In addition, descriptions of the organization of fighter units, from squadrons to wings to air commands, offer the reader limited understanding of the organization of the countries' air forces. The appendix is especially valuable, including statistics of production and losses organized by country, period, and type of fighter. However, in the absence of a bibliography, one cannot verify the veracity of this information.

Although the book is useful in providing general information about a number of different World War II fighters, it is constrained by a number of factors, such as the repetition of fighter models. Some, like the Supermarine Spitfire and P-51 Mustang, were fielded by multiple countries, and thus their images and statistics are repeated—almost excessively—while others are mentioned but not featured.

Further, the lack of careful editing is evident in occasional errors in the conversion of an aircraft's weight (p. 65) and another's ceiling (pp. 122–23). The latter is more significant since the description of the aircraft states that its low service ceiling hampered its usage, even though the ceiling listed was standard for aircraft of the period.

Given the short length and nature of the book as an aircraft guide, it is primarily meant for casual readers and modelers. Enthusiasts of the subject matter might find the appendix and performance information interesting but would desire a more in-depth description of the events.

Radu Venter
Kingston, Ontario

Armed Groups and Irregular Warfare: Adapting Professional Military Education by Richard Shultz, Roy Godson, and Querine Hanlon. National Strategy Information Center (http://www.strategycenter.org/), 1730 Rhode Island Avenue, NW, Suite 500, Washington, DC 20036-3117, 2009, 115 pages, $25.00 (softcover), ISBN 978-0-9817776-1-0.

Many defense and security establishments around the world recognize that irregular conflicts are on the rise and may dominate warfare for the foreseeable future while the number of conventionally fought wars is declining. *Armed Groups and Irregular Warfare: Adapting Professional Military Education* represents an attempt at awakening the US Department of Defense (DOD) not only to these burgeoning irregular warfare (IW) threats that our military leaders now face but also to the necessity of military education institutions offering a systematic understanding of this type of warfare. In their monograph, the authors—all faculty members experienced in national strategy and international security studies—propose curricular changes within the DOD's professional military education (PME) system. Although their proposed "Armed Groups and Irregular Warfare" syllabus may not be a rock-solid fit for all PME institutions, it represents a worthy starting point.

This book draws heavily on post–Cold War patterns of conflict to reveal how US security establishments have underestimated the challenges posed by substate and transstate armed groups. No longer is conflict waged in the grand Westphalian state-on-state manner; rather, it is "primarily taking place between states and nonstate armed groups that [are] frequently supported by political, social, religious, and criminal movements" (p. 9). Furthermore, weak, failing, and failed states that offer sanctuary to such armed groups raise ever-increasing security concerns for the United States and its allies.

The authors reason that existing pieces of military doctrine and guidance, such as the *Quadrennial Defense Review Report* and the *Irregular Warfare (IW) Joint Operating Concept (JOC)*, address arising irregular issues but oversimplify them and offer few specifics on countering them. Military practitioners can best understand this security context by utilizing existing PME schools. In 2005 the National Strategy Information Center surveyed the PME curriculum and found it lacking in its treatment of armed groups and IW. Consequently, the center set out on a three-year multiphased project that produced the advanced education program detailed in this book.

The last three-quarters of this work lay out the plan in detail. The 13-week course (condensable to one week in a "short course" version) was designed specifically for the PME community but is also a good fit for the US intelligence community's professional development programs. The syllabus includes five parts: Global Trends and Conflict; Types of Armed Groups; Profiling Armed Groups and Political Movements: A New Approach to Order of Battle; Armed Groups: Threats and Opportunities; and Meeting the Challenge. Each part contains two to four sections that adequately explain themes and subject matter as well as required and suggested readings. Four of the five parts address "armed groups, the ways they organize and operate, and how they employ a range of violent and other instruments to execute irregular warfare strategies" (p. 79). Granted, one must recognize and understand the problem at hand, but the course pays scant attention (only part five) to arguably the most difficult component—responding to the problem.

Ultimately, *Armed Groups and Irregular Warfare* is a step in the right direction in terms of developing critical thinkers and capable operators, planners, and commanders for the rigors of IW. It offers insight into the subject for those involved in modern PME curriculum design and instruction and for practitioners of IW. The work, however, is not without fault. To withstand the test of time, the syllabus must update the required readings. Additionally, as the United States becomes more experienced in fighting this long, irregular war, the authors should put more emphasis on an effective means of countering irregular threats and should follow through with lessons learned—another area to which the military typically pays only lip service. Finally, the study makes little to no reference to the Naval Postgraduate School's Special Operations / Irregular Warfare curriculum—the only one in the DOD devoted exclusively to IW. PME institutions could benefit greatly by evaluating what has made the Naval Postgraduate School a leader in the field of IW instruction for more than 20 years.

Maj Walter M. Winter, USAF
Naval Postgraduate School, Monterey, California

Psychology of Space Exploration: Contemporary Research in Historical Perspective edited by Douglas A. Vakoch. National Aeronautics and Space Administration (http://history.nasa.gov/publications.html), Office of Communications, History Program Office, 300 E Street SW, Washington, DC 20546, 2011, 254 pages, $16.99 (hardcover), ISBN 978-0-16-088358-3. Available free at http://history.nasa.gov/SP-4411.pdf.

This volume, a collection of eight essays along with introductory and closing material, provides varied perspectives on psychology and its relationship to astronauts and the history of space exploration. The chapters cover a variety of subjects: the checkered history of psychology and the US space program (chap. 1), behavioral health (chap. 2), analogs between earth exploration and space exploration (chap. 3), the possibility that taking photos of Earth from space improves the mental health of astronauts (chap. 4), the role of simulators in managing negative interactions in space crews (chap. 5), the effect of gender composition on crew cohesion during long-duration space missions (chap. 6), postmission reflections of multinational space crews (chap. 7), and spaceflight and cross-cultural psychology (chap. 8).

These essays not only span a number of subjects but also utilize multiple approaches. Two of the them are heavily statistical in nature, one seeking solid quantitative data to support the idea that taking photos of Earth is a beneficial experience and the other presenting evidence that tensions arise when multinational crew members are guests on the spaceships of other nations. Other chapters prefer a more qualitative approach, the one on spaceflight and cross-cultural psychology using ordinal rankings without known data points to examine such matters as long-term viewpoint between nations as well as patriarchal or matriarchal attitudes (pp. 188–89). In such cases, the lack of relevant data points makes the conclusions a bit tentative at best. In at least one case, the coauthors seek to make a politically motivated point in support of more women in space—a position that the accompanying empirical evidence directly contradicts. They make the entirely unsupported claim that women take a more interpersonal and caring approach when dealing with stress but admit that evidence shows that mixed-gender crews adversely affected performance at Antarctic bases, in naval vessels, and on offshore oil rigs (p. 140). The contributors blame this on immaturity, a lack of training, and poor personnel selection, persisting in supporting their politically motivated point despite the mixed-to-adverse empirical evidence at hand.

The biased political tone of some of the pieces will likely offend and alienate some readers. These include the chapter on mixed-gender crews as well as the introduction on psychology and the US space program, which praises Soviet interest in psychology while criticizing its neglect by the National Aeronautics and Space Administration (NASA) for several decades (pp. 6–7). It also questions the United States' political will to continue publicly funded research on psychology as it relates to spaceflight (p. 15). Otherwise, the number and scope of topics likely will appeal to most readers. Several essays, for example, comment on the importance of analogs between Antarctic exploration missions and space exploration, including the comparison of hazards between Antarctica and space and the role of that continent in providing a good staging area for training crews in the environmental rigors (e.g., isolation) of space.

This collection of essays aims to demonstrate the importance of psychology in successful space explorations, examining the past through both anecdotal accounts and data-driven research. The book also points to future goals such as long-term moon and Mars exploration that will require great attention to the concerns of the people engaging in such dangerous, lengthy journeys. Several of the chapters address the widespread concern among astronauts and NASA that too much psychological information about astronauts would hinder crew morale and lead others to question whether astronauts with admitted mental health issues had "the right stuff" to enter space (pp. 6, 35, 198).

Although the book appears to have a major political goal of legitimizing the role of psychology in the design of spaceships and the training of astronauts, it also offers a variety of intriguing glances at what makes space so fascinating. Further it makes useful recommendations on improving spaceflight as we deal with the reality of increasing space tourism and longer, more isolated space exploration further from Earth. Fortunately, regarding most of the essays, the contributors' political aims do not overwhelm the information they convey, making *Psychology of Space Exploration* of interest to readers intrigued by manned space exploration.

Nathan Albright
Portland, Oregon

Eyes in the Sky: Eisenhower, the CIA, and Cold War Aerial Espionage by Dino A. Brugioni. Naval Institute Press (http://www.usni.org/navalinstitutepress), 291 Wood Road, Annapolis, Maryland 21402, 2010, 572 pages, $36.95 (hardcover), ISBN 978-1-59114-082-5.

During the fateful days of the Cuban missile crisis, Dino Brugioni was working at the National Photographic Interpretation Center with the first images of Soviet SS-4 medium-range ballistic missiles in the Sierra del Rosario. He and a team of imagery analysts prepared the first images for President John F. Kennedy, and the rest, as they say, is history. Two decades ago, Brugioni wrote *Eyeball to Eyeball: The Inside Story of the Cuban Missile Crisis* (New York: Random House, 1991) as a comprehensive insider's account of the crisis and a historical survey of US photo reconnaissance.

Brugioni's recent book *Eyes in the Sky* offers a deeper study of US photo reconnaissance. He is well positioned to do this since he has been an expert "eye in the sky" since the mid-1950s, interpreting the first U-2, SR-71, and Corona satellite photos. Using newly declassified documents, Brugioni provides detailed, firsthand knowledge of an exhaustive collection of classified programs and an important resource for students and scholars of Cold War intelligence.

The strengths of the book include new insights into President Dwight D. Eisenhower's interest in aerial reconnaissance during the early Cold War. In 1955 Eisenhower proposed "mutual aerial observation" to Soviet premier Nikolai Bulganin, but the Soviets immediately rejected this proposal. Undeterred, Eisenhower tasked the Central Intelligence Agency (CIA) to evaluate Soviet military and nuclear capabilities unilaterally. The depth and range of these programs were immense. Although others have written on the importance of the U-2 aircraft in dispelling the "bomber gap" and "missile gap" between the US and Soviet military, Brugioni goes even further, exploring the use of imagery analysis to support US policy during crises and conflicts in the Suez, Hungary, Lebanon, Tibet, the Quemoy and Matsu Islands, Belgian Congo, Indonesia, Vietnam, and Israel. He offers fascinating details on an exhaustive list of specific covert missions and an impressive cast of characters.

Eisenhower comes across as a clear advocate of new aerial reconnaissance technology, and the author gives ample credit to Arthur Lundahl and Richard Bissell, the masterminds of high-altitude intelligence exploitation. The US Air Force role, however, though deeply intertwined, is not fully explored. Brugioni lauds Gen James H. "Jimmy" Doolittle for his vision and encouragement of reconnaissance innovation but portrays Gen Curtis E. LeMay and Strategic Air Command as disobliging rivals to the CIA (note the comments about LeMay on p. 161).

Brugioni's work may be difficult to follow at times as it travels back and forth between various programs and historical developments with rich operational detail; nevertheless, it remains a remarkable achievement in the scholarship on Cold War aerial reconnaissance. *Eyes in the Sky* should serve as an important reference for many years to come and as a starting point for much more research in the future.

Dr. Michael R. Rouland
Naval History and Heritage Command
Washington Navy Yard, DC

Freedom Flyers: The Tuskegee Airmen of World War II by J. Todd Moye. Oxford University Press (http://global.oup.com/academic/?cc=us&lang=en&), 198 Madison Avenue, New York, New York 10016, 2010, 256 pages, $24.95 (hardcover), ISBN 978-0-19-538655-4; 2012, 256 pages, $17.95 (softcover), ISBN 978-0-19-989655-4.

J. Todd Moye's *Freedom Flyers: The Tuskegee Airmen of World War II* is the best book to date about the total experience of the Army Air Forces' Tuskegee Airmen, the first African-American or black pilots, and their support personnel. Skillfully written by a scholarly author, this book is solidly based not only on extensive primary-source documentation but also on hundreds of oral-history interviews that Moye collected as head of the National Park Service's Tuskegee Airmen oral-history project. He includes much important information about the missions of the Tuskegee Airmen in combat overseas, which involved members of the 99th Fighter Squadron and the 332d Fighter Group as well as its three other squadrons. Those Tuskegee Airmen flew tactical missions for Twelfth Air Force and then escorted bombers for Fifteenth Air Force on raids deep into enemy territory. But Moye does not neglect the Tuskegee Airmen who never went overseas, including members of the 477th Bombardment Group and its four squadrons. He also addresses the many black Army Air Forces personnel who were not pilots, such as the members of ground crews or bomber crews who trained at bases beyond Tuskegee.

Freedom Flyers is valuable not only for offering a wealth of information about the Tuskegee Airmen groups and squadrons but also for placing them in the broader context of American history. Specifically, it examines the sociological and political forces that pressured the War Department and the Army Air Corps—and later the Army Air Forces—to include blacks among its pilots, for both fighters and bombers. The book begins with the origins of flight training for black men before World War II and carries the story through and beyond the war to the racial integration of the Air Force, noting the irony that a service which resisted the inclusion of blacks among its aviators and officers later led the way in integrating the armed forces and contributing eventually to the racial integration of American society. Moye is scrupulously objective, bringing out absurd and blatant instances of white racism, such as that which provoked the Freeman Field Mutiny in 1945. Furthermore, he points to instances in which white officers such as Col Noel Parrish, commander of Tuskegee Army Air Field, struggled against the traditions around them to give black Airmen and their support personnel more opportunities in the Army Air Forces.

This study, however, is primarily about black men and their individual experiences. They struggled against many odds, striving to attain success both for themselves and for their white countrymen—not to mention their efforts to defend their country, despite the fact that it continued to discriminate against them. Moye clearly brings out the Tuskegee Airmen's place in American history and even corrects some of the myths that appeared in previous books on the subject.

Freedom Flyers is not perfect. It contains a few historical errors, but they are few and far between. The book would have been even better if its author had relied a little more on the documentary resources of the Air Force Historical Research Agency, which maintains the original records of the Tuskegee Airmen units, written by the Tuskegee Airmen themselves during the war. They are at least as reliable as the memories of original Tuskegee Airmen with whom he conducted so many interviews.

Dr. Daniel L. Haulman
Air Force Historical Research Agency
Maxwell AFB, Alabama

Educating America's Military, Cass Military Studies, by Joan Johnson-Freese. Routledge (http://www.routledge.com), 711 Third Avenue, New York, New York 10017, 2012, 160 pages, $155.00 (hardcover) ISBN 978-0-415-63535-6; 2012, 160 pages, $35.95 (softcover), ISBN 978-0-415-63499-1.

Educating America's Military is a short book that provides a highly critical analysis of senior professional military education (PME). Such appraisals are not novel; however, most have been written from the safety of retirement, civilian universities, or external organizations. Dr. Johnson-Freese, by contrast, is a professor of national security affairs at the Naval War College. Her decades in PME make the book's perspective invaluable despite its shortcomings.

Educating America's Military consists of six chapters. The first two introduce PME and offer a hypothesis regarding its limitations. The body explores these issues in three chapters addressing students, faculty, and curriculum. The conclusion offers recommendations to improve the quality of PME, which the author considers crucial to national security.

Despite the book's title, Professor Johnson-Freese focuses exclusively on war colleges, a small slice of PME. Her justification disappoints, and her interchangeable use of the terms *PME* and *war colleges* misleads. Nevertheless, the author knows her subject well. She describes war colleges' purpose as providing officers graduate-level learning—uncomfortable, unfamiliar, and broad—to prepare them for greater responsibilities. Yet the schools' hybrid nature hinders their success. War colleges, she proclaims, are "riddled with the worst problems of military bureaucracy as well as the worst attributes of civilian academia" (p. 13), setting up her two-pronged thesis.

First, Dr. Johnson-Freese claims that war colleges approach learning as training, not education, because "few of those responsible for PME (individually or collectively) have spent much time thinking about the difference between education and training, or even what it means to be 'educated' " (p. 21). Unfortunately, she offers neither supporting evidence nor deep professional insight into these issues. Second, the author argues that military and academic cultures are antithetical. Tensions can be productive, but war colleges define "work habits, definitions of productivity, and views on what constitutes education" principally by military standards (p. 29). This approach produces an environment where process trumps product, clarity is preferred to ambiguity, answers carry more weight than questions, and *what* is asked more than *why*.

Professor Johnson-Freese believes that students reinforce this situation. She describes some as among the best anywhere and many as "average or even mediocre . . . [who] like to stay in the comfort zone" (p. 37). Diverse abilities are not surprising in large groups, but she identifies three differences with civilian counterparts that have more troubling implications. First, students are assigned to PME rather than applying, reducing intrinsic motivation. Second, the military believes that all students can complete the program, lowering standards and inflating grades. Third, leadership provides conflicting messages about the experience, fueling student apathy.

Dr. Johnson-Freese then notes that compared to faculty members in civilian colleges, those in PME have minimal say in hiring and governance. Although the latter is somewhat understandable in a military school, she laments the self-imposed obstacles to recruitment. Consequently, war colleges attract "civilian academics whose careers never took off" while also boasting "a surprising number of top-notch civilian academics" (pp. 66, 79). The author is even more critical of military (active and retired) faculty. She claims that many are "not qualified for the position, nor considered the best and the brightest" (p. 70) before conceding that some "can and do play a vital role" (p. 74). Yet she fails to explain how PME could operate *without* uniformed faculty and dismisses alternative approaches that better distinguish their expertise from that of civilians.

Professor Johnson-Freese is equally scathing in her criticism of war colleges' core curriculum. She believes that involving educators in the development of guidance produces vague, general, and unrealistic documents. This explanation ignores the nature of policy, role of deans, and faculty's general aversion to such administrative tasks. The author is similarly critical of how guidance is implemented. In her telling, nonexperts with varying degrees of teaching prowess present buzzword-laden slides developed by other nonexperts on the topic du jour. She echoes Howard Wiarda's conclusion that this produces "courses, readings, requirements, grading, etc. . . . of a junior-senior undergraduate course" (p. 97).

Educating America's Military is a study in ambivalence. Dr. Johnson-Freese offers unflinching, often perceptive observations but then fails to convince readers. She provides anecdotes, not data. The result is professional opinion, not valid and reliable research findings. The book's tone avoids the hyperbole of similar works while unnecessarily offending. The author identifies cultural differences but then ethnocentrically judges the military by academic standards. Most troublingly, she asserts that PME be benchmarked against "liberal education." This approach, borne of the Enlightenment, focuses on freethinking and learning for its own sake.

The most appropriate frame of reference for war colleges (and PME in general) is professional education: schools of law, business, medicine, and so forth. This model grew out of Industrialization, emphasizing more focused and practical postvocational learning. Professor Johnson-Freese acknowledges the difference but only late and fleetingly. Nevertheless, she keenly observes that too often civilian faculty are "told that military education is 'different' and has a kind of 'otherness' that academics need to accept and appreciate, or . . . leave" (p. 98). That is, PME overly emphasizes the *m*(ilitary) aspects that distinguish it from civilian schooling and minimizes the *p*(rofessional) and *e*(ducational) elements that unite them.

Such insights make this book compulsory reading for PME commandants, boards of visitors, educational policy makers, and congressional overseers. These senior leaders must set the conditions to strengthen the system, and Dr. Johnson-Freese will provide them with unvarnished perspectives and blunt recommendations. For most others, the author's *Orbis* article "The Reform of Military Education: Twenty-Five Years Later" (Winter 2012, pp. 135–53) should suffice. However, I exhort readers to dedicate the time saved to debating and addressing the issues. Stimulating these processes within PME could be this book's greatest contribution.

Dr. Johnson-Freese has broken a taboo by writing this book while still employed at a war college. Other faculty, staff, and administrators should be thankful, responding with empirical research and candid introspection rather than defensiveness or indifference. The coming years herald significant challenges for Air Force PME. With budgets tightening, force sizes shrinking, and threats changing, we must think deeply *now* about our service's educational future. This book underscores the urgency of striking the right balance between military and academic principles, practices, and personnel. Doing so is our duty and our responsibility, for as Chief of Staff Welsh stated in his *Vision*, education is "the foundation of our airpower advantage."

Dr. Brian R. Selmeski
Air University
Maxwell AFB, Alabama