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Despite accepted doctrinal terms, popular understanding continues to relegate the concept of air superiority to merely air-to-air combat. The historical record suggests the requirement to understand air superiority in terms of all threats to the air domain—regardless of threat altitude. Air superiority is a prerequisite for successful execution of conventional warfare across physical domains of land, sea, and air. There are two primary components of air superiority: freedom from enemy air operations and the subsequent freedom of maneuver. Fighter aircraft should be able to generate both these components of air superiority in order to enable broader Joint aviation participation in a localized battlespace.

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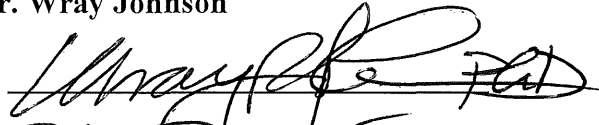
FUTURE WAR PAPER

Fighter Aircraft and Air Superiority: A Combined Arms Approach

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INTRODUCTION

Despite accepted doctrinal terms, popular understanding continues to relegate the concept of air superiority to merely air-to-air combat. The historical record suggests the requirement to understand air superiority in terms of all threats to the air domain—regardless of threat altitude. Air superiority is a prerequisite for successful execution of conventional warfare across physical domains of land, sea, and air. While the term “air superiority” evokes popular images of aerial duels, the true value of air superiority resides in its ability to provide freedom of maneuver throughout a joint area of responsibility (AOR). Comparing the requirements of creating air superiority with doctrinally defined aircraft roles and assigned missions illustrates a disconnect between the capabilities needed to generate effective air superiority, and current doctrinal understanding that limits the concept to merely air-to-air combat. In order to continue providing Joint Force Commanders (JFC) local air superiority, the joint community may consider the idea that the altitude of a threat is irrelevant to its ability to limit freedom of maneuver, and therefore to contest air superiority.

The recent history of asymmetric combat experience generates apathy about the ability of the Department of Defense (DoD) to create and maintain air superiority in a theater of war. The passive performance of the Iraqi and Afghan air forces notwithstanding, history suggests the air domain will be continuously contested by whatever means are available to an adversary. This trend is not unique to modern times. German efforts in World War II, the North Vietnamese experience during the 1960’s and 1970’s, and the Arab experience during the 1973 Arab-Israeli War all illustrate that well-trained militaries will likely continue to contest air superiority “even in the face of overwhelming odds.”¹ Most likely, the means to do so will not come primarily from threat aircraft, rather from advanced surface defenses.²

Losses from surface defenses account for the vast majority of combat losses of all aircraft, in every war in which aircraft participated.³ The surface threat, however, does not command primary attention in doctrinal understanding of air superiority, nor in the training plans of tactical flying units across the DoD. In order to avoid expensive wartime lessons, airman may be able to prepare for the next conflict more effectively by emphasizing threats to the air domain regardless of their altitude. In order to do so, consider a shift toward more emphasis on aircraft survivability against a threat array, rather than lethality in a specific mission set.

DoD leadership agrees with such a broadening of mindset, recognizing the need to sever aircraft platforms from specific missions. The 2014 Quadrennial Defense review calls simultaneously for the USAF to “reduce or eliminate capacity in some single-mission aviation platforms,” while warning that the Joint Force “has been focused on a single type of conflict for the past decade and needs to restore its readiness for the full spectrum of potential conflict.”⁴ Air Force senior leadership expresses this mandate with the term *strategic agility*— an institutional combination of flexibility, adaptability, and responsiveness.⁵ Translating the idea of strategic agility into concrete effects provided to a Joint Force Commander (JFC) requires a more comprehensive understanding of the concept of air superiority, and therefore a more holistic understanding of aircraft survivability.

AIR SUPERIORITY AS PREREQUISITE FOR SUCCESS

Historical evidence suggests air superiority is a prerequisite for successful military operations. This is true across recognized forms of warfare— from small-scale irregular conflicts to the national mobilization of a large-scale traditional war.⁶ While more than sixty years ago, World War II nonetheless offers the most recent example of full national mobilization for

traditional warfare. Considering some of the early German campaigns in Europe offers instructive warning against ceding air superiority to the adversary.

The opening years of World War II saw the German Wehrmacht rapidly advance across Europe beginning with Poland in the September campaign. While the Luftwaffe quickly established air superiority over the Poles, it has been suggested that the Germans did not require it.⁷ Turning to the west, however, the Luftwaffe faced a more effective adversary in the Allied forces of the Britain, Belgium, France, and the Netherlands. Beginning on May 10, 1940, “within two days, half of the Allied aircraft in the combat zone had been destroyed,” effectively ending the threat from Allied air operations and firmly establishing persistent air superiority in favor of the Wehrmacht.⁸ The German blitzkrieg exploited its advantage, isolated the British Expeditionary Force in the north, and shattered remaining French resistance. The continental Allies fell within six weeks with the surrender of France on June 22, 1940.

Initial stages of the German eastern offensive into the Soviet Union were equally as rapid. The Luftwaffe continued its strategy of concentrated airfield attack in order to establish theater air superiority—the first day saw the physical destruction of approximately half of the Soviet aircraft fleet, with the Luftwaffe subsequently able to “command the sky whenever and wherever they wanted.”⁹ The Wehrmacht again exploited the subsequent air superiority with rapid advances deep into Soviet Russia.

While the character of total war defies efforts to credit any campaign or element with singularly decisive effect, the establishment of air superiority contributed across various theaters of operation. British victory in the Battle of Britain, and the Allied Combined Bomber Offensive into Germany-proper established theater-wide air superiority in favor of the Allies. This effect reached across areas of responsibility—enabling Allied invasion of Italy, the subsequent Allied

invasion of France, and Soviet counterattack into eastern Germany. Summarizing the effect of losing air superiority over the battlefield, Luftwaffe general staff concluded, “Ground attack aircraft . . . no longer afforded any decisive support to the land forces, and the heavy losses incurred rose ultimately to a level out of all proportion to the successes achieved.”¹⁰ Separating the Luftwaffe from the rest of the Wehrmacht stifled its successful mix of combined arms. Subsequently, the loss of air superiority corresponded with the Wehrmacht’s loss of initiative and signaled a transition from maximizing gains, to minimizing losses.

The unprecedented scale of World War II may question the applicability of lessons taken from it. Accordingly, a smaller scale example of traditional war must be considered. Within about the same span of time as the Allied-German reversal, Israel and Egypt provide a similar example between 1967 and 1972. While often examined as an example of intelligence failure, this five-year narrative also offers important considerations regarding the loss of air superiority.¹¹ It provides an example of a different model for gaining air superiority—instead of offensive counter-air (OCA) missions flown by aircraft, against aircraft, ADA assets employed highly effective fires in a defensive counter-air (DCA) role in support of mobile ground forces.

In 1967, Israel took six days to crush the military capability of an ascendant Egypt.¹² The opening days of the Six-Day War saw a concerted effort by the Israeli Air Force (IAF) to establish persistent air superiority. This was achieved at the cost of nine IAF aircraft by way of 304 Egyptian aircraft destroyed, including “virtually the entire Egyptian bomber force,” and the 16 air surveillance radars constituting the backbone of Egyptian air defense capability.¹³ The Israeli military exploited the resulting air superiority to slice through Egyptian forces and seize the Suez Canal region.

A mere five years later, the gains of 1967 would be reversed by an Egyptian-Syrian alliance using an innovating model for contesting air superiority. After their humiliating defeat, Egypt began a frenzied military modernization effort through acquisition of Soviet arms. Israeli intelligence perceived Egyptian acquisitions as defensive weapons.¹⁴ In reality, both SA-6 Gainful (K212 Kub) surface-to-air missiles (SAM) and AT-3 Sagger (9M14 Malyutka) portable anti-tank missiles are highly mobile—a tactical capability suitable for either offensive or defensive campaigns. While the IAF continued to win decisive victories in air-to-air combat (approximately 20:1), the mobile SA-6 created local air superiority over advancing Egyptian forces.¹⁵ The result was a static, attritional battlefield. While the Egyptian victory was limited through a bold breakthrough and exploitation by Israeli armored forces, the Egyptian strategic goal of recapturing the Suez Canal was nonetheless achieved.

The preceding examples suggest air superiority enables success in traditional warfare. At the other end of the spectrum lies irregular warfare. The utility of airpower in small wars is well documented and in many ways not different than anywhere else along the spectrum of conflict.¹⁶ However, what is fundamentally different about irregular warfare is the tenuous nature of the larger population's will to fight them. Taking casualties in an irregular war has disproportionately higher costs than in traditional conflict—suggesting that even a limited ability to threaten operations in the air domain significantly contributes to the strategic goals of the smaller participant.

The North Vietnamese provide an excellent example of how merely contesting the air domain can provide strategic effects in an irregular war. On the very first mission of Operation Rolling Thunder in March 1965, Vietnamese surface defenses destroyed four American aircraft (a 3% rate of attrition for the 130 total sorties that day).¹⁷ This would set a pattern for the next

eight years of combat operations for American airmen. In total, surface guns alone engaged 25% of all flights over North Vietnam and accounted for 66% of the losses.¹⁸ These figures do not include the introduction of surface-to-air missile (SAM) threats by North Vietnam. Interestingly, the significant lessons learned from Vietnam as captured in the Red Baron Reports centered on poor performance against air threats, rather than the significantly weightier losses levied by ADA.¹⁹ While the Red Baron Reports motivated vastly more effective tactical training across the USAF,²⁰ the question remains whether or not a primary focus on airborne threats remains appropriate in the modern context of denser, more available, and vastly more lethal surface threats.

AIR SUPERIORITY: THE CONCEPT

The trend of history since the maturity of the combat aircraft suggests the most important contribution to a Joint Force Commander (JFC) airpower has to offer is the creation of air superiority across the AOR. Establishing and maintaining air superiority remains an expectation of the Joint Force, and a core mission of the USAF.²¹ History and current doctrine suggest it is a prerequisite to any desired end-state.²² While the importance of air superiority to a broader effort appears clear, what constitutes air superiority requires some definition—it is merely a means to whatever end the JFC works toward. Current DoD doctrine defines air superiority as, “That degree of dominance in the air battle of one force over another which permits the conduct of operations by the former and its related land, sea, and air forces at a given time and place without prohibitive interference by the opposing force.”²³ So there are two primary components of air superiority: freedom *from* enemy air operations and the subsequent freedom *of* maneuver. Notice both of these effects are relevant in all physical domains—air, land, and sea. Air superiority

ultimately provides the JFC with flexibility. It enables maneuver-style warfare while constraining similar opportunities for the adversary.²⁴

Understanding air superiority in such a broad context requires expansion beyond its current, commonly used application of air-to-air combat. Merely clearing the skies of enemy aircraft does not ensure freedom of maneuver through the air domain. In fact, in each of the case studies considered previously, surface threats inflicted more damage to aircraft than airborne threats. For example, “contrary to popular belief (fuelled by the claims of the Germans themselves) the Polish air force was not destroyed on the ground during early German bombing raids and kept on fighting until shot out of the sky by superior German fighters and highly effective ground based anti-aircraft firepower.”²⁵ The same was true of the French air force in 1940. Despite significant losses on the first day, Allied air arms were defeated by a combination of airborne and surface threats. As French and British aircraft entered the battle, “the losses from both German fighters and flak defenses were prohibitive. Within two days, half of the Allied aircraft in the combat zone had been destroyed.”²⁶ The formula was reversed at the battle of Moscow. “The 1,000 Soviet anti-aircraft guns concentrated in the city, as well as opposition from Red Air Force fighters, forced the Luftwaffe to operate mainly by night.”²⁷ This constraint crippled the Luftwaffe’s ability to apply accurate firepower, and significantly contributed to the Wehrmacht’s withdraw.

Thirty years later, in 1973 the Egyptians reversed Israeli gains of 1967 largely by fielding effective, layered surface threats. In the low intensity war of attrition fought between Israel and Egypt between 1967 and 1973, the IAF sustained fifteen combat losses (thirteen, or 86.7% of these from ADA threats).²⁸ The addition of modern ADA in the form of the SA-6 (K212 Kub) increased the lethality of the Egyptian air defense greatly. These accurate, highly lethal systems

were dubbed the “three fingers of death” by IAF pilots. As the 1973 Arab offensive began, the IAF retained dominance over air-to-air combat; this did not, however, result in freedom of maneuver for Israeli forces. Mobile Egyptian ADA inflicted 78-90 losses on the IAF in the first week of hostilities.²⁹ These losses were enough to keep the IAF ten to fifteen miles behind the front lines, keeping them from affecting the ground fight at all.

The primary desired effect encompassed by the term *air superiority* is freedom of maneuver. It is not merely the freedom *from* attack created by victory in air-to-air combat. In order to exploit the air domain as a means to an end, the defeat of enemy air defenses must encompass any threat to the air domain, regardless of its altitude above the ground.

AIR PLATFORMS AND AIRBORNE COMBINED ARMS

In recent history, American airmen employed specialized combat aircraft together in large packages to generate localized air superiority. Each airframe provides its specialized role to the aggregate mission in parallel. Properly packaged together, the mission creates effects greater than the sum of the component aircrafts’ parts. For example, F-15 and F-16 aircraft suppress the enemy’s airborne and surface-based air defenses respectively. The desired effect of this “arm” of the package is to provide air superiority as best described by J.C. Slessor as early as 1936: “the objective of air superiority is the control of air communications *firstly for our own use* and secondly to deny their use to the enemy.”³⁰ This temporary, localized air superiority then permits the operational maneuver of a broader range of specialized aircraft. These aircraft then expand the exploitation of the air domain in order to execute their mission and generate more persistent desired effects. For the USAF specifically, these options may include all other doctrinal missions: including strategic attack, air mobility, interdiction, and close air support.³¹ Such a

force structure of airframes specialized to specific mission, however, represents an unsustainable model for future airpower. The cost of maintaining specialized, single-mission combat aircraft is too high in current budgetary reality.³²

Instead of acquiring and maintaining specific aircraft against specific threat-types, mission assignments should create individual arms of the package. Rather than over specialization, the *fighter* component should offer a flexible, survivable, and lethal platform to task as appropriate in order to create freedom of maneuver for the greater force. Current DoD instructions define a *fighter* as an “aircraft designed to intercept and destroy other aircraft or missiles. [It also] includes multipurpose aircraft also designed for ground support missions such as interdiction and close air support.”³³ Contrast this general capability with the offensive counter-air (OCA) mission it typically accomplishes. “OCA operations include attack operations, [suppression of enemy surface-threats], fighter escort, and fighter sweep.”³⁴ Any aircraft accomplishing the OCA mission in support of air superiority should be capable of precision surface attack and destruction of enemy surface or airborne threats. Over specialization leaves a gap in capability that an adversary could exploit. Without survivability or lethality against surface threats, WWII aircraft were highly vulnerable to German ambush tactics:

[Wehrmacht] flak commanders took advantage of the fact that Allied [attack aircraft] pounced on everything that moved on the Norman roads by creating ingenious “low-flying-aircraft booby traps.” They deployed mobile canvas dummies equipped with glass panels to simulate glare from vehicle windshields. When [Allied aircraft] dove to the attack, massed anti-aircraft artillery (AAA) guns, usually camouflaged as shrubbery, opened fire.”³⁵

While the operational impact of such tactics was negligible in a conflict as broad reaching as World War II, consider the impact of a modern surface-threat ambush in a low-intensity conflict with tenuous popular support.³⁶ Localized air superiority cannot ignore a threat based merely on its altitude.

A clarification may be warranted at this point—none of the preceding should be understood to suggest that fighter aircraft should be limited in their survivability and lethality with respect to adversary aircraft. On the contrary, survivability and lethality against hostile air threat capability will continue to be an absolute requirement for establishing and maintaining air superiority. Even countering smaller air forces requires investment—as local air superiority can be quickly generated by even strategically weak air forces for periods of time.³⁷ It is in the unification of counter-threat capability that this paper advocates.

IMPLICATIONS FOR U.S. AIR FORCE ACQUISITIONS STRATEGY

U.S. acquisition strategy has long trended toward quality over quantity. Replacing 249 F-15C's with 183 F-22's accepts a 26.5% reduction in the counter-air fleet.³⁸ Perhaps this is *enough*, but consider what a fleet of 183 aircraft can provide to an operational theater. First, assume every F-22 in the inventory is combat coded. Then assume the target rate of 70.6% for “material availability,”³⁹ and an average, sustained generation capacity of 2.5 sorties per day.⁴⁰ This yields a planning factor of 323 F-22 sorties per day. Paired as 2-ship flights, with 24-hour coverage, including some optimistic rounding, results in *seven* F-22 missions per hour—for the entire fleet.

Current plans replace the Air Force's total purchase of 2,256 F-16's with 1,763 F-35A's, a 21.8% reduction in total fleet acquisition.⁴¹ Such a comparison is, however, over simplified. The 2,256 F-16s purchased by the USAF includes F-16A/B models retired from service in 2007, as well as years of attrition.⁴² The current USAF F-16 fleet stands at 1,018—the planned F-35A purchase would constitute a 73.1% *increase* in fleet size.⁴³ However, the F-35A acquisition schedule will not be completed until at least 2034.⁴⁴ So comparing fleet size between F-16 and F-

35 airframes may not be very illuminating. The unit cost may help compare like numbers: in 2014 dollars, adjusted for inflation, the F-35A comes in at \$188.5 million per aircraft, compared to \$26.5 million per F-16C/D.⁴⁵ At least when assessed by a dollar-per-airframe measure, it is clear Air Force leadership expects the F-35A to provide much more capability than its F-16 predecessor.

Such capability, however, is entirely one-dimensional in the context of opposed airspace. For example, General Michael Hostage, former commander of Air Combat Command stated in a interview, “If I do not keep that F-22 fleet viable, the F-35 fleet frankly will be irrelevant. The F-35 is not built as an air superiority platform. It needs the F-22.”⁴⁶ Consider General Hostage’s conceptualization of “air superiority.” His method of providing freedom of maneuver in the air domain is limited to victory over an airborne threat. To the Commander of Air Combat Command, merely winning air-to-air engagements generates air superiority. In doctrinal concepts, there appears to be an incomplete consideration for a surface-threat’s ability to affect mobility in the air domain. *Air Superiority* is synonymous with *air-to-air* combat; further, no distinction is made between the capable for surface-threat suppression and broad precision-strike capability.

CONCLUSION

Providing air superiority is about enabling freedom of maneuver—not about the specific threat restricting such maneuver. General “Pete” Quesada explained during the WWII Normandy invasion, “Air superiority does not mean immunity from harassing [air] attacks... it means relative freedom of movement.”⁴⁷ Perhaps the phrase “in the air battle” receives undue attention, or is too narrowly defined. This could be for intra-service, parochial reasons—“not a pound for

air-to-ground” was a common philosophy among many Air Force senior leaders for a good portion of their formative years. The strategy of specialization provided very successful capability while it could be afforded. However, survivable aircraft in a modern environment are too expensive to continue this model of specialization. Survivability in the high-end, technologically advanced, anti-access environment requires combined arms capability on a single platform. The USAF must jettison some weighty baggage of historic success to retain its core capability of air superiority. A combined arms fighter—designed specifically to provide freedom of maneuver for itself and an escorted strike platform wherever it flies must be the goal. In order to do so, a significant shift in the understanding of the term *air superiority* is required—creating freedom of maneuver requires the suppression of enemy threats to air operations, regardless of threat altitude. Enemy air defense artillery (ADA), consisting of AAA and modern SAM systems denies freedom of maneuver as effectively as enemy aircraft. Any current and future aircraft tasked with establishing local air superiority—termed a “fighter”— must be as survivable and lethal to surface threats as it is to airborne threats.

Limiting *air superiority* to the air-to-air element is contrary to the guiding philosophy of the Air Force, and maneuver-style warfare in general. Engaging and destroying hostile aircraft amounts to a threat reaction en route to a more effective application of airpower. The 5th Generation fighter, as currently envisioned, represents an inefficient application of airpower. The F-22 brings overwhelming capability to the air-to-air threat reaction realm. The F-35 promises to bring overwhelming capability to the air-to-surface threat reaction realm. Both are severely limited in the other’s domain—the F-22 is generally limited to static, pre-located surface targets vulnerable to small profile munitions. Outside of its immediate, individual self-defense, the F-35 generally lacks the payload and performance envelope to affect an airborne threat. Neither

presents a significant capability to generate local air superiority through the destruction of both surface- and airborne-threats.

The need to provide localized air superiority through destructive firepower will only increase. Currently, signature management (stealth) technology provides the USAF freedom to maneuver without the need for destructive air superiority campaign. While currently a powerful capability, avoiding detection is no panacea. Multi-spectral sensors continue to improve, threatening to make stealth based merely on limiting radar cross-section obsolete.⁴⁸ Without the ability to avoid detection, operational maneuver can only be restored by threat suppression.

Until Airmen start thinking about air superiority correctly, we will continue to be limited in our ability to provide it to the joint force. The nation cannot afford more record-setting acquisition programs that address limited aspects of a modern battlefield. Even while advocating the over-specialization of the British military, J.F.C Fuller wrote, “tactical demand should precede technical supply.”⁴⁹ In Fuller’s mind, the tank solved all problems of warfare, and while he certainly oversimplified what the tactical demand would be, his acquisitions strategy was correct. Modern integrated air defenses make the altitude of the threat irrelevant to forces operating in the air domain. Whether the threat stems from an airborne interceptor, or—far more likely— an advanced surface-to-air missile battery, Airmen must be able to secure our domain for exploitation by the joint force. Economic reality should drive the improvement of F-22 and F-35 capabilities toward commonality. Additionally, whatever is on the drawing board as the next fighter acquisition should not be limited to a 21st century pursuit aircraft. Current and future fighters should bring a combined arms mentality to bear against any threat to the air domain— regardless of that threat’s altitude. This will ensure the capability to provide the freedom of maneuver air superiority promises.

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ENDNOTES

¹ Richard R. Muller, "Losing Air Superiority: A Case Study from the Second World War," *Air and Space Power Journal*, 17, 4 (Winter 2003): 64.

² In fact, the most recent study available on USAF manned aircraft losses found none were lost to hostile aircraft—"either in aerial combat or because of enemy raids on friendly airfields." (Daniel L. Haulman, "USAF Manned Aircraft Combat Losses 1990-2002" (Dec 9, 2002), accessed December 2014, <http://oai.dtic.mil/oai/oai?verb=getRecord&metadataPrefix=html&identifier=ADA434084>).

³ This conclusion is based on two studies with data analyzed through Operation Iraqi Freedom in 2001: Kenneth P. Werrell, *Archie, Flak, AAA, and SAM: A Short Operational History of Ground-Based Air Defense* (Maxwell AFB, AL: Air University Press, 1988); and Daniel L. Haulman, "USAF Manned Aircraft Combat Losses 1990-2002" (Maxwell AFB, AL: Air Force Historical Research Agency, 2002) accessed December 2014, <http://oai.dtic.mil/oai/oai?verb=getRecord&metadataPrefix=html&identifier=ADA434084>.

⁴ Department of Defense, *Quadrennial Defense Review 2014* (4 March 2014), accessed December 2014, http://www.defense.gov/pubs/2014_Quadrennial_Defense_Review.pdf, IX and 59.

⁵ United States Air Force, *America's Air Force: A Call to the Future* (July 2014), accessed December 2014, http://www.defenseinnovationmarketplace.mil/resources/2014_AF_30_Year_Strategy_2.pdf, 8.

⁶ Department of Defense, "Doctrine for the Armed Forces of the United States," *Joint Publication 1*, March 25, 2013, accessed December 2014, http://www.dtic.mil/doctrine/new_pubs/jointpub_capstone.htm, I-5.

⁷ In an email interview with the author, Dr. Wray Johnson and a former associate of his from RAND Corporation suggested Polish air forces were too weak to threaten the *Wehrmacht*. Therefore "Germany could have defeated Poland even if the Luftwaffe had stayed on the ground." Even considering this exception, however, the important point is not the absence of the Luftwaffe but rather the inherent weakness of the Polish air force.

⁸ John Buckley, *Air Power in the Age of Total War* (Indianapolis, IN: Indiana University Press, 1999), 129.

⁹ Martin van Creveld, Kenneth S. Brower, and Steven L. Canby, *Air Power and Maneuver Warfare* (Maxwell Air Force Base, AL: Air University Press, 1994), 68-69.

¹⁰ Muller, 61.

¹¹ Colonel John Hughes-Wilson, *Military Intelligence Blunders and Cover-Ups*, (New York : Carroll & Graf, 2004), 218-259.

¹² Jesse Ferris, *Nasser's Gamble: How Intervention in Yemen Caused the Six-Day War and the Decline of Egyptian Power* (Princeton, NJ: Princeton University Press, 2013), 295.

¹³ Van Creveld, 165.

¹⁴ Hughes-Wilson, 241.

¹⁵ Van Creveld, 182.

¹⁶ James S. Corum and Wray R. Johnson, *Airpower in Small Wars: Fighting Insurgents and Terrorists*, (Lawrence, KS: University Press of Kansas, 2003).

¹⁷ Werrell, 99.

¹⁸ Ibid, 102.

¹⁹ William Sayers, "The Red Baron Reports: What They Really Said," *Airpower History*, 52.3 (Fall 2005) 4-13.

²⁰ The history of these training and acquisitions reforms offers outstanding case study for institutional change, successful military staff work, as well as strategic leadership. See Col. Marshall Michel (USAF, Ret.) "Revolt of the Majors," (unpublished dissertation) accessed March 2015, https://etd.suburn.edu/bitstream/handle/10415/595/MICHEL_III_55.pdf.

²¹ United States Air Force, "Air Force Core Missions" (August 15, 2013), accessed December 2014, <http://www.af.mil/News/ArticleDisplay/tabid/223/Article/466868/air-force-core-missions.aspx>.

²² While air superiority appears to be required for campaign success, it also is not likely sufficient. The notion of how to best exploit the air domain once air superiority is achieved is, however, beyond the scope of this work.

²³ Department of Defense, *Joint Publication 1-02: Dictionary of Military and Associated Terms* (15 August 2014), accessed 23 Oct 2014, http://www.dtic.mil/doctrine/new_pubs/jp1_02.pdf, 11.

²⁴ Maneuver-style warfare, as opposed to attritional-style warfare, seeks to "minimize actual fighting... place the enemy at a disadvantage by taking up favorable positions... [and] take maximum advantage of the outcome by pursuing the enemy, keeping him off balance, and striking into his vitals" (van Creveld, 1).

²⁵ Buckley, 127. Buckley refers to F. Heiss, *Der Sieg im Osten* (Berlin: Schoen, 1940), 3, and Richard P. Hallion, *Strike from the Sky* (Tuscaloosa, AL: University of Alabama Press, 2010), 133.

²⁶ Buckley, 129.

²⁷ Van Creveld, 88.

²⁸ Werrell, 138.

²⁹ Ibid, 143.

³⁰ J.C. Slessor, *Air Power and Armies* (Tuscaloosa, AL: University of Alabama Press, 2009), 4.

³¹ United States Air Force, *Doctrine Volume IV: Operations* (June 5, 2013), accessed December 2014, <https://doctrine.af.mil/download.jsp?filename=Volume-4-Operations.pdf>, 19-45.

³² See, for example, the controversy over the Air Force's proposal to retire the A-10 (Marina Malenic, "Congress Moves to Block A-10 Retirement in 2015," *IHS Jane's 360*, (December 2, 2014), accessed December 2014, <http://www.janes.com/article/46585/congress-moves-to-block-a-10-retirement-in-2015>).

³³ United States Air Force, *Designing and Naming Defense Military Aerospace Vehicles*, Air Force Instruction 16-401 (Washington, D.C.: Government Printing Office, 2014), 27.

³⁴ Department of Defense, *Joint Publication 3-01: Countering Air and Missile Threats* (March 23, 2012), accessed December 2014, http://www.dtic.mil/doctrine/new_pubs/jp3_01.pdf, IV-8.

³⁵ Muller, 61.

³⁶ Such an event is not unprecedented. The 1995 Serbian ambush of a USAF F-16 participating in Operation Deny Flight is the most recent example.

³⁷ Colonel Jose C. D’Odorico, “Air Superiority: A Sine Qua Non?” *Air and Space Power Journal*, 19.3, (Fall 2005): 55-63.

³⁸ United States Air Force, “F-15 Eagle” (March 14, 2005), and “F-22 Raptor” (September 16, 2005), accessed December 2014, <http://www.af.mil/AboutUs/FactSheets.aspx>

³⁹ “Materiel availability” is defined as the percentage of the fleet operationally capable of performing an assigned mission at any given time.” The rate as of 2011 was 61.2%, with a requirement to establish the rate at 70.6% by end of FY2015. (United States Government Accountability Office, “Report to Report to the Subcommittee on Tactical Air and Land Forces, Committee on Armed Services, House of Representatives: F-22 Modernization Cost and Schedule Transparency Is Improved, Further Visibility into Reliability Efforts Is Needed,” *GAO-14-425*, (May 2014), accessed December 2014, <http://www.gao.gov/assets/670/663196.pdf>, 11).

⁴⁰ In the author’s personal experience, 2.5 sorties per day is a common, realistic, albeit generic planning factor for sustained operations.

⁴¹ “F-16 Fleet Reports: Air Force F-16 Inventory,” accessed December 2014, http://www.f-16.net/fleet-reports_article1.html; Jeremiah Gertler, “F-35 Joint Strike Fighter (JSF) Program” (Washington, D.C: Congressional Research Service, 2014), 11.

⁴² The USAF received its final F-16 in March 2005. (Susan Ferns, “U.S. Air Force Receives Last F-16,” *Aeronautical Systems Center Public Affairs* (March 25, 2005), accessed December 2014, <http://www.f-16.net/f-16-news-article1332.html>; (Gabe Johnson, “Air Guard Retires Last F-16A in Service,” *National Guard*, June 20, 2007, accessed December 2014, <http://www.nationalguard.mil/News/ArticleView/tabid/5563/Article/386/air-guard-retires-last-f-16a-in-service.aspx>)

⁴³ United States Air Force, “F-16 Factsheet,” October 8, 2007, accessed December 2014, <http://www.af.mil/AboutUs/FactSheets/Display/tabid/224/Article/104505/f-16-fighting-falcon.aspx>.

⁴⁴ Gertler, 12.

⁴⁵ F-35A unit cost remains a highly contentious issue. The \$188.5 million figure was taken from an analysis of the DoD budget done by Winslow Wheeler, “On Final Approach to Fighter Fiscal Sanity,” *Time* (June 7, 2013), accessed December 2014, <http://nation.time.com/2013/06/07/on-final-approach-to-fighter-fiscal-sanity/>. The F-16 cost is less politically charged. The average airframe cost in 1995 of \$17 million was adjusted for inflation resulting in the \$26.5 million figure expressed in 2014 dollars (this does not include sensor and avionics upgrades), but even doubling the cost still paints a clear picture of the shift in acquisition strategy. F-16 cost taken from Mark Thompson, “Sticker Shock: Iraqi F-16s \$165 Million Each,” *Time* (September 28, 2011), accessed December 2014, <http://nation.time.com/2011/09/28/sticker-shock-iraqi-f-16s-165-million-each/>

⁴⁶ Mehta.

⁴⁷ Thomas Alexander Hughes, *Overlord: General Pete Quesada and the Triumph of Tactical Air Power in World War II* (New York, NY: The Free Press, 1995), 152.

⁴⁸ Michael J. Gething, “Sky Searchers,” *Jane’s Defense Weekly* (23 Oct 2014), accessed November 2, 2014, OpenSource.gov and Kelvin Wong, “China Unveils New Active/Passive Radar Range,” *International Defense Review*, (14 May 2014), accessed November 2, 2014, OpenSource.gov.

⁴⁹ J.F.C Fuller, *The Foundations of the Science of War* (London: Hutchinson & Co., LTD, 1926), 102.