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Senior Leader Perspective

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A New Era for Command and Control of Aerospace Operations

Lt Gen David A. Deptula, USAF, Retired

The AOR will become a CAOC.

Gen "Hawk" Carlisle
—Commander, Pacific Air Forces

Control of the aerospace environment is a fundamental prerequisite to successful operations in the physical domains of air, sea, land, and space. Once established, such control facilitates the freedom of action and movement for all joint forces. Accordingly, command and control (C2) of aerospace operations are critical functions that must be a priority for the Department of Defense.

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Our ability to C2 air and space forces will be affected by three major interrelated trends: emerging threats, new technologies, and the velocity of information. The changes in these three areas since the design, establishment, and operation of the air and space operations center—the AN/USQ-163 Falconer—have been dramatic and are accelerating. Therefore, it is time to determine whether we can achieve success in future operations by evolving our current concept of operations (CONOPS), organizations, and acquisition processes for modernization—or if we must seek fundamental change to each of these elements that affects our theater air control system (TACS). Before providing an answer, let's take a brief look at each of the trends affecting our ability to C2 our aerospace operations effectively.

Emerging Threats

The organization, size, and configuration of the AN/USQ-163 Falconer have basically remained the same since its inception. Furthermore, we have essentially been on a holiday from large-scale C2 airpower activities; for over two decades, we have had the luxury of not being contested in the air and space domains. Those days are rapidly changing. According to the Department of Defense's report on *Military and Security Developments Involving the People's Republic of China, 2014*, the People's Liberation Army Air Force "is pursuing modernization on a scale unprecedented in its history and is rapidly closing the gap with Western air forces across a broad spectrum of capabilities including aircraft, command and control (C2), jammers, electronic warfare (EW), and data links."[1] Such developments present a fundamental threat to the current American C2 construct. Additionally, other potential adversaries have studied the American way of war and have determined that it would be most advantageous to keep us out of their neighborhood rather than face our combat power.

Operations such as Desert Storm, Allied Force, Enduring Freedom, Iraqi Freedom, and Odyssey Dawn have repeatedly demonstrated the overwhelming prowess of American airpower. Therefore, possible adversaries are adopting (and proliferating) antiaccess and area-denial (A2/AD) expertise—new generations of cruise, ballistic, air-to-air, and surface-to-air missiles; antisatellite weapons; and cyberspace capabilities intended to deny US forces freedom of action. Failure to respond with new C2 thinking to these evolving A2/AD threats will force us to operate with greater risk and farther away from our areas of interest.[2]

A2/AD threatens our ability to C2 air and space operations in three ways. Near-peer adversaries can employ kinetic and nonkinetic weapons to deny us communications and intelligence, surveillance, and reconnaissance (ISR) from our space-based assets, thereby isolating our forces and blinding our leadership. Cyber attacks—now evolving beyond mere hacking or denial of service—are becoming more sophisticated and may be used to intentionally disrupt operations at the combined air and space operations center (CAOC). Accurate, long-range cruise and ballistic missiles are growing in their potential to threaten large, fixed, and exposed CAOCs.

As the most senior organizational element of the TACS and the factory for generating the air tasking order—the administrative vehicle for translating the combatant commander's air strategy into executable plans—the CAOC becomes an extremely lucrative target. This situation poses a question that challenges our conventional approach to C2. Can we deliver information to the war fighter at the tactical edge without having to rely on the traditional C/AOC model of hundreds of people organized in stovepiped divisions around segregated mission areas? The answer will have cascading effects on the architecture that we build to organize and operate C2 in the future—and the degree to which we enjoy operational success.

New Technologies

Innovative technologies, which enable new capabilities, will require novel ways to C2 as a means of optimizing the production of desired effects. We need to think beyond the constraints that traditional culture imposes on new technology. For example, fifth-generation aircraft are termed "fighters," but, technologically speaking, F-22s and F-35s are not just fighters—they are F-, A-, B-, E-, EA-, RC, AWACS-22s, and -35s. They are flying "sensor strikers" that will allow us to conduct information-age warfare inside a contested battlespace whenever we desire—*if* we fully exploit their "nontraditional" capabilities in a fashion that becomes the new "traditional."

Doing so will demand leading-edge networking capabilities and different approaches to solving our data-bandwidth issues. For example, to accommodate the explosion in data growth from new sensors, instead of building bigger pipes to transmit all the collected information, we should process it on board and transmit only the data of interest to the users. This approach inverts our current ISR processing methodology.

Existing service-component *integrated* capabilities could enable advanced joint operational concepts. For example, fifth-generation sensor strikers—F-22s and F-35s—could be used to cue Aegis fleet missile defense batteries to engage adversary antiship ballistic missiles launched against US carrier strike groups. Fully capitalizing on these capabilities calls for an innovative way of designing our force. As we bring a new long-range ISR/strike aircraft into the Air Force inventory to capitalize on the impact of long-range precision effects, we must amplify those effects through integration with the array of other forces by means of networked sensor/shooter capability from seabed to space.

Velocity of Information

Significant advancements in telecommunications, sensors, data storage, and processing power are emerging every day. As a result, the targeting cycle has evolved from months to weeks to days to minutes, and from multiple, specialized, and separate aircraft assigned to separate commands, to "finding, fixing, and finishing" from one aircraft in minutes.

Consider just one example from Operation Iraqi Freedom. A Predator piloted from Nevada by the Air Force successfully spotted and identified a sniper who had pinned down a Marine ground force. The remotely piloted aircraft delivered video of the sniper's location directly to an on-site Marine controller who used it to direct a Navy F/A-18 into the vicinity. The Predator laser-designated the target for the Navy jet's bombs, eliminating the sniper. The entire engagement took less than two minutes. That is the synergy of precision and information we must achieve routinely. With an MQ-9 Reaper, the engagement could have been shortened further by combining the ISR sensors, designator, and weapons on one aircraft.

Although the increase in information velocity dramatically enhances the effectiveness of combat operations, we must contend with a downside. As a result of modern telecommunications and the rapid transmission of information to, from, and between various levels of command, we have many examples of "information age" operations in which commanders at operational and even strategic levels usurp tactical-level execution. This devolution of the construct of centralized control / decentralized execution to one of centralized control / centralized execution has reduced effectiveness in accomplishing mission objectives. We need discipline to ensure that "reachback" does not become "reachforward." Centralized control / centralized execution represents the failed Soviet command model that stifled initiative, induced delay, moved decision authority away from execution expertise, and bred excessive caution and risk aversion. The results of such a model against a more flexible command structure were evident in 1991, when Soviet-sponsored Iraq unsuccessfully applied similar C2 constructs against the US-led coalition.

Higher-level commanders who are unwilling to delegate execution authority to the echelon with the greatest relevant situational knowledge and control suffer from their remote perspective, create discontinuity, and hamstring the capability of commanders at the tactical level to execute a coherent, purposeful strategic plan. Growing accessibility to information requires the restructure of C2 hierarchies to facilitate rapid engagement of perishable targets and capitalize on our technological advantage. Information synthesis and execution authority must be shifted to the lowest possible levels, and senior commanders and staffs must discipline themselves to stay at the appropriate level of war.

As described earlier, advancing threats demand that we move beyond large, centralized, and static C2 facilities. Replacing them with a mobile, distributed C2 structure that can handle the same volume and diversity of information as today's regional CAOC will call for a reappraisal of how we deal with information flow. The "art of command" will morph to realize Metcalfe's Law network values while the "science of control" will continue to demonstrate Moore's Law by expanding technology to extend human capacity.[3] The path for optimal growth of both is found through a focus upon gaining and maintaining a decision-cycle advantage as the critical path guide.

Elements of a New Architecture for Aerospace C2: Novel Concepts of Operations and Organizational Change

Concepts of Operations

The US military is now at a juncture where the velocity of information, advances in stealth and precision-engagement technologies, sensor developments, and other technologies will permit it to build completely new CONOPS from those based on legacy "combined arms warfare" models that simply align segregated land, air, and sea operations. We now have the potential to link information-age aerospace capabilities with sea- and land-based means to create an omnipresent defense complex that is self-forming and, if attacked, self-healing. Such a complex would be so difficult to incapacitate that it would possess a conventional deterrent quality that would exert a stabilizing influence wherever it is deployed. The central enabling idea is cross-domain synergy, which refers to the complementary, as opposed to merely additive, employment of capabilities in different domains such that each enhances the effectiveness—and compensates for the vulnerabilities—of the others. This combined-effects approach deals with integrating existing and future air, space, and cyber capabilities within an agile operational framework guided by human understanding.[4] It is an intellectual construct built on a technological infrastructure.

Developed with the idea of creating an ISR, strike, maneuver, and sustainment complex that employs information-age technologies to enable highly interconnected, distributed operations, this "combat cloud" will usher in an entirely different architecture for the conduct of warfare. Adoption of the combat-cloud concept and the resulting CONOPS will deliver accurate, decision-quality information to all relevant information nodes to produce the desired effect, regardless of service, domain, platform, or level within the command hierarchy.

The combat-cloud concept is somewhat analogous to "cloud computing," which is based on using a network (e.g., the Internet) to share information rapidly across a highly distributed, self-evolving, and self-compensating network of networks. However, instead of combining the computing power of multiple servers, the combat cloud combines the war-fighting power of combat systems by capitalizing on C2 and ISR networks to quickly exchange data derived from any source across an all-domain architecture of sensors and shooters to increase their effectiveness and attain economies of scale.

If enabled by sufficiently secure, jam/intrusion-resistant connectivity, a viable combat-cloud construct—compared to legacy operational concepts—would permit the employment of lower numbers of current and future-generation combat systems to produce higher levels of effectiveness across larger areas of influence. For example, instead of assembling traditional strike packages of massed fighters, bombers, and supporting aircraft to attack individual targets, the combat cloud could integrate complementary capabilities into a single combined "weapons system" capable of conducting disaggregated, distributed operations over a dynamic, fluid operational area.

The combat cloud requires equipping all platforms as sensors as well as "shooters" (defined as an ability to achieve a desired effect) and—even more importantly—employing them to that purpose. It demands a C2 paradigm that enables automatic linking analogous to today's cell-phone technology (i.e., moving from one cell zone to another is transparent to the user) as well as seamless data transfer, without the need for continual, deliberate human interaction within and/or between the air combat cloud nodes.

Organization

Although we need to realize and exploit the advantages of modern aerospace and information-age technology to build new CONOPS, we must also recognize that innovation can be applied *to* organization as well as *from* technology. The Operation Desert Storm air campaign was an inflection point that highlighted the need to reform and modernize our C2 processes to catch them up with the precision, stealth, and effects-based planning methodology that led to the campaign's success. Our AN/USQ-163 Falconer CAOCs and associated planning and execution processes were the outcome of the C2 lessons learned from that air campaign. They have served us well in the past, but we face a much different future—one that will be defined by the new threats, new technologies, and increasing velocity of information described previously. Our combat C2 organizational architecture, processes, and organizations must evolve and advance at least at the same pace as these trends.

For example, our current 1990s-designed CAOC organization is built around separate tasking processes for ISR (Planning Tool for Resource Integration, Synchronization, and Management [PRISM]) and force application (Theater Battle Management Core Systems [TBMCS]). However, we are now operating in an era when the platforms that PRISM and TBMCS were designed to manage can now perform either mission—or both. During the last two years of Air Force F-16 combat operations in Iraq, those aircraft were tasked nearly 100 percent of the time to conduct ISR activities using their targeting pods. Meanwhile, MQ-9 Reaper remotely piloted aircraft were equipped with laser-guided bombs to strike selected targets, including those discovered by the Reapers' own sensor suite. Despite such overlap, the Reapers were tasked through PRISM, and the F-16s through TBMCS. However, evolving technologies now afford us the opportunity to ensure that most of the aircraft in the Air Force's inventory can efficiently and effectively act as both sensors and shooters. It is time to end the segregation inherent in the current CAOC organizational and process design and move to a much more integrated planning and tasking function.

The fundamental C2 tenet of centralized control and decentralized execution has guided aerospace operations since World War II. Although that principle remains sound, emerging technologies and concepts permit us to consider evolving in the direction of a "centralized command, distributed control, and decentralized execution" construct. It is an appropriate progression towards more agile, flexible C2 in an era of increasing threats and accelerating information velocity. During the Desert Storm air campaign, aircrews were assigned the vast majority of targets to be attacked before they took off. Today, over Afghanistan, the vast majority of such targets are not specified to the aircrews delivering the effects—and often remain unknown to planners—until well after the sensor/shooter aircraft are airborne.

We now operate in an era of increasingly precise target discrimination and effects delivery. However, we can apply force more adeptly than we can assess its effects. Never has so much accurate firepower been placed on an adversary in such a compressed period of time. During Iraqi Freedom, for example, more than 600 coordinates for mobile targets were processed per day. Our challenge now is to skillfully C2 the rapid employment of precision systems, assess the effects, and react in the most productive way, all while operating in an efficient, distributed fashion.

A recent CONOPS innovation emerged in the design of the "Rapid Raptor" concept, which involves deploying a flight of four F-22s and one C-17 on short notice and being ready for operations at several distributed locations.[5] How will we carry out centralized command, distributed control, and decentralized execution when (not if) connectivity is severed? Deployed detachment commanders need to be an integral element of a new TACS—as do our wing commanders—fulfilling a role much more integral to a distributed C2 system than simply their historical force-provider role.

We have to think outside the organizational constructs that history has etched into our collective psyche. The days of strategies and plans based on unchanging divisions, wings, and fleets are coming to a long-overdue end. Network-centric, interdependent, and functionally integrated operations—performed by the right mix of available forces, regardless of service or nomenclature—are the keys to future success in war fighting.

Although General Carlisle's message at the beginning of this article specifically concerned his area of responsibility (AOR), his insights apply in all theaters. In the future, we need to invert the paradigm of large, centralized theater C2 nodes and develop a system that issues specific direction to particular elements of combat power according to a paradigm of multiple nodes responding in parallel to guidance designed to produce desired theater-wide effects. Determining how to do that should be the focus of the time, effort, and resources we spend on C2. This is how we should prepare for the next war rather than rely on the methods we used to fight the last one.

Conclusion

The challenges of emerging threats, new technologies, and the velocity of information demand more than a mere evolution of current C2ISR paradigms. We need a radically new approach that capitalizes on the opportunities inherent in those same challenges. We cannot expect to achieve future success through incremental enhancements à la CAOC 10.x upgrades—that method evokes an industrial-age approach to warfare that has lost its currency and much of its meaning. We cannot meet the requirements of information-age warfare with "spiral development"; rather, we must have modular, distributed technological maximization that permits and optimizes operational agility. That kind of agility calls for dramatic changes to our C2 CONOPS; our organizational paradigms for planning, processing, and executing aerospace operations; and our acquisition processes. It also demands a determined effort to match the results to the three critical challenges and opportunities while simultaneously fitting them seamlessly into the context of joint and combined operations.

We will not meet future national security issues in a fiscally constrained environment by simply buying less of what we already have. We must embrace and invest in innovation, creativity, and change—a charge that applies not only to the systems we procure in the future but also to the ends, ways, and means that we command and control them. ✪

Notes

1. Office of the Secretary of Defense, *Annual Report to Congress: Military and Security Developments Involving the People's Republic of China, 2014* (Washington, DC: Office of the Secretary of Defense, 2014), 9, http://www.defense.gov/pubs/2014_DoD_China_Report.pdf.

2. Air-Sea Battle Office, *Air-Sea Battle: Service Collaboration to Address Anti-Access and Area Denial Challenges* (Washington, DC: Air-Sea Battle Office, May 2013), 3, http://www.defense.gov/pubs/ASB-ConceptImplementation-Summary-May-2013.pdf.

3. Metcalfe's Law states that the value of a telecommunications network is proportional to the square of the number of connected users of the system. For more information, see "Metcalfe's Law," Princeton University, accessed 16 June 2014, http://www.princeton.edu/~achaney/tmve/wiki100k/docs/Metcalfe_s_law.html. For an expanded discussion of Moore's Law, see "Moore's Law," accessed 16 June 2014, http://www.mooreslaw.org/.

4. Ervin J. Rokke, Thomas A. Drohan, and Terry C. Pierce, "Combined Effects Power," *Joint Force Quarterly* 73 (2nd Quarter 2014): 26–31.

5. SSgt Blake Mize, "Rapid Raptor: Getting Fighters to the Fight," Pacific Air Forces, 20 February 2014, http://www.pacaf.af.mil/news/story.asp?id=123400928.

Lt Gen David A. Deptula, USAF, Retired

General Deptula (BS, MS, University of Virginia; MS, National War College) is a highly decorated military leader who transitioned from the US Air Force in 2010. He is a world-recognized leader and pioneer in conceptualizing, planning, and executing national security operations from humanitarian relief to major combat. He was the principal attack planner for the Operation Desert Storm air campaign; commander of no-fly-zone operations over Iraq in the late 1990s; director of the air campaign over Afghanistan in 2001; joint task force commander (twice); and air commander for the 2005 South Asia tsunami relief. General Deptula also served on two congressional commissions charged with outlining America's future defense posture. He is a fighter pilot with more than 3,000 flying hours—400 in combat—including multiple command assignments in the F-15. During his last assignment as the Air Force's first deputy chief of staff for intelligence, surveillance, and reconnaissance (ISR), he transformed America's military ISR and drone enterprises. General Deptula currently serves as dean of the Mitchell Institute of Airpower Studies; senior scholar at the Air Force Academy; board member on a variety of public, private, and think-tank institutions; and thought leader on defense, strategy, and ISR.

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Describing the Elephant

Framing a Discussion on Command and Control

Col Henry Cyr, USAF

> *To believe that the wars of the future, thanks to some extraordinary technological advances yet to take place in such fields as computers or remotely controlled sensors, will be less opaque and therefore more subject to rational calculations than their predecessors is, accordingly, sheer delusion.*
>
> —Martin van Creveld

One of the historical strengths of the US Air Force has been its rapid projection of combat airpower across the globe, leveraging command and control (C2) that expand our range and scope of action. Prior to the end of the Cold War, C2 capacity was closely aligned with the task and level of need. Airborne C2, the service's most operationally flexible component, was a central and understood element of a core mission well suited to tackle an existential war. With the passing of time, the nature of threats to the nation changed, and technology advanced. The Air Force retired legacy airborne and air-control C2 assets, updated remaining programs to reflect the evolving threat, and optimized technology accordingly. In an earlier age, the professionalism of the C2 crews and the singular task of major theater war with the USSR ensured technical competence and mission focus. As the range of threats to which the Department of Defense (DOD) responds has expanded and the effects of fiscal reduction have become manifest, our C2 construct and expertise have not kept pace. Today, more than ever, we need a deeper and holistic understanding of

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the broad mission area to help design appropriate and adaptive constructs that meet the C2 demands of the operational and tactical levels of war.

Discussing C2 can be a challenge because of the breadth of the topic and because we use similar words to express distinctly different meanings. When discussing air superiority; global strike; global mobility; and intelligence, surveillance, and reconnaissance (ISR), we readily understand the core meanings of these functions. This is not the case with C2. The denotation of that term varies across the levels of war; by service, mediums, career fields, and platforms; and across the realms of academics, joint-requirements modelers, and contractors—key partners in the development of C2 concepts and capabilities. Whether because of this confusion or in spite of it, among all five core missions of the Air Force, the intangible C2 tends to be the most assumed—an invisible given in our operations and our modeling. These challenges in understanding C2, coupled with the sense of its presumed ubiquity, prompt lingering questions about our C2 operations writ large.

As the Air Force faces sequestration budgets, basic and honest inquiries arise concerning its C2 operations. What "amount" of C2 is required, and how will we provide it? Who is qualified to do it—everyone? How is the task of airborne battle management appropriately and adaptively integrated along the spectrum of C2? Our success with remotely piloted aircraft and reachback ISR systems prompts the question, why can't we conduct tactical C2 remotely? Furthermore, can we do without it in the future if "fifth-generation" fighter/bomber aircraft have all the situational awareness (SA) they need? Addressing these questions demands fresh evidence and perspective but is also served by a reminder of enduring truths. The articles featured in this issue of *Air and Space Power Journal* use historical accounts, case studies, and theory to examine aspects of these honest inquiries.

In terms of scope, these articles touch all three levels of war, emphasizing the often-neglected tactical level of C2, where war takes on its most tangible forms. This level offers a detailed look at what C2 really entails in the battlespace. Although designed to be platform agnostic, most of the articles incorporate recent experience with the Joint Surveillance Target Attack Radar System (JSTARS), providing a practical framework for the theoretical discussions. It is this discussion in theory that will repave the path ahead for better understanding and operational performance in this complex core function. To move down this path requires a common frame of reference.

10 Propositions Regarding Command and Control

Ten general propositions concerning C2 emerge from the following articles. First, *C2 is a joint function with established tasks and doctrine*. Decades of US experience with C2 operations are layered into Joint Publication (JP) 1, *Doctrine for the Armed Forces of the United States*; JP 1-02, *Department of Defense Dictionary of Military and Associated Terms*; JP 3-0, *Joint Operations*; JP 6-0, *Joint Communications System*; and other governing doctrine. The prevalence of C2 in our joint doctrine reflects the centrality of performing C2 well and the tragedy of doing it poorly (e.g., Operation Eagle Claw during the Iran hostage crisis; the 1994 Blackhawk shoot-down in Operation Northern Watch; Operation Anaconda in Afghanistan; blue-on-blue Patriot engagements in 2003; and various incidents of civilian casualties). Those who ponder a future in which C2 is conducted safely remote from the chaos of battle might then be asked how this reconciles with the collective wisdom of such established and pervasive joint doctrine.

Second, *C2 requires unique operational competencies that span all military operations*. This statement contains two unique elements (competency and span of task) that coalesce into a unified theme: the ability to perform effective C2 is not simply inherent in the ability to accomplish other operational tasks. The pervasive need for C2 within all military operations oftentimes has the pernicious effect of making it appear as a rudimentary task, the effective performance of which is inherently innate to those operations. Unique C2 competencies exist; they are required to translate a commander's vision into action; and they are joint. Some articles in this issue convey these facts through operational vignettes that span multiple combatant commands and various levels of conflict. They demonstrate a desired end state in which military battle managers are trained to bring order from chaos, condensing stunningly complex environments into an understandable battlespace. All of these articles share a central theme—that these competencies must span every DOD operation, using doctrinally consistent skills which yield high-functioning C2 systems transportable to any fight.

Third, *airborne C2 inherently expands a commander's influence over operations*. From Marshal Mikhail Tukhachevskii forward, military thinkers valued the superior operational oversight from C2 in the air. By means of its mobility, airborne C2 offers range, reach, and adaptability—coupled with unique communications and surveillance feeds unmatched from space—to provide in situ problem solvers who align understanding of the commander's intent to the chaos of actual conflict. Many forms of remote C2 have been demonstrated, ranging from our own air defense sectors in the continental United States to some operations in US Central Command today. These options, however, require vast capital investments and years of infrastructure development that could not be matched in, say, Operation Odyssey Dawn / Unified Protector in Libya. Living without airborne C2 would also ignore the vast number of operations that still occur on line-of-sight radios, which cannot be heard remotely on any scale necessary to maintain C2 over a conventional fight.

Fourth, *overcoming fog, friction, and chance calls for continuous, in-battlespace problem solving with on-scene SA*. The US Africa Command and maritime case studies in this issue illustrate how much problem solving and initiative really take place at the tactical level of C2. Advances in reachback communication architectures, which have enabled routine strike and ISR missions, have prompted an increasing desire to push existing strategic- and operational-level reachback C2 down to the tactical level. This discussion, though certainly valuable, must be informed by "facts on the ground" and not analogy. Central to such dialogue is an understanding of the vast amount of decision making at the tactical level that is never made apparent outside the physical battlespace. When operations like Odyssey Dawn / Unified Protector in Libya succeed, no one sees the suspension of naval gunfire due to dense Strike Eagle operations in an open kill box. Nor does anyone know about the positive identification of non-English-speaking partisan forces *not* killed due to high levels of localized SA. Rather, the fact that those outside the battlespace simply see the successful outcome inherently masks the vast amount of problem solving that actually occurs in the battlespace, far removed from observers.

Fifth, *C2 arrangements supply an action arm in the battlespace by leveraging SA from all levels of war*. Arguably, we have developed the most powerful ISR capabilities in the history of the world. Additionally, fifth-generation aircraft present their own source of SA in new ways. Without the unifying force that is C2, these amazing technical advances may realize only individual success or localized advantage rather than broader operational-level advances. This point is further reinforced when we remember that the development and sharing of SA remain anchored in part to line-of-sight radio communications, with many participants in the air, on the ground, or at sea lacking dependable voice-satellite capability. Even if we cultivate such capability for all of the DOD, we will still require the line-of-sight radio for continuity of operations if an adversary "turns off" space.

Sixth, *the importance of C2 increases with operational complexity and cultural expectations about precision*. In his article "C2 Rising," Lt Col Paul Maykish shows a gradual rise in the significance and scale of C2 operations based on megatrends in war and an understanding of the unchanging nature of C2. An additional rise in the need to comprehend and develop adaptive C2 constructs derives from shifts in American culture that must be matched by more elegant solutions. From Operation Desert Storm forward, America and its coalition partners expect ever-increasing precision in operations. This enhanced expectation of precision and reduced tolerance for loss of life and destruction of property demand more operational oversight, not less—a situation that presents a paradox. That is, we prefer as little C2 as necessary to carry out missions but must have enough to satisfy the amount of oversight that our nation expects of a highly precise and less wantonly destructive military.

Seventh, *C2 systems ill matched to specific operations may produce dysfunction*. Voids in C2 systems force ad hoc arrangements to fulfill the unchanging C2 sub-functions. Several modern examples of C2 voids come to mind. For Odyssey Dawn / Unified Protector, JSTARS was initially tasked to support operations in Libya as an ISR asset but quickly filled operational-level C2 voids by chance rather than design (see "Command and Control in Africa" by Maj Damon Matlock, Maj Jonathan Gaustad, Maj Jason Scott, and Capt Danielle Bales). The joint air-to-ground integration cell, an initiative centered on large-scale close air support, addresses voids in the theater air control system in the old air support operations center's sphere of influence. The dynamic air response coordination cell is an ad hoc C2 node that is forming to deal with an Air Force–Navy seam for reroling aircraft to new missions. Special Operations Command has created a tactical air coordinator (airborne) role to manage higher-volume air operations associated with raids. Finally, numerous ongoing C2-of-ISR projects are driven largely by perceived C2-function-based voids.

All five examples may be good C2 adaptations worthy of praise, but they also serve as evidence. When we fail to honor the C2 sub-functions, voids appear that eventually must be filled. Every one of these is a window into what happens when C2 capabilities do not match an operational need. In these cases, we have seen the C2 voids and have adapted with the luxury of time. Without such a luxury in future conflicts, what burden do we levy upon commander(s) that could be more easily resolved by adaptive and appropriately constructed C2 systems?

Eighth, *to have high-functioning C2, we must consider all aspects of the C2 system (e.g., C2 professionals, doctrine/tactics, competencies, skills,* *platforms, technologies, plans, authorities, tasks, sub-functions, and effects)*. The sheer complexity of the C2 mission area makes taking a holistic view challenging. Whether due to the magnitude of the task, differing service views of C2, or confusion about how we discuss the topic, coherently integrating the many aspects of C2 has proven problematic, oftentimes leading to suboptimal operational results. Descriptively, C2 operations remind us of the classic story of the Sufi elephant in which blind men examine one part of the creature, each believing that it represents the whole but all presenting vastly different views of the beast. Similarly, when we address C2 questions, we will find it helpful to consider all parts of the system to determine if our concepts lead us to holistic, adaptive, and effective ends.

Ninth, *commanders control operations in a mix of three ways: in person, by plans (e.g., the joint air operations plan, air operations directive, air tasking order, and airspace control order), and by delegation with intent (e.g., decentralized execution, distributed C2, mission-type orders, and mission command)*.[1] Currently, the Air Force is navigating this spectrum of control with the idea of moving authorities for certain C2 tasks down to the tactical level of war. The "distributed C2" concept is a response to contested, degraded environments.[2] Yet, the concept is moving forward, accompanied by uneasiness regarding the risks we take if we distribute more decision making "to the edge."[3] Martin van Creveld notes that this is normal in dealing with uncertainty in war insofar as centralization and decentralization come down to "readiness at higher headquarters to accept more uncertainty while simultaneously reducing it at lower ones."[4] He captures the idea that all centralized/decentralized debates in military operations simply come down to where we distribute uncertainty in war.

Finally, *the measure of merit for any C2 system is results—accomplishing missions in any situation*. Never really about career fields, platforms, or specific capabilities, C2 operations instead have to do with strength in the form of adaptive integration—that essential requirement to forge mission accomplishment in diverse joint and coalition fights. A recurring theme throughout this C2 focus issue is that our strength lies not singularly in our people, ideas, weapons, or platforms but in their systematic and adaptive integration via C2—by way of the unifying vision of a commander. Results are, and will always remain, the ultimate measure of merit for our thoughts regarding C2.

Conclusion

Commanding and controlling forces reflect an immutable need of a commander to array and employ those forces. The core challenges—to commanders and, by extension, the C2 function—are enduring. The specific methods and means to do so have changed over time, but effective C2 has always called for unique competencies and systems. Given the complexity of the topic, refocusing within the DOD to meet the demands of over a dozen years of counterinsurgency and counterterror operations and, now, declining military budgets, we must engage in informed discussion about the C2 needs of commanders to deal with warfare that is increasingly distributed, complex, and varied. Thus, to overcome the inevitable fog, friction, and chance that these future commanders will face, we need mobile and adaptive C2 capable of bringing order from chaos—just as we needed it when the first observation balloon launched. The articles in this issue of *Air and Space Power Journal* work towards clarifying a modern doctrinal understanding of C2 by offering research and discussion informed by the actual work of today's C2 operations. ✪

Notes

1. Adapted from Allan English, Richard Gimblett, and Howard G. Coombs, *Networked Operations and Transformation: Context and Canadian Contributions* (Montreal: McGill-Queen's University Press, 2007), 19–20.

2. See Lt Col Alan Docauer, "Peeling the Onion: Why Centralized Control / Decentralized Execution Works," *Air and Space Power Journal* 28, no. 2 (March–April 2014): 24–44, http://www.airpower.maxwell.af.mil/digital/PDF/Issues/2014/ASPJ-Mar-Apr-2014.pdf.

3. David S. Alberts and Richard E. Hayes, *Power to the Edge: Command, Control in the Information Age*, Information Age Transformation Series (Washington, DC: CCRP Publication Series, 2003).

4. Martin van Creveld, *Command in War* (Cambridge, MA: Harvard University Press, 1985), 274.

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C2 Rising

A Historical View of Our Critical Advantage

Lt Col Paul J. Maykish, USAF

Life can only be understood backwards, but it must be lived forwards.

—Søren Kierkegaard

The command and control (C2) core function can be somewhat difficult to grasp. For example, consider the service publication *Global Vigilance, Global Reach, Global Power for America*. This compelling piece lays out concise, one-page descriptions of the original five Air Force core functions: air and space superiority; intelli-

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gence, surveillance, and reconnaissance (ISR); rapid global mobility; global strike; and C2.[1] The first four core functions have power and clarity. They are the legacy of the air and space nation. However, when readers reach the fifth core function, they are led to believe that the meaning of C2 is maintaining networks in the cyber age. Yet, in terms of grasping C2, networks do not explain that concept any more than missiles explain air superiority or bombs define global strike.

America's greatest advantage in war fighting lies not in the quality of its people, ideas, weapons, or planes but in the systematic integration of those elements via C2. Going back to Napoleon, modern thinkers have consistently made this observation. Men such as Field Marshal Helmuth von Moltke (the Elder) and the US Air Force's Col John Boyd mark a steady rise toward identifying C2 operations as the prime integrator of military power in terms of people, ideas, weapons, and machines.[2]

To analyze the concepts of these thinkers, Carl von Clausewitz offered a helpful distinction. He taught that the *character* of war will change while certain aspects in the *nature* of war never change. Both the changing and the unchanging aspects are always at play in war, and both merit our devoted study.[3] Moltke, Marshal of the Soviet Union Mikhail Tukhachevskii, Air Chief Marshal Hugh Dowding, and Boyd were forced to think about C2 operations based on the evolving character of war in their day but also produced insights about C2 fundamentals in the nature of war. They navigated (1) the rise of industrial-age warfare, (2) the new operational level of war, (3) the range and speed of the aviation age, and (4) the beginning of information-age warfare. At the same time, they found that universal C2 sub-functions and concepts are inherent to the unchanging nature of war. Both the changing and unchanging aspects of C2 in their works represent a constant movement toward viewing C2 as our critical advantage (or its neglect—our critical weakness). Moreover, we can now observe these same universal sub-functions across industries ranging from NASA's mission control to national power grids. Seeing the nature of C2 through both the eyes of its greatest contemporary thinkers and universal forms can also make this subject more tangible to anchor our views of how we fulfill these sub-functions in the future.

A Six-Stage History of Modern Airpower Command and Control

Until Waterloo, military C2 in war was predominantly a single-man, single-battlefield affair. While empires like Greece, Persia, and Rome had periods of "grand strategy," the portrait of C2 in ancient warfare is framed largely through individual battles—often great ones. In these battles, the commander could apprehend the scope of the battlefield and control it with an officer corps and signals.

Napoleon Bonaparte. (From "The Emperor Napoleon in His Study at the Tuileries," ***Wikipedia: The Free Encyclopedia***, accessed 1 June 2014, http://en.wikipedia.org/wiki/File:Jacques-Louis_David_-_The_Emperor_Napoleon_in_His_Study_at_the_Tuileries_-_Google_Art_Project.jpg.)

In this stage, Napoleon was a transitional figure in expanding the art of C2. His dispersed armies often moved along a wide front and then converged on the day of battle. One division would engage, and the others would "march to the sound of the guns." Often, a corps would arrive at the 11th hour of battle, providing decisive reserves and the margin of victory. This era, stage one, is represented by the looming of industrial-age warfare and an expansion of C2 art by Napoleon.

Helmuth von Moltke (the Elder). (From "General von Moltke," Wikimedia Commons, accessed 1 June 2014, http://upload.wikimedia.org/wikipedia/commons/8/8f/General_von_Moltke.jpg.)

By 1870, revolutions in transportation (the train) and communication (the telegraph) expanded the commander's operations over many battlefields simultaneously. These revolutions changed the character of war for Moltke during the Franco-Prussian war. In 1932 Russian theorist Georgii S. Isserson captured Moltke's role by noting that "Moltke the strategist was faced with a completely new problem of coordinating and directing combat efforts, tactically dissociated and dispersed in space to achieve the overall aim of defeating the enemy."[4] Until then, only the strategic and tactical levels of war existed. This new phenomenon, the nascent emergence of an operational level in war, was something separate from the tactical and strategic levels.[5] Moltke observed that new transportation and communication phenomena allowed forces to "move divided and fight united" (largely how we fight today).[6]

This change in the character of war indirectly shaped C2 history in the ideas of Moltke. He thought that winning strategies would now involve having what he called a "system of expedients" to take advantage of the opportunities found at this new level of war. He went as far as saying that "strategy *is* a system of expedients" (emphasis added).[7] Two key leaps in Moltke's observation transfer to C2 theory: (1) warfare now required a systems approach to accommodate its broader character, and (2) the system with the best inherent adaptability in responding to fog and friction ("expedients") would prove superior. This idea created a quiet turn toward a C2 profession ushered in by revolutions in technology and the character of industrial-style warfare.[8]

C2 systems in this era were simple compared to modern ones. In Moltke's era, such systems were also remarkably high functioning:

> A relatively small staff (even Moltke's General Staff in 1870 numbered only approximately seventy officers, as against close to a million men that it controlled during hostilities against France), some wagons with filing cabinets and maps, a pool of mounted orderlies, and such technical contrivances as field telescopes, standards, trumpets, drums, and pigeons (later supplemented by telegraph and telephone) formed the sum total of command systems.[9]

Even until World War I, fielded forces used carrier pigeons for C2 communication at the Battle of Verdun—less than 100 years ago.[10] Yet, in these simple systems, Moltke and the Prussians adapted to a new level in war while grasping the systems approach we still use today. Thus, Moltke's era, stage two, is marked by the front edge of an operational level in war and foresight into systems warfare.

Mikhail Tukhachevskii. (From "Mikhail Tukhachevsky," Wikimedia Commons, accessed 1 June 2014, http://upload.wikimedia.org/wikipedia/commons/6/66/Mikhail_Tukhachevsky.jpg.)

The next great leap in understanding modern C2 came in the brutal form of the Red Army. The genius of that Soviet war machine, Mikhail Tukhachevskii, advanced many characteristics of modern warfare, including airborne paratroopers and tanks. He was also fascinated by how airplanes could (1) transform the concept of range (what he called "deep battle") and (2) provide unparalleled observation and integrated firepower to advancing forces (what he called "airmechanization"). One could argue that the Germans married the same ideas in the blitzkrieg concept that crippled Poland and Western Europe in 1939 and 1940.

By 1924 Tukhachevskii had begun to grasp the new complexity of C2 by articulating its sub-functions inherent to the nature of warfare. In that same year, he had five of the six functions we use today in Air Force Tactics, Techniques, and Procedures (AFTTP) 3-1, *Theater Air Control System 2013*, and by 1937, six of six.[11] In 1937 Tukhachevskii even conceptualized these C2 functions performed in the air, where a bird's-eye view would offer maximum awareness to both commanders and shooters:

> Communications aircraft carry out the following tasks: (a) delivery of orders and collection of situation reports, (b) maintenance of communications between divisions, [and] (c) battlefield surveillance. Translators note: "Voiskovoi" now normally implies "divisional, organic to divisions," but here probably includes corps as well. "Liaison with tanks" (lit. fr. "accompaniment of tanks") is a complex concept [to translate]. The same term is now used for artillery support of the leading elements of a mobile force once they have broken loose. In this Regulation [from Tukhachevskii] it implies a mixture of guiding the tanks navigationally and tactically, reporting their progress back, and probably controlling the fire of their supporting artillery.[12]

Here we see that Tukhachevskii imagined something like the Joint Surveillance Target Attack Radar System (JSTARS) well before we Americans built it. His era, stage three, is marked by the post–World War I operational level of war and articulation of unchanging C2 functions in the nature of war.

From Tukhachevskii forward, a scientific quest occurred to feed C2 functions with more situational awareness (SA). Radar and radios became the backbone of these SA feeds.[13] Thus, as soon as technology allowed, radar became central to modern forms of C2. The British "Dowding" system of radar, observers, and mission controllers represents the classic leap into this stage of C2.

Hugh Dowding. (From "Hugh Dowding," Wikimedia Commons, accessed 1 June 2014, http://upload.wikimedia.org/wikipedia/commons/7/7c/Hugh_Dowding.jpg.)

Britain's Air Chief Marshal Hugh Dowding, a veteran of World War I, had a brilliant mind and reserved character (thus the nickname "Stuffy"). In 1936 he became head of the United Kingdom (UK) Fighter Command and offered an alternative view to that of strategic bombing advocates such as Giulio Douhet (Italy), Hugh Trenchard (England), and William "Billy" Mitchell (United States). Dowding wanted deterrence based on "fear of the fighter" planes. As the theory went, if an island nation like England possessed a dominant fighter force, then no significant attack on the homeland would take place from the air. As Stephen Bungay points out, however, Dowding knew that "all the fighters in the world were of little use if they could not find their enemy."[14] To address this kill-chain problem and match the Luftwaffe, Dowding pushed to develop a nationwide awareness system of costal radars known as "Chain Home."

In theory, at the heart of Dowding's system were the human problem solvers running C2 operations:

> The quality of the information depended crucially on the skill and experience of the operators, for judgment as well as calculation played a role. They had to work very fast, or their information was useless. They were also under pressure, as lives depended on the accuracy of their reports. . . . [They had] rigorous performance measures, and so improved constantly. Operator skill was paramount to the system's effectiveness. . . . For the system to work, everybody in it had to practice.[15]

Officers and enlisted troops in this system performed C2 sub-functions as we know them today. Shooters needed to be oriented and paired dynamically on a grand scale. Problems woven into the nature of war demanded human judgment and intervention. Basic forms of order to air operations were necessary to execute decentralized missions. Real-time assessments had to be made, relayed, and acted upon. Radars fed the mission controllers, who functioned as "sheepdogs," herding the fighter squadrons into battle to save their nation. To this day, the United States uses the Dowding model to guard its airspace via the Western Air Defense Sector and Northeastern Air Defense Sector.

The Operations Room at Headquarters Royal Air Force Fighter Command, Bentley Priory. (From Imperial War Museum, © IWM [C 1869], http://www.iwm.org.uk/collections/item/object/205195170. Reprinted with permission.)

Interior of the Sector "G" Operations Room at Duxford, Cambridgeshire. The call signs of fighter squadrons controlled by this sector can be seen on the wall behind the operator sitting third from left. The controller is sitting fifth from the left, and on the extreme right, behind the Army liaison officer, are the R/T operators in direct touch with the aircraft. (From Imperial War Museum, © IWM [CH 1401], http://www.iwm.org.uk/collections/item/object/205195667. Reprinted with permission.).

After the success of this air defense system, large radars were eventually placed on airborne early warning aircraft like the E-2 and EC-121. In theory these platforms became extended-range and air-mobile versions of the defensive Chain Home radar model.[16] This period, stage four, is marked by increased depth in battlespaces from the speed and range of the aviation era in full swing and sophisticated SA feeds used by teams of controllers to form a complex, adaptive defensive system.

Photo courtesy Public Affairs, 116th Air Control Wing, Robins AFB, Georgia

An airborne JSTARS crew bears much resemblance to the Royal Air Force control room 70 years later.

John Boyd, pilot. (From Wikimedia Commons, accessed 1 June 2014, http://commons.wikimedia.org/wiki/File:JohnBoyd_Pilot.jpg.)

Although the Dowding system emerged from defense, Col John Boyd ushered in a comprehensive dimension to C2 using competition fundamentals. Airmen recognize Boyd's observe, orient, decide, act (OODA) loop as a model for obtaining air dominance in war.[17] In theory, if our OODA loop is shorter than that of our enemies, we end up on the proper side of fighting. Less well known is Boyd's presentation "Organic Design for Command and Control," in which he brings OODA to a system-wide level reminiscent of Moltke's call for a system of expedients. Boyd thought that bringing the OODA concept to a system level could maximize our capacity for independent action, calling these qualities "initiative and adaptability." At the same time, this system could ensure that all actions at the speed of air war would remain aligned to the commander's intent and vision. He referred to this quality and the reduction of friction as "harmony." Yet, all three of these qualities hang on the ability to produce "insight" on a system-wide level. Thus, a key distinction of Boyd's trust-based C2 system involves adding system-level "insight" to the defensive "expedients" found in the Dowding model.[18]

In principle, Boyd added a comprehensive quality to C2 operations whereas the Dowding system was defensive from inception. In doing so, Boyd advanced yet another level of detail to the concept of Moltke's "expedients" from stage two. The Dowding system concentrated on defensive expedients while Boyd extended expedients to include the proactive production of insight motivated by competition fundamentals.

Whether or not we think of it this way, we moved toward Boyd in the form of the theater air control system (TACS), within which both ISR and C2 enterprises feed offensive air operations in a way the Dowding system did not.[19] Today we can witness our move in this direction by noting the sheer size of US Central Command's intelligence, surveillance, and reconnaissance division—comparable to the size of the air and space operations center's combat operations floor. The early TACS and these modern expansions began to transfer the OODA concept past a four-ship to an entire complex, adaptive system for harnessing airpower and producing insight.[20] Thus, changes in Boyd's era are marked by the front edge of the information age, including computer-based C2 and adding system-wide "insight" to the defensive expedients found in the Dowding model. This multistage view of C2 history shows that C2 theorists navigated megatrend-type changes while gaining insight into C2 fundamentals at the same time (table 1).

Table 1. Six stages of modern command and control operations

Stages of Modern C2	*Waypoints*	*Navigating Megatrends*	*Discovering Fundamentals*	*Key C2 Result*
Stage 1	Napoleon (France)	The looming of industrial-style warfare	Expanding C2 art in the single leader, single battlefield model	Pushed C2 art
Stage 2	Moltke (Prussia)	Transportation and communication revolutions	A "system of expedients" over multiple battlefields	Envisioned systems warfare
Stage 3	Tukhachevskii (Russia)	New operational level of war and the front edge of the aviation age	"Expedients" refined into clear C2 sub-functions	Made C2 tangible
Stage 4	Dowding (United Kingdom)	Range and speed of the aviation era in full swing with increasing battlespace depths	Sophisticated SA feeds and teams of controllers performing C2 sub-functions form an adaptive system for defense	Systematized feeds and teams
Stage 5	Boyd (America)	Computer-based data management and the front edge of the information age	Transferring competition fundamentals into a system of "insight"	Incorporated competition fundamentals
Stage 6	Uncertain	Network-centric C2 operations and cyber warfare	Uncertain	Uncertain

Stage one characterizes C2 in most of human history. Stage two introduces systems warfare and the C2 concept of "expedients" (rapid adaptations). Stage three transfers expedients into detailed and intrinsic C2 sub-functions, which are enduring C2 fundamentals in the nature of war. Stage four introduces elaborate SA feeds into a defensive C2 system with sensors, radios, operators, and observers matched to the range and speed of the aviation era in full swing. Airborne early warning aircraft appear in this stage to extend and geographically transport the stage-four model. Furthermore, because the Air Force came into being during this stage (by means of the 1947 Key West agreement), our C2 core function was then known as "air defense." Stage five added a comprehensive and offensive edge to C2 functions via Boyd's description of competition fundamentals designed to create maximum insight and adaptability at a system level. During this stage, the Massachusetts Institute of Technology created the Semi-Automatic Ground Environment (SAGE) system for the Air Force, introducing the role of computers for processing large amounts of information in a C2 system.[21] Stage five also resulted in offensive-spirited systems like JSTARS (the very name containing the terms *target* and *attack*). Appropriately, the name of this service core function migrated from *air defense* to *command and control* in this stage.

In stage six, our work is characterized by network-centric warfare as a stronger shift into the information age acts upon our military C2 systems. The Department of Defense commissioned the Command and Control Research Program as a means of understanding the effects of the information age. On the one hand, program authors David Alberts and Richard Hayes follow Boyd in calling for a system of insight that empowers the "edge" of our systems. They aggressively concluded that "traditional approaches to Command and Control are not up to the challenge. Simply stated, they lack the agility required in the 21st century."[22] On the other hand, Col Jeffrey Vandenbussche, USAF, notes how militaries operate in a context of increased political sensitivity and thus may need to remain traditionally hierarchical at times to check-and-balance risk vertically.[23] Additionally, other futurists have predicted that stage-six C2 will be known as knowledge-centric warfare (KWAR) in which winning and losing boils down to pure strategies of competitive knowledge.[24]

To ground our perception of stage six, we would do well to revisit Clausewitz's distinction between the "character" and "nature" of war. Its *character* may change (e.g., information-age networks and cyber warfare), but its fundamental *nature* does not (e.g., C2 sub-functions and war being characterized by fog, friction, and chance). Both deserve our devoted study. No matter what we conclude about the changing character of C2 operations in stage six, it is equally important to recognize the unchanging C2 sub-functions and competition fundamentals woven into the very nature of war. The future of our C2 core function should feel like grasping the current megatrends without letting go of the C2 universals.

Unchanging and Tangible C2 Sub-functions

Tukhachevskii wrote extensively on C2 from 1924 to 1936 before he was executed as a result of a fabricated charge of treason in Stalin's "Great Purge" of 1937. His work remained inaccessible until 1987, when Richard Simpkin published an English translation. There are three key aspects of Tukhachevskii's C2 writings in stage three: (1) C2 planes extend a commander's influence over the chaotic and deepening battlespace, (2) using "functions" helps define C2 concretely, and (3) the similarity of Tukhachevskii's functions to ours demonstrates the unchanging nature of the C2 sub-functions in war.

First, Tukhachevskii began to leverage aircraft for C2. In the 1936 Russian Field Service Regulation, he wrote that "the complexity of the modern battle turns a particularly bright spotlight on the question of command and control" to include the use of planes.[25] His writings span levels (operational/tactical) and mediums of war (air/land/sea) with an emphasis on land war, based on his stage of history. Yet, without question, he viewed aircraft in a C2 role to

1. drive reconnaissance and surveillance that feed all other C2 functions,
2. deliver dynamic orders,

3. collect situation reports or battle damage assessments,
4. bridge and maintain line-of-sight communications in depth, and
5. help link combined-arms fighting ("airmechanization").[26]

Tukhachevskii also captured the often-neglected tactical level of C2, writing that "due to complexity, real control of the battle must necessarily imply control of the entire tactical process."[27]

Second, using "functions" to comprehend C2 constituted a major leap toward grasping its meaning. Complex concepts are often defined this way. For instance, macroeconomists use this approach to understand money. Specifically, if something serves as (1) a medium of exchange, (2) a store of value, and (3) a measure of wealth, then it is money. To a macroeconomist, it does not matter if this means Polynesian stones of varying sizes or commoditized Monopoly money. If something serves those three functions, we call it money. In the same way, if something fulfills these C2 functions, we call it C2 at the tactical level of war.

Third, Tukhachevskii's writings have strong parallels with our own tactical service doctrine (table 2). In 2009 the Air Force traced the same basic set of Tukhachevskii's tactical C2 functions in AFTTP 3-1, *TACS*. These correlations help demonstrate a universal quality of C2 work found in the nature of war.

Table 2. Tukhachevskii and modern tactical service doctrine

Tukhachevskii's Writings	*AFTTP 3-1, TACS: Tactical C2 Functions*
• thorough reconnaissance (p. 193) • adoption of a plan that matches the situation (p. 193) • organization of physical security of communications and resupply (pp. 193, 194) • systematic control over reconnaissance and surveillance (p. 207) • imminent threat-warning arrangements for physical security and air defense (p. 208)	Orient shooters
• orders that lay down the final missions with locations and times (p. 100) • concentration of forces on a single, clear-cut, and clearly stated aim (p. 150) • allocation of tasks to troops (p. 193)	Pair shooters
• responsiveness to changes in the situation (p. 193)	Solve problems
• dynamic need to lay down intermediate [fire support coordination measures] (p. 100); provisions for cooperation (p. 193); setup of "control arrangements" (p. 152) • issue of orders in good time (pp. 193, 208) • observation of the way orders are carried out at lower levels (p. 193) • collation and observation of friendly forces (p. 208) • organization of communications (p. 208) • provisions for all arms [fires] cooperation in each phase of the operation (p. 208) • policy on radio use (p. 208) • means of maintaining uninterrupted communications with mobile forces and rearwards (p. 208)	Bring order
• personal initiative (p. 193)	Speed decisions
• prompt passing of reliable information downwards and sideways and of situation reports upwards (p. 193)	Produce assessments

Source: For the page references, see Richard Simpkin, *Deep Battle: The Brainchild of Marshal Tukhachevskii*, trans. Richard Simpkin and John Erickson (London: Brassey's Defense Publishers, 1987).

These tactical C2 sub-functions also have numerous C2 tasks in our doctrine that *fulfill* each function. However, staying above the task level of detail, we can describe our current tactical sub-functions by using Boyd's OODA loop terminology.

- F1, orient shooters: increase shooter/sensor SA and threat warning by providing SA. Battle management and ISR fusion tasks in this function enhance the observe/orient steps of Boyd's OODA loop.
- F2, pair shooters: improve economy of force in dynamic situations. Use of SA orchestrated from sensors enhances the decide step of Boyd's OODA loop.
- F3, solve problems: apply resourcefulness for adaptive execution of the air tasking order. Countless problems resolved at the tactical level require critical thought to ensure the commander's intent and mission accomplishment. This function surrounds every step of the system-wide OODA loop. Problem solving brings harmony or dynamic order to operations.
- F4, bring order: employ routine force accountability and overwatch integrating sensors, fires, and friendly locations. This function surrounds every step of the system-wide OODA loop and brings static order to operations.
- F5, speed decisions: streamline and minimize processes fusing combat identification and applications of the rules of engagement. This function lies at the heart of the decide step in Boyd's OODA loop.
- F6, produce assessments: convert information into accurate estimates of situations in all directions—down to a joint terminal attack controller (JTAC) and up to the combined force air component commander (CFACC). This function pervades each step in Boyd's OODA loop.[28]

These functions manifest in current phenomena of our tactical C2 operations. Our C2 jets have massive radars for finding and early warning to *orient shooters*.[29] *Pairing shooters* produces economy of force, guided dynamically to the commander's intent (when the air plan meets reality); it is the reason that Air Force C2 players immerse in shooter/sensor formats, norms, and tactics, techniques, and procedures. *Solving problems* lies at the heart of C2. Continuous problem solving at a level above a four-ship (or two-ship these days) addresses Clausewitz's problem that war is characterized by fog, friction, and chance. Problem solving at the tactical level creates the resourcefulness needed to implement an air tasking order and align solutions to the commander's intent. *Bringing order* creates the minimum structure necessary to enable optimization and adaptation of air assets at the speed of air operations. *Speeding* (good) *decisions* represents the essence of the OODA loop transferred to an area-of-responsibility scale. The *producing assessments* function moves key conclusions 360 degrees down to the JTAC and up to the CFACC at the speed of air operations. This function allows the system to "think" beyond a single flight of aircraft or bombers in near-real time with accurate estimates of the situation.[30]

The historical continuity between our functions and Tukhachevskii's reveals an apparent permanence of these sub-functions. This C2 pattern should also guide our visions of how we perform them in future war. In real conflict of any scale, someone has to fulfill these poorly understood C2 functions embedded in the nature of war. The tactical C2 functions help define C2 in broader terms that most warriors can understand and perhaps value as an "advantage."

History Shows That Work Remains

At the same time, we cannot say that C2 is fully understood. For example, at the next level of war, we can observe other sub-functions, but they are not quite unified at this time. Tukhachevskii captured other functions that seem to apply to the operational level of war:[31]

- optimizing assets
- producing operational thought
- pairing cross-theater fires
- weighing strategic value of tactical actions
- providing theaterwide warning
- organizing scramble orders
- delegating authority to maximize independent action
- ensuring interoperability
- performing cross-nation coordination
- issuing dynamic orders
- controlling phases

A second source of operational functions comes from historian Martin van Creveld, another champion of the functional approach to C2 as reflected in the vast sweep of history depicted in his book *Command in War*. He articulated that an ideal C2 system has functions to gather, distinguish, distribute, estimate situations, develop objectives, analyze, adapt, decide, plan order, and monitor.[32] Yet, "Annex 3-30, Command and Control," sketches operational C2 functions as planning, directing, coordinating, controlling, tasking, executing, monitoring, and assessing air, space, and cyberspace operations.[33]

Among Tukhachevskii, van Creveld, and "Annex 3-30," one finds a general picture of functions at the operational level of war, but they are not quite in sync (table 3). With the addition of complexity, tactical and operational levels also share identical functions (like assessment) while other functions are completely different (further complicating our efforts to grasp the art and science of C2). In stage six, we must work toward a comprehensive taxonomy of C2 functions to be more surgical about how we design C2 systems for any environment. Adding the C2 joint capability areas shows some, but not identical, similarities.

Table 3. Operational C2 functions in Tukhachevskii, van Creveld, Air Force doctrine, and C2 joint capability areas

Tukhachevskii	*Van Creveld*	*"Annex 3-30"*	*C2 Joint Capability Areas**
• Optimizing assets • Producing operational thought • Pairing cross-theater fires • Weighing strategic value of tactical actions • Providing theaterwide warning • Organizing scramble orders • Delegating authority to maximize independent action • Ensuring interoperability • Performing cross-nation coordination • Issuing dynamic orders • Controlling phases	• Gathering information • Distinguishing (filtering) • Distributing (displaying) • Estimating situations • Developing objectives • Adapting • Deciding • Planning • Ordering • Monitoring	• Planning • Directing • Coordinating • Controlling • Tasking • Executing • Monitoring • Assessing air, space, and cyberspace operations	• Planning • Organizing • Understanding • Deciding • Directing • Monitoring

*See "Joint Staff J6: Warfighting Mission Area (WMA) Architectures," accessed 7 June 2014, https://sadie.nmci.navy.mil/jafe/jid/JCAs.aspx.

C2 of Anything

Between stages four and five, large-scale C2 operations began to spread across multiple industries. The similarity of the sub-functions across industries is telling, perhaps pointing toward what we could call "universal C2" and continuing to underscore the criticality of C2. For example, NASA mission control is famously committed to the success of its astronauts who venture out into complex and potentially fatal missions. The activities in Houston during a space shuttle mission bear a remarkable physical similarity to those in our TACS—headsets, booms, radios, consoles, logs, and situation displays—hinting at some universality of C2 in any complex endeavor. In Houston, mission controllers orient astronauts, pair them to tasks necessitated by the mission, solve problems for them (famously for *Apollo 13*), bring order to a mission through norms such as a countdown, speed decision making at the pace of manned spaceflight, and continuously produce assessments of the mission (out to the astronauts and up to the president). As such, they are basically performing the same AFTTP 3-1 C2 functions for a completely different mission.

NASA photo

NASA mission control for space shuttle launch STS-128.

All complex operations in this era seem to stumble upon the need for high-functioning C2 systems. Carrier war rooms, nuclear reactor control rooms, the National Military Command Center, the Federal Emergency Management Agency, and command posts around the world all resemble each other in both function and form. The apparent universality of C2 offers more evidence for the need to have full-time, adaptive problem solvers directly connected to operations—individuals who will watch over and act upon any complex human endeavor. This universal phenomenon has even spawned the parallel academic discipline of operations management—a requirement in the complex systems of the industrial age.

Universal C2 is a growing subject of study across industries. In the 2007 essay *Development of a Generic Activities Model of Command and Control*, British authors examined a range of C2 operations: national power grids, railway networks, air traffic systems, emergency services, and the UK military (three different service examples). They sought "to provide a research tool that may be applied to any command and control domain."[34] While the authors focused only on communication tasks instead of coordination actions and critical thought, the result is clear similarities in the form of a taxonomy that slices across industries. The researchers found an aspect of universal C2.

Coming back to military operations, we see that universal C2 is also evidenced in the steady reemergence of ad hoc forms today wherever C2 voids exist. Air Combat Command (ACC) has various "C2 of ISR" initiatives that focus on the orientation, pairing, and problem solving associated with the employment of sensors as opposed to shooters. In another ad hoc form of C2, US Special Operations Command (SOCOM) has experienced busier air operations in "the funnel" over special operations forces (SOF) objectives in the 9/11 era. These busier air operations have demanded creation of new tactical air coordinator (airborne) (TAC[A]) players devoted to SOF missions. Regardless of the air player who takes on this new role, it performs exactly the same

TAC(A) tasks common to full-time problem solvers in a large close air support fight.

In both the ACC and SOCOM examples, why are there grassroots pushes for an ad hoc C2 arrangement? C2 voids were discovered. Why do they exist? The C2 sub-functions were not being fulfilled. We observe the need for tactical C2 in new forms wherever C2 voids exist in complex operations. This is just another way to observe the universal need for tactical C2 as any operation increases in complexity or precision. In these voids, we can observe how C2 sub-functions engender from the nature of war and how the functions simply take on new forms as required by the changing character and scope of war.[35]

Conclusion

The six-stage concept history shows an increasing need to think about C2 operations in terms of advantage. Both the changing *character* and the unchanging *nature* of war point to a general rise in the significance of C2 operations. Regarding the character of war, the bloom of industrial-age warfare led Napoleon to become a transitional figure pushing the art of C2. The front edge of an operational level in war forced Moltke to think about a "system of expedients." He saw so much advantage in a system of adaptations that he labeled this strategy itself. For Tukhachevskii, the operational level of war made a full arrival in his World War I experience, forcing him to think and shed "a particularly bright light" on the subject of C2 to include fundamental sub-functions that do not appear to change. The range and speed of the aviation era in full tilt forced Dowding to create a new air defense system with elaborate SA feeds. With this C2 system, he helped to save England. Finally, early forms of the information age surrounded Boyd as he envisioned a C2 system that produces pure competitive advantage in the forms of insight, initiative, adaptability, and harmony.

These same men came upon unchanging aspects of C2 in the nature of war itself—like the C2 sub-functions. Tukhachevskii was the first modern warrior to write about sub-functions of a C2 system in stage three. This functional view allowed him to creatively fulfill these unchanging functions, including an early pitch for C2 aircraft. These subfunctions and concepts like OODA mark a quest to trace this invisible profession with the tangible. The quest itself parallels a general rise in the significance of C2 operations as its own subject and a form of advantage.

In stage five, C2 operations also proliferated across industries. One can find very similar sub-functions as another hint at the universal quality of C2 work. As history unfolds before us, the ad hoc emergence of new C2 arrangements pops up wherever C2 voids occur. These voids appear in many forms, but all derive from ignoring the sub-functions—offering another indication about their universal quality and importance.

As we move forward in stage six, C2 may remain an elusive service core function. We know its significance and often address it, but rarely with deep satisfaction.[36] C2 is perplexing for several reasons. When we say "C2," we bound several subjects at once: the people who do C2, doctrine, competencies, skills, platforms, technologies, systems, authorities, tasks, sub-functions, and effects. Addressing any one of these "boxes" alone can lead to only partial understanding and dissatisfaction.[37] Other compounding factors add to the perplexity of C2: the range/speed of air operations, C2 across varying levels of war, joint differences in doctrine and capabilities, C2 as a junction of art and science, Colonel Boyd's three science problems (uncertainty, incompleteness, and entropy of SA), continuous joint interoperability dilemmas, unrehearsed C2 in international coalitions (e.g., Libya), a new era of cyber war, performance of C2 across the full range of the Department of Defense's operations with limited training, and a host of unarticulated social factors that create friction points in C2 operations.

In the end, C2 theory has come a long way since the use of carrier pigeons in Verdun less than 100 years ago. In some ways, we are only just beginning to grasp the enormity of what has been achieved and what is yet to be achieved. Our C2 operations are a critical advantage over adversaries who must perform the same hard work in complex operations. Although such operations are by no means new, grasping the changing and unchanging aspects of C2 like our theorists will foster our C2 mastery into the future. The full power of our people, ideas, platforms, and weapons would remain untapped without a high-functioning C2 system that is strong in the fundamentals. ✪

Notes

1. Department of the Air Force, *Global Vigilance, Global Reach, Global Power for America* (Washington, DC: Department of the Air Force, 2013), 4–9, http://www.af.mil/Portals/1/images/airpower/GV_GR_GP_300DPI.pdf.

2. In response to the idea that technology won Operation Desert Storm, Secretary of Defense Les Aspin addressed the meaninglessness of technology without C2 when he stated that "we know how to orchestrate [technology] in a way that makes the sum bigger than all the parts." Benjamin S. Lambeth, *The Transformation of American Air Power*, Cornell Series on Security Affairs (Ithaca, NY: Cornell University Press, 2000), 152.

3. Carl von Clausewitz, *On War*, ed. and trans. Michael Howard and Peter Paret (Princeton, NJ: Princeton University Press, 1984), 88, 593. Clausewitz discusses how commanders should judge the unique "kind of war" (i.e., the character of war) they face without turning war into something "contrary to its nature" (p. 88). Later he notes that "every age had its own kind of war" and that war retains "a universal element with which every theorist ought above all to be concerned" (i.e., the nature of war) (p. 593).

4. Quoted in Harold S. Orenstein, trans., *The Evolution of Soviet Operational Art, 1927–1991: The Documentary Basis*, vol 1, Cass Series on the Soviet Study of War 7 (London: Frank Cass, 1995), 59.

5. In *Evolution of Soviet Operational Art*, Isserson defines an operation "as a chain of combat efforts, continuous along a front, uniform with respect to depth, and united by an overall plan for defeating the enemy or opposing him. The primary mission of operational art as the study of conducting an operation was the unification of separate combat efforts, not directly connected tactically, in space along a front, in time and in depth to achieve an overall assigned aim, that is, *bringing an entire chain of combat events into an active system*, coordinated along a front and in the depth, which purposefully and successively leads to the defeat of an enemy" (emphasis added) (p. 66). It is commonly believed that the operational level of war did not fully emerge until World War I. Here I simply imply that Moltke was observing the front edge of that evolution and that it began to shape his thinking.

6. Helmuth von Moltke, *Moltke on the Art of War: Selected Writings*, ed. Daniel J. Hughes, trans. Daniel J. Hughes and Harry Bell (Novato, CA: Presidio Press, 1993), 12. Before the Prussians, Pierre de Bourcet of the Ancient Regime in France pioneered an early version of this concept toward the end of the eighteenth century in his treatise *Principles of Mountain*

Warfare and gave rise to the "divisional system" in the French armies of the revolution and Napoleon. The French used flag semaphore to communicate; Moltke used the telegraph.

7. Moltke, *Moltke on the Art of War*, 47.

8. Richard Simpkin, *Deep Battle: The Brainchild of Marshal Tukhachevskii*, trans. Richard Simpkin and John Erickson (London: Brassey's Defense Publishers, 1987). Tukhachevskii referred to these professionals as "special groups of forces . . . formed for purposes of operational direction" (p. 100).

9. Martin van Creveld, *Command in War* (Cambridge, MA: Harvard University Press, 1985), 4.

10. Alistair Horne, *The Price of Glory: Verdun 1916*, unabridged ed., Penguin History (London: Penguin, 1993), 258.

11. See the next section for details. In short, five of these six functions are characterized by 1924 (Simpkin, *Deep Battle*, 97–101). By 1937 he adds "adoption of plans" fed by reconnaissance, which we term "orient shooters" (ibid., 193). One finds elemental functions of C2 throughout his writings, including this definition of C2: "The essence of command and control lies in thorough reconnaissance; adoption of a plan which matches the situation; allocation of tasks to troops; provisions for co-operation; the issue of orders in good time; observation of the way orders are carried out at lower levels; prompt passing of reliable information downwards and sideways and of situation reports upwards; responsiveness to changes in the situation; showing personal initiative; and organization of physical security, of all means of communication and of resupply" (ibid.).

12. Ibid., 202.

13. Ibid., 142–43. Tukhachevskii notes that the radio would transform from a means of communication to a "direct combat resource" for controlling aircraft and the like (ibid., 142–43).

14. Stephen Bungay, *The Most Dangerous Enemy: An Illustrated History of the Battle of Britain* (Minneapolis: Zenith Press, 2010), 45.

15. Ibid.

16. Edwin Leigh Armistead, *AWACS and Hawkeyes: The Complete History of Airborne Early Warning Aircraft* (St. Paul, MN: MBI Publishing Co., 2002), 4.

17. Grant Tedrick Hammond, *The Mind of War: John Boyd and American Security* (Washington, DC: Smithsonian Institution Press, 2001), 2.

18. Frans P. B. Osinga, *Science, Strategy and War: The Strategic Theory of John Boyd*, Strategy and History (London: Routledge, 2007), 190.

19. The US Army is coming closer to Boyd's concept of maximum adaptive initiative with the evolving concept of "mission command," defined as "the exercise of authority and direction by the commander using mission orders to enable disciplined initiative within the commander's intent to empower agile and adaptive leaders [at subordinate levels] in the conduct of unified land operations." Army Doctrine Publication (ADP) 6-0, *Mission Command*, May 2012, 1, http://armypubs.army.mil/doctrine/DR_pubs/dr_a/pdf/adp6_0_new.pdf. This is a modern reformulation of *Auftragstaktik* in the German army as mission-type orders debuted at the battle of Verdun and were applied extensively at the battles of Riga and Caporetto. By 1918 the entire German army had been trained in this philosophy as part of the infiltration tactics that guided the Ludendorff offensives in the West. As adapted from ADP 6-0 (FM 6-0), the mission command philosophy "matches the nature of complex military operations. During complex operations, unexpected opportunities and threats rapidly present them-

selves. Operations require responsibility and decision-making at the point of action. Through C2, commanders initiate and integrate all military functions and operations toward a common goal—mission accomplishment" (p. 1). The Air Force is cautiously flirting with this concept—once again—in the form of "distributed control." See Lt Col Alan Docauer, "Peeling the Onion: Why Centralized Control/Decentralized Execution Works," *Air and Space Power Journal* 28, no. 2 (March–April 2014): 24–44, http://www.airpower.maxwell.af.mil/digital/PDF/Issues/2014/ASPJ-Mar-Apr-2014.pdf.

20. The loops we commonly think of within the TACS now are find, fix, track, target, engage, and assess (F2T2EA) in Joint Publication 3-60, *Joint Targeting*, 31 January 2013, or "find, fix, finish" in Special Operations Command. Yet, the tactical C2 functions in AFTTP 3-1 use both OODA and F2T2EA to explain the substance of each tactical C2 sub-function.

21. Thomas Parke Hughes, *Rescuing Prometheus*, 1st ed. (New York: Pantheon Books, 1998), 16. SAGE is a stage four/five "boundary" system since it has the same purpose as the Dowding model but uses computers in advanced ways—a characteristic of the emerging stage five or Boyd model. By using computers for C2 in basically the same way we use them today, SAGE is placed here in the beginning of stage five.

22. David S. Alberts and Richard E. Hayes, *Understanding Command and Control*, Future of Command and Control (Washington, DC: CCRP Publications, 2006), 2.

23. Jeffrey Vandenbussche, "Centering the Ball: Command and Control in Joint Warfare" (master's thesis, School of Advanced Air and Space Studies, Air University, 2007), 67, 68.

24. Mark Ashley, "KWAR: Cyber and Epistemological Warfare—Winning the Knowledge War by Rethinking Command and Control," *Air and Space Power Journal* 26, no.4 (July–August 2012): 58, http://www.airpower.au.af.mil/digital/pdf/issues/2012/ASPJ-Jul-Aug-2012.pdf.

25. Simpkin, *Deep Battle*, 165.

26. Ibid., 193, 202, 136–37.

27. Ibid., 148.

28. This function lost its parallel wording in the 2012 version of AFTTP 3-1, *TACS*. However, the simple construction of "produce assessments" in 2009 is in common use today, including a 2013 Joint Requirements Oversight Council memo addressing the meaning of manned C2 platforms.

29. Recent experiences in the JSTARS have led to broadening the C2 customer base beyond "shooters." For example, when we orient a ship toward a nonkinetic interdiction at sea, we have supported a "finisher" rather than a shooter per se. Similarly, in operations with several ISR assets all cooperating for one mission, our wide-area radar and communication capabilities have lent to organizing "sensors." Whether we are working with shooters, sensors, or finishers, we have observed that the C2 sub-functions remain the same—like the nature of war.

30. C2 is completely scalable across levels of operations. Producing assessments happens at all levels of war and may be best captured by the relationship of METT-TC, OODA, and "shoot-move-communicate" cycles. The Army acronym METT-TC stands for subjects that require constant assessment, such as mission, enemy, terrain and weather, troops and support available, time available, and civilian considerations. METT-TC represents assessment subjects for the application of Boyd's OODA information cycle, which then, in turn, feeds the entire "shoot-move-communicate" action cycle down to a single warrior (the "A" in OODA). Here in AFTTP 3-1, *TACS*, the "produce assessments" function is designed to capture what happens in aggregate at a tactical level of air operations within the battlespace

where the SA of the actual fight is highest (line-of-sight sounds, the tone of human voices, sights, intuition, local signals intelligence, cumulative line-of-sight radio traffic, local human intelligence from sensitive site exploitation, real-time radar instead of data-link symbols, the feel of weather and topography, etc.). Aggregate examples of tactical assessments would include, "Suspect convoy, 20 vehicles, heading S on Highway 1 with civilian shields" or "Wolf 52 has not checked back in with Wolf 51; last known location x, y, z. Searching." Confusion enters when we assume that the intelligence process-evaluate-disseminate cycle in its various phases is conflated with assessment in the action cycle represented by METT-TC, OODA, and shoot-move-communicate (and vice versa). Assessments in the intelligence and action cycles should marry, as many have pointed out, but the work of each represents different competencies and skills that require constant integration. A Green Beret in an Afghan village, an F-15E flight lead performing close air support, and an intelligence officer doing Phase 2 multi-intelligence fusion all require different competencies and skills to assess in their situations even though all are "assessing."

31. Simpkin, *Deep Battle*, 98–99, 108, 149, 150–52, 168, 208, 250, 256.

32. Van Creveld, *Command in War*, 6–7.

33. Curtis E. LeMay Center for Doctrine Development and Education, "Annex 3-30, Command and Control," 1 June 2007, 75–76, 81–84, https://doctrine.af.mil/download.jsp?filename=3-30-Annex-COMMAND-CONTROL.pdf.

34. N. A. Stanton et al. *Development of a Generic Activities Model of Command and Control* (Uxbridge, Middlesex: Defence Technology Centre for Human Factors Integration, August 2007), 1, http://dspace.brunel.ac.uk/bitstream/2438/1634/1/Development_of_a_generic_activitied_model_of_command_and_control_Stanton_et_al(postprint).pdf.

35. One can see several contemporary examples of C2 voids in Department of Defense operations. First, the joint air-to-ground integration cell (JAGIC) is a close-air-support-centered initiative to address gaps in the TACS in the old air support operations center's sphere of influence. Second, the dynamic air response coordination cell (DARCC) is an ad hoc C2 node that has been forming for approximately two years to deal with an Air Force–Navy seam for reroling aircraft to new missions (see also Dalman, Kopp, and Redman in this issue). Third, JSTARS was tasked to Libya as an ISR asset but filled numerous C2 voids by chance rather than design (see also Matlock, Gaustad, Scott, and Bales in this issue). As mentioned above, Air Force Special Operations Command and C2 of ISR projects are driven largely by C2-function-based voids. In these five contemporary examples, we see C2 voids appear wherever the C2 sub-functions are not fulfilled.

36. One can observe the perplexity in the numerous initiatives that still address fundamental issues about the meaning of C2. Examples include the National Research Council research to "Realize the Potential of C4I" (1996–99); the Command and Control Research Program paper "Understanding C2" (2006); the US Air Force Warfare Center's TACS Tiger Team (2006–8) led by Col Keith Bretscher; the ACC Tiger Team led by Col Francis Xavier; the "C2 Framework" brief (2009) by Col Gary Crowder, USAF, retired; the JAGIC initiative by Col Gator Neal, USAF, retired, and Col El Cid Neuenswander; the Headquarters Air Force–commissioned "ABM Crew Study" (2010); Lt Gen William Rew's AF/A9 brief on C2 (ca. 2009 and beyond); AFTTP 3-1, *TACS*, articulation of C2 tasks, functions, and authorities (2006–9); the Service Core Function Master Plan for C2 (2009); the C2 white paper by Col Tank McKenzie (former 505 ACW/CC) (2010); ACC's "TACS Functional Concept" (2008); the US Air Force Warfare Center's "Re-Blue" briefs in 2009 on defining C2; current ACC initiatives to

define "distributed C2"; and Lt Col Beep Zall's current C2 definition project at the USAF Weapons School (2014), to name a few.

37. The acronym DOTMLPF (doctrine, organization, training, materiel, leadership and education, personnel, and facilities) provides a cross-reference for the problem of partial solutions to building a program of any kind. Dr. Craig Admundson of Cask LLC defined each term the following way in a briefing: doctrine—the way we fight (e.g., emphasizing maneuver warfare combined air-ground campaigns); organization—how we organize to fight (divisions, air wings, Marine air-ground task forces, etc.); training—how we prepare to fight tactically (basic training to advanced individual training, various types of unit training, joint exercises, etc); materiel—all the "stuff" necessary to equip our forces (weapons, spares, etc.) so they can operate effectively; leadership and education—how we prepare our leaders to lead the fight from squad leader to four-star general/admiral (professional development); personnel—availability of qualified people for peacetime, wartime, and various contingency operations; and facilities—real property (installations and industrial facilities, such as government-owned ammunition production facilities that support our forces). New thinking or changes in any one of these areas could be incomplete if taken out of context with the whole institutionalization process represented by DOTMLPF.

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The Rest of the C2 Iceberg

Lt Col Dave Lyle, USAF

Perhaps nothing is more human than to assume that things easily seen are more real and important than those largely hidden from view. Take icebergs, for example. Typically, we focus on the highly visible tips of icebergs above the water's surface rather than the much larger masses of ice hidden from us under the cold, dark water. We fail to appreciate how much the tip depends on all of that mass below it in order to float and how much additional mass is hidden from our view.

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***Titanic* iceberg.** (From Wikimedia Commons, accessed 3 June 2014, http://commons.wikimedia.org/wiki/File:Titanic_iceberg.jpg.)

In many ways, it's the same story with Air Force command and control (C2). Over the last couple of decades, the US Air Force has pioneered and developed a C2 enterprise for joint and coalition airpower that is rivaled by none.[1] When we describe it, we tend to emphasize the highly visible aspects of tactical employment, like the mission-package coordination and tactical execution activities practiced in every Red Flag exercise.[2] As one would expect, however, there is much, much more to the C2 story in terms of who created the plan and whether it will contribute to our desired strategic outcomes.

As we make difficult choices in an era of reduced resources, we must ensure that we do not lose sight of the people, processes, and ideas that help link our tactical actions to desired strategic outcomes. This article describes the foundational C2 concepts that comprise the "entire C2 iceberg." After a brief discussion of the more familiar "tip of the C2 iceberg," it then addresses "the rest of the C2 iceberg"—the people, processes, and products that constitute the air tasking cycle in component major command and numbered air force headquarters. For our purposes—and to suggest a useful distinction not discriminatingly demarcated in Air Force C2 doctrine—the article refers to these as component headquarters command and control (CHQ C2). It lays out current threats to CHQ C2, including cognitive traps, systemic factors, *and "systems illiteracy," all of which currently work to weaken our entire C2 system design*—and, ultimately, our strategic performance—from within. Finally, the article discusses what can be done to ensure that the Air Force's operational-level C2 skills maintain pace with our tactical prowess, assuring that this prowess—as well as the Air Force itself—remains relevant in future security environments.

The Whole Iceberg: Fundamental Functions of C2

Military historian Martin van Creveld observed, "As even a cursory look at their nature will reveal, the functions of command are eternal. Provided he had a force of any size at his disposal, a stone-age chieftain would be confronted with every single one of them, just as is his present day successor."[3] A functional approach to C2 system design anchors planners in the fundamentals of *what* must be done in C2 operations before getting specific about *how* to do it or *who* should do it. In a metaphorical sense, let us lift the entire C2 iceberg, step back far enough to see the whole thing, and describe what it does.

According to Joint Publication (JP) 1-02, *Department of Defense Dictionary of Military and Associated Terms*, command and control is "the exercise of authority and direction by a properly designated commander over assigned and attached forces in the accomplishment of the mission."[4] Thus, the two most essential elements are (1) a commander who has the authority to assign missions and direct forces to accomplish them and (2) a system through which the commander can control his or her forces to carry out that mission.

Commanders exercise command through use of a C2 system, defined in JP 1-02 as "the facilities, equipment, communications, procedures, and personnel essential to a commander for planning, directing, and controlling operations of assigned forces pursuant to the missions assigned."[5] Thus, the design of a C2 system must concentrate on serving the needs and requirements of the commander and the mission. The system's design must have the ability to flex to both the individual commander's specific requirements and the ever-changing mission environment. As described in the 1989 RAND study *Command Concepts: A Theory Derived from the Practice of Command and Control*, the essence of C2 is developing, transmitting, and executing the "command concept," which only the commander has the authority to develop and promulgate:

> Going beyond personality alone, . . . the essence of command lies in the cognitive processes of the commander—not so much the way certain people do think or should think as the ideas that motivate command decisions and serve as the basis of control actions: Ideally, the commander has a prior concept of impending operations that cues him (and his C2 system) to look for certain pieces of information. Our theory cuts through the technological overlay that now burdens the subject . . . [and] represents an attempt to separate the intellectual performance of the commander from the technical performance of the C2 system.[6]

In other words, the critical minimum infrastructure of a holistic C2 system cannot be determined generically or agnostically; rather, it is entirely dependent upon the commander's requirements, given specific missions to accomplish under specific conditions. This C2 system is then used to translate the specific command concept into meaningful, collective action.

Holistic C2 systems, however constructed, must be adequate to match the needs of the commander, whose responsibility can range from very small areas of interest in the case of a highly specialized task force to the breadth of the entire globe in the case of a functional combatant command. At a minimum, they must

- *build situational awareness* (keep the commander and staff informed of the current situation and his/her guidance from higher headquarters);
- *translate commander's intent* (assist the commander in the development and communication of the command concept [which includes both their organizational and operational concepts]);
- *produce feasible plans* (disseminate the command concept to subordinates in clear and unambiguous terms); and
- *conduct mission control* (be sufficient to monitor and control the execution actions of subordinates to the minimum degree required to accomplish the commander's concept, and to allow the commander to issue new instructions when the situation and/or the commander's concept changes).

Any discussion of holistic C2 systems, under contested conditions or otherwise, will concentrate on supporting these most basic functions. It is the job of the commanders and the staff to build and adapt the C2 system to meet those parameters in each case, and there is seldom only one feasible and acceptable way to do it. No matter how it is done, the C2 system serves as an extension of the commander and thus can never be divorced from human interaction.

"The Tip" versus "the Rest" of the C2 Iceberg

When we talk about C2 in the context of Air Force tactical employment, we usually have in mind the C2 elements that execute the air tasking order (ATO)—the Airborne Warning and Control system (AWACS), Joint Surveillance Target Attack Radar System (JSTARS), control and reporting center (CRC), air support operations center (ASOC), and air and space operations center (AOC) combat operations division (COD).[7] Typically, personnel receive training in these elements during common exercises such as Red Flag (live fly) and Virtual Flag (simulated flight environments), in which we sharpen our execution tactics, techniques, and procedures. The C2 elements above—the ones focused on executing the current plan in real time—can be thought of as the tip of our metaphorical C2 iceberg. They serve as connections to the larger C2 system that almost all operators became familiar with early in their initial tactical assignments. Other vital actions support employment (e.g., space enhancement and cyber activities), but this article examines the central tasking processes for air-breathing assets.

The rest of the iceberg includes everything that produces the overarching plan which allows commanders to translate their strategy into the operations and tasks that will fulfill the mission. The rest of the iceberg creates the conceptual and logistical underpinnings of the joint campaign executed by mission commanders at the tip of the iceberg. This requires a blend of operational art and science as well as the ability to negotiate complex bureaucratic environments.[8] C2 systems literacy—the construction of sufficiently accurate individual and collective mental models of the world with which to take useful action—involves understanding the whole C2 iceberg and the dynamic organizational processes that keep it afloat (see the figure below).

Figure. The C2 iceberg (notional). (From Shutterstock, http://www.shutterstock.com/pic.mhtml?id=131163173&src=id, adapted for this article in accordance with the licensing agreement, http://www.shutterstock.com/licensing.mhtml.)

AAMDC - US Army Air and Missile Defense Command

AETF - air expeditionary task force

AFFOR - Air Force forces

AOC - air operations center

AOD - air operations directive

ASOC - air support operations center

ATO/ACO - air tasking order / airspace control order

AWACS - Airborne Warning and Control System

BCD - battlefield coordination detachment

CC - component commander

C-MAJCOM/C-NAF - component major command / component numbered air force

COCOM - combatant command

CRC - control and reporting center

DIRMOBFOR - director of mobility forces

DIRSPACEFOR - director of space forces

ISR - intelligence, surveillance, and reconnaissance

(J)ACCE - joint air component coordination element

JAOP - joint air operations plan

JPRC - joint personnel recovery center

JSTARS - Joint Surveillance Target Attack Radar System

JTF - joint task force

MARLO - Marine liaison officer

MISREP - mission report

NALE - naval and amphibious liaison element

OGA/IA - other governmental agency / international agency

OPORD - operation order

OPTASKLINK - operations task link

ROE - rules of engagement

SOLE - special operations liaison element

SPINS - special instructions

TACREP - tactical report

TST - time sensitive target

In the US Air Force, the rest of the iceberg deals with component major command or component numbered air force processes that support specific geographic and functional combatant commanders.[9] These can be described generically as the component headquarters or CHQ, each of which has an Air Force forces (AFFOR) commander and staff who present forces to the joint force commander and deal with Air Force service-specific issues as a "force provider." It also includes the AOC, with the trained and proficient core of a joint or coalition air operations center (JAOC/CAOC) staff.[10] When the joint task force (JTF) commander establishes functional components, the joint force air component commander (JFACC) uses the jointly manned JAOC/CAOC to perform operational missions as a "force consumer." The commander of Air Force forces is always an Air Force commander and typically "dual hatted" as the JFACC although a JFACC can be an Airman from any service. Furthermore a JAOC should always be jointly manned with augmentees from the other service and coalition components. In practice, it is not unusual for the deputy JFACC to be an aviator from another service or coalition military partner. Air Force operational forces are normally presented to the joint force as an air expeditionary task force (AETF) in accordance with joint and service doctrine.[11]

The organizational skills required of commanders and their staffs to perform well in the rest of the iceberg are not the same as those tactical skills needed to succeed in the tip although having an in-depth understanding of tip activities is absolutely critical to building feasible plans in the rest of the iceberg.[12] Practitioners of CHQ C2 must be able to think beyond their tactical "family of origin" weapons systems and understand how the various joint and coalition forces can fit together into a coherent scheme of maneuver. Air planners in the JAOC are specifically trained in the joint operation planning process for air but also support the parallel joint operation planning process performed by JTF headquarters.[13] Thus, they must be familiar with multiple joint and functional operational-art concepts, doctrine, and terms. Moreover, they must be able to translate between them as they produce air component supporting plans to the joint campaign.[14] CHQ planners must work with various embedded liaisons from other agencies to coordinate integrated planning. Above all, they must focus these processes on getting the right decision-quality information to the appropriate commanders, who then use the same system to assess the situation, choose courses of action, accept risk, disseminate their guidance, and assign concrete tasks to the tactical units in the tip.

Just as one must understand aerodynamics, engineering, thermodynamics, computer science, and more when designing and operating aircraft, so must people who design and operate C2 systems grasp the organizational theories and concepts inherent to CHQ C2. They must be versed in group decision-making theories, jargon used in operational graphics and orders production, war gaming, operational analysis, communications network architecture, and information security. These concepts, and many others not detailed here, are like the crystalline structure upon which the collective strength of the entire C2 iceberg depends.

These people, processes, and tools of CHQ C2 bring predictability, rigor, and discipline to the air tasking cycle, which is very important to a process in which seemingly minute details can often have a disproportionately large impact on effectiveness during execution. They enable the detailed integration of many assets from many locations, help to eliminate costly resource mismatches and targeting errors, identify operational limits, and create the cognitive and logistical backbone of the plan that the COD and its subordinate tactical C2 elements can then modify as needed on the day of execution. Shortcutting this process may be necessary at times or even desirable, but doing so almost always comes with additional costs in a systemic sense: it usually increases strategic and operational risk when careful target analysis and weaponeering, requirements resourcing, deconfliction of friendly forces, synchronization of supporting effects, collateral damage estimates, and so forth, are abbreviated or omitted for the sake of operational urgency. For very good reasons, these processes and procedures have withstood the test of time and should be the entering argument for the evolution of our C2 systems. Those who fail to understand the holistic nature of the system when offering alterative solutions risk introducing internal threats to our C2 excellence.

Threats to C2 Excellence

Complacency in C2 System Design

Often, long periods of success without serious challenge lead to complacency. When something is done well for a long period with few notable mishaps, the human tendency is to forget lessons previously learned, become comfortable, and assume that the future will closely resemble the past. When this happens, it becomes very difficult to recognize game-changing events in the operational environment—that is, until it is too late. Four conditions that we have collectively become accustomed to over decades of deployed combat operations may lead to cognitive complacency in the design and maintenance of C2 systems.

The "recent" operational environments have been largely static and predictable compared to likely future conflicts. The Air Force can be proud of the service provided to the joint force in areas like ISR, close air support, air mobility, tactical C2, personnel recovery, and medical evacuation. Much has been accomplished with relatively few assets—and made to look relatively easy in most cases due to a permissive air-threat situation, sufficient basing, and the fairly static nature of associated logistical problems. This operational environment allowed incremental improvements, added by a succession of staffs over time. However, many of the professionals responsible for these improvements have largely moved out of C2 assignments, taking their experience and understanding with them.

The operational C2 environment has been tactically focused on ground operations rather than robust, multidomain campaigns. Although we have trained CHQs with robust scenarios in Blue

Flag and other higher headquarters command post exercieses, funding for those activities has been significantly curtailed or eliminated, with many being cancelled or relegated to "tabletop only" status.[15] We are rapidly approaching a point where some CHQ staff members will never have seen "what right looks like" regarding the full CHQ C2 requirements for high-intensity major combat operations.

We have slowly regressed to simpler processes and products that will not support higher-intensity war fighting, to the detriment of high-level C2 skills. Our total weight of effort in US Central Command's area of responsibility (CENTCOM AOR) has been low enough that we have been able to plan and track the entire ATO using basic Microsoft Office tools. At the same time, our skills with the tools necessary for planning major combat operations via theater battle management core systems applications have atrophied.[16] It has been logical to do so—there is no reason to make a task more difficult during actual combat operations when something less complex works better. However, we need to recognize that the less simplified processes of today may be completely unsuitable to handle more complex issues tomorrow. Now is the appropriate time to challenge ourselves and regain the skills needed for a much higher-demand signal from airpower.

Our ability to conduct C2 has not been significantly contested. Conventional wisdom requires us to consider the likelihood of contested and degraded operations, but we have only recently begun considering their implications for CHQ C2. Currently, we can coordinate the simultaneous actions of military forces around the globe and perform feats of synchronization and precision of which futurists of old could only dream. Allowing ourselves to become more dependent on our tools, we may have lost touch with many of the basic tenets of C2. Articulating the fundamental challenges and trade-offs of C2 across the entire combat air forces (specifically those in operations) will help us take proactive measures to protect our C2 in contested environments. This will also help us avoid the "one size fits all" mentality that never addresses all of the problems involved in a contested and degraded operations scenario.

Threats from Systemic Factors

Because C2 has been "assured" in the conditions described above, an enterprise-level solution has not developed to address some systemic matters that threaten our C2 expertise in terms of managing human capital and resources. We must address eight emerging issues.

C2 demand signals and resource allocations are going in opposite directions. At the very time that more institutional C2 knowledge and experience are needed to deal with near-peer challenges as called for in the Joint Operational Access Concept and supporting concepts like the Air Sea Battle Concept, our C2 resources either remain static or decrease.[17]

C2 experience in the staffs is decreasing because of personnel policies, including the present system of career incentives. A career field for air battle managers in the AWACS and CRC exists, but there is no similar career field at the CHQ C2 level in the Air Force that helps the Air Force Personnel Center match people with the organizational experiences discussed previously with CHQ C2 assignments. Because of the lack of a career field for CHQ C2 operational-level planners—and very few opportunities for squadron command outside a small number of AOC training and testing squadrons—our brightest future leaders (who usually understand the tactical tilt of the Air Force system very well) enjoy few career incentives to seek CHQ C2 assignments actively. Ironically, these AOC and AFFOR assignments would prepare someone for operational and strategic command later as an AFFOR and AOC division director, AOC commander, and JFACC. Instead, these assignments tend to hurt rather than help chances for promotion to senior rank.[18] As a result, those who do attain senior rank usually do so through a succession of mostly tactical assignments or staff assignments other than those in CHQ C2. Often, these officers end up making major decisions that affect the future of the AOC and AFFOR albeit without the full understanding of what CHQs do and what sustaining and modernizing them requires. Talent and intelligence can make up for many deficiencies; the leaders we get through the mandatory path of tactical assignments at the squadron, group, and wing levels usually have those qualities in abundance. However, the development of expertise in a complex enterprise carries fundamental demands for focused engagement with the conceptual elements over time to cultivate intuition, expertise, and mastery. Sometimes there is simply no substitute for time and experience under actual conditions to become truly proficient.[19] When it comes to the complexities of CHQ C2, no crash course can teach personnel all they need to know, no matter how talented the students may be.

C2 is not in our cultural DNA, as are tactical weapons systems. Despite its foundational importance, joint and combined organizational-level C2 is difficult to visualize and even more difficult to fit into service narratives that we use to describe our organizational essence. Good Air Force commanders have traditionally recognized the importance of organizational-level operational C2—hence, the AOC and AFFOR construct. However, few senior leaders have an emotional attachment to C2 in the same way they do airframes, leading to a subtle bias towards the tip-of-the-iceberg systems that most individuals have more familiarity with from their tactical backgrounds. The Air Force's service culture reinforces this propensity to value tactical operations and advanced technologies over operational-level competency.[20] When C2 initiatives have to compete for precious attention and resources, commanders may tend to fall back on the heuristics emphasized by their personal experience in tactical assignments and deemphasize less familiar CHQ programs, even if they are critical to future success from a larger, much more systemic perspective.[21]

Some legacy CHQ C2 training has already fallen victim to budget pressures. AOC initial qualification training has been normalized in the program objective memorandum (POM), but both in-residence advanced AOC training (the Command and Control Warrior Advanced

Course or C2WAC) and initial AFFOR training have been curtailed in recent years because of a lack of funding rather than a lack of demand in the field. Blue Flag, the operational AOC training specifically designed to train AOC, joint air component coordination element (JACCE), and AFFOR personnel in the full range of air tasking cycle processes, has already been cut in fiscal years 2014 and 2015 due to budget pressures, increasing the risk that personnel assigned to the AOC and AFFOR will not experience realistic CHQ C2 battle-rhythm processes until an actual contingency occurs. Emphasis on operational planning has improved in Air Force professional military education (PME) for officers (specifically, Air Command and Staff College), but many officers assigned to AOC and AFFOR staffs do not attend those courses before receiving their AOC, JACCE, and AFFOR assignments. Budget pressures have eliminated CHQ C2 training previously offered by the 505th Command and Control Wing at Hurlburt Field, Florida, to students of the School of Advanced Air and Space Studies despite the high probability that many of its graduates will be assigned to high-impact CHQ C2 jobs after graduation.[22] The service has never offered a formal course to train members of the JACCE, regardless of the critical role they play in connecting higher headquarters and functional component planning with centralized air planning in the JAOC.[23]

Cessation of in-residence AFFOR and advanced training creates systemic effects in the C2 force. When the people selected for these CHQ assignments do not have formal training in the basics, they do the best they can when they get there. They take the initiative and develop procedures on their own that address the exigencies of the particular moment. Nevertheless, these local solutions usually are neither scalable to different levels of intensity nor translatable to other headquarters. Over time, this situation creates a pernicious effect on the aggregate levels of C2 experience and understanding across the force, making adaptation to different situations or combining personnel from various CHQs in an emergency situation a much more intractable problem. The result, validated by our own historical experience before establishment of the CHQ C2 processes, is extended C2 "pickup games" and process disconnects during critical moments of escalation and conflict.

The lack of proper understanding of CHQ C2 and of sufficient doctrinal terminology to distinguish "tip" from "rest" functions creates the illusion that we are adequately addressing C2 from an institutional perspective. Because we don't make a clear doctrinal distinction between the mostly tactical C2 processes in the tip and the mostly bureaucratic C2 processes involved in CHQ C2 in the rest of the iceberg, we tend to talk past each other when we mention C2 generically among different C2-related activities. Sometimes the false impression that "C2 is covered" encourages us to neglect some critical aspects entirely (e.g., CHQ advanced training and career management) in our steady-state budgeting and programming and personnel system. Air battle managers are considered a distinct C2 career field, and many of them later become excellent leaders in CHQ C2 organizations, but their normal duties in the JSTARS, AWACS, and CRC do not specifically prepare them for CHQ assignments or make them CHQ C2 process experts upon initial arrival. POM normalization for AOC initial qualification training has been very beneficial and stabilizing for initial training, but failure to fund the AOC simulation capabilities and their upgrades threatens our ability to provide mission-qualification training once the students leave the schoolhouse.

CHQ C2 systems illiteracy leads directly to strategic illiteracy and service irrelevance. As a distinguished Air Force strategist once remarked, "You're not a strategist unless you're a strategist of bureaucracy."[24] The best strategy is useless unless one understands and knows how to maneuver through the social systems in which strategy is informed, formed into a plan, and transformed into taskings. Further, as the venerable physicist Stephen Hawking once said, "The greatest enemy of knowledge is not ignorance; it is the illusion of knowledge."[25] If leaders rise to rank primarily through demonstrating tactical excellence without the requisite CHQ experience and awareness to understand the relevant issues, they probably will not make the right decisions, no matter how well intentioned, intelligent, or talented they are.

Systemic deficiencies have been concealed by abundant resourcing so far, but that is about to end. In an era of funding for overseas contingency operations, we have often been able to address systemic inattention to CHQ C2 via rapid-acquisition programs and fallout funds. In times of budget austerity, this is less likely to happen. Our ability to create local "bailing wire and paper clip" solutions for C2 technical issues is not going to keep pace with the rate of change as some parts of the C2 system are upgraded through normalized POM inputs while others are neglected.[26]

Faulty C2 Assumptions Caused by Systems Illiteracy

As we explore alternative options to the current AOC and AFFOR constructs in the future, we must be cautious not to oversimplify the problem with proposed solutions that do not acknowledge the full depth of our current C2 processes. Each process has evolved out of necessity to add depth and rigor to the air tasking process, and significant risks may arise if its contributions—and the reasons they were introduced in the first place—are not fully understood. Unless one is truly "systems literate" and considers the whole of the C2 issue before offering simplifying prescriptions, proposals to modify our C2 will probably solve only part of the problem and may make its other parts worse. Knowledge of foundational C2 theory validated by a thorough understanding of history suggests that the following general assumptions about C2 are fundamentally flawed unless they are carefully qualified.

We can automate situational awareness and eliminate the fog of war through technology.[27] Airpower is not just about collecting data, looking for patterns, and selecting the right preprogrammed decision algorithm to activate or deactivate strike packages. It is much more complex, involving an understanding of the entire environment and choosing multiple responses to shape outcomes favorably across the physical, cognitive, and moral domains.[28] In war the desired ends are political effects, which are social constructs by definition. Humans in the loop—more specifically, groups of them working in concert—are still the only parallel processors capable of deducing social context from the results of potential or actual tactical actions.[29] Even the best algorithms behind automated "big data" analysis depend on assumptions built into their search algorithms, ones developed ahead of actual events that may not yield appropriate insights when social contexts change faster than the algorithm can be reprogrammed. Any proposed operational concept that treats air warfare as reducible to a targeting exercise against certain types of targets—and nothing more—is fundamentally flawed from inception.[30]

We can automate the planning process and gain efficiencies in personnel. Blanket information technology solutions, even when well funded, can seldom adapt to very different requirements driven by complex joint and coalition operations. If an automated data-collection process is not configured to "ask" the right questions or the means of displaying information does not match the way that rotating commanders visualize and absorb information, then the tool will actually hinder effective C2. This is a general truth of any complex situation—as the system becomes more complex, "blanket solution" attempts to control them tend to generate more unintended consequences.

We can centralize all of the global requirements for "function X" in one place to gain efficiencies in personnel. Because the social interface prevents full automation of C2 decision making, any C2 system has fundamental human-cognitive load limits. One has only limited time to build the situational awareness and context needed to correctly interpret the information received by humans in the loop. Although it may be possible to centralize some very discrete functions that do not require screening for social context (e.g., weaponeering analysis on discrete target sets or imagery analysis), the artificial intelligence required to do so with the entire C2 enterprise does not yet exist and never will as long as social effects matter. Detailed contextual knowledge is needed to estimate the social effect that airpower actions will have in specific areas and contexts; thus, generalists with wide-area or global responsibilities are less likely to draw correct conclusions looking at the same data as a specialist intimately familiar with local contexts. Air strategy is not simply a matter of hitting targets in a mechanistic fashion—it's about knowing which targets matter in a social sense and why. Consequently, one needs specific area expertise and concentration in areas like geography, economics, local culture, threats, doctrine, and so forth.

We can conduct all of our planning via distributed means. The Air Force learned the importance of "actual presence" the hard way during development of the JACCE, whereby possessing a "seat at the table" became a requirement to have a voice in the plan.[31] This comes down to basic human psychology. We communicate and form trust primarily through receiving nonverbal cues of intent, embodied in what are often unconscious cues passed through gesture and tone of voice, and physical cues that affect our perceptions of trustworthiness in others.[32] Without these, we become suspicious of each other and fill in the missing data with stereotypes that often erode trust and communication. The effect of being on different sleep cycles further reinforces the misperception that distributed planning efforts are not supporting and often run counter to the requirements of war fighters closer to the fight. As anyone who has served in the CENTCOM AOR can attest, it is usually impossible to get anything done with a higher headquarters back home until afternoon, CENTCOM time, and the questions from that headquarters usually arrive at the same time deployed planners are ready to turn in for the night.

We also need to acknowledge that not all critical C2 processes happen during scheduled battle-rhythm events and that having forward planning presence and personal relationships with the key planners is critical to joint planning and execution. Without liaisons and regular battlefield circulation, the air component has less influence in shaping the initial presentation of joint courses of action, which tend to dominate the discussion over subsequent suggestions, even the sounder ones—another documented cognitive bias that is largely subconscious. A final opportunity lost by not having a forward geographic presence is the prospect of chance meetings with planners of the other services. These often lead to better solutions and detection of previously unknown problems that may never surface during preplanned battle-rhythm distributed meetings in which the social pressures of rank and precedence may restrict free discussion or sidebars that often generate the most creative solutions.

Most C2 functions can be distributed to subordinate units and entities. The C2 system necessary to carry out the mission is completely dependent on what the mission is—there is no universal solution for C2. As long as the system can perform the basic strategy-to-task-to-assessment processes described at the beginning of this article and personnel can accomplish their mission in the conditions they encounter, the C2 system is adequate, even without all of the processes in the iceberg. But oftentimes the AOC and AFFOR processes developed the way they did for good reasons. Before options for distribution or consolidation of functions are considered, commanders must understand the impact on their ability to control forces effectively and efficiently when assumptions prove incorrect—when friction and chance enter the equation. Commanders must realize that when they delegate control, they also delegate risk acceptance. If the distributed node does not have the expertise, situational awareness, or span of control necessary to make good command and risk decisions, then delegation of C2 may prove worse than taking an operational pause while the CHQ C2 elements reconstitute their critical processes. This is especially true when joint schemes of maneuver are highly interdependent and when the distributed node is already under stress to perform its primary mission.[33]

"What works in Red Flag and weapons school for C2 training will work for CHQ C2." As we have seen above, the rest of the iceberg gets good training when large organizations have to work with other large organizations and merge their bureaucratic processes in common directions. The tip-of-the-iceberg forces get good training when they have to adapt to changes to a plan that had already been provided in order to fulfill previously defined missions. Thus, with the exception of the combat operations floor, exercise events that usually offer good training for the AOC (conducting parallel planning, racking and stacking priorities, and resolving resource shortfall dilemmas) leave the tactical units spinning uselessly, losing valuable training time while waiting for guidance. It is much better to have a controlled, constructive model for CHQ training in which a simulated air entity can hold endlessly while the staff works through its training objectives and perhaps learns more from a mistake than making the right call in the first place.

Similarly, trying to conduct AOC process training during a tactical exercise with defined takeoff times, airspace, targets, and mandatory lists of players makes it impossible for AOC planners to exercise operational art in a real sense. In real life, the AOC's job is to ask what problems should be solved and design feasible, creative solutions for operational and tactical problems, which may or may not involve all of their assets. Thus, AOC play in a live or virtual event in which players, roles, timing, and locations are defined is analogous to having to define and solve a word problem or receiving an already-solved algebra problem and being told to concoct a story about the variables so that the predetermined flying or simulator schedule solution makes sense. It is good exercise support for the tactical units, but it is not effective CHQ C2 training. If inexperienced AOC personnel serving as AOC response cells (i.e., people who create simulated outputs from processes that aren't really happening to create a realistic training environment for others) don't know "what right looks like," then participation in Red Flag can actually constitute negative training. CHQ training has to do with processes, and CHQ processes do not happen when other headquarters elements are neither participating nor being simulated by someone else.

Having so many outstanding tactical C2 "hammers" in the tip and only a small cadre of identified CHQ C2 experts to consult on new proposals makes it really easy to imagine that all CHQ problems are "nails." Recent proposals for the Advanced Integrated Warfighting Weapons Instructor Course, designed by tactical C2 integration experts to address issues in operational warfare, are going in exactly the *wrong* direction for CHQ C2. Instead of doubling down on tactical experience by requiring participants to spend more time in their specialized family-of-origin major weapons system as tactical integrators, we need to pull tacticians *out* of those systems *sooner* and teach them to be generalist, multidisciplinary CHQ planners and organizational-process experts as senior captains and junior majors.[34] Doing so will give them more time to season in an actual CHQ rather than learn all of their CHQ C2 skills in classrooms and labs. It will allow them to bring real-world CHQ C2 experience into intermediate developmental education and improve their capability to serve later as AOC and AFFOR division chiefs and directors, who need more organizational than tactical skills to perform their CHQ C2 missions.

Six Ways to Secure Operational-Level C2 Excellence

Given the requirements of operational C2 discussed previously and the need for holistic systems literacy to be effective across the entirety of the C2 enterprise, we can make a few general recommendations regarding requirements for maintaining current C2 capabilities in the face of increasing external and internal challenges.

Recognize That CHQ C2 Is Very Challenging and That How Well It Is Done Has a Significant Effect on Strategic Outcomes, with Far-Reaching Consequences for National Security and Prestige

CHQ C2 is not rocket science—it is much more difficult than that. When the hand moves the handle slightly at a component headquarters, the end of the tactical whip can quickly go supersonic. In other high-impact professions that require multidisciplinary knowledge to perform competently, such as medicine or law, we demand extensive screening and professional preparation—including thorough testing and board screening processes—before selecting someone for the task. CHQ C2 should be no different. Assignments there should not be seen as the "alpha tours" of old, a manning bill to be paid and escaped from as soon as possible to maintain career viability in a system biased more towards tactical achievement.

Acknowledge That the Heart of Operational C2 Is a Human Problem, Not a Technical One, Which Requires Specialized Organizational Skills and Practical Experience Earned over Time to Build and Maintain C2 Excellence

The skills necessary at this level are not identical to those required at the tactical level. We must actively encourage and develop dedicated, organizational-level C2 experts with the same rigor as we do at the tactical, identify and track them in the personnel system, and ensure that CHQ C2 experts have career opportunities commensurate with those available to tacticians and strategists. Organizational-level C2 expertise must be multidisciplinary by nature, and those who practice it must have a solid grounding in many different fields of theory and knowledge, as well as the organizational techniques to bring people and insights from various fields into the same planning effort.[35] The background that one needs to perform in the rest of the iceberg includes, but is not limited to, history, geography, decision theory, social and organizational theory, internal and external cultural awareness, awareness of the negative effects of cognitive bias, and familiarity with a number of analytical tools and group-planning techniques that support good decision making.[36] Many of these skills take years of concentrated study before their practitioners become proficient—skills not required or learned in the tactical assignments in which most members begin their career.

We also need to be more proactive in identifying individuals with the aptitude and desire to assume the complex challenges of organizational-level operational C2 and in consciously steering them into viable career paths and command opportunities so they can build the experience they need to lead the C2 enterprise later. This also includes creating squadron-command-equivalent billets within CHQ C2 assignments so that C2 leaders can compete for senior leadership positions later, along with the tactical specialists. It makes no sense to train people specifically for multidisciplinary CHQ C2 positions but then insist that they spend the next four to six years commanding tactically focused units before they can use those skills again, thus allowing their CHQ C2 skills to stagnate in the meantime. It leaves little time for the deliberate engagement and reflection that our future CHQ C2 leaders need to propose innovative CHQ C2 solutions—the current CHQ C2 system is *not* the final answer to our future rest-of-the-iceberg questions.

CHQ C2 assignments should be career enhancements, not speed bumps to avoid. Because these jobs are inherently joint, steering our sharpest young minds towards them will increase our competence—hence, influence—in joint settings as well. The same young officers and noncommissioned officers who rub shoulders with their sister-service equivalents in CHQ C2 assignments will surely see them again someday in a joint headquarters, the Pentagon, and possibly even in the "Tank"—and those personal relationships will pay dividends.[37] If the Air Force wants more say in joint planning and processes, it needs to send Air Force people who can already speak in terms of joint planning processes—not those who are just learning it on the fly after a lifetime as inwardly focused Air Force tactical specialists.

Recognize That Tactical Proficiency in a Specific Mission Design Series and the Ability to "Speak Air Force" Are the Cost of Entry but Are Not Sufficient in Themselves to Succeed at CHQ C2

Simply to survive in joint- and coalition-planning environments, organizational-level operational C2 practitioners must not only be familiar with joint, allied, and sister-service doctrinal concepts and language but also be conversant in several operational-planning methodologies. They must be able to serve as translators between different service languages and cultures, but first they must have proficiency of their own in terms of Air Force doctrine and C2 terminology. They should begin their work in C2 with expertise in at least one or more tactical areas, but they should not stay with one mission design series too long before receiving an operational C2 assignment. This ensures that they have time to develop the organizational skills needed to carry the air tasking cycle all the way from strategy to task. Incentives should be offered to those who pursue sister-service PME after they complete Air Force PME. Allowing people to self-identify themselves for CHQ C2 assignments in such a way is a good indicator of individuals who have the perspicacity and drive to make the dramatic shift from tactics, to operations, and eventually strategy.

Invest in In-Residence Initial and Advanced Training for Organizational-Level Operational C2 Assignments, and Spread Specialized Education across a Career in the Same Way We Do with Our PME

Online AFFOR education is better than nothing, but it robs students of the opportunity to gather valuable insights gleaned from face-to-face interaction with experienced teachers who can tailor their instruction to specific requirements of the students and their assignments. Additionally, spreading out initial and advanced operational-level C2 training—as was the practice between AOC initial qualification training and the Command and Control Warrior Advanced Course—allows students to see a CHQ in action before reengaging in the theory. Doing so leads to a richer educational experience when they return to the classroom and even greater dividends when they become advanced-training graduates. Requiring some experience between initial C2 training and advanced training will better prepare students to engage with the advanced material, and they will even bring back new insights and lessons learned that will strengthen the entire community. CHQ skills require a lifelong-learning mind-set, and our preparations for these positions should mirror this fact. It is good that some of our formal PME courses have already incorporated CHQ C2 education and training into their syllabi, but it is also true that many of the people assigned to CHQ C2 assignments have not yet attended these courses.

Continue to Invest in Organizational CHQ Operational C2 Exercises and Encourage COCOM-Level Exercises to Include Training Objectives That Involve CHQ Processes

Except for people who monitor and direct tactical execution (found mostly in the COD), AOC and AFFOR players get useful mission training when they actually interact with the staffs and entities they would have to talk to in real life to conduct joint and coalition parallel planning, including active participation in joint battle-rhythm processes. Such training can occur in the context of major COCOM exercises like Terminal Fury, Austere Challenge, and Emerald Warrior, as well as Blue Flag, in which those processes can be simulated with enough fidelity to offer AOC personnel accurate inputs and useful critiques of their processes and products to facilitate learning. This does require commitment on the part of the primary training audience—usually the COCOM staff—to create scenarios and master-scenario event lists that address AOC and AFFOR needs since these may be the only opportunities that these entities have to fully exercise their C2 functions in the joint boards, bureaus, centers, and cells that drive a joint battle rhythm.

Explore New Three-Dimensional Operational Graphics, Animations, and Computer Simulations to Raise General Awareness of "Rest of the Iceberg" Issues and to Improve the Systems Literacy of Those Who Are Not C2 Experts but Will Find Themselves Making Decisions about the C2 Enterprise

It is almost impossible to engage either creatively or critically with something without a basic mental model. Rich visualizations and animation have an amazing power to access the creative mind and to inform our intuitions about systemic complexity. Even prespeech infants who do not understand anything about the inner workings of computers can easily manipulate computer interfaces of today to access and play their favorite video games on touch-screen devices using the visual metaphors of Windows-based user interfaces.[38] We have an unprecedented ability to use data to create empirically accurate simulations of operational scenarios. We can and should visually depict our schemes of maneuver, using both rich, multidimensional graphics and simulations to help C2 practitioners better visualize the operational constraints and linkages that make the rest-of-the-iceberg activities especially daunting. This is not to say that we should allow ourselves to be dependent on such tools—the ultimate goal is still to build systemic intuition that can be applied with a grease board as easily as a projector. Currently, however, the products we use are usually too simple for either educating C2 or practicing high-level operational C2. We still employ two-dimensional Microsoft Word and PowerPoint products to frame and war-game complex, multidisciplinary operational problems in the planning process, and we too often present gross oversimplifications of complex planning efforts to decision makers in three-to-four-slide quad-chart decision briefings.

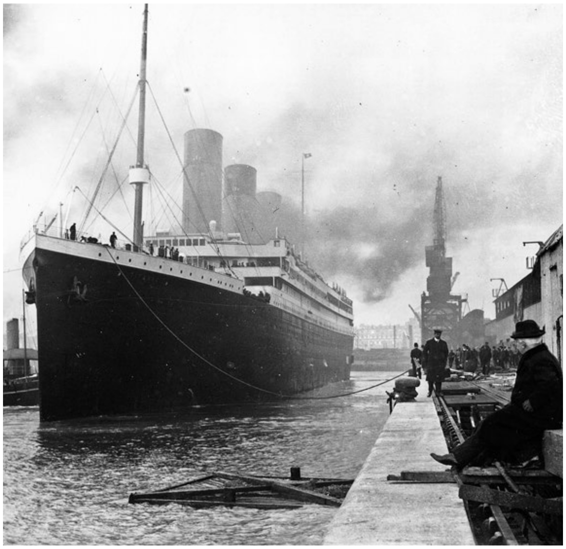
Animated operational graphics that utilize standard symbology—used from initial education through actual mission rehearsals and debriefings—will help us better illustrate joint interdependencies in ways that static, two-dimensional products never can. Using them, we can develop the same kind of intuitive feel for operational warfare that we experience every time we use colored and animated weather maps to evaluate complex weather systems: within just a few seconds of observation, we can usually tell whether or not we need an umbrella. If we had similar visual tools for operational-art concepts, it would be much more difficult to take for granted rest-of-the-iceberg operational considerations like resource allocation and mutual interdependence if the simulation stops when it encounters a constraint. Airpower advocate Alexander de Seversky understood this concept well when he collaborated with Walt Disney in making the film *Victory through Air Power* in 1943. De Seversky used simple, hand-animated operational graphics to illustrate complex concepts of operational art to the general public. Even if his message was at times overly simplistic, the explanatory power of the animations is undeniable and, in many ways, superior to the way we teach the same operational concepts today.[39]

In an ideal situation, we could replace de Seversky's cartoons with accurate, simulator-generated depictions of our operational schemes of maneuver and threats. We could play out an entire joint scheme of maneuver in a simulated battlespace, checking for seams in the plan and limiting operational constraints before presenting joint courses of action to commanders. For example, if a joint plan called for more air-refueling tanker gas than actually available, if the same asset were assigned to multiple locations, or if an asset were planned to penetrate an enemy's integrated air defense system without sufficient mutual support, then the simulation should highlight the discrepancy and point to the limiting factors, in much the same way that commercially available strategy games do with combinations of color and sound alerts. We are already training a generation of gamers to think this way, so why are we not training a generation of planners in a similar fashion?

Are we going to have this kind of modeling and briefing capability soon? No. Would our situational awareness and systemic literacy benefit from the incremental steps it would take to get there, rather than just using the static slides and diagrams we rely on today? Yes. And would it help us to make our planning assumptions explicit and open for debate, even if absolute systemic truth could never be depicted? Absolutely.

Conclusion

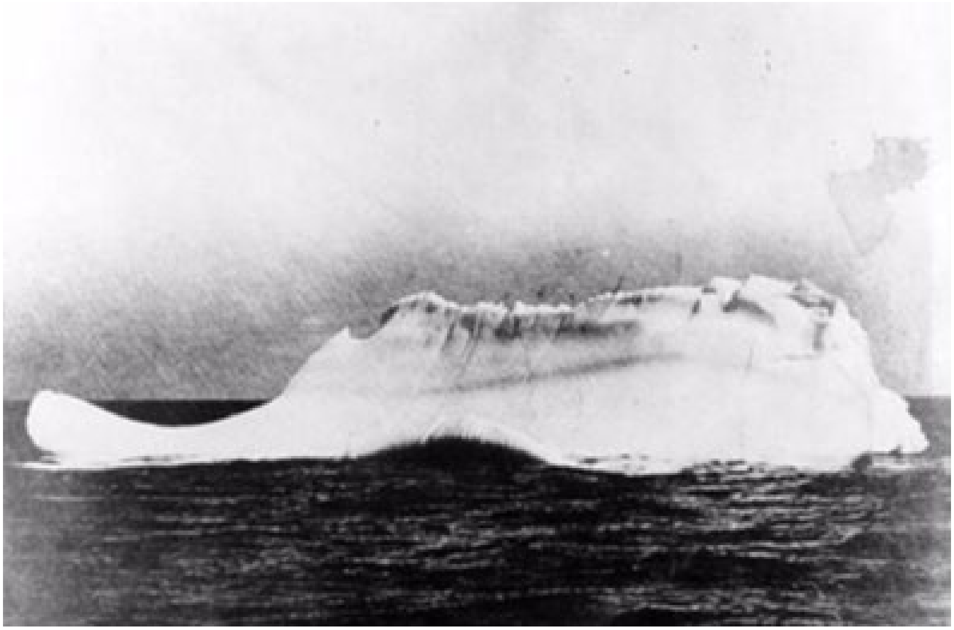
Any discussion of icebergs would have to include the tragedy of RMS *Titanic*—the largest, most advanced ship of its time, possessing staggering levels of capacity, technology, prestige, and raw power. Many people, perhaps including some members of its crew, considered it "unsinkable." Of course, they didn't realize the danger presented by icebergs and how little steering command they had with their comparatively small rudder until it was too late.



***Titanic* at the docks**. (From Wikimedia Commons, accessed 3 June 2014, http://commons.wikimedia.org/wiki/RMS_Titanic#mediaviewer/File:Titanic.jpg.)

Titanic**'s stern and rudder**. (From Library of Congress, George Grantham Bain Collection, accessed 3 June 2014, http://www.loc.gov/pictures/item/2001704333/.)

This is not to say that having superior technology and the most impressive gear is undesirable in dangerous environments. Because declining budgets will certainly prompt difficult choices, however, it is crucial to remember that tactical power is useless without sufficient C2 to direct it well. Our service needs a good CHQ C2 rudder and a highly competent crew to direct it in order to avoid leaving Air Force–blue paint marks on an unexpected iceberg someday.[40]



***Titanic* iceberg**. (From Wikimedia Commons, accessed 3 June 2014, http://commons.wikimedia.org/wiki/File:Theberg.jpg.)

The challenges involved in CHQ C2 and the skill sets needed to execute the plans made there are not the same. The most important way to hedge against future C2 problems is to make sure we maintain—and institutionally value—a deep bench of people who have holistic C2 systems literacy and creatively use the tools available to them to make the needed communication and coordination happen. This means a continued investment in the people, processes, and tools of CHQ C2, lest our tactical excellence be all for naught. ✪

Notes

1. For a detailed description of our current air and space operations center and Air Force forces constructs and planning processes, see Curtis E. LeMay Center for Doctrine Development and Education, "Annex 3-30, Command and Control," 1 June 2007, https://doctrine.af.mil/download.jsp?filename=3-30-Annex-COMMAND-CONTROL.pdf.

2. For detailed information on Red Flag, see "414th Combat Training Squadron 'Red Flag,'" Nellis Air Force Base, 6 July 2012, http://www.nellis.af.mil/library/factsheets/factsheet.asp?id=19160.

3. Martin van Creveld, "Command in War: A Historical Overview," in *Advanced Technology Concepts for Command and Control*, ed. Alexander Kott (Philadelphia: Xlibris Corporation, 2004), 27.

4. Joint Publication (JP) 1-02, *Department of Defense Dictionary of Military and Associated Terms*, 8 November 2010 (as amended through 15 March 2014), 45, http://www.dtic.mil/doctrine/new_pubs/jp1_02.pdf.

5. Ibid.

6. Carl H. Builder, Steven C. Bankes, and Richard Nordin, *Command Concepts: A Theory Derived from the Practice of Command and Control* (Santa Monica, CA: RAND, 1998), xiii–xiv, http://www.rand.org/pubs/monograph_reports/MR775.html.

7. The Joint Air Operations Command and Control system and its subordinate systems are described in JP 3-30, *Command and Control for Joint Air Operations*, 10 February 2014, II-7–II-13, http://www.dtic.mil/doctrine/new_pubs/jp3_30.pdf.

8. For a plethora of guides and descriptions on the subject of operational art, see "Air War College Gateway to the Internet," Air University, accessed 3 June 2014, http://www.au.af.mil/au/awc/awcgate/awc-forc.htm#opart.

9. Air Force organizational descriptions can be found in Air Force Instruction 38-101, *Air Force Organization*, 16 March 2011, http://static.e-publishing.af.mil/production/1/af_a1/publication/afi38-101/afi38-101.pdf. Component major commands are described in par. 2.2.2.2. Component numbered air forces are described in par. 2.2.5.1.

10. Although difficult to find, the most concise description of the AOC is "The CAOC Primer" by Col Dale Shoupe, USAF, retired, a 2008 lesson reading from Air War College. For the official US Air Force description of AOC and AFFOR functions, see Curtis E. LeMay Center for Doctrine Development and Education, *Volume 4, Operations*, 5 June 2013, "Appendix: The Air Operations Center," https://doctrine.af.mil/download.jsp?filename=V4-D31-Appendix-AOC.pdf.

11. See Curtis E. LeMay Center for Doctrine Development and Education, *Volume 1, Basic Doctrine*, 14 October 2011, "Air Force Component Presentation Considerations," https://doctrine.af.mil/download.jsp?filename=V1-D45-AF-Presentation-Consider.pdf. See also Curtis E. LeMay Center for Doctrine Development and Education, *Volume 4, Operations*, "Command and Control Mechanisms," https://doctrine.af.mil/download.jsp?filename=V4-D11-C2-mechanisms.pdf.

12. For an excellent discussion of both tip and rest-of-the-iceberg C2 activities and where they fit within the joint concept of "mission command," see Col Dale S. Shoupe, USAF, Retired, "An Airman's Perspective on Mission Command," *Air and Space Power Journal* 26, no. 5 (September–October 2012): 95–108, http://www.airpower.maxwell.af.mil/digital/pdf/articles/2012-Sep-Oct/V-Shoupe.pdf.

13. For a description of the joint operation planning process for air, see JP 3-30, *Command and Control for Joint Air Operations*, III-1–III-15. For information on the joint operations planning process, see JP 5-0, *Joint Operation Planning*, 11 August 2011, chap. 4, http://www.dtic.mil/doctrine/new_pubs/jp5_0.pdf.

14. These plans include the joint air operations plan (JAOP), air operations directives (AOD), air tasking orders (ATO), AFFOR operation orders (OPORD), and various other subordinate plans, branch plans, and sequel plans.

15. For a description of this exercise, see "Blue Flag," 505th Command and Control Wing, 10 April 2013, http://www.505ccw.acc.af.mil/library/factsheets/factsheet.asp?id=15317.

16. George l. Seffers, "U.S. Air Force Races to Modernize Critical Battle Control System," *Signal Online*, 1 August 2013, http://www.afcea.org/content/?q=node/11453.

17. The Joint Operational Access Concept and its subordinate concepts—the Navy / Air Force–authored Air Sea Battle Concept and the Army / Marine Corps–authored Gaining and Maintaining Access—all call for increased integration among the services, all of which are fundamentally problems that must initially be solved at the JTF and CHQ C2–equivalent level before they are implemented by subordinate C2 nodes in tactical execution. See Department of Defense, *Joint Operational Access Concept (JOAC)*, version 1.0 (Washington, DC: Department of Defense, 17 January 2012), http://www.defense.gov/pubs/pdfs/joac_jan%20 2012_signed.pdf; Air-Sea Battle Office, *Air-Sea Battle: Service Collaboration to Address Anti-Access and Area Denial Challenges* (Washington, DC: Air-Sea Battle Office, May 2013), http:// www.defense.gov/pubs/ASB-ConceptImplementation-Summary-May-2013.pdf; and US Army and US Marine Corps, *Gaining and Maintaining Access: An Army–Marine Corps Concept* (Washington, DC: US Army and US Marine Corps, March 2012), http://www.defense innovationmarketplace.mil/resources/Army%20Marine%20Corp%20Gaining%20and%20 Maintaining%20Access.pdf.

18. One must be a squadron, group, and wing commander to become a general officer. Thus, many of the people who have to pass through these wickets and still make the necessary gates and timing can afford to spend only a single-year or two-year tour at the most on the way up the chain. There are no squadron command opportunities in CHQ that I am aware of outside the 505th Command and Control Wing assignments, and personnel are still nominated for command by their old major weapons system porch. Consequently, if individuals go to an AOC or AFFOR as majors, there's a good chance that they are alienating the people who would otherwise have to choose them for that crucial squadron command position at a sufficiently young age to be marked off for possible wing command track.

19. For an excellent summary of some of the latest research on building expertise and mastery, see Dan Goleman, *Focus: The Hidden Driver of Excellence* (New York: Harper, 2013); and Gary Klein, *Streetlights and Shadows: Searching for the Keys to Adaptive Decision Making* (Cambridge, MA: MIT Press, 2009).

20. For the classic analysis of Air Force service culture, as well as an analysis of the institutional ethos of all of the US military services, see Carl Builder, *The Masks of War: American Military Styles in Strategy and Analysis* (Baltimore: John Hopkins University Press, 1989).

21. See Gary Klein, *Sources of Power: How People Make Decisions* (Cambridge, MA: MIT Press, 1998).

22. The mission of the School of Advanced Air and Space Studies is to "Educate strategists for the Air Force and the Nation." See "About SAASS," School of Advanced Air and Space Studies, accessed 3 June 2014, http://usafsaass.blogspot.com/p/about-saass.html. Thus, the decision to curtail C2 training to focus on larger strategy issues in an era of budget austerity is both in line with SAASS's primary emphasis and appropriate. The school's curriculum does include operational-level warfare concepts in its lessons, providing some engagement with CHQ C2 concepts. The primary gap left by the curtailment of 505th Com-

mand and Control Wing training is the chance for SAASS students to engage with highly experienced JFACC senior mentors and the Operational Command Training Program instructors, who collectively have centuries of CHQ C2 experience. They are also current on worldwide CHQ C2 configurations due to their frequent rotations into the field conducting exercise support. The larger issue with C2 education is the systemic one beyond the scope of SAASS. The Air Force does not make expertise in operational C2 a prerequisite—or even preferred—to attend SAASS, despite the fact that many of its graduates will be expected to lead joint and Air Force planning efforts as operational planning team leads in their "payback" assignments. In the latter, they will work side by side with graduates of the School of Advanced Military Studies, School of Advanced Warfighting, Maritime Advanced Warfighting School, and Joint Advanced Warfighting School who have been specifically trained in higher-headquarters-level C2 planning processes. Thus, there is an expectation of CHQ C2 proficiency in SAASS graduates in the field and in the personnel system but no guarantee that they will possess it when they arrive at CHQ C2 assignments as operational planning team leads or division directors.

23. For a brief description of the evolution of the air component coordination element, which will be referred to as the joint air component coordination element in future doctrine documents, see Maj Gen Kenneth S. Wilsbach and Lt Col David J. Lyle, "NATO Air Command–Afghanistan: The Continuing Evolution of Airpower Command and Control," *Air and Space Power Journal* 28, no. 1 (January–February 2014): 11–25, http://www.airpower.maxwell.af.mil/digital/pdf/articles/2014-Jan-Feb/SLP-Wilsbach-Lyle.pdf.

24. Dr. Tom Ehrhard (remarks during the School of Advanced Air and Space Studies "Grad Jam," Maxwell AFB, AL, Spring 2011).

25. Nola Taylor Redd, "Stephen Hawking Biography," Space.com, 30 May 2012, http://www.space.com/15923-stephen-hawking.html.

26. Not to be taken literally, this is a common expression used by people forced to adapt various program-of-record C2 systems to non-program-of-record systems that are not designed or upgraded together. This usually results in disconnects between the C2 systems used for mission accomplishment and the constructive simulations of real-world inputs, such as radar feeds and message traffic during C2 training. Additionally, cross-domain security-level transfer issues often must be overcome creatively when working with different CHQ C2 entities. Despite the existence of baseline AOC systems, each AOC adapts to fit its particular local situation (including establishing connectivity with host nation and coalition forces), so each training event requires unique information technology solutions to facilitate it. The further that program-of-record systems advance compared to the training and testing systems with which they must connect, the more challenging becomes the prospect of keeping the systems compatible.

27. This is overreach typically ascribed to those advocating approaches based on the philosophy of network-centric warfare, best described in ADM A. K. Cebrowski, *The Implementation of Network Centric Warfare* (Washington, DC: Department of Defense, Office of Force Transformation, 5 January 2005), http://www.carlisle.army.mil/DIME/documents/oft_implementation_ncw%5B1%5D.pdf. See also publications by the Department of Defense's C4ISR Cooperative Research Program, such as David S. Alberts, John J. Garstka, and Frederick P. Stein, *Network Centric Warfare: Developing and Leveraging Information Superiority*, 2nd ed. rev. (Washington, DC: CCRP, 2000), http://www.dodccrp.org/files/Alberts_NCW.pdf; and David S. Alberts and Richard E. Hayes, *Power to the Edge: Command . . . Control . . . in the In-*

formation Age (Washington, DC: CCRP, 2005), http://www.dodccrp.org/files/Alberts_Power.pdf. For the most current CCRP documents, see "The Command and Control Research Program," accessed 3 June 2014, http://www.dodccrp.org/.

28. Using three domains to approximate reality has many historical antecedents, including versions by Plato through J. F. C. Fuller and John Boyd. For the purposes of this article, the domains are defined as follows: physical domain (the physical artifacts of the world, including the earth, ourselves, our tools, and the electromagnetic spectrum); cognitive domain (the means by which we process information from the physical world through a combination of individual neurobiological processes, social interaction, and interaction with the physical domain using various forms of information technologies; this also includes the subconscious processing of information in the human brain); moral domain (the uniquely human domain that defines the personal and collective meanings of the information we process in the cognitive domain; this includes the conscious portion of human thought and memory that interprets the various signals produced in the cognitive domain and gives them meaning in a social sense). For more explanation, see Lt Col David J. Lyle, "Complexity, Neuroscience, Networks, and Violent Extremism: Foundations for an Operational Approach," in *Tools for Operational Considerations: Insights from Neurobiology and Neuropsychology on Influence and Extremism—An Operational Perspective*, ed. Col Marty Reynolds and Lt Col David Lyle (Washington, DC: Joint Chiefs of Staff, April 2013), 64–65, http://nsiteam.com/scientist/wp-content/uploads/2014/02/Influence-and-Extremism-White-Paper-Approved-for-Public-Release-30Apr13v3R.pdf.

29. For a discussion of sociological factors pertaining to operational C2 in CHQ C2 settings, see Dr. Hriar Cabayan et al., eds., *Humans in the Loop: Validation and Validity Concepts in the Social Sciences in the Context of Applied and Operational Settings*, Strategic Multilayer Assessment Occasional White Paper (Washington, DC: Joint Chiefs of Staff, August 2013), http://nsiteam.com/scientist/wp-content/uploads/2014/02/U_Social-Science-II-White-Paper-Approved-for-Public-Release-26Aug13.pdf.

30. For a typical critique of network-centric warfare and concepts deriving from it, see Thomas P. M. Barnett, "The Seven Deadly Sins of Network Centric Warfare," US Naval Institute *Proceedings* 125, no. 1 (January 1999): 36–39, http://www.usni.org/magazines/proceedings/1999-01/seven-deadly-sins-network-centric-warfare. See also Mary Sterpka King, "Preparing the Instantaneous Battlespace: A Cultural Examination of Network-Centric Warfare," *Topia*, nos. 23–24 (2010): 304–29, http://pi.library.yorku.ca/ojs/index.php/topia/article/view/31834. For an excellent critical analysis of the systems thinking behind the concepts of network-centric warfare, see Sean T. Lawson, *Nonlinear Science and Warfare: Chaos, Complexity, and the US Military in the Information Age* (New York: Routledge, 2014).

31. A popular saying among forward planning elements, "virtual presence equals actual absence," reflects a perception problem that CHQ C2 headquarters constantly have unless they also possess effective liaisons placed forward to provide the "actual presence." See Wilsbach and Lyle, "NATO Air Command–Afghanistan," for a brief description of the evolution of the air component coordination element, which will be referred to as the joint air component coordination element in future doctrine documents.

32. The most significant revelations in recent cognitive neuroscience are not that we have unconscious processes that drive conscious thought; rather, they reflect the realization that we have very little conscious access to them in most cases. Several notable, recent works summarize some of these findings at a level accessible to the general reader; the most no-

table is *Thinking Fast and Slow* by Nobel Laureate economist Daniel Kahneman (New York: Farrar, Strauss, and Giroux, 2011). See also David Eagleman, *Incognito: The Secret Lives of the Brain* (New York: Random House, 2011); Duncan J. Watts, *Everything Is Obvious (Once You Know the Answer): How Common Sense Fails Us* (New York: Crown Business, 2011); Shankar Vendantam, *The Hidden Brain: How Our Unconscious Minds Elect Presidents, Control Markets, Wage Wars, and Save Our Lives* (New York: Spiegel and Grau, 2010); and Michael S. Gazzaniga, *Who's in Charge? Free Will and the Science of the Brain* (New York: HarperCollins, 2011).

33. See the discussion of C2 systems "coupling" in Lt Col Michael Kometer, *Command in Air War: Centralized versus Decentralized Control of Combat Airpower* (Maxwell AFB, AL: Air University Press, June 2007), 60–62, http://www.au.af.mil/au/aupress/digital/pdf/book/b_0107_kometer_command_air_war.pdf.

34. The advanced integrated war-fighting concept calls for 10 years in the primary Air Force specialty code and 120 months of operational flying duty accumulation (OFDA) for aircrews before attending the Advanced Integrated Warfighting Weapons Instructor Course, including three years of instructor experience in their family-of-origin tactical weapons system. Instead, personnel showing interest and promise for CHQ C2 should be allowed to leave with 100 months OFDA and serve in AFFOR and AOC positions after seven years of flying. Doing so will allow them to gain between two and four years of CHQ C2 experience and remain competitive for intermediate developmental education attendance, including participation in the Advanced Studies Group programs (School of Advanced Air and Space Studies [SAASS], School of Advanced Military Studies [SAMS], School of Advanced Warfighting [SAW], Marine Advanced Warfighting School [MAWS]) along normal timelines.

35. The benefits of multidisciplinary approaches to problem solving are detailed in Steven Johnson's *Where Good Ideas Come From: The Natural History of Innovation* (New York: Riverhead Books, 2010); and Scott E. Page's *The Difference: How the Power of Diversity Creates Better Groups, Firms, Schools, and Societies* (Princeton, NJ: Princeton University Press, 2007).

36. For an excellent discussion of individual and group biases that influence decision making, see Richards J. Heuer Jr., *Psychology of Intelligence Analysis* (McLean, VA: Center for the Study of Intelligence, Central Intelligence Agency, 1999), https://www.cia.gov/library/center-for-the-study-of-intelligence/csi-publications/books-and-monographs/psychology-of-intelligence-analysis/PsychofIntelNew.pdf; Strategic Multilayer Assessment Editorial Board, *From the Mind to the Feet: Assessing the Perception-to-Intent-to-Action Dynamic* (Maxwell AFB, AL: Air University Press, 2011), http://www.au.af.mil/au/awc/awcgate/afri/from_the_mind_to_the_feet.pdf; and Dylan Evans, *Risk Intelligence: How to Live With Uncertainty* (New York: Free Press, 2012). For a detailed description of multiframe referencing in operational processes, see Dr. Chris Paparone, *The Sociology of Military Science: Prospects for Postinstitutional Military Design* (New York: Bloomsbury, 2013).

37. It is highly likely that the field grade officers who serve as joint planners during the contingencies of today will end up being the O-6s and general/flag officers of tomorrow. Building strong personal relationships over years can only improve trust and honest dealing when institutional preferences clash in the future, ultimately resolved by the most senior officers making decisions in places like the "Tank," where the members of the Joint Chiefs of Staff use their staffs' recommendations to collectively make decisions that affect the entire joint force. Anecdotally, the author challenges the reader to find any senior leader with experience in either situation who will say that personal relationships with members from the other services were not critical to achieving positive outcomes.

38. For an excellent presentation on the power of visualization, see the TED (Technology, Entertainment, and Design) talk by David McCandless, "The Beauty of Data Visualization," video, 17:56, July 2010, http://www.ted.com/talks/david_mccandless_the_beauty_of_data_visualization; and Eric Berlow, "Simplifying Complexity," video, 3:42, TED, July 2010, http://www.ted.com/talks/eric_berlow_how_complexity_leads_to_simplicity. For a study of using visualization for campaign planning, see MAJ Richard D. Paz, "Visualizing War: Visual Technologies and Military Campaign Planning," research paper (Fort Leavenworth, KS: US Army Command and General Staff College, 2003), http://www.au.af.mil/au/awc/awcgate/army/visualizing_war.pdf.

39. Review of *Victory through Air Power* by Alexander de Seversky (Disney Studios), 1943, Youtube video, 1:05:20, accessed 16 May 2014, http://www.youtube.com/watch?v=J7NjJ59bf0M/.

40. Alasdair Wilkins, "What Happened to the Iceberg That Sank the Titanic?," *Wired*, 16 April 2012, http://www.wired.com/2012/04/titanic-iceberg-history//.

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The Imperative to Integrate Air Force Command and Control Systems into Maritime Plans

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Those far distant, storm-beaten ships, upon which the Grand Army never looked, stood between it and the dominion of the world.

—Alfred Thayer Mahan

Command and control (C2) is an elusive Air Force core function. In the twenty-first century, globalized economies and worldwide threats make protection of the global commons more im-

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portant than ever. Future conflicts may be more challenging in the maritime domain than any since the Second World War. In a time when budgets force difficult force-composition decisions, risks in the maritime domain demand new forms of joint integration. Airpower remains the most responsive tool for many maritime tasks, but the Navy and Air Force require a new level of cooperation. Maritime commanders build maritime plans, but only Air Force systems possess the range, endurance, persistence, and capacity to provide sustained tactical C2 of the air-to-surface missions.

Risks to Supremacy in the Maritime Domain

Despite the evolution of airpower and the dawn of the information age, the sea remains vital to the diplomatic, economic, and military elements of power. Over the past 500 years, the world's great powers have depended on control of the seas for their hegemony.[1] Water covers 70 percent of the earth's surface and carries 90 percent of global commerce.[2] Locations like the Strait of Hormuz, Taiwan Strait, Senkaku Islands, and Black Sea are well known to the public for their strategic significance.

In this environment, modern near-peer or credible asymmetric threats may challenge US interests at great range and in ways that significantly disrupt freedom of action. In these antiaccess and area denial (A2/AD) scenarios, friendly forces will have to operate with many capabilities constrained or compromised.[3] Rapid technological growth has created a world defined by "proliferation gone wild," and our military supremacy will be contested rather than conceded.[4]

US and allied reductions in forces compound this threat. Even when capability and lethality are preserved, capacity and flexibility decline. Fiscal cuts can also erode technology, doctrine, and training advantages, allowing militaries and threat groups around the world to close the gap. Friendly forces distributed across numerous land bases allow more flexibility to address the expanded and shifting A2/AD fronts.

As threats grow and resources diminish, the services must increasingly lean on each other to attain operational objectives. Air Force and sea service cooperation is one area for improvement that has received significant commitment at the highest levels, translating into deliberate changes for many platforms.[5] Air Force fighters, bombers, and other aircraft now train to supply the Navy with additional muscle in war at sea. By doing so, the service addresses one limitation inherent to carrier basing but actually aggravates another risk—limited Navy capacity to provide the requisite C2 to orchestrate those additional numbers of joint air assets over wider areas for longer periods.[6] Coordinating and directing countersea airpower call for persistent, flexible, long-range, and high-capacity tactical C2 systems that can orchestrate the airborne elements of the surface fight on behalf of maritime commanders even when a carrier is absent, en route, or unable to respond. This need becomes apparent when one compares forecasted threats to present doctrine and fielded capabilities; further, it has been demonstrated by recent operational experience.

Air and Water Mix

Historically, most Air Force experience and doctrine have focused on cooperation with land forces, but airpower is an inherently cross-domain asset.[7] The air component exploits the air to generate effects and enable freedom of action in the land and maritime domains below. Indeed, the independent Air Force was born with a countersea legacy, stemming from Gen William "Billy" Mitchell's infamous tests culminating in the sinking of the battleship *Ostfriesland* in 1921. Because the US Navy has not been involved in a sustained conflict at sea since the Second World War, however, integration of the Air Force's countersea capabilities has languished for 70 years.

Navy and Air Force doctrine does not differ because of disagreement on universal truths about airpower but because a carrier air wing's first priority has to be defensive. The five carrier-on-carrier battles of the Second World War proved Mitchell right—it is possible to dominate the sea from the air.[8] The Navy applied that lesson well by superseding the battleship with the carrier, building fleets around air strike, and re-christening carrier battle groups as carrier strike groups (CSG). At the same time, those experiences also taught that the source of the Navy's most flexible attack capability—the aircraft carrier—is a point target. Preservation of that force-projection capability throughout an operation demands protection of that base.[9] The resulting multiservice tactics currently emphasize the defensive, with a ship-centric bias that centers surveillance and engagement areas on the carrier rather than on an assigned area in which control of the sea is necessary (fig. 1).[10] Air Force doctrine, however, leverages larger, redundant, and distributed bases to enhance survivability and concentrate on the offensive nature of airpower.[11] Each force is right—or intends to be—for its service but has inherent strengths and vulnerabilities. Commanders should leverage both to carry out assigned missions.

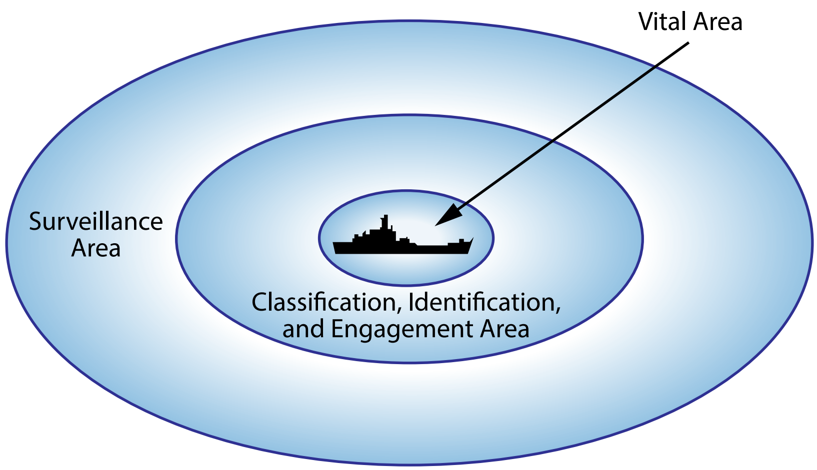


Figure 1. Surveillance area.(From Marine Corps Reference Publication [MCRP] 3-25J / Navy Tactics, Techniques, and Procedures [NTTP] 3-20.8 / Air Force Tactics, Techniques and Procedures [AFTTP] 3-2.74, *Multi-Service Tactics, Techniques, and Procedures for Air Operations in Maritime Surface Warfare*, 15 January 2014, 15, https://wwwmil.alsa.mil/library/mttps/pdf/aomsw_2014.pdf.)

Leveraging Joint Command and Control

Future maritime missions probably will demand joint air-to-surface force projection beyond the prioritized defensive layers around a CSG, in turn requiring coordination beyond the current capacity and capability of the sea services alone. No recent experience has challenged today's maritime force and tactics in this way, but contingency plans acknowledge that the intersection of threats and capabilities has changed. Direction of aircraft that support maritime commanders will likely be needed over broader and more dynamic geographic and tactical problems than ship-based C2 can manage. To project power and influence from the sea anywhere at any time demands the flexibility, speed, and range of airborne C2. The sea service's organic airborne C2 platforms, though, are far more limited in endurance, persistence, and capacity than those of the Air Force. Resolving such shortfalls materially would be fiscally prohibitive, but they can be and have been addressed well through the Navy's intellectual investment in sibling service platforms. This concept is not radical. The ongoing loan of Navy EA-6B Prowlers and EA-18G Growlers to the air component for expeditionary suppression of enemy air defense offers an excellent example of leveraging cross-service capabilities.

Though neither widely recognized nor explicitly directed, the maritime component's use of Air Force C2 to extend the maritime commanders' intent is already becoming common. The Air Force E-3 Airborne Warning and Control System (AWACS) has long been accepted as a supplement or extension to E-2 Hawkeyes for counterair missions. For countersea, the E-8C Joint Surveillance Target Attack Radar System (JSTARS) is emerging as an equally vital complement to Navy systems. Although designed to track tanks and trucks, that platform's radar inherently pursues anything moving, including boats and ships. Recognition of this capability has recently led to maritime missions in five combatant commands.[12]

Two recent experiences illustrate the efforts and imperative to integrate Air Force C2 systems into maritime C2 plans using the JSTARS.

In US Southern Command (SOUTHCOM), JSTARS crews have coordinated Coast Guard and allied sea and air operations in the absence of naval tactical C2. In US Central Command (CENTCOM), joint plans demonstrate a contingency in which JSTARS capabilities are critical to control of the sea.

Operational Example: US Southern Command

Illegal narcotics trafficking in the sea-lanes between South and North America is prolific. Joint Interagency Task Force–South (JIATF-S) is charged with the daunting task of interdicting those drugs. Budget constraints have significantly reduced the already limited participation of the United States and other allies. Both ships and aircraft have been scarce. Thus, recently, the JIATF-S had funds for just one heavy airborne asset and chose to fund the JSTARS to optimize limited resources by using its wide-area surveillance, robust communications, and C2 capabilities. That aircraft exceeded "detection and monitoring" expectations. Its range, speed, and endurance enabled tracking of possible smugglers transiting the vast SOUTHCOM area of responsibility (AOR); its flexibility allowed adaptation of the planned mission to developing intelligence and other factors—often several times in a single sortie.

JIATF-S is a complex organization that must coordinate the effort of 15 US agencies and departments and 14 partner nations, but mechanisms for the real-time direction of forces are limited. Without a tactical C2 intermediary, the full range of operational and tactical responsibilities is conducted by a small watch team on the joint operations center's floor, communicating directly with each asset. Centralized decision making far from the "front" and limited lateral coordination left substantial room for tactical C2 to grow.

After weeks spent building relationships, the JSTARS demonstrated the value of a capable and persistent C2 platform during a rigorous three-day hunt. The E-8C arrived on orbit shortly after dark to stalk smugglers who used the cover of night for protection from visual detection. The platform's radar scanned the full length of the expected routes—more than 10,000 square miles of the AOR—in minutes. Using assessed profiles and cooperative identification methods, the crew detected numerous vessels and methodically sifted through known friendlies and legal traffic.

After hours on station, the surveillance team correlated an unknown surface contact to an off-board intelligence report for action. The internal fusion led the crew to a rapid decision to direct a US Customs and Border Protection P-3 Orion to investigate. The P-3 pursued the track and covertly obtained visual identification (VID) of a "go-fast"—a 35-foot commercial boat overpowered for smuggling (fig. 2). JIATF-S declared the track suspect as the P-3 ran out of fuel, validating the rapid, expedited decision making. Unfortunately, no ship was available to intercept. The JSTARS, with extended endurance from aerial refueling, maintained continuous tracking and thus preserved the identification (ID) in the event an interceptor was found. Over several hours, the suspect vessel followed a coast north and then evaded west among islands of a major inlet to hide from aircraft equipped with electro-optical/infrared sensors, often restricted to international airspace. The radar range of the JSTARS, however, easily covered the bay, enabling track continuity from an orbit over international waters. The crew assessed that its target was looking for a hide site and reported its last location to JIATF-S.

Figure 2. Helicopter-interdiction tactical squadron intercepting a go-fast boat during a training mission.(From "USCG Pursuing Gofast Boat," Wikimedia Commons, accessed 9 June 2014, http://commons.wikimedia.org/wiki/File:USCG_pursuing_gofast_boat.jpg.)

Two tense nights later, intelligence suggested the smugglers would resume their route, but this time partner nation patrols would be ready. The JSTARS would catch the departure and report their maneuvers so the interceptors could pounce as soon as the suspects crossed into their jurisdiction. As predicted, the crew did find a boat departing the last known location and reported it heading north. Unfortunately, the adversary also possessed a sophisticated network and warned the go-fast. Aware that interceptors were waiting, the target doubled back to another hide site, this time on the southwest side of a populated island. The JSTARS crew again passed its assessment and the latest position to

JIATF-S. In turn, Drug Enforcement Agency liaisons delivered the tip to local officials. What followed was an early morning law enforcement raid that confiscated 2,201 kilograms (2.2 metric tons) of packaged cocaine worth $235 million in the United States. Made possible by the range, endurance, persistence, and competence of the JSTARS crew, that one bust was one of the largest in the agency's history.

Command and Control Voids Filled by Command and Control Systems

The JSTARS arrived in SOUTHCOM as an additional surveillance asset but left as an integrated part of JIATF-S's C2 architecture. During formative early sorties, crews and planners perceived C2 voids and used the JSTARS to fill them within existing C2 plans to solve problems and expedite decisions. Over two months of operations, crews developed tactics including rapid orbit changes to orchestrate mass and maneuver at the critical point, prioritization of surveillance to orient air and surface assets, and expedition of partner nation execution using bilingual crew members. When it could and as it was able, the JSTARS bridged the operational-to-tactical gap and brought information dominance, decision superiority, and operational synergy to the counternarcotics fight.

This example illustrates what an airborne C2 platform can add to maritime missions when a robust, sea-based Navy C2 structure like a CSG is not present. Though it demonstrates the ability to expand influence and improve responsiveness, it does not demonstrate best integration into operational plans. Because of the brevity of the SOUTHCOM deployment, the JSTARS was included only in short-range planning, and C2 plans experienced no permanent changes. Law enforcement interdiction remained nonlethal, and the stakes did not directly include national survival or threats to the commons. Other maritime missions, however, stress the full range of military operations.

Operational Example: US Central Command

On the other side of the world, the JSTARS has an enduring presence and deeper cross-component integration. It has been a constant presence in CENTCOM, supporting operations in Iraq and Afghanistan since 2001. But in the second half of 2012, as the US withdrawal from Afghanistan took shape, readiness for other contingencies in the Middle East gained priority, and the JSTARS received new mission assignments.

The Arabian Gulf is a much narrower and more congested body than the Caribbean. Any future armed conflict in the Gulf has been likened to "a knife fight in a phone booth."[13] The Strait of Hormuz separates Iran and Oman by only 35 nautical miles, yet one-fifth of the world's oil is shipped through it.[14] The area is entwined in United Nations and US economic, diplomatic, security, and humanitarian interests. In the event of hostilities, the entire length of the Gulf would be a "front." Given the limited number of friendly warships in the Gulf, detecting and tracking the dynamic, low-signature small boats of the Iranian Revolutionary Guard Corps Navy can prove difficult. Further, its modern standoff threats and well-rehearsed asymmetric tactics pose significant indications and warning (I&W) issues. In 2011 US Naval Forces Central Command issued an urgent operational need to address the I&W problem by improving the inherent maritime surveillance capability of the JSTARS and maximizing its untapped capacity to extend the combined force maritime component commander's (CFMCC) influence across the battlespace. In 2012 crews arrived in-theater with a game-changing, improved maritime mode and trained on maritime C2 structures.[15]

In the Gulf, potential targets range from jet skis improvised as fast inshore attack craft to purpose-built fast attack craft and frigates (fig. 3). At first, JSTARS crews pushed every track they found beyond the range of friendly-ship organic sensors. Often reaching 80 tracks, this data proved too much, distracting individual ships with contacts beyond their task area and generating a prioritization problem to C2 and intelligence entities. Over time, the JSTARS began to better understand the CFMCC's intent, fleet priorities, and I&W needs of each ship. Air Force C2 gradually became a better steward of maritime domain awareness and built confidence in the JSTARS as a maritime asset—the same confidence it has always enjoyed as an Army asset.

Figure 3. Example of modern Houbei-class fast attack craft. (From "Houbei [Type 022] Class Fast Attack Craft," Wikimedia Commons, accessed 11 June 2014, https://commons.wikimedia.org/wiki/File:Houbei_(Type_022)_Class_Fast_Attack_Craft.JPG.)

The JSTARS became a trusted I&W source while it controlled a maritime interdiction training mission with a flight of F-15E Strike Eagles. During the evolution, The E-8C detected numerous contacts departing an Iranian military port north of the exercise area. The surveillance team observed a complex formation of tens of contacts behaving atypically. First they set off across the Gulf, perpendicular to the usual flow of traffic. Then they executed synchronized maneuvers in concert with low, slow aircraft. The crew assessed that the formation could be only military and reported the activity. Later, overhead imagery confirmed the formation as an Iranian Revolutionary Guard Corps Navy fast attack craft / fast inshore attack craft exercise. No platform other than the JSTARS reported the potential threat in real time.

Beyond I&W, JSTARS supplied many forms of control to maritime missions. Its planners made a case to the combined air operations center's intelligence, surveillance, and reconnaissance (ISR) planners to put surveillance assets under JSTARS control to amplify the surveillance picture. At the time, surveillance and reconnaissance platforms in the Gulf operated without tactical C2, using nothing other than their own electro-optical/infrared sensors to conduct maritime surveillance. Eventually the air tasking order assigned a single MQ-1 Predator to the JSTARS for an hour of overlapping station time and field of view.

The E-8C generated a surveillance picture, prioritized tracks for investigation, and directed the Predator to move rapidly from one location to the next. The JSTARS crew initiated tracks on all surface contacts in the Predator's operating area before it ever checked in, essentially performing the "find" step for the Predator. Rather than using computer-based tactical chat to direct the Predator, JSTARS controllers employed voice control, resulting in more rapid acknowledgement and execution of each task. Tactical chat was reserved for less timely and more detailed coordination. As soon as the Predator crew reported a VID, the C2 professionals aboard the JSTARS directed "skip it" and tasked the Predator to investigate the next-nearest contact while the E-8C maintained continuous tracking of the identified vessels. The combined C2/ISR team identified 13 contacts in just over an hour, five of which were Iranian military vessels. The reconnaissance asset moved from one contact to the next to rapidly build an ID layer on the surveillance picture rather than loiter on each target, as typically occurred in Operations Enduring Freedom and Iraqi Freedom, which demanded long sensor dwell to estimate collateral damage or assess hostile intent. After the mission, the Predator mission commander lauded the results—both the volume of tracks identified and the percentage that matched the tasking—declaring it the "best integration" of maritime surveillance yet.[16]

Building on those successes, JSTARS surveillance, intelligence fusion, and C2 became the tactical backbone of air operations in the Gulf whenever it was airborne and in the absence of a carrier. In the combined air operations center, planners ensured that the JSTARS always had control of at least one aircraft with ID capability—often a fighter conducting maritime interdiction training with the E-8C.

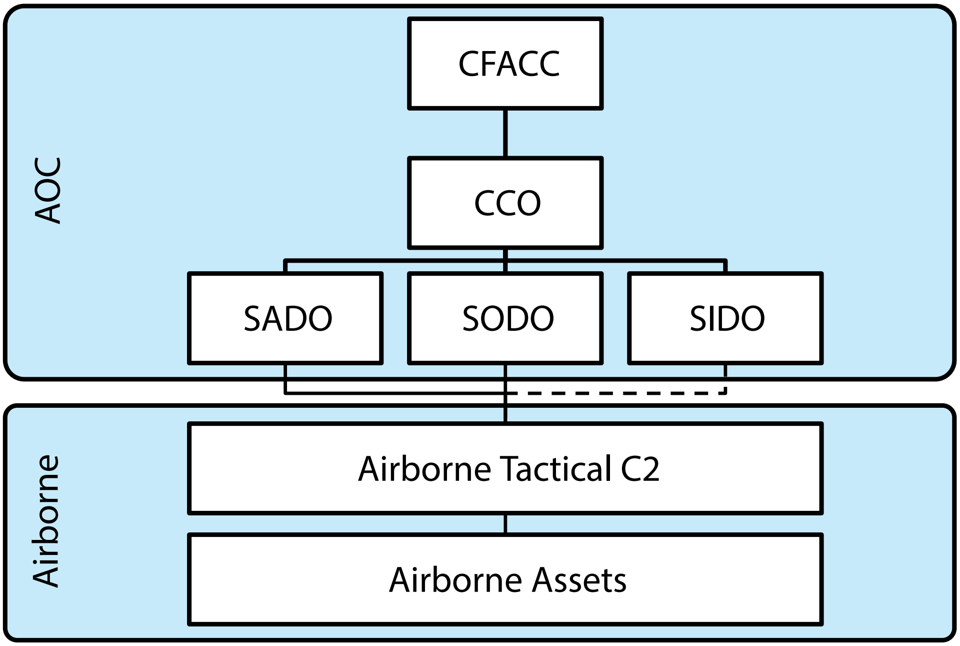
During one exercise, the JSTARS checked in with the sea combat commander (SCC) for a simple point-defense scenario. Two simulated opponent fast attack craft marshaled 60 miles west of a single destroyer, and the JSTARS controlled a flight of Strike Eagles to find, fix, and finish the adversary before it threatened the defended asset. JSTARS surveillance covered the friendly ship, the expected threat axis, the entire exercise area, and more. The controller directed two F-15Es to investigate two tracks in formation approaching the defended asset and promptly received VID of two patrol craft on a southeasterly course. The JSTARS mission crew commander passed the descriptions to the SCC, received a hostile declaration, and changed the Strike Eagle's task to target.[17] After a moment, the SCC received an update that both briefed threats were eliminated 60 miles from the friendly vessel. Skeptically, the exercise director reset the fighters, regenerated the opposing force, and resumed the scenario at 40 miles. The Air Force team repeated the rapid find, fix, and finish achievement two more times—at 40 and again at 20 miles. The debriefing verified the results and validated the JSTARS in maritime missions for US Naval Forces Central Command.

Supplementing a Ship-Centric Perspective

The seas are a vast stage where the curtain never drops; to be a star means meeting any cue any time. Seafaring nations exercise their economic and military elements of power over very large areas of influence. The CFMCC will be responsible for correspondingly large AORs, regardless of how well organic assets can cover it. With limited resources, the Navy must prioritize and position ships to defend and attack at the most effective time and place while the enemy will naturally seek advantage elsewhere. The gap between enemy lines of advance and friendly-ship ranges is primarily the province of airpower, but carrier air wing C2 is limited in ways that land-based aviation is not. The constraints occur principally in quantity, range, payload, and persistence—especially during long-duration, high-tempo operations. In short, the CFMCC's ability to respond with the full range of military capabilities is constrained by the availability of ships, operational limitations of carrier-based aviation, and ship-centric doctrine. It is important to note that these limitations represent an even greater risk for the US Coast Guard, Marine Corps, and coalition navies who have little or no airborne C2 to begin with.

Doctrinal Differences

Adding Air Force C2 to existing maritime resources would expand and enhance the CFMCC's awareness and influence; doing so, however, requires the integration of two historically different command philosophies and C2 systems. The Air Force centralizes control in operational headquarters and in competent, capable, subordinate forward systems while necessarily allowing individual flights to execute their own tactics on time lines too short for higher echelons to manage.[18] The Navy, by tradition and necessity, typically commands through enduring but distributed nodes.[19] Each ship is an independent entity entrusted to carry out the commander's intent. The Air Force's theater air control system favors a clear break between operational and tactical C2 exercised by distinct platforms in the rear and forward areas (fig. 4). The Navy's composite warfare construct mixes operational and tactical responsibilities by function usually assigned to individual ships afloat with limited rear elements (fig. 5).[20]



Air Operations Center (AOC)
Combined Force Air Component Commander (CFACC)
Chief of Combat Operations (CCO)
Senior Air Defense Duty Officer (SADO)
Senior Offensive Duty Officer (SODO)
Senior Intelligence Duty Officer (SIDO)

Figure 4. Theater air control system. (Adapted from AFTTP 3-1.TACS, *Tactical Employment—Theater Air Control System*, 1 February 2013, chap. 1; and MCRP 3-25J/NTTP 3-20.8/AFTTP 3-2.74, *Multi-Service Tactics, Techniques, and Procedures for Air Operations in Maritime Surface Warfare*, 15 January 2014, 4–6, https://wwwmil.alsa.mil/library/mttps/pdf/aomsw_2014.pdf.)

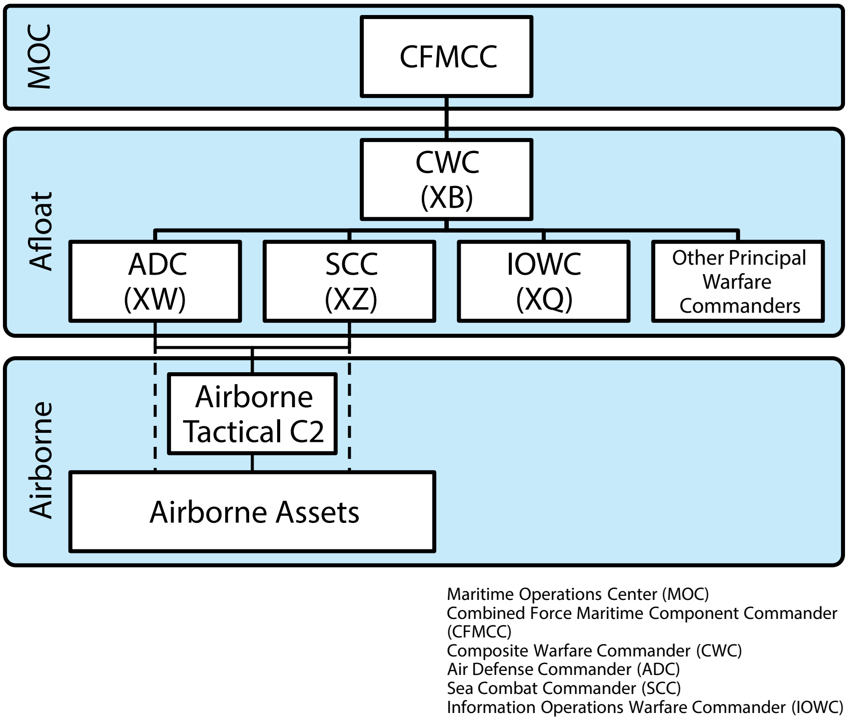


Figure 5. Composite warfare construct. (Adapted from AFTTP 3-1.TACS, *Tactical Employment—Theater Air Control System*, 1 February 2013, chap. 1; and MCRP 3-25J/NTTP 3-20.8/AFTTP 3-2.74, *Multi-Service Tactics, Techniques, and Procedures for Air Operations in Maritime Surface Warfare*, 15 January 2014, 4–6, https://wwwmil.alsa.mil/library/mttps/pdf/aomsw_2014.pdf.)

Command and Control Systems and Plans

There is no single C2 solution for all missions although most dedicated C2 systems, by design, are flexible enough to solve a variety of problems. C2 requirements should be defined and integrated during deliberate and contingency planning and periodically reevaluated at all levels as operations evolve. Consider a theoretical near-future conflict in the Pacific theater in which air superiority is required but counterland operations are secondary to sea control. The AOR in the Pacific Ocean, the largest body of water in the world, could range from Japan to Australia and involve some of the biggest, most capable militaries in the world.[21] To maintain sea control in the face of widespread threats in a contested and degraded operations environment complicated by fog, friction, and chance, the maritime component must direct air operations beyond the CSG. Doing so, in turn, calls for unity of command and coordination of effort—in short, an appropriate C2 system integrated into tailored C2 plans (see table). So what does one need in a flexible C2 system to increase the range, capacity, and lethality of maritime commanders in the face of anticipated threats across the range of military operations? How would it be employed in cooperation with existing C2 plans?

Table. Components of C2 systems and plans

C2 Systems	*C2 Plans*
People	Intent
Competencies	Authorities
Platforms	Functions
Technologies	Tasks
Doctrine	Effects

C2 Systems

The requirements for such a system can be expressed in terms of its components: people, competencies, platforms, technologies, and doctrine. The people connect to the human elements of war and leverage their particular knowledge and skills that collectively form competence. They direct their prowess using the technology available from the vantage afforded by their platform. Finally, the system will craft ways of managing the battle and integrating to carry out the mission through doctrine. The most significant system risks that must be addressed are task capacity, a product of people and technology, and airframe endurance, a product of the platform.

People. Disseminating tactically relevant information and tactically sound decisions is the essence of C2, and it takes people to make assessments and issue judgments. Surveillance capacity must be sufficient to detect, track, and report on all surface tracks across an assigned lane for air operations. Similarly, there must be sufficient weapons-control capacity to maintain accountability for and direct the movement and mission assignments of all aircraft conducting ISR and countersea operations, including manned and remotely piloted, rotary- and fixed-wing. Cruisers and destroyers have three controller positions, primarily for helicopter operations or control of a single fixed-wing division.[22] Hawkeyes have five crew members, typically performing CSG defense and therefore divided between air intercept control and maritime air control responsibilities. Though right-sized for individual ship operations or the scale of air operations that can be generated by the deck flow of a single carrier, they would become task saturated by the demands of large-scale, AOR-wide, cross-domain C2.[23]

Technologies. Technologies affect a C2 system in a variety of ways. The most externally relevant are sensors and communications. Anticipated A2/AD challenges demand a sensor capable of detecting and tracking as much of the maritime target set as possible at standoff ranges and a robust communications suite for contested and degraded operations. Radar, the prevalent airborne sensor for wide-area maritime surveillance, comes in many varieties. In a force-on-force scenario in blue water, the ability to track patrol craft and larger vessels is essential.[24] Modern air operations depend on a variety of voice and data methods, and interaction with the sea services levies additional requirements. Simultaneous and secure UHF, VHF, and satellite communications are essential to reach the full range of players reliably. To reduce workload through machine-to-machine interaction, one must have interoperable line-of-sight data links for working with US ships and aircraft; furthermore, those links are immensely beneficial for working with US and allied navies. Access to classified networks, especially for chat, has also become increasingly important.[25] Failure to participate in theater-wide tactical chat may slow the vital observe, orient, decide, act loop, whereas participation could close it.

Platforms. The perch for the C2 system, the platform defines how close to the fight the people in the C2 system will be and how far their influence can reach. The size of Pacific Command's AOR, the presence of regional and intercontinental threats, and the potential for around-the-clock operations drive demand for C2 systems with great range, mobility, endurance, persistence, and survivability. The ability to base from all over the AOR enables rapid response and opens up distributed basing options to ensure survivability of high-demand/low-density assets. For the theoretical scenario, highly enduring, capable, and survivable platforms might be needed to provide 24-hour operations in at least two locations at once—one to supplement where the CSG has primary responsibility and another in at least one additional place where the maritime commander needs to extend influence. The carrier-based Hawkeye significantly constrains the projection of maritime C2. E-2s are limited in speed, range, and endurance by turboprop engines and a lack of air-refueling capability, and in persistence by their crew and aircraft quantity as well as maintenance and deck turn times.[26]

C2 Plans

No matter how powerful or flexible a C2 system, failing to plan for it renders it less effective. If appropriate systems are not properly enabled by C2 plans, the unrealized or unfilled need for coordination may become significant enough for some unplanned asset affected by the problem to fill the need on its own initiative. Doing so can be unsafe, redundant, or—at the least—uncoordinated and poorly implemented. To ensure methodical, well-integrated, and tactically sound solutions, C2 plans must connect specific C2 systems to intent, authorities, functions, tasks, and effects to manage all applicable mission types. Existing operation plans and future deliberate and dynamic plans must be reviewed with this goal in mind. Consequently, maritime planners and commanders must be well educated about joint options, which could be addressed in formal courses for senior leaders and reinforced institutionally within the numbered fleets and CSGs.[27]

Intent. To control forces in the pursuit of the commander's objectives requires a clear understanding of his or her intent. The latter provides the operational momentum that keeps all subordinate forces traveling toward operational objectives even when commanders are not able to steer forces directly. For the Air Force, intent is usually received in the special instructions and the air operations directive. In the Navy, intent may be found in the operation order and daily intentions messages. When air operations support the maritime domain, two visions must be harmonized where they intersect to prevent friction. They must enable each other while honoring the fact that in the maritime fight, the CFMCC's intent is the authoritative one. C2 systems conducting maritime missions will be assigned to the CFMCC for tactical control. By extension, so will every asset that checks in with them. Over the past decade in Afghanistan, the Air Force has become quite comfortable taking control of Navy assets for close air support and suppression of enemy air defenses, but it is much less used to swapping roles and giving up control of its own assets to a supported commander. However, doing just that is essential to the unity of mission command.

Authorities. C2 systems are force multipliers even without the authority to make decisions and direct operations. To serve their purpose fully, however, they must be enabled to implement the commander's intent through clearly defined and specifically delegated authorities to decide, act, or direct. The most important authorities for controlling maritime interdiction are those required to prosecute and expedite the kill chain, including investigate and ID authority and possibly hostile declaration and target authority. Certain enabling authorities, such as engagement and rerole, probably will not be delegated to the tactical level but must be clearly assigned so that tactical coordination remains predictable and rapid.

Functions. Broad guidance of the kinds of things C2 platforms should do for superior commanders, subordinate forces, and all partners to influence the mission is the purview of functions. Air Force doctrine defines six universal functions of tactical C2, which, when expanded, apply to any maritime mission: orient assets, pair effects, solve problems, speed decisions, bring order, and provide assessments.[28] Changing "orient and pair shooters" to encompass all mission players reflects the true breadth of C2, which affects all mission types, centralizing data from numerous manned and remotely piloted platforms, distributing it efficiently to air and surface assets alike, and pairing any effect to any target, whether kinetic, nonkinetic, or informational. This expanded definition is especially essential to maritime operations in which graduated responses and nonlethal operations such as boarding actions are common.

Tasks. Analyzing mission objectives in light of functions generates tactical tasks—specific actions that C2 must carry out. The list of functions is finite, but the complexities of the mission are legion when human error, the environment, and the enemy cast their vote. Tasks are therefore inherently dynamic and innumerable. Some can be planned for and articulated well in advance to guide preparation and execution of the C2 system. Others will become apparent only as they emerge and should be captured as lessons learned. Either way, they may emerge, fade, or change over time.

Air operations in maritime surface warfare (AOMSW) borrow some fundamental tasks from counterland tactics, such as reporting a VID to operational C2 and requesting permission to target. Even fundamental counterair tasks such as picture building are required to communicate fast inshore attack craft formations rapidly. Common tasks that the assigned C2 system must understand include safe deconfliction of airspace transit requests. Others are less apparent. We may need C2 to point out an adversary's remotely piloted aircraft to a frigate's bridge spotters or talk a fighter onto the wake of a passing suspect vessel. When explicit, tasks directly influence execution and must be managed effectively. Systems should not be assigned responsibility for tasks that lie outside their strengths. For example, the JSTARS should not receive counterair taskings just as the AWACS should not receive countersea taskings. Any C2 system able to perform a task must, however, be prepared to do so in a contingency if it would accomplish any of the functions of C2.

Effects. Ultimately, C2 plans must enable C2 systems to generate mission effects. Like intelligence, C2 itself does not influence the enemy, but no coordinated military operation can succeed without it. C2 tasks ultimately get the right information to the right operator in the right place at the right time to generate the desired effect to further the commander's intent. In AOMSW this means that C2 should be focused on shaping operations to generate the intelligence, influence, or interdiction effects necessary to meet the maritime commander's intent.

Conclusion

The Hawkeye remains the premier tactical C2 system for countersea missions, but it is not singularly sufficient for the range of AOMSW challenges. To deal with numerous, determined, and competent foes, we need tactical C2 with higher task loads and coverage in more places and more often than carrier-based aviation can generate with the present or planned fleet. This tactical problem demands greater capacity, quantity, endurance, and persistence.

To mitigate these vulnerabilities, the maritime component must maintain unity of command in the maritime domain but incorporate joint C2 systems into training, doctrine, and C2 plans. Land-based Air Force C2 assets with larger crews can handle more substantial task loads and provide additional numbers; moreover, they are capable of greater durations and can sustain longer than carrier-based solutions. Sea services must train commanders and tacticians at all levels to take advantage of these capabilities and make their requirements for these joint resources known to influence systems from acquisition to operations. The comprehensive inclusion of these capabilities will significantly augment, amplify, and extend the effects of maritime forces to better address future missions, threats, and AORs.

The Air Force must enable supported maritime commanders by offering C2 systems and planning support. Other mission priorities should always be weighed and balanced. Nevertheless, during A2/AD phases of conflicts when surface threats and targets have a higher priority than land targets or when the latter are inaccessible even by standoff sensors, Airmen must consider whether the best use of the Air Force's tactical C2 may involve supporting the maritime component.

JSTARS crews have already demonstrated the value of integrating joint C2 in cross-domain missions in numerous operations and exercises around the world. Focused by a high-fidelity, wide-area surveillance suite building a comprehensive and accurate surface picture and an institutionally joint culture, the E-8C is ideally suited and already vetted to complement the sea services' own systems for AOMSW, surface surveillance, and other maritime missions. All services must work together to further develop a sense of cross-service investment in tactical C2 systems like the JSTARS, which perform so many vital functions to support commanders in the cross-domain battles of the future. ✪

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21. Based on open-source reporting, the top five navies by number of ships include those of the Democratic People's Republic of Korea, China, United States, Iran, and Russia. The top three air forces by number of aircraft include those of the United States, Russia, and China. "Total Naval Ship Power by Country," Global Firepower, accessed 9 June 2014, http://www.globalfirepower.com/navy-ships.asp; and "Aircraft Strength by Country," Global Firepower, accessed 9 June 2014, http://www.globalfirepower.com/aircraft-total.asp.

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Command and Control in Africa

Three Case Studies before and after Tactical C2

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Africa provides a unique context to study the role of the United States in coalition command and control (C2) systems. The Air Force's tactical C2 is not well understood outside the platforms that supply the capability despite its importance to mission success. This article highlights modern-day tactical C2 of airpower by using three recent examples in US Africa Command (AFRICOM). The Joint Surveillance Target Attack Radar System (JSTARS) was the common tactical C2 thread throughout the operations and thus offers a good lens through which to study AFRICOM's C2 writ large.

In particular, these operations in Africa have gone largely undocumented since 2011, and properly employed C2 is often treated as an afterthought or a given. The study of examples from Africa is ideal for demonstrating the value of C2 in a wide spectrum of operations. Libya provides conventional C2 battle employment. Additional examples emphasize flexibility and utility of C2 in nontraditional means. These case studies prove the critical nature of tactical C2.

Libya Operations: Odyssey Dawn and Unified Protector

Arguably the most decisive factor in modern airpower is the ability to move rapidly and efficiently to any locale in the world and conduct effective operations. When we do so, we use portable C2 platforms as

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the primary means to ensure theaterwide continuity. This is the role of tactical C2—those who bring overall order to a fractionalized campaign.[1] The Libya campaigns offer a classic example. Odyssey Dawn and Unified Protector demonstrated how modern tactical C2 translated commander's intent, operational guidance, and combat potential into decisive action for a large force-on-force campaign.

The decisiveness of airpower and operational C2 was tested from the first night in Libya. On 17 March 2011, the United Nations (UN) Security Council adopted Resolution 1973, which authorized the use of force under chapter 7 of the UN charter in three areas: enforcement of a no-fly zone, enforcement of a UN arms embargo against Libya, and protection of civilians targeted by the regime of Mu'ammar Gadhafi and its supporters. French, British, and US military action began under Odyssey Dawn on 19 March.[2]

C2 is doctrinally defined as a joint function, but it was not planned this way in Africa.[3] Additionally, C2 in Africa involved an international coalition that was even less defined than its joint dimensions. Specifically, Maj Gen Margaret Woodward, the AFRICOM combined force air component commander, hosted by the European Command's combined air and space operations center (CAOC), maintained operational C2. Although commanders requested tactical C2 assets such as the E-8C JSTARS and E-3 Airborne Warning and Control System (AWACS) from the start of planning, they were not approved until after strike operations were under way.[4] Libya operations began with operational C2 and strike assets with nothing in between the two. That is, the absence of C2 structure in the battlespace to supply real-time direction, solve problems, and bring order to a diverse coalition operation created a stovepipe command structure.[5] Communications were routed along country-specific lines or through the naval vessels, which were ill equipped to handle the volume of information and lacked line-of-sight radio coverage to shooters/sensors in the battlespace, thus causing numerous delays in operations—including targeting.

The dynamic nature of warfare calls for real-time decision making inherent in tactical C2. We relearned that the latter should be present at the onset of hostilities—even more so in a coalition fight. Odyssey Dawn's air campaign constituted a significant departure from practices found in conventional Western airpower doctrine. Instead of beginning with offensive counterair strikes to take down the Libyan integrated air defense system, it sought to produce an immediate impact on the ground to meet the UN resolution and protect civilians as the highest priority.[6] In these opening strikes, the coalition's Rafale and Mirage fighter-bombers expertly destroyed several armored vehicles on the outskirts of Benghazi, the rebel stronghold in eastern Libya.

By 24 March, no aircraft were assigned to pure air-to-air missions; rather, all air-to-ground-capable assets performed dual roles (air and ground).[7] Since the initial strikes did not have either the JSTARS or AWACS performing battle management at the point of attack, an enormous C2 burden was placed directly on the aircrews, according to Major General Woodward.[8] Fighter/bomber aircrews were initially expected to complete the entire find, fix, track, target, engage, and assess (F2T2EA) kill chain without external support from command, control, intelligence, surveillance, and reconnaissance (C2ISR). Major General Woodward had orders to minimize civilian casualties, avoid aircrew losses, and do nothing to suggest that Gadhafi himself was targeted.[9] Yet the C2 structure was organized, trained, and equipped only to meet the demands of a traditional no-fly zone—not interdiction operations—resulting in a C2 system ill matched for the mission. Thus, the addition of air-to-ground C2 players was pivotal to overall campaign success.

Overcoming fog, friction, and chance calls for continuous, in-battlespace, and real-time problem solving with "line of sight" situational awareness (SA). In coalition ground operations, many players in the air or at sea lack dependable voice-satellite capability. In Libya, passing SA remains anchored primarily to line-of-sight radio communications. The reachback distances resulted in area limitations and, in some cases, area denial until C2 assets were in place.

Speeding the kill chain was a direct result of adding tactical C2 to combined operations. When tactical C2 aircraft entered the fight, "their job was to orient shooters, pair shooters with targets, solve battlespace problems, [and] speed accurate decision-making," Major General Woodward reported.[10] By meeting core C2 functions, the airborne C2 assets inherently expanded the commander's influence over operations. A blanket of order was cast over the entire operation in the reformed C2 structure.

The kill chain was reduced from 20 minutes to seconds. The JSTARS crew blended internal sensor data to assess ground scheme of maneuver, rules of engagement (ROE), special instructions, asset availability, ordnance type, and commander's intent to identify potential targets. The vehicles used by Gadhafi's forces were identical to those of the rebel forces—trucks with heavy machine guns or rocket launchers. Features such as point of origin, direction of travel, and direction of fire (determined by the asset conducting the air strike) were quickly matched to grant target authority. This complete cycle often took seconds and, due to alignment with the commander's intent, required no coordination with the CAOC.

The United States' tactical C2 systems and experience were necessary for successful combined operations, even when partner nations provide the vast majority of combat power. This is especially true if the coalition lacks an air-to-ground-focused C2 platform for counterland operations. On 23 March, Odyssey Dawn shifted to Unified Protector, and the North Atlantic Treaty Organization (NATO) assumed operational C2 to enforce the UN arms embargo. The execution of NATO's Unified Protector overwhelmingly relied on C2 systems from the United States. At the same time, non-American member states carried out 75 percent of strike sorties and 100 percent of sea-based enforcement of the arms embargo.[11] France and Britain successfully ran the coalition strike operations, driven by the use of NATO assets for C2—most of which belong to the United States. Additionally, America continued to provide nearly 80 percent of all air refueling, 75 percent of aerial surveillance, and 100 percent of all electronic warfare missions.[12]

Unified air operations in Africa needed a robust tactical C2 network, but modelers did not develop it when they created the plan. US AFRICOM had neither the staff to run a full-scale air campaign nor the organic C2 assets to meet the daily requirements of the air tasking order, which introduced additional fog, friction, and chance into the operation (see the figure below). No one expected US AFRICOM to be "a command that conducted and led" air campaigns, observed Gen Carter F. Ham, US Army, head of that command.[13] When created, AFRICOM was expected to concentrate on training, advising, and support missions.

Blue = United States Air Force **Purple = Non-US Coalition** **Magenta = United States Navy**

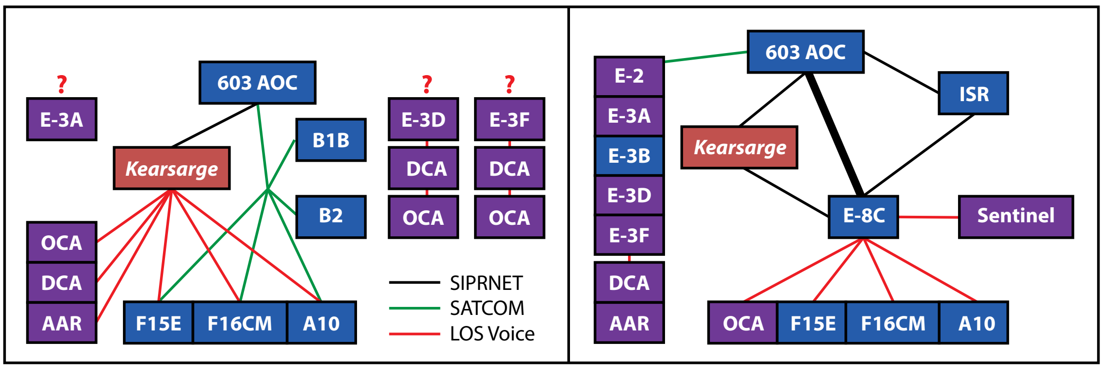

Figure. The left chart represents the initial fragmented C2 effort. The one on the right reflects the refined C2 organization that aligned C2, ISR, and strike assets in a coherent manner by having E-3 variants control defensive counterair while the JSTARS controlled offensive counterair.

603 AOC = 603rd Air and Space Operations Center

A-10 = US close air support fighter

AAR = air-to-air refueling

B-1B = US bomber

B-2 = US bomber

DCA = defensive counterair

E-3A = NATO AWACS

E-3B = US AWACS

E-3D = British AWACS

E-3F = French AWACS

E-8C = JSTARS

F-15E = US strike fighter

F-16CM = US attack fighter

Kearsarge = US amphibious assault ship

LOS Voice = line-of-sight voice radios

OCA = offensive counterair

Sentinel = British airborne standoff radar

SATCOM = satellite communications

SIPRNET = Secret Internet Protocol Router Network

Tactical C2 arrangements are critical to the continuous problem solving necessary to cut through the fog, friction, and chance inherent to war. The JSTARS proved uniquely suited to meet this C2 challenge. This C2ISR asset identified targets, applied the ROEs, and supplied that continuous problem-solving function.[14] C2 in Africa at the operational level also offered insight into the requirement for future joint/coalition operations.

Operational Examples in Libya

Lessons for operational C2 also support modern-day tactical C2. The JSTARS was present throughout much of Odyssey Dawn and all of Unified Protector, flying nearly 150 C2 missions.[15] Consequently, viewing operational lessons through the JSTARS is simply an objective way to study C2 rather than advocate for a specific platform. Six key observations address melding the operational and tactical levels of C2.

First, compounding problems with air-to-ground targeting demanded tactical C2 players to bridge the operational and tactical seam in the war. Planners had to complete the F2T2EA process against regime forces without the benefit of an allied ground force for coordination and target cueing. As implemented, operations included strikes on mechanized forces, artillery, mobile surface-to-air missile sites, and lines of communications that supplied regime forces as well as the C2 of any regime-sustainment activities of forces attacking civilian populations and cities.[16] After 10 years of close air support in counterinsurgency operations, many people were unaccustomed to the quantity and pace of the targeting effort. The counterinsurgency target sets of "individuals" were very different from the target types in Libya.

Second, the rapid onset of hostilities in Odyssey Dawn and the subsequent short buildup of forces became a forcing function to honor airpower doctrine rather than transfer concepts in use at the time in US Central Command. Major General Woodward, the joint force air component commander, empowered the air and space operations center (AOC) planners to honor the airpower tenet of centralized control and decentralized execution. Centralized control maximized the flexibility and effectiveness of air and space power. Yet her staff realized that this control must neither become a recipe for micromanagement nor stifle subordinates' initiative when dealing with combat's inevitable uncertainties.[17] In doing so, the Odyssey Dawn planners were free to use available ISR sources to focus airpower on the joint force commander's priority areas. Sensor fusion allowed quick adaptation to the changing battlespace situation, such as gains by antiregime forces.[18]

Decentralized execution allowed subordinates of the AOC to exploit opportunities in rapidly changing, fluid situations through delegation of decision making to the lowest level.[19] In this case, delegation of targeting authority often went to tactical C2 platforms such as the JSTARS and to individual strike aircraft rather than centralizing engagement authority at the AOC. The JSTARS crews efficiently divided the operating areas using kill boxes to deconflict assets and define targeting assignments while preventing targeting redundancies.

Third, tactical C2 bridged the tyranny of operational distance in Africa. The size of the area in which regime forces were arrayed (the distance from Tripoli to Benghazi is roughly that from Oklahoma City to Denver) and the distance that aircraft had to fly simply to get to their targets created unique problems. Air assets often had little time to assess the situation and make targeting decisions, much less inform the AOC and wait for a decision before fuel states required an abort. The JSTARS was able to solve this problem. Operators applied the joint force commander's priorities and intent, used available ISR cueing and information fusion, applied ROEs, and paired assets to destroy regime forces that threatened civilians. In particular, the fusion and dissemination of available information to speed the kill chain taught a valuable lesson to apply toward future antiaccess/area-denial battlefields.[20]

Fourth, the JSTARS significantly increased the speed of dynamic C2 tasks, resulting in a more responsive kill chain for the whole operation. All assets conducting operations over Libya were under control of the JSTARS with the noted exceptions of preplanned strikes, which occurred three times a day on average with strike packages that routinely had fewer than 10 aircraft. These strikes were important to the operations but did not constitute the main effort.

Unified Protector's primary emphasis involved finding, fixing, and targeting the Gadhafi regime's forces in order to protect the civilian population, and the JSTARS was ideally suited to meet those requirements. Its crews tracked enemy movement of tanks, armored transports, and trucks. On a typical day, NATO forces flew 132 missions, including 50 strike sorties, destroying five heavy vehicles, three tanks, two rocket launchers, one ammunition storage site, one communication tower, and one radar.[21]

Fifth, to bridge the operational-tactical seam in counterland operations, tactical C2 should have robust, well-trained crews and extensive communications suites well suited to counterland operations. The primary mission of the JSTARS is to conduct battlefield surveillance for supported ground commanders and exercise C2 over assigned assets conducting a range of missions.[22] Unique to the JSTARS is its ability to take data in the form of radar moving-target indications and to interpret that data to convert surveillance and reconnaissance information into real-time intelligence. The crew can then determine the best asset to strike the target and communicate through radios or links to fighters (C2 functions), thereby reducing the kill chain's time line.[23]

Sixth, tactical C2 functions result in three operational "rights": right target, right time, and right purpose (i.e., the commander's intent and weapon choices). In Libya the three rights were compounded by numerous factors. The JSTARS managed operational complexities that included language barriers, differing means of communications (whether radio or links), differing ROEs for each coalition nation, and the desire to have coalition countries' aircraft flown together during the same time frame.

A key technology—Internet relay chat (IRC) via satellite—melded the three rights in coalition warfare. IRC "rooms" were used in the battlespace like "visual" radios to paint a "word picture" of real-time events for the CAOC. Air Force doctrine captures this effect by noting that secure IRC enhanced critical C2 capabilities through exponentially improved vertical and horizontal data communications. It did so by simultaneously transmitting C2 information to, and receiving data from, all participating and monitoring organizations across all echelons, thus providing greater SA resulting from increased information volume and reduced latency of information exchange.[24]

The utilization of IRC in warfare is not new; it prevailed during operations in both Iraq and Afghanistan. However, prior to Odyssey Dawn, the network of systems using IRC (both terrestrial and airborne) was never used to conduct C2 of a major phase-one air-to-ground targeting effort. These C2 nodes included the AOC (ground), the USS *Kearsarge* (sea), and the E-8C JSTARS (air), all using common IRC rooms to collaborate targeting efforts.[25] During operations over Libya, IRC proved the most effective communication tool available. In particular, the ability of airborne platforms to receive and share information immediately with the AOC and relay IRC-derived information to "shooters" via radio (fighter, bomber, and armed remotely piloted aircraft) sped up all decision making, often resulting in target engagements measured in seconds rather than minutes.

Additionally, IRC produced a digital log of communications, which allowed operators to review missed posts and monitor more chat rooms than radios—all via secure means.[26] Planners developed innovative tactics, techniques, and procedures to collaborate targeting information in preplanned IRC rooms in an agreed-upon format that became known as a "10-line," designed over IRC for dissemination using line-of-sight voice radios or tactical data links. After it "posted" in IRC and following review of the information, the 10-line was pushed to shooters and considered actionable. Planners avoided data saturation by enforcing proven communications techniques, such as designating "room owners" to add oversight and priorities for the posted information in a given IRC room. IRC became a powerful method of conducting secure, distributive, and collaborative targeting within the C2 community.[27]

Unnamed Operation No. 1: Command and Control of Intelligence, Surveillance, and Reconnaissance

Operations in Libya set the stage for other JSTARS missions in Africa. Demand for this platform in AFRICOM increased after Odyssey Dawn / Unified Protector. Two additional, unnamed operations in Africa followed Libya—very different from their predecessor. The first example examines an unnamed operation conducted in support of Africa that involved deployment of the JSTARS under sensitive reconnaissance operations (SRO) authorities.

SRO missions by nature have to do with operation preparation of the environment (OPE), emphasizing the "find/fix" portion of the kill chain rather than "engagement." Although the synchronization of intelligence requirements and collection is doctrinally held in intelligence channels, the JSTARS had the mission capacity for tactical and real-time C2 of ISR and SRO operations. This happened by fusing the intelligence, surveillance, and operations sections of the crew with a mission-support cell dedicated to fusing data from the JSTARS and off-board sources to create a cohesive operational picture. The aircraft's SRO missions validated the requirement for the conduct of what is known at Nellis AFB, Nevada, as ISR package command.

During SRO OPE missions, the integration and fusion of all aspects of collection (often referred to as the tasking, collection, processing, exploitation, and dissemination [TCPED or simply PED] model) demanded as much "C2" as traditional military operations (and was generally less understood by planners). C2 professionals overcame this lack of understanding through a routine education process on the capabilities of the JSTARS (see the table below). Subsequently, the E-8C's sensor was placed in a position to collect on specified and prioritized targets over austere and sparsely governed areas, doing so safely and in accordance with SRO procedures.

Table. Phases of JSTARS processing, exploitation, and dissemination

Phase I	Near real time during the mission	• Basic MTI/SAR analysis *during* the mission • Off-board cross-cue required to add significance/context/combat ID to MTI	• TADIL-J, SCDL track broadcast • Juliet TACREP/SALTREP (near-real-time reporting conducted during E-8C on-station via voice, FTM, or SIPR IRC as events develop) • Screen-capture products sent directly at the request of unit	• E-8C JSTARS crew
	Forensics less than 12 hours after mission	• MTI/SAR analysis conducted *immediately following completion of every mission* • Unless specifically tasked otherwise, this would primarily be MTI derived without fusion	• Density plots annotating choke points or • Traffic pattern analysis characterizing heavy/medium/light • Track backtracking highlighting point of origin and/or end point • AF DCGS analysis report • Graphical reports for the sortie duration or highlighted time period	• Distributed PAD crew - DART MTI cell
Phase II	Forensics less than 24–72 hours after mission	• Multiple missions of data, multiple intelligence-source fusion products	• Various fusion products including MTI (no standard product type)	• National Geospatial Agency (NGA) • Distributed mission site - National Air and Space Intelligence Center (DMS-NASIC)
Phase III	Forensics over a period of weeks or months	• Many missions of data, multiple intelligence-source fusion products	• Various fusion products including MTI (no standard product type)	• NGA • DMS-NASIC

MTI - Moving Target Indicator
SAR - Synthetic Aperture Radar
TADIL-J - Tactical Digital Information Link-J
SCDL - Surveillance and Control Data Link
TACREP - Tactical Report
SALTREP - Size Activity Location Time Report
FTM - Free Text Message
SIPR - Secure Internet Protocol Router
DCGS - Distributed Common Ground Station
PAD - Processing Analysis Dissemination
DART - DCGS Analysis Reporting Team

SRO missions included lead responsibility for the JSTARS crews to fill capability gaps in the overall intelligence channels to process, exploit, and disseminate "forensic" information in areas or missions not fully addressed by combatant command processes. Additionally, although the JSTARS conducted the OPE mission set, the ability to conduct additional C2 mission sets (e.g., kinetic operations) was not diminished.

During this unnamed operation, delegated authorities were defined in clear mission type orders that produced an effective collection strategy which aligned all ISR/SRO missions. Rather than simply matching "collection to requirements" (i.e., "greening up" the Excel spreadsheet and metrics-based measures of effectiveness), effects-based operations were more productive. The "mission command" style of mission type orders allows operators to layer "multi-intelligence" approaches with multiple platforms simultaneously to cross-cue information dynamically for the commander's intent.

A clearly defined commander's intent and the freedom of mission type orders allowed C2 and ISR subject-matter experts to devise collection strategies and adapt quickly to real-time situations. In turn, this allowed decentralized execution of ISR operations, taking advantage of the multitude of problem solvers available for the mission to solve pieces of the puzzle rather than send the thousands of variables up the channel to stovepiped PED organizations that lack an action arm in the battlespace.[28] The completion of this "phase zero" PED process resulted in identification of routes of travel and the takedown of numerous high-value individuals fed by postmission PED phases.

Unnamed Operation No. 2: Command and Control and Special Operations Forces

A second unnamed operation in Africa showed how Air Force tactical C2 provides range and reach to support special operations forces (SOF). The previous two examples in Africa demonstrated how the

JSTARS can bring order to chaos in conventional warfare and SRO. In spring 2013, the JSTARS supported unconventional coalition action in northern Africa, indicating that tactical C2 can also be pivotal to SOF operations.

In austere and remote environments, doctrinal forms of C2 are not the norm. Tactical C2 agencies are often called upon to bridge operational C2 and the tactical fight. Additionally, tactical C2 is vital to communicate between two or more operational C2 nodes to ensure common understanding of the real-time fight. This tactical C2 node can bridge interservice, intraservice, or coalition agencies, similar to forming the functions of a joint interagency task force without naming one. The JSTARS brought long loiter time, long-range communication, and tactical C2 operators into a ground situation that, until the platform's arrival in-theater, had no C2 allotted or assigned to coalition SOF. The C2 void does not stem from the SOF forces themselves but from all of the coalition assets supporting them.

Updating commanders on the ground and then immediately applying fixes to unfolding events in the battlespace were key components of flexible C2 in Africa. During the second unnamed operation, the operations area featured multiple AOCs manned and supported by US and coalition forces with no directed C2 node to bridge the gap between all of the players. Two AOCs resided within the European theater, one staffed mostly by US forces and the second manned by coalition forces with a minimal number of US liaison officers to bridge the gap at the strategic and operational levels. A third AOC operated by the coalition was located in Africa, with limited communication to the US AOC in Europe. This situation resulted in a communications void at the operational level—one that the JSTARS crews filled by utilizing beyond-line-of-sight communications to pass ground-situation updates to three AOCs simultaneously. Removing the lag time in communication from one AOC to another led to a more efficient use of air assets in a resource-constrained environment.

Due to the sensitive nature of the coalition operations and a general SOF requirement for higher operations security, many of the executed missions occurred with little coordination between the units supporting the unnamed operation at the tactical level. This produced fog and friction between the ground forces, which consisted of coalition SOF, conventional armies, and air assets split among countries.

Theater allocation of air support further contributed to the overall fog and friction at the tactical level. Air assets were assigned not to overall ground operations or individual objectives but solely to SOF or conventional ground forces. JSTARS missions were assigned only to support coalition SOF, creating an additional communication layer in which coalition forces either refused or could not share data with US partners for mission execution beyond the traditional SOF close-hold plans. Only late in the deployment were the E-8C's wide-area surveillance and C2 capabilities extended to support multiple commands in a single mission. The JSTARS bridged the gap between multiple ground units, executing on objectives and communication plans by relaying data to higher headquarters. Operators also gave ground-movement information to land forces and interpreted vague plans for ground scheme of maneuver along with commander's intent to prioritize limited assets and loiter time in a large theater of operations.

C2 naturally occurred via crews that overcame stifled information flow and bridged the gap between SOF and conventional forces. Multiple JSTARS missions were executed despite having little to no information regarding the friendly ground picture and ground forces' scheme of maneuver, including such basic information as ground-unit call signs and working frequencies. To circumvent these issues, JSTARS crew members prioritize sensors and communications, often armed with only a theater communications plan, a list of possible joint terminal attack controller call signs, and vague ground-operations plans written in the coalition country's language. The crew utilizes commander's intent and end state derived both from the theater air operations directive and the SOF operation's end game. The JSTARS was not specifically deployed to execute tactical C2, but operators on the E-8C utilized their tactical C2 training to speed decision making by serving as a connecting node between SOF and conventional forces, prioritizing the use of limited air assets to meet the commander's intent.

Perhaps the most important aspect in this unnamed operation was the fact that the JSTARS filled a void in the C2 of ISR. The aircraft deployed with the ability to fuse wide-area surveillance, moving-target-indicator data with near-real-time airborne ISR reporting and reachback to a mission-support cell with access to multi-intelligence products.[29] JSTARS crew members were also ready to provide real-time deconfliction of air assets with sensors. They not only made real-time decisions on allocation of sensors supporting SOF operations but also supplied high-fidelity target and threat point-outs to forces on the ground. To do so, they combined an advanced understanding of the commander's intent, a working knowledge of airspace procedures, the ability to reach out to players on the ground, reachback to three AOCs, and coordination with intelligence agencies in-theater and at the home station. The JSTARS applied the commander's intent in near real time to the tactical situation by maintaining SA of the ground situation via radio, data links, and IRC. It then prioritized air support to units on the ground by moving sensors and airborne assets from one operation to another.

The E-8C's successful provision of both ISR and tactical C2 resulted in the tracking of eight high-value individuals, directly contributing to the capture of one such person and confirming the killing of three others. Long loiter times, long-range communication levels, and execution of the tactical C2 role contributed to the platform's success. The increase in end game while the JSTARS executed in-country reflects the immense value and additional capability that tactical C2 brings to the fight in Africa. JSTARS support in the AFRICOM theater demonstrated that a national asset equipped with tactical C2 operators can enhance the operational-level common operational picture. This platform connected multiple AOCs, bringing clarity and order to a chaotic ground and air situation at the tactical level.

Conclusion

Political sensitivities in war demand more robust C2, not less. The fact that our culture must have more precision and detailed information during combat operations necessitates an expanded focus on C2. Recent operations in Africa demonstrate that the United States is likely to provide the majority of C2, electronic warfare, and tanker support. Recording the successes and failures of the operations is essential to gaining an understanding of applications for future endeavors.

Africa provides a unique context to study the need for C2 design in coalition warfare. The contributions and successes of tactical C2, as seen through the lens of the JSTARS, highlight the requirement to incorporate C2 in full-spectrum operations. These contributions are often intangible and overlooked as silent successes, resulting in a decreased emphasis on the importance of tactical C2. A well-executed mission rarely underlines the significance of the C2 role, which creates a design/requirement difference in the next fight. Studies tend to emphasize C2 in failures rather than successes. Thus, these three Africa case studies show what success really requires in the form of C2 systems.

In Libya, six observations stand out regarding tactical C2. First, C2 by definition is joint. Coalition building has increased the probability of C2 becoming a combined (i.e., international) structure with unique challenges. Second, coalitions are more common, but the capacity to provide C2 is increasingly held by US assets. Third, the lack of tactical C2 results in a less decisive operational C2 structure. Real-time decision making during force-on-force operations is best delegated where the most SA exists—at the tactical C2 level. Fourth, decisions made by tactical C2 ultimately serve to speed the kill chain when speed matters. Fifth, the transfer of information between operational-level and tactical-level C2 is vital, calling for robust, redundant communication.

Sixth, solving problems at the tactical C2 level permits continuous prosecution of warfare.

Consequently, operations in Africa reflect the importance and necessity of C2. Whether conducting traditional operations as in Odyssey Dawn / Unified Protector, support to SOF, and C2 of ISR, these examples showcase the critical nature of tactical C2. ✪

Notes

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28. Examples include partners in distributed ground control stations and interagency and intelligence community watch personnel.

29. These products included Google Earth KML files, intelligence feeds inaccessible to the airborne crew members, and imagery files from agencies such as the National Air and Space Intelligence Center and the National Geospatial Agency.

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Examining the Importance of the Tactical Air Coordinator (Airborne)

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Capt Matthew B. Chapman, USAF

Both the correct application of the force-multiplying effects of airpower and the failures resulting from its misapplication have been evident in the twenty-first century. One must conduct a careful examination of the misapplications of airpower to prevent future mistakes and ensure mission success. Any discussion of the minor errors that have occurred would be lengthy, but one fatal misapplication of airpower must be dissected because of its implications for troops on the ground. Antoine Henri Jomini captures the criticality of incorporating lessons learned in future military operations: "It is true that theories cannot teach men with mathematical precision what they should do in every possible case; but it is also certain that they will always point out the errors which should be avoided; and this is a highly-important consideration, for these rules thus become, in the hands of skillful generals commanding brave troops, means of almost certain success."[1]

The execution of robust close air support (CAS) without a tactical air coordinator (airborne) (TAC[A]) is an egregious error that costs lives. Although codified in general terms in Joint Publication (JP) 3-09.3, *Close Air Support*, the TAC(A) has either gone unfilled or has been underapplied in numerous actions, most notably in Operation Anaconda in Afghanistan and in operations over Najaf and Fallujah in Iraq.

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In March 2002, US and coalition forces met stiff resistance during Anaconda when they encountered a well-entrenched enemy force much larger than expected. By many accounts, this complex, robust operation was not well planned with regard to air support. Multiple factors contributed to the ineffective air support to ground operations.[2] These included both the close proximity of forces and too many joint terminal attack controllers (JTAC) who were not properly organized and spaced for the operation; moreover, the sheer number of air support requests overwhelmed the system. The virtually indistinguishable terrain and failure to accurately prioritize the requests made it very difficult for CAS responders to tell the difference between those that had been filled and those awaiting support. Furthermore, insufficient air support had been allocated to fill them. The close proximity of friendly forces created danger-close situations made even more complicated by the kinetics-delivery limitations caused by the terrain.[3]

In the battles for Fallujah and Najaf, US forces faced multiple airpower-integration challenges. Shared airspace-control authorities between Marine and Air Force command and control (C2) agencies led to major issues with coordination, deconfliction, and flow of air assets, slowing response times and creating delays of up to 20 minutes once aircraft were over the target area to make contact with the forward air controller or JTAC.[4]

The problems in Anaconda and the operations over Najaf and Fallujah could have been mitigated with an existing capability—the TAC(A). However, the joint community does not use this coordinator because of a lack of understanding. Specifically, the concept is not defined with enough detail in joint publications, and the training in joint exercises does not address it. That said, what is the TAC(A), and how does it enable operations synergy in a joint environment?

Understanding the Tactical Air Coordinator (Airborne)

Current doctrinal understanding of the TAC(A) holds that it augments the air support operations center (ASOC) by extending its range and allowing it to send and receive information at greater distances—essentially radio relay.[5] JP 3-09.3, the only joint publication that defines the TAC(A), provides only a broad overview of its employment and does not mention its most essential function—battle management command and control (BMC2).[6] Two essential components enable the TAC(A) to provide BMC2: capable platforms and highly trained operators.

Capable platforms employ networked systems, including radio communication, data links, tactical chat, and surveillance radars; further, they should have long loiter times, stability, and redundant systems. Capable operators can run C2 systems and functions competently, offering radar and sensor control as well as making and implementing decisions. Noted strategist Colin Gray once observed that aircraft "are lethally hostage to the quality of applied technology and to the skill of air and ground crews. In air as well as sea warfare, enthusiastic amateurs die in short order."[7] Nowhere is this more applicable than in BMC2, whose very nature requires skilled professionals leveraging capable technology to direct employment of airpower. Platforms such as the Royal Air Force's Sentinel and the US Navy's P-3 LSRS possess networked and integrated capabilities but do not have battle-management professionals to conduct BMC2. Rather, they are relegated to surveillance-only missions.

Although most Air Force practitioners of BMC2 naturally gravitate to air assets as the primary C2 weapons system, the "right platform" does not necessarily have to be airborne. When performed by assets such as the Airborne Warning and Control System or the Joint Surveillance Target Attack Radar System (JSTARS), the "A" in "TAC(A)" is applicable. However, the tactical air coordinator is often ground-based, out of the control and reporting center or tactical air operations center. The current definition of the TAC(A) does not account for ground-based agencies; however, like their airborne counterparts, they are globally connected battle-management hubs. Tactical air coordinators, whether airborne or ground-based, act as information fusion centers that enable effects while minimizing friendly losses.

Specifying the capabilities and effects of these tactical BMC2 fusion centers would add a level of clarity that does not currently exist in TAC(A) source documents. This clarity would assist mission planners in making better decisions about allocation requests for assets and help ensure that TAC(A)s are integrated effectively into operations.

When utilized properly, the TAC(A) is not simply a relay platform but a tactical C2 platform capable of battle management. It combines capable platforms that enable networked operations and capable people to leverage those networks and provide battle management. Whether this occurs on the E-8C, E-3, E-2, or MC-12—or in a ground-based control and reporting center or tactical air operations center—the BMC2 function exists.[8] BMC2 creates operations synergy by (1) optimizing tactical capabilities, (2) providing information dominance, and (3) exercising decision superiority (see the figure below).[9]

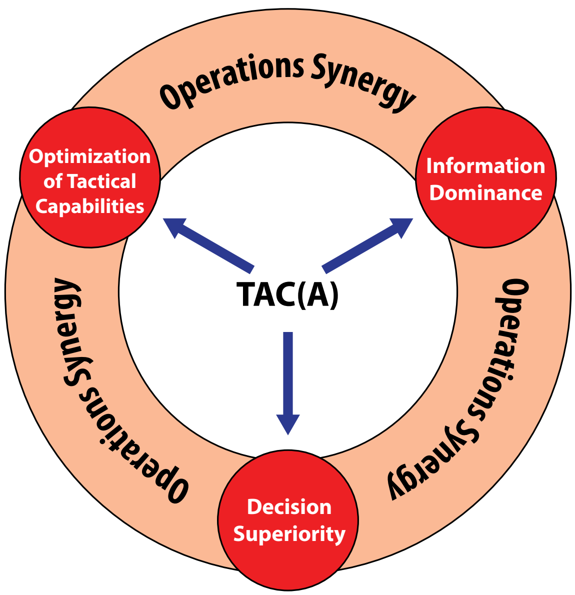

Figure. TAC(A) enabling operations synergy

Optimizing Tactical Capabilities

Optimizing the tactical capabilities of airpower in its area of control is the essential function of battle management.[10] Simply put, such optimization involves leveraging all knowledge, training, and planning to place the right asset, at the right location, at the right time to affect the battlespace in favor of friendly forces. Considerations include both weapons and sensor employment. Military strategist J. C. Slessor captures the essence of optimizing tactical capabilities in his definition of concentration: "The application of this principle [concentration] consists in the concentration and employment of the maximum force . . . at the decisive time and place."[11] TAC(A)s can optimize overall tactical capabilities by understanding asset-employment procedures, weaponeering, fuel loads, sensors, communication, and data links. They manage the airspace by using deconfliction techniques, hold points, and routing procedures; TAC(A)s also maintain force accountability.[12]

Slessor also notes that "the capacity to concentrate the maximum force at the decisive time and place obviously involves as a first essential a clear understanding of *what is the decisive place at the time*" (emphasis in original).[13] Positioning aircraft in time and space is the first step towards creating operations synergy. It allows friendly forces to best employ their technology and sensors to enable the flow of information, which enables the TAC(A) to gain and maintain information dominance.

Providing Information Dominance

The degree to which reality is understood and communicated across the battlespace either enables mission accomplishment or contributes to failure. Information control is specifically applied to the understanding of friendly capabilities and force posture as well as knowledge of the adversary's disposition and operational environment. The understanding of available friendly capabilities and force posture drives options for tactical action. Surveillance of the operational environment and adversary disposition allows for threat warning, identification of ambiguities, and anticipation of potential courses of action. The TAC(A)'s ability to supply information dominance requires harnessing, filtering, and communicating relevant information in a timely manner.[14]

When employed correctly, the TAC(A) collects, validates, and acts on information through employing sensors and operators trained in their usage. The coordinator utilizes networked sensors, data links, and communication systems to build air, ground, and surface surveillance pictures; offer current situation updates; and locate and identify emerging targets.[15] In his study of airpower in Operation Enduring Freedom, Benjamin Lambeth makes the following observations regarding the harnessing, filtering, and communicating of relevant information: "The multiplicity of interlinked and mutually supporting sensors enabled a greatly increased refinement of ISR input over that which had been available during earlier conflicts . . . [leading to the] merging of multiple sources of information and the channeling of the resulting product into the cockpits of armed aircraft ready to act on it."[16] Mr. Lambeth describes the function of the TAC(A) with regard to leveraging knowledge of the enemy disposition. The coordinator manages and fuses sensors to refine knowledge of the enemy's disposition and of direct friendly action.

Directing friendly action calls for the TAC(A) to manage information on friendly-asset posture and to leverage available forces to facilitate mission accomplishment. Doing so includes knowing the location, station/loiter time, and weaponry available as well as the effects of both airborne and ground-based offensive elements. The TAC(A)'s ability to build and maintain situational awareness, filter information, and communicate it enables timely and effective decision making.

Exercising Decision Superiority

Decision superiority entails the ability of one force to gather information faster, make decisions quicker, and execute them before the enemy can react.[17] Col John Boyd's observe, orient, decide, act (OODA) loop framework offers perhaps the most famous understanding of the importance of decision superiority.[18] A force that possesses decision superiority can overcome its adversary despite disadvantages such as having fewer forces and less effective weaponry.

The TAC(A) should execute operations in accordance with the commander's intent and priorities through building and maintaining situational awareness across the tactical and operational levels of warfare. The coordinator must leverage the above-mentioned battle-management functions combined with his or her inherent C2 decision-making competencies to apply the rules of engagement, manage ambiguous C2 authorities, and recommend solutions to tactical problems.[19] Finally, the TAC(A) should assess the impacts of air tasking order changes and tactically retask assets to compensate.[20]

The TAC(A) should exercise decentralized decision-making authority, an ability made increasingly important by the advancement of a near-peer adversary's capabilities. In contested, degraded, or operationally limited environments, the tactical level must include decision makers. Currently, technological advancements are causing tactical C2 agencies to experience attrition in the realm of delegated decision-making competencies. Such advancements have made it possible for operational and strategic leadership to maintain a degree of situational awareness on the tactical fight as never before and therefore make tactical decisions at the operational and strategic levels. TAC(A) operators require knowledge of their leaders' operational and strategic intent and the authority to make command decisions in accordance with rules of engagement and an acceptable level of risk.[21]

Vignette

JP 3-09.3 only scratches the surface of the TAC(A) role, relegating it to the status of a relay asset and thereby limiting the coordinator to passing words to and from the ASOC, tactical operations center (TOC), and aircraft. However, as discussed previously, a correctly employed

TAC(A) plays a major role in ensuring mission success. The coordinator can position friendly air assets in the safest and most efficient manner to maximize their operational capabilities, allowing the TAC(A) to control the flow of information and thus establish dominance in the information domain. With the right balance of delegated authorities from higher headquarters, the TAC(A) can then execute the planned mission, aiding decision superiority on the operational and tactical levels. Doing so synergizes operations that enable friendly forces to produce superior effects on enemy combatants.

This article has addressed the limitations of JP 3-09.3 in regard to TAC(A) and has prescribed capabilities and functions that the coordinator should provide. The following fictional scenario reinforces these principles.

Taliban forces numbering more than 1,000 have seized an Afghan town. Friendly forces intend to take it back and restore government services to the population. Ground units are planning a major combat operation that will span several weeks. This particular population center is highly urban with mountains surrounding it on three sides. Coalition mission planners have divided the town and surrounding area into nine zones, each with a JTAC team. The ASOC and air and space operations center have coordinated for 40 CAS sorties per day during this operation.

The tactical problem for this mission lies in coordinating the large number of assets and various JTAC units in close proximity to each other. Normally, significant geographic separation exists between JTACs, enabling the use of a single initial point so that the controllers can flow aircraft towards their position and enable fires against enemy positions. However, in this scenario, there are numerous aircraft in congested, overlapping airspace and JTACs close together.

Successful employment depends upon detailed integration. If each JTAC operated independently, then maximizing the totality of airpower would be impossible. Aircraft would likely remain underutilized or used against lower-priority taskings. Additionally, the threat of midair collisions and friendly fire would be significant. Adding a BMC2 asset to perform the functions of the TAC(A) would synchronize operations by optimizing tactical capabilities, offering information dominance, and ensuring decision superiority.

The TAC(A) immediately optimizes tactical capabilities *by establishing and controlling routing from the hold point through the congested airspace to each of the nine JTACs. After dropping ordnance, assets are then routed back to the hold point or to the tanker for additional fuel, thus freeing the JTACs and forward air controller (airborne) to prioritize and control the terminal fires. Currently, the tanker cell includes two two-ships of A-10s, and a two-ship of GR-4s transits the airspace en route to another tasking.*

The TAC(A) provides information dominance *by facilitating communication between the TOC and air assets. The TAC(A), who checks in aircraft and offers force accountability, coordinates directly with the TOC, advising it of mass ground movements that appear to be flanking friendly positions.*

Realizing that this is a potential troops-in-contact situation, the coordinator exerts decision superiority *by passing this assessment to the AOC and TOC, rerouting the GR-4s to the hold point, and coordinating retasking authority from the C2 director of operations. Simultaneously, the TAC(A) coordinates to expedite one of the two-ships of A-10s from the tanker back to the hold point and monitors the JTAC frequencies in the vicinity of the ground movement. As the GR-4s check in at the hold point, the TAC(A) gives them a situation update, the JTAC call sign, and frequency. As this happens, the JTAC takes fire, requests support, and the GR-4s check in on his tactical frequency with high awareness of the developing tactical situation.*

This *operations synergy* is the essence of what a TAC(A) provides.

Conclusion

More than a communications relay platform, the TAC(A) remains underapplied in current operations. This networked and integrated information fusion and battle-management center is an effects enabler that can protect friendly forces and deliver debilitating effects on the adversary. Proper application of the TAC(A) enables operations synergy, achieved only when the right assets with onboard, trained operators are in a position to optimize tactical capabilities, facilitate information dominance, and enable decision superiority. Current fielded tactical C2 platforms have the capabilities and trained personnel to perform this role.

The battle-management functions and tasks associated with the TAC(A) are applicable not only to CAS but also to a variety of C2 missions. In the case of air operations in maritime surface warfare, the Navy organically developed a TAC(A) analogue in maritime air control. Because the special operations community needs a TAC(A), an equivalent role has been developed in Air Force Special Operations Command with duties very similar to those of a TAC(A) but executed in a limited geographic area.

Whether airborne or ground-based, supporting special operations or CAS, the BMC2 functions of the TAC(A) remain the same. As evidenced in Najaf and Fallujah, the absence of a TAC(A) limits the effectiveness of airpower applications. Because the growing complexity of joint and coalition operations will increase reliance on the TAC(A), it is paramount that the Air Force define this role based on its BMC2 capabilities, offer training in its employment, and execute it. ✪

Notes

1. Antoine Henri Jomini, *The Art of War*, new ed., trans. G. H. Mendell and W. P. Craighill (Westport, CT: Greenwood Press, 1971), 323.

2. Maj Erik Haeuptle, interview by Maj Greg Blom, 2 April 2014. These lessons learned are based on an e-mail exchange with Haeuptle, a former air liaison officer.

3. Ibid.

4. Maj Fred H. Allison, USMC, Retired, *Lessons Learned: The USMC Approach to Close Air Support in Fallujah (Part Two)*, 7 February 2010, http://www.sldinfo.com/lessons-learned-the-usmc-approach-to-close-air-support-in-fallujah-part-two/. Major Allison cites the Marine Corps direct air support center (DASC) as the eventual solution to this air coordination issue in Fallujah, but the authors of this article see limitations in using the DASC in a nonpermissive environment or during contested, degraded operations.

5. "**TAC(A) provides an extension** for the ASOC/DASC with the goal of extending the ASOC/DASC's range and ability to send and receive tactical information. The TAC(A) acts as a **communications relay** between the JTAC and attack aircraft as well as other agencies of the TACS. . . . [boldface in original] In the TACS/AAGS [Army air-ground system], TAC(A) provides communications relay between the TACP [tactical air control party] and attack aircraft, as well as other agencies of the TACS, in the absence of JSTARS, or a FAC(A) [forward air controller (airborne)]. The TAC(A) also expedites CAS aircraft-to-JTAC handoff during 'heavy traffic' CAS operations. Air Force two-ship FAC(A) flights, especially in higher threat environments, may divide responsibilities so one aircraft fills the normal FAC(A) role while the second becomes a TAC(A)." Joint Publication 3-09.3, *Close Air Support*, 8 July 2009, 74.

6. Ibid.

7. Colin S. Gray, *Modern Strategy* (New York: Oxford University Press, 1999), 234.

8. Air Force Tactics, Techniques, and Procedures (AFTTP) 3-1, *MC-12*, 25 January 2013. TAC(A) is mentioned as part of the MC-12's role in support of special operations forces.

9. Lt Col Jonathan Zall, "Weapons Officer Talk: What Is Tactical C2?" (lecture, 461st Operations Group, Robins AFB, GA, 12 March 2014). Lieutenant Colonel Zall developed these battle-management concepts. Although not applied directly to TAC(A), they were discussed in terms of their relationship to the role of tactical C2.

10. Ibid.

11. J. C. Slessor, *Air Power and Armies* (Tuscaloosa, AL: University of Alabama Press, 2009), 62.

12. These C2 tasks were first listed in AFTTP 3-1, *TACS*, 30 September 2009, and were moved to attachment 6 in the last edition (1 February 2013).

13. Slessor, *Air Power and Armies*, 63.

14. Zall, "Weapons Officer Talk."

15. These C2 tasks were listed in AFTTP 3-1, *TACS*, until the last edition of 30 September 2009.

16. Benjamin S. Lambeth, *Air Power against Terror: America's Conduct of Operation Enduring Freedom* (Santa Monica, CA: RAND Corporation, 2005), 254.

17. Zall, "Weapons Officer Talk."

18. See Grant Tedrick Hammond, *The Mind of War: John Boyd and American Security* (Washington, DC: Smithsonian Institution Press, 2001). The OODA loop is a well-established tool for military problem solving and decision making. Boyd was famous for performing the loop within seconds during air-to-air intercepts.

19. Allison, *Lessons Learned*. During CAS operations in Fallujah, the two competing air control organizations—DASC and AOC—owned different parts of the airspace, creating coordination issues and delays in moving CAS assets into position to support ground troops.

20. These C2 tasks were listed in AFTTP 3-1, *TACS*, until the last edition of 30 September 2009.

21. See Lt Col Alan Docauer, "Peeling the Onion: Why Centralized Control/Decentralized Execution Works," *Air and Space Power Journal* 28, no. 2 (March–April 2014): 24–44.

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Crossing the Streams

Integrating Stovepipes with Command and Control

Maj Matt "Radar" Gaetke, USAF

As any Air Force weapons officer, participant in a Red Flag exercise, or graduate of Squadron Officer School (SOS) knows, Airmen integrate airpower capabilities to achieve desired effects—but integration is hard to find over Afghanistan. None of our air platforms excel at every mission; the capabilities of each cover the weaknesses of others. Removing a capability exposes a vulnerability that adversaries can exploit. If a capability is present but the command and control (C2) system has not fully integrated it, then the same vulnerability is exposed. Current airpower planning and execution processes reveal significant integration gaps. To fix these problems, Airmen must reexamine the people, processes, and products of the air and space operations center (AOC). In the future, the AOC should perform all planning in a single division, publish the plan in a single document, and package capabilities under mission commanders empowered to respond to changing circumstances.

The capabilities of Air Force platforms currently flying over Afghanistan are poorly integrated. That is not to say they are ineffective; rather, the volume of assets compensates for failures to integrate. A C-130 might air-drop supplies to a drop zone plagued by small-arms antiaircraft fire. The drop might occur immediately beneath an MQ-1 Predator orbit, but the Predator crew would not know that the airdrop is planned, much less scan for threats to the C-130—unless the supported unit happens to task it to do so. Simultaneously, one regional command over, an F-16 provides armed reconnaissance along a route

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that friendly forces will patrol the following day, oblivious to the fact that an MC-12—in an overlapping orbit—has found and fixed a high-value target, hoping that a strike asset arrives in the area before collateral concerns preclude an attack. An HH-60 takes fire during a casualty evacuation mission, not knowing that a Sandy-qualified A-10 is in the next kill box. These are fundamental breakdowns.

These problems mostly stem from stovepiped planning, which is conducted separately by function, with limited visibility into and much less integration with parallel efforts. For instance, close air support (CAS); intelligence, surveillance, and reconnaissance (ISR); and mobility missions are planned in separated divisions of the AOC. Furthermore, in counterinsurgency operations, this planning is largely driven by requests from supported units, despite similarities in both requests and capabilities among many of these assets. A supported unit's planned tasks for CAS inevitably include scanning, overwatching, and detecting. Meanwhile, units request MQ-1 and MQ-9 aircraft because of their armament. As capabilities improve, the distinction between CAS and ISR almost disappears—they are best viewed as points on a continuum rather than as distinct species. CAS planners, however, do not consider the planned locations of armed ISR assets. The ISR plan is completed on a different timeline by different people in a different division in the AOC and published in a different document. If CAS and ISR integrate, they do so by luck. One hand of these multirole assets remains always cuffed to its respective stovepipe. The air mobility plan is even further removed. Despite their brief mention in the air tasking order (ATO), both ISR and mobility pilots refer to other documents for details—the details necessary for integration.

Problems continue in execution. Occasionally an armed ISR asset will respond to a troops-in-contact situation when no traditional CAS assets are immediately available. It would never respond *in addition* to a traditional CAS asset. Yet, the responding CAS asset is oftentimes immediately asked to scan an area or supply positive identification, tasks better suited for ISR platforms, particularly when supported by the massive and capable processing, exploitation, and dissemination architecture. Instead, ISR remains tasked to its supported unit, allowing the insurgents to exploit disintegrated airpower.

Although volume masks these failures in Afghanistan, we may have insufficient numbers to hide integration deficiences in future conflicts. Budget cuts could reduce our force structure. Increasingly contested operations could exhaust our reserves. We cannot afford to use assets inefficiently if we wish to be effective. We need to reevaluate the way we command and control the people, processes, and products of the AOC. The Air Force can solve these problems at almost no cost, starting in four areas:

1. Plan airpower within a single AOC division as an integrated whole.
2. Publish the plan in a single document.
3. Package capabilities in a tactical structure empowered to react to changing circumstances (i.e., group multiple platforms into a coordinated package and designate a mission commander).
4. Manage these packages from the operational level to maintain coherence in reaction to changing circumstances: let the AOC command and control.

First, airpower capabilities must be planned as an integrated whole. At a minimum, all planning must occur in the same room, under a single leader, and with constant collaboration among planners of different disciplines. At the tactical level, every mission-planning cell works that way. All planners receive guidance, determine how to maximize their specific capabilities, and then assemble a detailed plan integrated to maximize the strengths and compensate for the weaknesses of all players. AOC planning is different in scope, but it is all the more important that the operational planners assemble the right capabilities so tactical operators can produce the desired effects. Doing so requires an organizational change (moving the planning function into a single AOC division under the leadership of a single Airman) and a physical change (moving the planners to one room, allowing collaboration);

otherwise, it is cost free. Although supported organizations would still prioritize requirements—the joint tactical air strike request prioritization process for CAS and collections-requirements management for ISR—the AOC would be postured to fill these needs in an integrated way. Additionally, when air is the supported effort, these planners would be more prepared to integrate necessary capabilities when resources are scarce.

Second, the complete, integrated plan must be published in a single document. Currently, different varieties of information wind up in the ATO for different types of aircraft, making it impossible for pilots to determine which other aircraft will operate in the same area at the same time. Seemingly, this structure was designed to prevent airborne assets from collaborating or integrating capabilities. Potential deconfliction problems are solved in real time; the integration problems are not. Instead, all assets should be tasked in the ATO at the same level of detail. The ATO should include the location of the tasking, the time, and a request identifier pointing to more detailed data, even if that identifier demands access to higher levels of classification.

Third, assets that offer particularly symbiotic capabilities should be assigned to a package—a construct universal in major combat exercises yet unheard of in Afghanistan. Electronic warfare assets and certain ISR assets work best when they can leverage each other's capabilities. They should be tasked together to areas where they can support one another and should be assembled into a package. Smaller packages might combine the effects of multi-intelligence assets and fighters. F-16s and MC-12s demonstrate this scheme perfectly. A flight of F-16s could be packaged with several MC-12s, spread out around the fighters' expected working area. If the F-16 flight is retasked, it can shuttle between MC-12s to retain that combination of capabilities despite airspeed differences. These packages should have a mission commander who retains the authority to modify how the package provides support. Within certain parameters, this mission commander can adjust the plan if a changing situation dictates a shift in priorities.

Finally, this execution should be backed up at the AOC in the combat operations division (COD). Although less stovepiped than those divisions responsible for planning, the COD can still integrate more effectively during ATO execution. Our newly empowered mission commanders can make tactical decisions, but the COD could dynamically reallocate assets to a package as the situation changes, whether due to varying requirements of supported units or asset fallout. Additionally, given the difficulty of tactical integration with national assets, the COD can make sure that space and cyberspace effects are integrated into the ongoing effort.

These are unoriginal ideas. In fact, all of them are simply adaptations of practices used for major combat operations, perfected over years of training. In that game, the Air Force takes institutional pride in integrating all available capabilities. Unfortunately, in places like Afghanistan, where airpower plays a supporting role, these solutions do not immediately present themselves. Providing support has devolved into mindlessly filling requests, even when the result runs contrary to the Air Force's airpower expertise. We must right this trend and return to integrating capabilities—supporting with effects rather than a disjointed menu of capabilities.

Critics will claim that the waning months of the war in Afghanistan is not the time to experiment with a new process or concept. Nevertheless, forcing increased integration now will not only enhance our effectiveness throughout the drawdown in Afghanistan but also help us prepare for future combat operations, "major" or otherwise. Making integration work in the current war is the best way to ensure that it will work in the next. We must revitalize the culture of integration. The weapons officers, Red Flag veterans, and SOS graduates at the AOC and the air expeditionary task force headquarters can make this happen. They have a successful model but need to open their apertures beyond the scope of recent squadron experience. We cannot afford to continue our reliance on volume to solve problems. Instead, we must rejuvenate the culture of Airmen, at all levels, by integrating capabilities to produce desired effects. ✪

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A Concept for Directing Combat Air Operations*

Major General Sam J. Byerley

As early as 1946, Lieutenant General Hoyt S. Vandenberg, speaking of the capabilities which modern tactical air forces had demonstrated during the European air war, observed that flexibility in the application of air forces was necessary in order to achieve maximum results. Flexibility, he stated, enabled air forces to achieve maximum responsiveness and effectiveness in coordinated efforts with other military forces and permitted the diversion of tactical air power to meet critical situations on the ground rapidly. He further observed that, to achieve the degree of flexibility required, direct control of all available air power should be centralized under a single air force commander.

The validity of the concept of "centralized control/single management" of air resources within tactical areas of responsibility was demonstrated in World War II and in the Korean conflict. Unfortunately, the concept and the organization developed to administer it lost substantial support at the conclusion of each of those wars, and significant time and effort were required to re-establish an adequate system during subsequent conflicts.

doctrine in the sixties

Current doctrine remains in basic agreement with General Vandenberg. Tactical air forces are organized, equipped, and trained to conduct sustained air operations against enemy military forces at any level of conflict which national policy may require.

*Reprinted from *Air University Review* 21, no. 3 (March–April 1970): 10–19.

To fully exploit the flexibility of air power, a highly mobile complex of forces is required. If tactical air forces are to maximize their potential, they must be capable of responding quickly and selectively, be versatile, and be able to concentrate precise striking power against selected targets. Air Force Manual 2-7 warns that:

> Precautions must be taken to avoid operational demands of a divisive nature which segment the forces concerned and diffuse their effort in unrelated, infeasible or excessively costly undertakings. When forces are segmented, the full advantages of flexibility are lost, the unity of air forces involved destroyed, and their strength dissipated in a fragmented effort.

an air control system

An effective tactical air control system is an integral and basic part of the concept of single management of air resources. Such a system should provide a single manager with the organization, equipment, and trained personnel necessary to plan, direct, and control tactical air operations and coordinate joint operations with components of other military services. Utilizing such an air control system, a commander can shift, deploy, and concentrate his forces to cope with rapidly changing situations in the most efficient and economical manner.

Since a tactical air control system is a basic part of the concept of single management of air resources, an effective control system should be maintained in readiness for rapid deployment to any combat zone where air forces are required. The maintenance and improvement of the system should be supported with the same vigor given any weapon system. The system, comprising equipment, proven procedures, and trained personnel, should be an in-being, viable organization and fully subscribed to by all services and their participants.

single air management

The concept of placing all air resources in a combat zone under the direction of a single air manager is not new. As indicated earlier, the concept surfaced during World War II and again during the Korean conflict. Late in the Korean War the air resources of the Fifth Air Force, Seventh Fleet, and 1st Marine Air Wing were placed under the direction of the Joint Operations Center of the Fifth Air Force. The commanders of Fifth Air Force and Seventh Fleet determined that air combat operations of the two services had to be integrated in order to inflict maximum damage upon the enemy with greater efficiency and economy of forces. The Seventh Fleet accordingly granted the Fifth Air Force Joint Operations Center positive control of close air support assignments. Although integration of Navy resources came very late in the course of the war, it was considered the final step in creating the centralized control so necessary to efficient tactical air operations. At the end of hostilities a joint board, including Army, Air Force, Marine, and Navy officers, recommended the establishment of an approved official joint doctrine for air-ground operations that would facilitate the training, organizing, and equipping of all three military services.

Although single air management proved to be a valuable and effective concept during the Korean conflict, the concept was not established in an approved joint doctrine during the ensuing period of peace. Consequently single management of fixed-wing tactical forces was not an accepted joint concept at the start of the Vietnam conflict. It was only after five years of active U.S. involvement in Southeast Asia (SEA) that single management became a reality.

Prior to March 1968 there were two independently controlled tactical air control systems in-being in South Vietnam: one operated by 7AF throughout the country and another operated in I Corps by the Marines. The resultant overlapping control arrangements in I Corps were operationally inefficient, and there was no central agency responsible for determining target priorities. Overkill and/or target omission were often the result. The duplicate systems did not provide a coordinated plan for the flow of tactical air, the result being periods of excessive congestion followed by periods of little or no coverage. Tasking responsibilities for supplementary roles of tactical air (e.g., airlift, escort, herbicide, etc.) were not clearly defined, and there was no single source of information to assist in determining the adequacy or inadequacy of tactical air operations. However, the most significant weakness of the dual system was the inability to allocate air resources in support of all allied ground forces in an optimum manner to meet changing enemy tactics and threats.

The initial impetus that led to the establishment of a single air manager in South Vietnam stemmed from a sharp increase in enemy offensives during the early months of 1968. In February, during the Tet offensive, the enemy waged major offensive operations throughout South Vietnam, the most intensive pressure being brought to bear on free world forces just south of the Demilitarized Zone (DMZ) in I Corps. Friendly reinforcements quickly moved into that area, and the battle of Khe Sanh ensued. Planning and application of air resources during the first few weeks of the defense of Khe Sanh were not adequately centralized. The resultant problems were a product of the sheer magnitude of air support directed into an extremely small geographic area. The overwhelming need for effective air allocation and cycling, airspace control, targeting, bomb assessment, and overall responsibility pointed to a major problem in the management and control of air resources. Commitment of USAF, U.S. Marine, U.S. Navy, and VNAF air resources to support multination ground force operations on a high-density basis firmly identified the immediate need for management by a single authority, to integrate the air effort, prevent mutual interference, and provide the needed air support for all ground and support units operating in the area.

On 8 March 1968, the Commander, U.S. Military Assistance Command, Vietnam (COMUSMACV) designated the Commander, Seventh Air Force (his Deputy for Air Operations), as the single manager of fixed-wing tactical fighter and reconnaissance air operations in South Vietnam and charged him with the responsibility for coordinating and directing the entire fixed-wing tactical fighter and reconnaissance air effort. This decision made it possible for the Deputy for Air Operations to apply the total force in the most effective manner in support of the MACV mission, distributing force application as the ground situation dictated.

The change to a single air manager for fixed-wing tactical fighter and reconnaissance aircraft in South Vietnam provided COMUSMACV with a method of allocating and controlling air resources that permitted the inherent flexibility of tactical air power to be fully exploited. It provided centralized control and decentralized execution of operations. It also fostered rapid coordination, close integration of operations, and flexibility in force allocation.

Once again the validity of the concept of centralized control/single management of air resources in a combat zone was proven.

The single air manager system developed in Vietnam provides a significant steppingstone toward our ultimate goal of an in-being single air manager concept. We should not let this progress falter. We must aggressively work toward establishing joint doctrine, subscribed to by all services, which will allow the immediate implementation of the single air manager concept in future conflicts. In addition, during peacetime the concept should be exercised through its supporting tactical air control system, so that all users understand completely the flexibility and potential of air power when properly controlled and applied.

Air Force tactical air control units

Regardless of how worthy or how acceptable the single manager concept is, it cannot be implemented without the physical facilities, equipment, and personnel necessary to administer the system. Tactical air control units of this type have functioned as the Air Force commanders' primary control agency for operational air activities during the last two wars. Unfortunately, the tactical air control organizations and their equipment and personnel were not maintained at the conclusion of each war—primarily because of budgetary considerations—at the levels subsequently required for deployment at the onset of each succeeding conflict. The tactical air control equipment available for a war has more often than not been that remaining from the previous conflict. Expansion and improvements were initiated after combat had begun. Personnel were taken out of other critical positions to man the Tactical Air Control System. Bits and pieces were scraped together from equipment-short Air Force squadrons or even from our sister services. The results, as might be expected, have been less than optimum, and the commander often was seriously handicapped for lack of an adequate control system.

trained personnel a major problem

Failure to maintain a fully manned cadre of experienced tactical air control personnel between the wars has been a major factor in the initial performance of the Tactical Air Control System (TACS). For example, the end of the Korean War saw the immediate dispersion of most of the trained personnel, leaving only a relatively small cadre that had so efficiently operated the control system in the latter phases of the war. We did not adequately maintain the identity of either the operators or the technicians who had manned the tactical operations centers within the Fifth Air Force.

Likewise, insufficient effort was expended during the intervening years between the Korean and Vietnamese conflicts to train Air Force personnel not previously assigned to the TACS in the intricacies of tactical air control. With the exception of a short academic course presented by the Joint Air Ground Operations School and some joint air-ground exercises, there were few opportunities for training service personnel in tactical air control concepts, procedures, and techniques.

U.S. involvement in Southeast Asia brought out once again the pressing need for trained personnel to operate a Tactical Air Control System. The first TACS elements were deployed in 1961, manned with hastily indoctrinated replacement personnel. Meanwhile, in the United States, tactical units were being stripped of highly qualified pilots and technicians to train and man the new TACS elements, particularly the Tactical Air Control Parties.

Southeast Asia has provided us with the opportunity to gain valuable experience in the techniques of tactical control. Literally thousands of Air Force people have been involved in the daily TACS operations and have become expert in the system. But once again, as happened after Korea, the talent is being absorbed into other units. Although manning authorizations have been established for our post-SEA system, adequate, skilled TACS personnel will not be available for the next conflict unless the Air Force continues to maintain fully manned Tactical Air Control Systems as a portion of the combat-ready general-purpose forces. It is also essential that individuals who have had experience in the TACS be permanently identified so that any future expansion of the systems can be accomplished with a minimum of additional training.

TACS aircraft discarded

As in the historic lack of emphasis given to TACS personnel requirements, little priority was given to retention of an inventory of TACS aircraft. Throughout World War II and into the Korean conflict, the basic philosophy behind a forward air controller (FAC) centered in his function as adviser to ground force commanders and in the direction of air strikes from the ground. The utility of an airborne vantage point for controlling air came to light only in the latter stages of the European war when artillery spotters in light observation aircraft found it advantageous to assist the ground controller in sorting out enemy and friendly troops and pinpointing the target for air strikes. Unfortunately, with subsequent demobilization, the airborne FAC concept was submerged.

The outbreak of the Korean War saw the FAC again directing strikes from the ground. It was not until the war was well under way that the idea of an airborne FAC re-emerged, and T-6 aircraft were modified to carry white phosphorous rockets for target marking. These "Mosquito" aircraft again proved the value of an airborne forward air controller and provided the basis for today's doctrine and procedures. As in the past, however, the airborne FAC concept was given a low priority in the demobilization which began in 1953, and the T-6 aircraft were phased out of the USAF inventory.

Ten years later military activity in South Vietnam increased, and the idea of an airborne FAC was rekindled. Because little interest had been generated in retaining an airborne FAC capability, it is not surprising that the Air Force was unable to find a suitable FAC aircraft within its inventory to meet this new requirement. However, by borrowing from the U.S. Army, a force of O-1 aircraft was assembled at Bien Hoa in July 1963.

The remainder of the FAC aircraft story is common knowledge. The O-1 Bird Dog continued to be the only FAC aircraft in service until early 1967, when an off-the-shelf commercial aircraft, the O-2, began service. Five years after the activation of the Bien Hoa O-1 squadron, and roughly a quarter of a century after the airborne artillery spotter began his unofficial control of air strikes, the first aircraft designed for the FAC role, the OV-10 Bronco, entered combat. From that time the OV-10 has repeatedly justified its worth as a specially designed combat aircraft.

The airborne FAC concept has proved to be an integral, necessary part of the Tactical Air Control System. However, the FAC aircraft force has historically disappeared from the inventory between wars and has not reappeared until the next conflict forced us to reequip. Until the Bronco arrived, the aircraft which filled the requirement had been hand-me-down or off-the-shelf commercial aircraft needing modification to meet exacting performance requirements. We can ill afford to discard our FAC aircraft again as we have done after each of the past wars. The day is past when it is practical to buy a commercial, liaison-type aircraft to perform the mission and satisfy the needs of the commander for strike control. In future conflicts we may not be permitted the extended development time that we have been allowed in past conflicts.

retention of facilities and equipment also critical

The requirement for facilities and equipment associated with the TACS also lost significant support soon after termination of the Korean War. An effort was made during the nonwar years to develop portions of a total TACS facility, but many of the programs failed or were discarded almost as soon as they were introduced. For example, the 412L Air Weapons Control System, which was to be an air-mobile control system, failed to meet specifications, and the project was abandoned.* In any event, our development efforts and buy programs were marginal, and as a result early TACS facilities and equipment available for Vietnam were limited in number and provided less than satisfactory service. Extraordinary initiative and an unrelenting determination by the pioneers of the USAF TACS in Vietnam combined to overcome most of the handicaps, and a workable system has been developed.

Again we must not let support for the system die when the aggression in SEA stops. It is essential that we continue to emphasize the requirement to provide our new tactical air control units with

*The equipment for the single 412L system that was produced before the project was abandoned eventually became a portion of the fixed control system currently in use in USAFE.

the best equipment available if we are to retain a state of readiness for future conflicts.

R&D support for the TACS

The decisive nature of modern warfare may deny us the time to improve the equipment of our TACS after hostilities have begun. Therefore, system capabilities must be continuously improved if we are to enhance our ability to exploit effectively the inherent flexibility of tactical air power. The dynamic pace of technological development makes it imperative that R&D support for the TACS not be de-emphasized after a Vietnam settlement as it was after World War II and the Korean War. For example, as a result of the low priority given research and development support for the TACS after World War II, command and control communication capabilities in Korea were inadequate. A makeshift U.S. Army radio-teletype system, in conjunction with a radio relay capability improvised by airborne forward air controllers, served as the only means by which air support could be requested. The inflexibility of this system prevented the optimum utilization of tactical air resources.

R&D efforts, resulting from experience in SEA, have already provided numerous improvements to the current Tactical Air Control System. These include more sophisticated FAC aircraft, improved communication vehicles and radios for use by the forward air controllers, new lightweight radar and ancillary support equipment, and compact air-ground communication facilities. These improvements have significantly increased present tactical air control capabilities.

Other projects under way are designed to improve the current TACS. For example, the 407L program provides a significant improvement in the mobility and quality of the TACS ground elements. This program is evolutionary and requires continued support for the development of improved equipment. Equally important is the requirement for an airborne warning and control capability for the TACS to deploy worldwide on a moment's notice in support of any contingency. To meet this need we have under development a Tactical Airborne Warning and Control System (AWACS) which will be an integral part of the TACS. Housed in a jet airframe, the Tactical AWACS will be an integrated and self-contained control element equipped with sophisticated sensor and communications capabilities that will provide surveillance and control deep into enemy territory, far beyond the line-of-sight capability provided by present ground-based elements of the TACS. The requirement for continued support and development of these capabilities will not end with the onset of a ceasefire.

The premise of a future TACS is that it be a system with built-in growth potential. Automation must be emphasized so that future needs can be met by merely adapting the anticipated expansions of technology to the current requirement. It should be mobile enough to provide an immediate capability to control tactical air power in any area of the world. The hardware to be utilized by sub-components of the TACS should be easily transportable by either surface or air vehicle. Operations centers should be developed that are lightweight and quickly erectable, yet which can be hardened sufficiently to withstand ground attack. Other foreseeable improvements should include an improved three-dimensional radar, compact processors for message centers, and electronic direct-dialing systems to replace switchboards. Powerful yet easily transportable radios for use throughout the system are a basic necessity.

Finally, a new FAC aircraft is needed to operate in the more hostile defense environments of the future.

R&D support for the TACS must be maintained and emphasized after the end of the Vietnam conflict. The consequences of our failure to ensure adequate R&D support for TACS development after World War II and Korea provide ample incentive to emphasize this support beyond Vietnam.

challenge for the future

The requirement for an effective in-being system at the onset of any future conflict is reflected in the current Air Force Programming Documents. We have provided for five post-SEA TACS, which will include air liaison officers/forward air controllers and FAC aircraft. These requirements should be aggressively supported. The shortcomings of the past must not be repeated if the concept of single air management within a joint centralized system is to be realized. If the single manager concept can provide both economy and efficiency to air operations at all levels of warfare, its effectiveness must be protected and expanded with the same vigor given any weapon system or developmental project.

The single air management concept and the tactical air control system selected for retention should be actively supported by all services and should be available, viable, and responsive to the needs of the highest national authorities. Developmental tasks should be identified that will provide significant R&D improvements to tactical equipment and operating capabilities across the entire air control spectrum. Above all, TACS capabilities must not be subordinated in the future as they were after World War II and Korea. Today's requirement is to add to the knowledge we have gained in this and previous conflicts and to ensure that a system and a capability for the integrated direction of all combat air are available for tomorrow.

Hq United States Air Force

Contributor

Major General Sam J. Byerley (B.S., Oklahoma State University) is Deputy Director of Operations, DCS/P&O, Hq USAF. After flying training, 1941, he served in training, operations, inspector, and squadron commander assignments until 1946, when he was assigned to Hq Far East Air Forces as Troop Control Officer, A-3. He attended the Air Command and Staff College, 1949, then served in the Strategic Air Command until 1965, in operations and command of bombardment units, including the 93d Bombardment Wing and B-29 combat missions during the Korean War. General Byerley has served in England, Alaska, the Philippines, Japan, and Turkey, the last as Commander of TUSLOG from October 1965 until his current assignment in August 1967.

Realizing Tomorrow: The Path to Private Spaceflight by Chris Dubbs and Emeline Paat-Dahlstrom. University of Nebraska Press (http://nebraskapress.unl.edu), 1111 Lincoln Mall, Lincoln, Nebraska 68588-0630, 2011, 344 pages, $34.95 (hardcover), ISBN 978-0-8032-1610-5; 2013, $24.95 (softcover), ISBN 978-0-8032-6667-4.

The *Apollo 17* launch on 4 December 1972 closed a "glorious chapter in space exploration" (p. 3). On the evening of that launch, astronauts, space artists, science fiction writers, and heads of various space organizations gathered on the deck of the SS *Statendam* to answer a single question: What will America's new space vision be? With that question in mind, coauthors Chris Dubbs and Emeline Paat-Dahlstrom dive into the evolution of space exploration from 1972 to today.

Realizing Tomorrow is the seventh entry in the series Outward Odyssey: A People's History of Spaceflight, which seeks to expand public knowledge of space development—and this book delivers. The coauthors boast résumés built upon space research, development, consulting, and publication. They do an amazing job of adding to this series by taking us from government-funded space development to the world of high-finance entrepreneurs wishing to make space an option for civilians.

Many people are aware of the space race between the United States and Russia, but not many know about the importance of Robert Truax, an accomplished rocket scientist, to vessel development. His desire to build a rocket with private funding "consumed him for a decade" (p. 47). The authors detail how Truax paired with Evel Knievel and came up with the idea that public relations could generate support for space innovation. Truax, who had either plenty of time or plenty of money but never both, was continuously plagued by slow development, which would cause the money to dry up. However, despite such problems, his legacy "set the standard for the swim-against-the-current entrepreneurs who would follow" (p. 60).

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With rocket companies searching for ways to identify funding options, the other important factor involved locating people willing to pay the price, both financial and physical. Would the public show enough interest to make space travel viable? The answer was a resounding yes. Biologists, teachers, venture capitalists, and many others from around the world entered competitions or paid millions just for the chance to be on a waiting list. The stories of Christa McAuliffe and the explosion of the space shuttle *Challenger*; Dennis Tito and his legal battles to visit the *Mir* space station or *International Space Station* (*ISS*); and Anousheh Ansari, who would prove vital by partnering to create the Ansari X Prize, all appear in this chaotic pursuit of space.

Readers looking for intricate details about the Apollo space program will be disappointed. By focusing on the commercial side of the house, Dubbs and Paat-Dahlstrom contrast the bureaucracy of government programs with the efficiency of the private sector. Further, they show the value of both the public and private sectors in research and development as well as the inevitable conflict that can occur between these entities. However, in the end, the National Aeronautics and Space Administration (NASA)—along with many government and commercial clients—is helping to push the development of cheaper transportation to space. Whether space habitats, satellites, resupply missions to the *ISS*, or just space tourism, the applications are numerous. It has become "easy to imagine a tidal shift in access to space, as if the whole private space industry had just stepped forward to stand on a more even footing with NASA" (p. 266).

Realizing Tomorrow offers a compelling, elaborate look at the evolution of commercial space travel and masterfully intertwines a group of people who have pursued and are pursuing privately funded space exploration. This book compels us to believe that space is within our grasp and that the progress made from Kitty Hawk to present-day aviation will occur during today's "Space Age."

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True Faith and Allegiance: An American Paratrooper and the 1972 Battle for An Loc by Mike McDermott. University of Alabama Press (http://www.uapress.ua.edu/catalog/CategoryInfo.aspx?cid=152), Box 870380, Tuscaloosa, Alabama 35487-0380, 2012, 208 pages, $29.95 (hardcover), ISBN 978-0-8173-1755-3.

In 1972 American troops found themselves in the midst of an extensive drawdown as President Nixon's policy of Vietnamization neared completion. As their numbers on the ground decreased, a small contingent of American advisors remained in place to liaise with South Vietnamese ground troops, becoming the critical link between the latter and US airpower.

Army captain Mike McDermott, a paratrooper, was assigned as senior advisor to the 5th Airborne Battalion of South Vietnam. In *True Faith and Allegiance*, he provides a no-holds-barred, personal account of the Battle of An Loc, which took place from April to June 1972. The author's firsthand insights into the battle trace his experiences from first contact with the enemy to his extraction under heavy artillery fire. McDermott's performance during this battle earned him the Distinguished Service Cross (First Oak Leaf Cluster) and the Silver Star.

The action occurs nonstop throughout the book, and several of the author's experiences on the ground are worth noting. First, McDermott develops immense respect for the Vietnamese paratroopers with whom he had the privilege to fight: "I was extraordinarily proud of the paratroopers of the 5th Airborne Battalion, and I valued my experience with those warriors more than I can say" (p. 145). McDermott paints a picture of the Vietnamese paratrooper as a tenacious soldier—violent and professional—who always places the mission above self-preservation.

Second, the author clearly indicates that airpower made the difference in this battle. Throughout the fight, McDermott used airborne forward air controllers to direct strike aircraft onto targets that he identified from the ground. The Air Force used its entire inventory to win this battle: B-52s, which rained mass destruction on the enemy; cargo planes, which delivered critical resupplies; and the AC-130 Spectre gunship, the "enemy's worst nightmare" (p. 129). McDermott represented a critical link between ground and air forces, one that continues to the present as joint terminal attack controllers supply expertise in close air support to ground commanders throughout Afghanistan and, earlier, Iraq.

Finally, on a more somber note, McDermott briefly discusses, at the beginning and the end of the book, his disenchantment with American policy makers of the time, the abandonment of his Vietnamese counterparts, and the post-traumatic stress he experiences to this day. Indeed, he candidly describes the nightly patrols around his home where he searches for an enemy that never comes. McDermott remains hostile toward those policy makers, declaring that the 58,260 individuals whose names appear on the Vietnam Memorial died in vain (p. 158). He does, however, take comfort in reflecting on the men who served next to him and in the reassurance offered by his wife, Chulan, on those sleepless nights.

The author's saga reminds us that ground and air forces must continue to work in concert to realize national objectives on the battlefield. We must attend to the lessons from both history and the present day to avoid critical mistakes in future conflicts. *True Faith and Allegiance* tells yet another tale of the sometimes tragic effects of war on the human psyche when the battle is over. We must learn from the well-documented lack of care experienced by our brave Vietnam veterans and make sure that we provide for returning veterans as we come to the end of more than a decade of war.

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Grab Their Belts to Fight Them: The Viet Cong's Big-Unit War against the U.S., 1965–1966 by Warren Wilkins. Naval Institute Press (http://www.usni.org/navalinstitutepress), 291 Wood Road, Annapolis, Maryland 21402, 2011, 288 pages, $35.95 (hardcover), ISBN 9781591149613.

One finds an unfortunate level of truth in Warren Wilkins's assessment that the Vietcong (VC) are popularly remembered as little more than a black-pajama-clad guerrilla force from a bygone chapter in American military history. The vision of men in black dress, sandals, and conical hats running around setting rudimentary booby traps and lining pits with bamboo spears often appears synonymous with Vietnamese guerrilla warfare and the VC's art of war. Wilkins's latest contribution to the literature on the Vietnam War demonstrates that this was not necessarily the case. Marrying both communist Vietnamese sources with US military recollections and after-action reports, the author undertakes to show that between 1965 and 1966, communist leaders in the North had a very specific strategy in mind for VC forces fighting in South Vietnam: the big-unit conventional war.

Wilkins, a Fellow at the Center for Threat Awareness, provides a richly detailed history of the VC's big-unit war by tracing events from the policy-making level in the North right down to the tactical experiences of VC main-force fighters in the South. As a result, he offers readers insight into the plenum meetings of the Communist Party Central Committee and Hanoi's strategic direction for VC and North Vietnamese army regiments designed to quickly and decisively defeat US and South Vietnamese forces and bring them to the bargaining table. Spreading his analysis to the tactical level of VC warfare, Wilkins underlines the practice of these main-force VC units "hugging" American units in both offensive *and* defensive actions to separate the American GI from the greatest tool in his inventory—supporting arms.

The book's title, *Grab Their Belts to Fight Them*, refers to an oft-recited army mantra that would dictate the VC's best means of overcoming American conventional military superiority. That is, by getting close enough to see the shine on a GI's buttons, the VC hoped to void the tactical impact of impressive American firepower employed in support of the infantry. Thus, during engagements at Bau Bang, Trung Loi, the Ia Drang Valley, and others, VC main-force units strove to get close enough to American infantry lines to make them think twice about calling in support from artillery and aircraft. Unfortunately for the VC, the US troops' superiority in maneuver and the employment of air mobility enabled them to keep their belts out of reach without losing the tactical objective. Simply put, according to Wilkins, the big-unit battles of 1965 and 1966 represent a continual failure for the VC in trying to force the United States out of the war quickly and decisively. By detailing a number of VC/US infantry clashes during those years and showing that VC units often went headlong into battle with their opponents, the author makes a strong case that the VC's pre–Tet Offensive modus operandi was more conventional than often thought.

In detailing VC big-unit warfare of the mid-1960s, the book also gauges another strategy of the war—Gen William Westmoreland's scheme of focusing US war efforts primarily on defeating conventional communist Vietnamese units. It is hard to find strategic successes in a war that, for years after, seemed the proverbial stain on the reputation of American proficiency of arms. Nevertheless, by highlighting the preeminence of big-unit warfare in VC strategy and displaying the perpetuity of tactical failures experienced by the VC between 1965 and 1966, Wilkins shows that Westmoreland's strategy in the South was not as misguided as it might appear. The author also underlines the effectiveness of the American military triad of maneuver, firepower, and combined-arms action that, in practice, saw a US conventional force able to outmaneuver, outgun, and outwit its communist counterparts. In relating the effects of American firepower and supporting arms on the VC's big-unit battles, this history demonstrates that airpower in the Vietnam War involved far more than the strategic bombing operations that targeted the North. Combined with artillery and helicopter gunships, fighter-bombers provided useful close air support in various US/

VC engagements that enabled American Soldiers to fight another day—and keep their belts too.

Wilkins strikes a fine balance by offering a book accessible to everybody. One need not have extensive knowledge of the Vietnam War to understand the author's highly academic and well-supported analysis of two years of VC strategy. Perhaps the book's greatest strength is the inclusion of so much communist Vietnamese primary material, all wonderfully translated, which gives readers insight into the mind-set of VC strategic leadership; further, it provides more of a frontline Vietnamese reflection of the conventional tactics employed by the VC to attain strategic success. By presenting the recollections of American troops and military reports, Wilkins illustrates the experiences from both sides of the VC big-unit war. The author does not set out to wholly destroy the image of VC irregular warfare; indeed, he notes that VC main-force units often fought in conjunction with their "local force" guerrilla affiliates. Rather, Wilkins shows that the VC's art of war entailed much more than bamboo spears and booby traps, a task he carries out very well. *Grab Their Belts to Fight Them* portrays the VC as a more complex organism than previously understood, and Wilkins's account of VC big-unit warfare between 1965 and 1966 is a necessary addition to the literature if we wish to keep learning from the Vietnam War. If nothing else, this assessment of VC fighting highlights the fact that, with the right strategic direction, seemingly unconventional armies are quite capable of fighting in a more conventional manner, whether or not they wear pajamas.

Harry Knight
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In the Shadow of Greatness: Voices of Leadership, Sacrifice, and Service from America's Longest War by US Naval Academy Class of 2002, edited by Joshua Welle, John Ennis, Katherine Kranz, and Graham Plaster. Naval Institute Press (http://www.usni.org/navalinstitutepress), 291 Wood Road, Annapolis, Maryland 21402, 2012, 264 pages, $29.95 (hardcover), ISBN 978-1-61251-138-2.

Grand strategy, the operational arts, tactics, and of course memoirs are all common ground for military books. *In the Shadow of Greatness* takes a different tack, relying on the personal stories of 33 graduates of the Naval Academy Class of 2002 and their experiences from their days at the academy, though deployments, and up to the present. Beginning with Induction Day, and in some cases the occurrences leading up to that momentous event, these former midshipmen recount the actions, trials, and tribulations that helped them develop as officers and leaders. The fact that each "story" is fairly short allows all 33 recollections, along with photos and introductions, to fit into this fairly compact book.

In the Shadow of Greatness becomes especially compelling during its recounting of activities after graduation, when the stories shift from the "Leadership Laboratory" to the fleet, and these new ensigns and second lieutenants begin to put theory into practice. Covering all aspects of Navy life, from air, sea, and ground to multiple career fields and experiences, the stories paint a vivid picture of a nation at war.

These episodes concern themselves less with the greater strategy or the war as a whole than with leadership at work—both their own and that of their mentors. Integrity, service before self, and teamwork become subjects of discussion and examination in the "real world" outside the academy. The stories are at times funny but at other times quite moving—take for example one young lieutenant's recollection of his first casualty notification to a spouse or classmates writing about the loss of a classmate and friend.

The contributors do not focus on any one community but run the gamut of their experiences, both deployed and stateside, concentrating on leadership. The book's value lies in its ability to convey some of the lessons that these young men and women paid such a high price to learn. Their stories will give anyone, of any rank or experience, an idea of how young leaders think and why they choose the courses they do. *In the Shadow of Greatness* is not required reading for airpower historians; however, anyone with an interest in leadership—its development, motivations, and the toll it can exact—should pick up a copy.

Lt Col Aaron Burgstein, USAF
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Afghanistan: The Perfect Failure by John L. Cook. Xlibris Corporation (http://www.xlibris.com), 1663 Liberty Drive, Suite 200, Bloomington, Indiana 47403, 2012, 223 pages, $19.99 (softcover), ISBN 978-1479720705.

John Cook, a retired Army lieutenant colonel, chose his book's oxymoronic subtitle for good reason: it foreshadows the many ironies that he illustrates in his exposé of the Afghanistan war. Cook pours his depth of knowledge of Afghanistan into this enlightening work, which occupies a place somewhere between memoir and manifesto. In fact, his understanding gleaned from spending four years in Kabul (2008 to 2012) would rival any Westerner's firsthand knowledge of this landlocked Central Asian country. Cook writes entertainingly in an illuminating and engaging style, occasionally making pop-culture references (e.g., to *Dances with Wolves* or the *Sopranos*) to illustrate a metaphor when needed. Never dull or pedantic, he is enjoyable and informative. A cursory glance at the title and introduction would lead some readers to consider him a pessimist writing for therapy. In truth, he writes objectively as he defends his claims.

Cook comes out punching in the first round, presenting his thesis in the foreword; specifically, he declares that the coalition's efforts to win the Afghan war are failing miserably. The main points that support the thesis include the unchecked poppy harvesting and opium production in Afghanistan, the corruption of Hamid Karzai's regime, the lack of a coalition strategy to "win," the lack of Afghan nationalism, and the unyielding grip of Islam on the Afghans' lives.

The author sprinkles the ironies found in Afghanistan throughout the book. For example, Afghan interpreters typically represent the most educated individuals in the country, yet, as an incentive to serve the coalition, they are offered a special visa program to emigrate from Afghanistan to the United States. Clearly, they are precisely the people who should stay in the country to rebuild and lead it. Cook also calls out bureaucratic blunders when he sees them. In Afghanistan "it's very likely that a fire truck, costing $500,000, will be dispatched twenty miles, over very rough terrain, to put out a fire in a $50 building. If this sounds bizarre, remember this is Afghanistan and this is how things are done" (p. 73). Numerous ironies such as these appear throughout the book.

In the closing pages, Cook presents institutional groupthink and the Abilene Paradox (a collective decision to act in a way that opposes the interests of the individuals who made the decision) as possible factors that contribute to the coalition's strategic missteps in Afghanistan. He then makes a final plea to national decision makers to (1) destroy the poppies, (2) have Karzai enact a national draft, (3) get more serious with Pakistan, and (4) loosen up the rules of engagement that are causing American and coalition deaths.

The book's individual chapters, whether about Afghan women, poppies, or the Taliban, can stand on their own as informative essays. Naturally, they do build upon each another as Cook acquaints readers with personalities like Karzai and Mullah Mohammed Omar as well as Afghan legends such as Ahmad Shah Massoud. He introduces complex topics (e.g., the structure of the Afghan National Police) in a palatable way that actually makes sense. The author has the ability to connect with readers on any level—those new to Afghanistan or those with multiple combat tours during Operation Enduring Freedom.

The fact that the book does not qualify as a scholarly work (it has no bibliography, endnotes, or appendices) does not detract from its credibility. In fact, I find the lack of documentation refreshing because it helps the book read like a fast-paced novel. Additionally, I genuinely appreciate its timeliness. Having gone to press just before the 2012 US presidential election, it refers to events that happened well into that year. Although readers will value this work in years to come as a historical commentary, I imagine that Cook rushed it into print for one simple reason: this story needs to be heard by the American people and our nation's political and military decision makers *now*. Consequently, I recommend *Afghanistan: The Perfect Failure* to anyone in the US military—especially its leaders. Hopefully, some individuals with the power to enact some of its recommendations will do so before the Afghan war is in the history books. If not, I'm sure Cook will not be offended because, after all, this is Afghanistan we are talking about, and one more irony wouldn't change a thing.

Capt Robert M. Whitney, USAF
Creech AFB, Nevada

Airpower at 18,000': The Indian Air Force in the Kargil War by Benjamin S. Lambeth. Carnegie Endowment for International Peace (http://carnegieendowment.org/publications/), 1779 Massachusetts Avenue NW, Washington, DC 20036-2103, 2012, 58 pages, available free at http://carnegieendowment.org/files/kargil.pdf.

This slim volume contains a brief but detailed scholarly analysis of the operations of the Bharatiya Vāyu Senā (Indian air force) in support of Operation Vijay to regain control of territory that Pakistan seized in a remote part of Indian-controlled Kashmir in 1999. Even more than a decade after, this particular operation remains relatively unknown, largely overshadowed by the effort of the United States and its North Atlantic Treaty Organization allies against Serbia over the Kosovo problem. Despite its obscurity, the Kargil conflict offers some important lessons for students of airpower, and the author discusses them with considerable skill, taking a clinical, academic approach.

With considerable brevity and elegance, author Benjamin Lambeth examines the contribution of the Indian air force in its indirect combat-support role as well as its key logistics and intelligence-gathering function. He also addresses the larger context of the service's behavior during the conflict, which included the following: initial intelligence failures that allowed Pakistan's infiltration to take India completely by surprise; the air force's early losses in the face of Pakistani surface-to-air missiles, which forced a change in behavior to avoid further attrition of its air assets; the bureaucratic rivalry and initial lack of communication and collaboration with the Bhāratīya Thalasēnā (Indian army); and the paucity of prior training for high-altitude combat. All of these factors forced the Indian air force to extemporize and quickly adapt to conditions for which it had not prepared. Lambeth is generous in his praise for the air arm, critical of its failings, and interested in the larger political and geopolitical implications of the Kargil War and the way it was waged.

For one, the author addresses the Indian army's view of airpower and the air force's use of its superiority to provide key support in the eventually successful counterattack. He also compares the Indian and Pakistani air forces, particularly India's restrained use of its assets (forbidden to cross the Line of Control, preventing the Kargil conflict from escalating) and Pakistan's difficulty supporting soldiers it had effectively disowned by pretending they were merely Kashmiri irregulars. Both the skill of the Indian air force and the restraint shown by both air arms prevented sharp conflict between hostile nuclear neighbors and allowed India to make a successful counterattack despite its initial lack of organization.

The author's conclusions give a great deal of credit to India's air force for its adaptability and skill, but he offers some words of caution about the problems of interservice rivalry. This thoughtful analysis of airpower at the extremes of high-altitude fighting will be of great interest to readers who wish to examine political constraints on the use of airpower (and conventional military strength in general) between nuclear enemies. *Airpower at 18,000'* provides a worthwhile and sober treatment of a little-known conflict that nonetheless offers valuable lessons to students of airpower. Pictures, maps, and charts add to the discussion, and sidebars convey the book's most important comments and conclusions, all of which make this work easier to understand without losing any of its technical excellence.

Nathan Albright
Portland, Oregon

When Biospheres Collide: A History of NASA's Planetary Protection Program, NASA SP-2011-4234, by Michael Meltzer. US Government Printing Office (http://bookstore.gpo.gov), P. O. Box 979050, St. Louis, Missouri 63197-9000, 2011, 544 pages, $57.00 (hardcover), ISBN 978-0-16-085327-2; 2011, 542 pages, $49.00 (softcover), ISBN 978-0-16-088804-5. Available free from http://history.nasa.gov/SP-4234.pdf.

Even among hard-core space enthusiasts, planetary protection is hardly a well-known concept. However, as Michael Meltzer ably describes in *When Biospheres Collide*, planetary protection has greatly influenced the American space effort and may prove even more influential in the future. The field of planetary protection attempts to prevent contamination of planetary systems with biology from a different body, keeping "actual or possible 'zones of life' pure and unspoiled" (p. 4). In other words, when a space probe is launched from Earth to another space body, planetary protection attempts to prevent "back" contamination (inadvertently releasing microbes or other life from the moon into Earth's environment) as well as "forward" contamination (transporting unwanted Earth microbes to Mars via unsterilized landers).

Meltzer's book is a complete survey of planetary protection with sections concerning ethics, law, politics, technologies, procedures, mission histories, and future concerns. The author introduces the ethics and politics of planetary protection first, describing personalities who began the National Aeronautics and Space Administration's (NASA) program and the issues they confronted. However, much of the book examines planetary protection's impact on NASA missions. Back contamination dominates the chapter on the Apollo program, in which Meltzer conveys how planetary protection drove many requirements. The latter included adding a multimillion-dollar construction program for biologically sealed facilities to study returned lunar samples, an astronaut-quarantine protocol (including quarantining unfortunate technicians accidentally exposed to lunar samples), and even potentially dangerous steps to astronaut-recovery procedures for the already astronomically complex and expensive moon effort. A chapter on the Viking Mars landers deftly explores problems defending against forward contamination, showing how the Viking program's search for life could have been fatally compromised by confusing stowaway terrestrial organisms from the lander itself for real Martian life. Later chapters cover the more recent NASA probes, ranging from the Galileo mission to the Jovian planetary system to the famous Mars landers of the early twenty-first century. Throughout the book, Meltzer explains methods of planetary protection considered and used by each mission, including relatively straightforward ones such as dry-heat microbial reduction (cooking the spacecraft) and gas sterilization (flooding the probe with antimicrobial toxic gas). Meltzer also introduces techniques that the uninitiated might not consider, such as choosing toxic propellants (e.g., hydrazine) over fuels that may harbor microorganisms themselves and adjusting orbital trajectories to minimize the probability of unintended collisions with space bodies.

Planetary protection itself may have little direct application, but the book's glimpse into the psyches of its advocates makes *When Biospheres Collide* uniquely valuable for military space professionals. Whereas these advocates initially were most concerned about the dangers of back contamination (think Michael Crichton's *The Andromeda Strain*), modern proponents now mostly argue against the danger of forward contamination, particularly its potential to damage future space science. Planetary protection proponents often resort to sensationalist language to pursue their agenda. Carl Sagan said that contaminating the moon with terrestrial microbes would be an "unparalleled scientific disaster" (p. 80), and Meltzer himself concludes his work by cautioning that "careless planetary exploration in the present could forever obfuscate the answer to a vital question: Are we Earthlings alone in the universe?" (p. 459). Sold by such dire warnings, planetary protection has had its costs. The author notes that dry-heat sterilization probably caused the very public failures of the early US Ranger lunar probes (p. 50). The all-important gas-chromatograph mass spectrometers designed to search for life on Mars, carried by both Viking landers, eventually failed on Mars. Again, many people blamed heat sterilization for the loss (p. 270). These planetary protection costs may have been worthwhile had they secured the goal of a pristine environment, but Meltzer notes that many unsterilized probes have already crashed, possibly contaminating heavenly targets. The Soviet Venus (*Venera 3*) probe crashed on Venus, and the *Zond 2* probe may have done so on Mars—and both may have been understerilized. The NASA Genesis spacecraft went down in Utah, exposing solar wind samples to the open environment, and the Mars Polar Lander crashed near the Martian south-polar ice cap. Back and forward contamination may have already occurred. Meteorites and comets may have been cross-contaminating planets for millennia.

These facts shouldn't keep us from sterilizing our spacecraft and taking as many precautions as feasible to avoid contamination. Rather, we should do so, knowing that contamination—much like space debris—is probably unavoidable if humans continue to operate in space. We should keep this realization in mind when more radical scientists invoke planetary protection to argue against potentially rewarding endeavors such as human exploration and colonization of Mars or the moon. Instead of taking extreme measures to eliminate the possibility of any contamination (such as avoiding a manned Mars mission), we must find approaches that balance risk with reward and develop ways to clean or otherwise mitigate contaminations that may occur. Meltzer, a planetary protection advocate, argues that "we are accountable to future generations of scientists to explore our solar system without destroying the capability of others to conduct their own investigations"

(p. 459). Alternatively, Air Force space professionals know that the American space program is accountable to all members of future generations, not just those who want to be exobiologists.

When Biospheres Collide is surprisingly readable, given its subject. Whether discussing arguments among scientists or the details of technical processes, Meltzer writes in a conversational, illuminating, and enjoyable style. His section on Jupiter's moons and their capacity for harboring life was particularly satisfying. The narrative seemed to "hiccup" occasionally as he jumped from one subject to another one only indirectly related. These rare events detracted from the book somewhat, but on balance it is very well written. Useful appendices add to Meltzer's detailed research and quality narrative to make *When Biospheres Collide* a standard work for anyone studying planetary protection.

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Reserve National Security Space Institute, Colorado

A Fearful Symmetry: A New Soldier in the Age of Asymmetric Conflict by Rumu Sarkar. ABC-CLIO, 130 Cremona Drive, Santa Barbara, California 93117, 2010, 160 pages, $34.95 (hardcover), ISBN 978-0-313-38232-1.

Today's threat environment involves diverse national security challenges, which include asymmetric warfare such as terrorism. By its nature, asymmetric warfare is amorphous. Adversaries adapt quickly, assessing an enemy's vulnerabilities and often using the superior military capabilities of the nation-state against it. Conventional wisdom asserts that the dynamic, adaptive, and highly complex nature of asymmetric warfare demands that US national security strategy implement a holistic approach that integrates all of the nation's capabilities to combat these threats. A layered strategy, adaptive to the nature of asymmetric warfare, should be implemented in conjunction with existing symmetric strategies. Such efforts are vital to counter terrorism and enhance national security. In *A Fearful Symmetry*, Dr. Rumu Sarkar masterfully discusses global terrorism and some of its causes as well as innovative strategies for approaching global terrorism by developing a "new soldier," defined as one who uses cultural understanding, empathy, and compassion as strategic weapons.

Dr. Sarkar, who currently serves as senior legal advisor at CALIBRE Systems, a defense consulting group, offers a highly structured analysis of existing linkages among state failure, poverty, and the absence of development as contributors to the rise of terrorism in modern conflicts. She argues that a direct correlation exists between global terrorism and the new challenges to the structure of the nation-state. Accordingly, the weakening of the nation-state paradigm in some instances has enabled the current rise of terrorism and many individuals' acceptance of it as a tactic. Through a multidisciplinary examination of these issues, Dr. Sarkar offers possible courses of action. By utilizing both narrative and academic writing styles, she masterfully argues that asymmetric challenges demand asymmetric responses. She posits that aspects of political, economic, cultural, informational, and psychological strategies, tactics, and techniques are necessary to combat modern terrorists' organizations successfully. Further, Dr. Sarkar astutely observes that much of the threat environment involves enemies who avoid direct, conventional conflict with the United States and seek asymmetric tactics of irregular warfare. Given the change in the threat environment, our strategies and training must also change, including an ability to understand and maneuver through cultural and emotional terrains. Doing so can enhance our agility in operational environments and further develop non-weapon-based tactical maneuvering. According to the author, integral to this paradigm are the new soldiers, whose skills and capabilities are critical operational assets for successfully combating terrorism and resolving issues that lead to global conflict. Their cultural understanding, empathy, compassion, wisdom, and intuitive skills will enable them to better establish trust and develop relationships that they can use in understanding the essentials of a conflict and its underlying causes.

The United States has become increasingly conscious of the fact that, despite its tremendous military power, it remains vulnerable in this new threat environment and its associated asymmetric challenges. Dr. Sarkar's innovative approach offers valuable insights for the United States and its allies that seek to develop successful strategies with global reach. Overall, civilian leaders concerned with policy and military planners will benefit from integrating her recommendations into their security paradigm. Dr. Sarkar provides effective and fundamental tools for the US military's stability, security, transition, and reconstruction plan paradigm. The effects might very well result in the reduction of global risk and enhance US national security.

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