

NATIONAL DEFENSE UNIVERSITY

JOINT FORCES STAFF COLLEGE

JOINT ADVANCED WARFIGHTING SCHOOL



BREAK THE KILL CHAIN, NOT THE BUDGET: HOW TO AVOID U.S.

STRATEGIC RETRENCHMENT

by

Bryce A. Silver

Lieutenant Colonel, United States Air Force

ABSTRACT

In order to avoid an economic collapse and strategic retrenchment similar to what the Soviet Union went through at the end of the Cold War, the United States needs to adopt a blended defense acquisitions strategy. As the Cold War began and facing mounting Western military strength, the Soviet Union needed to grow their defense forces. The Soviets decided on an offset strategy that sought a quantitatively superior force designed to break individual links in the United States and Western kill chains. The decision had detrimental impacts on Soviet foreign policy and its economy. In contrast, the United States invested in a qualitatively superior military manifested by advanced technologies. Designed to annihilate the enemy kill chain, the United States offset strategy was the polar opposite of the Soviet decision. However, unlike the Soviet Union, the United States had a sufficiently resilient economy to back the qualitative offset strategy. The United States addiction to advanced technologies enabled the asymmetric military advantage it helped build during the Cold War and enjoys today, but the fiscal reality of perpetuating such a trend is bleak. In order to escape the Cold War fate of the Soviet Union, the United States must continue to utilize existing military platforms with added off the shelf technologies, complete existing advanced programs such as the F-35 Joint Strike Fighter, DDG-1000 Zumwalt class destroyer, and the Long-Range Strike Bomber, as well as increase unmanned systems utilization. Additionally, the United States must remain committed to investing in research and development in order to feed the American innovation machine that draws the envy of allies and adversaries alike.

DEDICATION

This thesis is dedicated to my wife and children who selflessly gave their husband and father to academic solitude for innumerable hours. Without their unwavering love and support this endeavor would not have been possible.

ACKNOWLEDGEMENTS

I would like to pass on specific gratitude to my thesis advisors Dr. S. Mike Pavelec and Colonel Kevin Therrien. Without their mentoring, shepherding, occasional prodding, and patience of Job, this thesis would be a compilation of blank pages. A special thanks to Mr. Jeffrey Turner from the Joint Forces Staff College Writing Center for his assistance on thesis formulation and continued education on structure and revision.

TABLE OF CONTENTS

INTRODUCTION 1

CHAPTER 1: THE SOVIET UNION DURING THE COLD WAR.....4

 Quantitative Offset.....5

 Kill Chain Degradation.....6

 Catalyst to Economic Collapse and Strategic Retrenchment.....7

**CHAPTER 2: UNITED STATES DURING THE COLD WAR THROUGH
PRESENT DAY**.....12

 Qualitative Offset.....13

 Kill Chain Anihilation.....15

 Technology, National Debt, and Avoiding Retrenchment.....18

CHAPTER 3: THE WAY FORWARD.....21

 Complete Programs of Record.....24

 Upgrade Current Systems with Existing Technology.....28

 Expanding Drone Technologies.....31

 Investment in Research and Development.....35

CONCLUSION.....39

BIBLIOGRAPHY43

VITA.....51

INTRODUCTION

From catapults to precision guided munitions, the quest for technological advancements on the battlefield is timeless and while innovative ideas abound, fiscal limitations present obstacles to their development. The challenge lies in discerning the appropriate balance between the technology required as an instrument of war to defeat the enemy and the associated budgetary commitment. This challenge has vexed ruling powers for centuries. Over the decades some nations have shown a proclivity for costly technology in warfare. The conscious decision to focus on advanced technology intended to offset the capabilities of the enemy theoretically gives an asymmetric advantage in warfare. Pursuing the offset is known as an offset strategy. This offset strategy, as defined by H.R. McMaster, is a strategy that develops military capabilities in an effort to offset or overcome the capabilities of the enemy.¹

In a recent speech at the Joint Forces Staff College a general officer stated that “There are two ways to fight an enemy, asymmetric and stupid. We want to fight with an asymmetric advantage.” The United States is in its third offset strategy punctuated by military platforms incorporating ultra-high levels of costly technology.² The aim of these military platforms is to unequivocally dominate the enemy with an asymmetric advantage while ensuring unrivaled force survival. Force survival, for the purposes of this paper, focuses on surviving within the enemy’s environment or battlespace.

¹ H. R. McMaster, “The Uncertainties of Strategy,” *Survival* 57, No. 1, 2015, 197-208.

² Who's Afraid of America?; Weapons Technology, *The Economist*, No. 57, June 13, 2015, <http://search.proquest.com.nduezproxy.idm.oclc.org/docview/1688011216?accountid=12686> (accessed October 19, 2015).

Surviving within the enemy's battlespace involves breaking the enemy's kill chain. The kill chain, as explained by Gen Hawk Carlisle, is the time between when "you [a combatant] arrive in the battle space and when the enemy weapon approaches you."³ The chain has many links represented by aspects such as command and control, communication, detection, acquisition, tracking, firing, weapons intercept, and impact. In order to survive in an enemy's battlespace, one needs to break the enemy kill chain at any point and by any means necessary.⁴ It is possible to break the enemy's kill chain simultaneously at multiple points and, with advanced platforms, even destroy the kill chain altogether. The survivability afforded by obliterating the enemy kill chain is superior to a scenario with a single broken link, but the advanced technology required to do so comes at a price and with potential impacts to a government's economic instrument of national power.

The debate over quality, cost, and quantity is at the heart of the offset strategy decision. The debate begins with the fundamental choice on the balance between high quality but low quantity weapons systems, designed to break multiple links in a kill chain, versus lower quality but higher quantity weapons that tend to break only a single link. Fiscal constraints normally limit either bookend of the quality versus quantity continuum. An uninformed disregard or inattention to these associated financial aspects can have significant geopolitical and economic impacts such as strategic retrenchment or economic collapse. Strategic retrenchment, as defined by Matthew Harris, "emphasizes the [nation's] need to reduce military expenditures, reallocate resources at home, and

³ AF: Stealth 'Incredibly Important,' *Air Force Times*, No. 22, 2015, <http://search.proquest.com.-nduezproxy.idm.oclc.org/docview/1663520254?accountid=12686> (accessed October 10, 2015).

⁴ Ibid.

redefine a more modest definition of the national interest.”⁵ Retrenchment is either a decided strategy or a consequence forced by economic mismanagement or trauma.

The purpose of this paper is to examine the United States and its Cold War foe, the Soviet Union, through the lenses of offset strategies, their intended effects on kill chains, and the resultant economic and geopolitical impacts. In doing so, the desire is to further enhance intellectual discourse on the future U.S. defense acquisition philosophy. In order to avoid an economic collapse and strategic retrenchment similar to what the Soviet Union went through at the end of the Cold War, the United States needs to adopt a blended defense acquisitions strategy. This blended strategy includes utilizing existing military platforms with added off the shelf technologies, continuing development of existing advanced programs such as the F-35 Joint Strike Fighter, DDG-1000 Zumwalt class destroyer, and the Long-Range Strike Bomber also known as the B-21, as well as increasing unmanned systems utilization.

This paper begins with a chapter of historical analysis on the Soviet Union during the Cold War that details Soviet offset strategies, kill chain philosophies, and how these contributed to the Soviet Union’s economic collapse and strategic retrenchment. The next chapter follows the same historical analysis structure for the United States during the Cold War and concludes with a discussion on U.S. defense spending and the potential for U.S. strategic retrenchment. The last chapter provides a potential solution to the technology, cost, and quantity dilemma with the aim of avoiding U.S. strategic retrenchment and economic collapse due to runaway defense expenditures.

⁵ Matthew J. Harris, “Strategic Retrenchment and Renewal in the American Experience,” *Comparative Strategy* Vol. 34, No. 2, 240, 2015, <http://search.proquest.com.nduezproxy.-idm.oclc.org/docview/1685383357?accountid=12686> (accessed September 23, 2015).

CHAPTER 1: THE SOVIET UNION DURING THE COLD WAR

In a post WWII environment that trended towards bipolarity where the Soviet Union sat opposite the United States on the global stage, the Soviet Union found itself at odds ideologically with the West. The United States positioned itself well geopolitically with the Truman Doctrine adopted in 1947, the Marshall Plan passed in 1948, and the North Atlantic Treaty signed in 1949 which became a collective shield of democracy against communism, particularly in tumultuous countries that were economically and politically weak.⁶ The Soviet Union challenged the shield of democracy by signing the Council for Mutual Economic Assistance (COMECON) in 1949 followed by the Warsaw Pact in 1955 to provide legitimate institutions to balance the scale of power vis-à-vis the United States.⁷ The Warsaw Pact, essentially the military arm of COMECON, required manpower for which the Soviet Union bore the greatest burden.⁸ With bipolar global powers solidified, the Soviet Union faced the decision on how to grow their military forces in the face of mounting Western opposition and military strength. The decisions made on force quality, quantity, associated costs, and effect on the kill chain had consequential impacts on Soviet foreign policy and its economy.

Quantitative Offset: Joseph Stalin, referring to the buildup of the Red Army, stated that “Quantity has a quality all of its own.”⁹ In his convocation speech to the

⁶ U.S. Department of State: Office of the Historian, “1945–1952: The Early Cold War,” <https://history.state.gov/milestones/1945-1952> (accessed November 20, 2015).

⁷ U.S. Department of State: Office of the Historian, “1953–1960: Entrenchment of Bi-Polar Foreign Policy,” <https://history.state.gov/milestones/1953-1960> (accessed November 20, 2015).

⁸ Ibid.

⁹ Joseph V. Stalin, “The Tasks of Economic Executives,” *Problems of Leninism*, 1931, 519-31.

National Defense University in 2014, Robert Work articulated the evolution of Soviet offset strategies during the Cold War. The Soviets gained and maintained numerical superiority in conventional weapons and further sought to increase their nuclear inventory in an attempt to match the U.S.¹⁰ Absent the vast oceanic buffer zones available to the U.S., and given the proximity of the Soviet Union to potential Cold War adversaries geographically separated by over 4,000 miles in Europe and Southeast Asia, prudence dictated a quantitatively superior Soviet force. In the face of leadership change from Nikita Khrushchev to Leonid Brezhnev on October 14, 1964 the Soviet Union grappled with their decision on the composition of future Soviet military forces.¹¹

Soviet strategy kept the United States, along with NATO, as principal threats to the Eastern bloc and socialism.¹² Beginning in the early 1960s, Soviet strategy dictated nuclear parity, at a minimum, with the West, combined with the ability to conduct conventional strategic operations under the nuclear umbrella.¹³ Soviet defense forces went from a decades-low force of under 3 million personnel in 1960 to a crescendo of 6.2 million personnel in 1988.¹⁴ Influencing the decision for greatly increased defense forces was Brezhnev's concept of 'parity' which, in his opinion, meant having enough Soviet forces and weaponry to simultaneously counter all potential enemies, to include the

¹⁰ Robert Work, "Convocation Speech," National Defense University 2014 Convocation, Lanham, United States, Federal Information & News Dispatch, Inc., August 5, 2014, <http://search.proquest.com.-nduezproxy.idm.oclc.org/docview/1551186984?accountid=12686> (accessed September 21, 2015).

¹¹ David M. Glantz, "The Development of the Soviet and Russian Armies in Context, 1946-2008: A Chronological and Topical Outline," *Journal of Slavic Military Studies* Vol. 23, No. 1, 2010, 27-235, <https://nduezproxy.idm.oclc.org/login?url=https://search.ebscohost.com/login.aspx?direct=true&db=mth&AN=48253383&site=ehost-live&scope=site> (accessed October 7, 2015).

¹² Ibid.

¹³ Ibid.

¹⁴ Ibid.

United States, western Europe, Japan, and China.¹⁵ Brezhnev's concept of parity drove the Soviet Union to build up quantitatively massive defense forces and equipment that numerically outmatched the United States.¹⁶ The numerical superiority enjoyed by the Soviets gave them a formidable defense force and enhanced their ability to break single links in the U.S. kill chain.

Kill Chain Degradation: Utilizing a quantitative approach to military fortification, the Soviet Union focused on breaking single links in the kill chain. The Soviet Union, with borders spanning thousands of miles, desired a formidable and layered defense network as they planned against Western intercontinental ballistic missiles, sea launched ballistic missiles, long range bombers, and shorter range tactical fighters and bombers. At times the Soviet defense systems held a technological edge over Western forces, compelling the U.S. to offset Soviet innovation. It was an era of intense competition between the United States and the Soviet Union marked by several advances in weaponry on both sides.

Ben Rich, director of Lockheed's Skunk Works from 1975 to 1991, worked in one of the most secretive development divisions in the world and held a truly unique perspective on advanced technologies and their effect on kill chains. He witnessed and contributed to the point-counterpoint, or offset, development of weapons to oppose Soviet long-range radars, the high-altitude and nuclear capable SAM-5 missile defense system, plus 15 additional varied surface-to-air missile systems and radars that formed

¹⁵ Edwin Bacon and Mark A. Sandle, eds., *Brezhnev Reconsidered* (Houndmills, Basingstoke: Palgrave Macmillan, 2003).

¹⁶ *Ibid.*

the iron curtain which posed a forbidding threat to U.S. forces.¹⁷ The U.S. philosophy on countering these Soviet technologies is covered later in this paper.

With a layered and costly defense network involving overlapping radar and missile coverages, Soviet defense forces focused their efforts on negating inbound missile and aircraft threats, disrupting the U.S. kill chain. The Soviet defense challenge, as previously mentioned, involved the protection of immense borders with incredible separation complicated by access across the polar cap from a plethora of U.S. threats of varying ranges and capabilities. These variables logically pointed to a defense force able to span great distances with overlapping capabilities that allowed for the disruption of inbound U.S. missiles and aircraft at multiple points in their profile from launch to target destruction, described here as a kill chain. The quantitative superiority of Soviet forces allowed for disruptions at single points in the kill chain but came with significant economic consequences.

Catalyst to Economic Collapse and Strategic Retrenchment: John F. Kennedy once proclaimed that “The cost of freedom is always high, but Americans have always paid it.”¹⁸ Based upon the Soviet economic struggles during the Cold War, one could ask if Leonid Brezhnev, who led the Soviet Union from 1964 until his death in 1982, had similar sentiments for Soviet communism.¹⁹ The economic demise of the Soviet Union in the Cold War comprised many factors including significant defense expenditures paired with a weakening Soviet economy.

¹⁷ Ben R. Rich and Leo Janos, *Skunk Works: A Personal Memoir of My Years at Lockheed* (Boston: Little, Brown), 1994.

¹⁸ John F. Kennedy, *The Cuban Missile Crisis: President Kennedy's Address to the Nation, October 22, 1962*, National Archives and Records Administration, 1988.

¹⁹ Edwin Bacon and Mark A. Sandle, eds., *Brezhnev Reconsidered* (Houndmills, Basingstoke: Palgrave Macmillan, 2003).

Financially, the Soviet's Cold War offset strategy contributed to eventual economic collapse and strategic retrenchment for the Soviet Union.²⁰ In order for the Soviet Union, specifically during the Brezhnev era, to maintain its arms race with the United States and offset both nuclear and conventional capabilities, the Soviet Union became heavily committed economically. In the period from 1965 to 1989 the Soviet Union outspent the United States in the defense sector by almost 250 billion dollars and outright more than the United States annually from 1972 to 1985 (reference figure 1).²¹ The substantial financial commitment, made possible by the Kremlin's strict control of the Soviet economy, enabled the Soviet arms race surge during the Cold War.²²

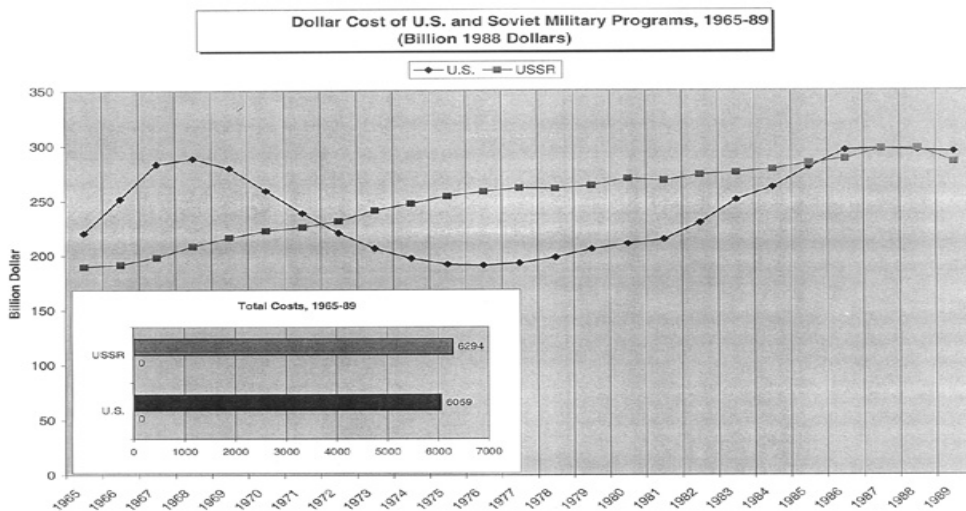


Figure 1: Russia vs U.S. Defense Spending²³

²⁰ Matthew J. Harris, "Strategic Retrenchment and Renewal in the American Experience," *Comparative Strategy* Vol. 34, No. 2, 240, 2015, <http://search.proquest.com.nduezproxy.idm.oclc.org/docview/1685383357?accountid=12686> (accessed September 23, 2015).

²¹ Gerald K. Haines and Robert E. Leggett, eds., *Watching the Bear: Essays on CIA's Analysis of the Soviet Union*, Government Printing Office, 2003.

²² Patrick J. McDonald, "Complicating Commitment: Free Resources, Power Shifts, and the Fiscal Politics of Preventive War," *International Studies Quarterly* Vol. 55, No. 4, 2011, 1095-1120, <https://nduezproxy.idm.oclc.org/login?url=https://search.ebscohost.com/login.aspx?direct=true&db=tsh&AN=67057177&site=ehost-live&scope=site> (accessed September 23, 2015).

²³ Gerald K. Haines and Robert E. Leggett, eds., *Watching the Bear: Essays on CIA's Analysis of the Soviet Union*, Government Printing Office, 2003.

The Soviet financial commitment to defense was noteworthy since the Soviet economy faltered during the Cold War and was not as resilient as the U.S. economy.²⁴ The U.S. economy was strong enough to handle increased defense spending, and during the height of the Cold War defense spending remained within sight of the U.S. 45-year average of 5.5 percent of the U.S. Gross Domestic Product (reference figure 2).²⁵ In contrast, the Soviet Union experienced a 40 percent increase in defense spending between 1965 and 1970 which, relative to GDP, equated to approximately a three percent increase in military spending over the period that topped out at over 15 percent in 1982.²⁶ Additionally, the 15 percent spending in relation to GDP paralleled a ballooning 20

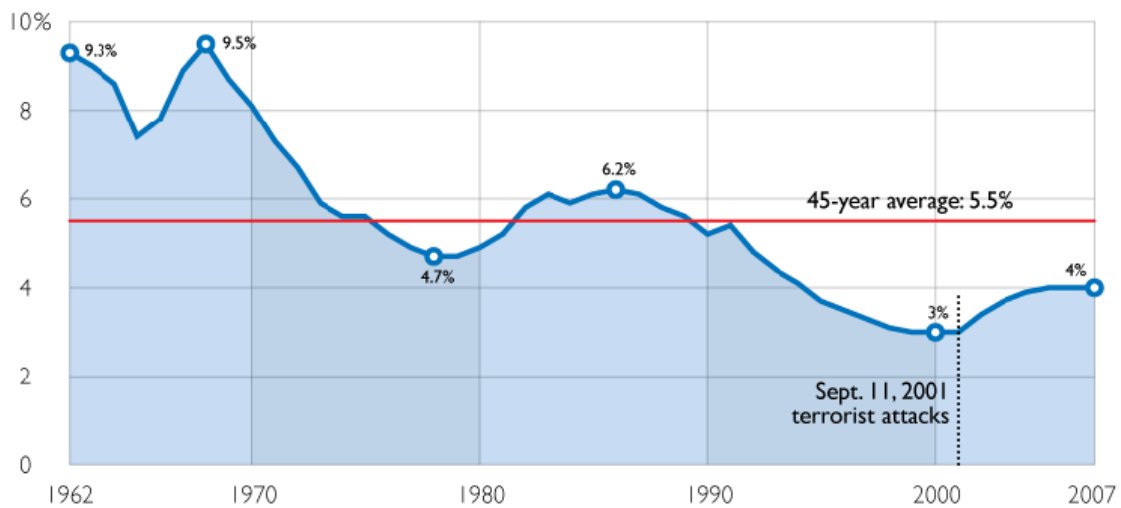


Figure 2: U.S. Defense Spending as a Percentage of GDP²⁷

²⁴ Matthew J. Harris, "Strategic Retrenchment and Renewal in the American Experience," *Comparative Strategy* Vol. 34, No. 2, 240, 2015, <http://search.proquest.com.nduezproxy.idm.oclc.-org/docview/1685383357?accountid=12686> (accessed September 23, 2015).

²⁵ Megan Mcardle, "A Real Domestic Threat: How Health-Care Spending Strains the U.S. Military," *The Atlantic*, March 12, 2012, <http://www.theatlantic.com/business/archive/2012/03/a-real-domestic-threat-how-health-care-spending-strains-the-us-military/254350/> (accessed November 3, 2015).

²⁶ Edwin Bacon and Mark A. Sandle, eds., *Brezhnev Reconsidered* (Houndmills, Basingstoke: Palgrave Macmillan, 2003).

²⁷ Megan Mcardle, "A Real Domestic Threat: How Health-Care Spending Strains the U.S. Military," *The Atlantic*, March 12, 2012, <http://www.theatlantic.com/business/archive/2012/03/a-real-domestic-threat-how-health-care-spending-strains-the-us-military/254350/> (accessed November 3, 2015).

percent internal Soviet domestic debt.²⁸ These figures point to Soviet fiscal policies that supported an over commitment to the defense sector, and when left unaddressed contributed to the Soviet economic collapse. Defense spending was not the sole culprit of Soviet economic woes, but was a significant contributor.

The economic fall of the Soviet Union under Brezhnev was more complex than a myopic view of military equipment overspending would allow. Other key factors, although not the focus of this paper, warrant a cursory mention. It is important to note the costs associated with the USSR's geopolitical positions around the globe. Afghanistan in particular, contributed to the Soviet's power decline and eventual economic collapse.²⁹ Additionally, a slow isolation from emerging technologies during the period not only impaired the technological advances of the Soviet defense sector, but also distanced the country from the main market of innovation which had second and third order economic effects.³⁰ It is not the aim of this paper to espouse that Soviet military overspending was the only cause of economic decline, but instead that it played a decidedly important role in that decline.

In his analysis on the Soviet Union's military during the Cold War, Gerhard Wettig states that the "imminent danger of war proved the necessity of strengthening the fighting force of the Warsaw Treaty so that it can crush any oppressor at any frontier"

²⁸ Mark L. Haas, "The United States and the End of the Cold War: Reactions to Shifts in Soviet Power, Policies, or Domestic Politics?" *International Organization* Vol. 61, No. 1, 2007, 145-179, <https://nduezproxy.idm.oclc.org/login?url=https://search.ebscohost.com/login.aspx?direct=true&db=tsh&AN=24179005&site=ehost-live&scope=site> (accessed October 9, 2015).

²⁹ Megan Mcardle, "A Real Domestic Threat: How Health-Care Spending Strains the U.S. Military," *The Atlantic*, March 12, 2012, <http://www.theatlantic.com/business/archive/2012/03/a-real-domestic-threat-how-health-care-spending-strains-the-us-military/254350/> (accessed November 3, 2015).

³⁰ John Tirman, "How the Cold War Ended," *Global Dialogue* Vol. 3, No. 4, 2001, 80- 90, <http://search.proquest.com.nduezproxy.idm.oclc.org/docview/211508216?accountid=12686> (accessed September 21, 2015).

and that an overwhelming Soviet defense force was critical in defeating Western powers.³¹ The result of massive Soviet defense expenditures was that Western powers, namely the United States, in an effort to maintain a balance of power, invested in military weaponry at appropriate levels to counter the Soviet Union. It was the over commitment of the Soviet economy that led to eventual Soviet economic decline and forced the Soviet Union, then unable to support operations outside its borders, into a period of strategic retrenchment. Realists profess that Soviet economic troubles forced “large-scale reductions in military spending, retreat from Afghanistan, surrendering the Soviet empire in Eastern Europe, and acquiescing to German unification in NATO” and were “so conducive to American interests that U.S. leaders could declare the Cold War over.”³²

³¹ Gerhard Wettig, “The Last Soviet Offensive in the Cold War: Emergence and Development of the Campaign against NATO Euromissiles, 1979-1983,” *Cold War History* Vol. 9, No. 1, 79-110, <https://nduezproxy.idm.oclc.org/login?url=https://search.ebscohost.com/login.aspx?direct=true&db=tsh&AN=36677755&site=ehost-live&scope=site> (accessed October 17, 2015).

³² Mark L. Haas, “The United States and the End of the Cold War: Reactions to Shifts in Soviet Power, Policies, or Domestic Politics?” *International Organization* Vol. 61, No. 1, 2007, 145-179, <https://nduezproxy.idm.oclc.org/login?url=https://search.ebscohost.com/login.aspx?direct=true&db=tsh&AN=24179005&site=ehost-live&scope=site> (accessed October 9, 2015).

CHAPTER 2:

UNITED STATES DURING THE COLD WAR THROUGH PRESENT DAY

Acknowledged by the United States and Western powers, the Soviet buildup during the Cold War was not a state secret. In August, 1981, President Reagan eloquently stressed in several iconic White House addresses that the Soviet Union built up unprecedented offensive military forces to use against the United States and its NATO partners.¹ Reagan's Defense Secretary Casper Weinberger added that "it was neither reasonable nor prudent to view the Soviet military buildup as defensive in nature."² Secretary of State Alexander Haig also highlighted the Soviet buildup as a threat to global stability and overall world peace.³ The voices from the U.S. Executive Branch spoke in unison. The Soviet Union was an existential threat to the United States and required a focused defense policy with associated budgetary allocations.

As the Cold War progressed into the 1970s and 1980s, analysts professed that the numerical superiority of Soviet and Warsaw Pact militaries could overwhelm United States and NATO forces that relied heavily on firepower and qualitative superiority.⁴ During both President Carter's and President Reagan's administrations, the U.S. sought to capitalize on the U.S. edge in advanced technologies in order to oppose the Soviet's quantitative superiority.⁵ In essence, this attempted to leverage the U.S. lead in areas such

¹ Beth A. Fischer, "Toeing the Hardline? The Reagan Administration and the Ending of the Cold War," *Political Science Quarterly* (Academy of Political Science) Vol. 112, No. 3, 1997, 477-496, <https://nduezproxy.idm.oclc.org/login?url=https://search.ebscohost.com/login.aspx?direct=true&db=aph&AN=9711061994&site=ehost-live&scope=site> (accessed November 17, 2015).

² Ibid.

³ Ibid.

⁴ Alex Roland, "Technology, Ground Warfare, and Strategy: The Paradox of American Experience," *The Journal of Military History* Vol. 55, No. 4, 1991, 447-468.

⁵ Thomas G. Mahnken, *Technology and the American Way of War* (New York: Columbia University Press, 2008).

as information technology against the Soviet Union's advantage in heavy industry and production.⁶ This U.S. qualitative strategy focus was in direct contrast to the Soviet Union philosophy on defense force composition weighted heavily towards mass quantities. The United States maintained a Cold War offset strategy focused on technology and kill chain annihilation with an understanding of economic impacts that did not lead to strategic retrenchment.

Qualitative Offset: The U.S. has a fascination with and addiction to technology. It is an addiction pervasive at all levels of government and leadership. Testifying before the U.S. Senate in October of 1945, General Henry "Hap" Arnold stated that "We must remember at all times that the degree of national security rapidly declines when reliance is placed on the quantity of existing equipment instead of quality."⁷ In *Rise of the Fighter Generals*, former U.S. Air Force Chief of Staff General Thomas White said "We in the Air Force...always want to see technology move faster because we realize that it is from the area of new developments that our lifeblood stems."⁸ President Reagan, dubbed as one of the greatest public speakers to reside in the Oval Office, stated the U.S. qualitative strategy better than any other in his address to the nation:

"The U.S. must modernize its military force—both nuclear and conventional—so that the Soviet leaders perceive that the U.S. is determined never to accept second place or a deteriorating military posture. Soviet calculations of possible war outcomes under any contingency must always result in outcomes so unfavorable to

⁶ Thomas G. Mahnken, *Technology and the American Way of War* (New York: Columbia University Press, 2008).

⁷ Ibid.

⁸ Roy M. Worden, "The Rise of the Fighter Generals: The Vietnam Era and the Problem of Air Force Leadership (1945-1982)," Duke University, 1993, <http://search.proquest.com.nduezproxy.idm.oclc.org/docview/304030550?accountid=12686> (accessed October 21, 2015).

the USSR that there would be no incentive for Soviet leaders to initiate an attack.

The future strength of U.S. military capabilities must be assured.”⁹

Other than the overwhelming German war machine in WWII, no country in history focused more time, energy, and resources into military technological developments than the United States did during the Cold War.¹⁰

In contrast to the Soviet Union, the U.S. focused heavily on high quality technological developments over lower quality and higher quantity instruments of war.¹¹ Ben Rich, former director of the Lockheed Skunk Works Division, illustrated this point when he conveyed that his secret organization “had orders from Washington to produce airplanes or weapons systems that were so advanced that the Soviet bloc would be impotent to stop their missions.”¹² He also discussed that the Lockheed products were produced with extremely high quality and durability and that a legendary Russian aerodynamicist later reflected that “You Americans build airplanes like a Rolex watch...we build airplanes like a cheap alarm clock.”¹³ These statements ring true as Lockheed’s Skunk Works Division produced some of the most technologically advanced instruments of war to date.

During the post-WWII and Cold War era, the Lockheed Skunk Works Division built aircraft such as the F-80 Shooting Star, F-104 Starfighter, U-2 Dragon Lady, SR-71 Blackbird, and F-117 Nighthawk that all slipped furtively out of the secretive hangars in Palmdale California and into U.S. military service, much to the chagrin of their Soviet

⁹ Ronald Reagan, "National Security Decision Directive Number 75: US Relations with the USSR," 1983.

¹⁰ Thomas G. Mahnken, *Technology and the American Way of War* (New York: Columbia University Press, 2008).

¹¹ Ashton Carter, “Adapting US Defense to Future Needs,” *Survival* Vol. 41, No. 4, 1999, 101-123.

¹² Ben R. Rich and Leo Janos, *Skunk Works: A Personal Memoir of My Years at Lockheed* (Boston: Little, Brown), 1994.

¹³ *Ibid.*

adversaries.¹⁴ The Skunk Works Division also built the Sea Shadow, a prototype stealth ship that achieved stunning results but never the favor of the U.S. Navy.¹⁵ The acquisition of the Skunk Works aircraft benefitted from National Security Decision Directive 75 when the Reagan administration made it policy to exploit the U.S. technological edge against the Soviet Union.¹⁶ The concept of embracing advanced technology did not fade away with the end of the Cold War. It continues today in the 2015 National Security Strategy as President Obama stated that “We will safeguard our science and technology base to keep our edge in the capabilities needed to prevail against any adversary.”¹⁷ It is important to highlight that with asymmetrically advanced technology, the aim is to overwhelm the enemy in such a capacity to render them incapable of defending themselves. The ultimate achievement is the ability to annihilate the enemy’s kill chain, ensuring that at no point in an adversary’s battlespace is the attacker vulnerable to counterattack at any point. It is the achievement of complete force survival through advanced technology.

Kill chain annihilation: Sun Tzu wisely stated: “Know the enemy and know yourself; in a hundred battles you will never be in peril.”¹⁸ This wise edict espoused by one of the most admired military strategists in history reinforces the kill chain analogy. Knowing the enemy, their instruments of war, employment techniques, strengths and weaknesses, and most importantly their vulnerabilities empowers an adversary to exploit

¹⁴ Ben R. Rich and Leo Janos, *Skunk Works: A Personal Memoir of My Years at Lockheed* (Boston: Little, Brown), 1994.

¹⁵ Ibid.

¹⁶ Reagan, Ronald. "National Security Decision Directive Number 75: US Relations with the USSR." 1983.

¹⁷ Barack Obama, *2015 National Security Strategy*, Washington, DC, February, 2015, Quoted from the ‘Security’ section of the NSS under ‘Strengthen Our National Defense,’ https://www.whitehouse.gov/sites/default/files/docs/2015_national_security_strategy.pdf (accessed October 3, 2015).

¹⁸ Sun Tzu, *The Art of War* (London: Oxford University Press, 1971).

the kill chain.¹⁹ More precise knowledge of the enemy kill chain enables a clearer perception of all the individual links allowing multiple points of exploitation. During the Cold War, with an emphasis on high quality and technology infused weaponry, the U.S. focused on the capability to not only break individual links in the kill chain, but to completely overwhelm and annihilate the enemy kill chain.

In a specific offset strategy against Soviet layered defense networks across the Russian borders and Warsaw Pact countries, the United States focused significant resources on the quiet development of stealth technology.²⁰ It was a necessary investment for aviation since previous aircraft such as the B-1 Lancer, developed and touted to sneak under Russian radars at low-altitude, proved easily detectable by Russian systems leaving the U.S. at a disadvantage against Soviet defense systems.²¹ Although the results of the development of stealth technology materialized in production en masse after the collapse of the Soviet Union, the technology influenced generations of follow-on aircraft, drones, and naval vessels. Operational and later combat testing showed that stealth technology enabled the United States to not just defeat but annihilate the enemy's kill chain. Stealth currently allows entry into the enemy's battlespace without detection and the freedom to operate therein with impunity. It is an asymmetric advantage that continues to enable and guide U.S. military forces today.

¹⁹ Jonathan White and Sean Filipowski, "Know The Environment, Know The Enemy, Know The Target," *United States Naval Institute Proceedings*, No. 7, 2014, 30-35, <http://search.proquest.com.nduezproxy.idm.oclc.org/docview/1555349284?accountid=12686> (accessed October 7, 2015).

²⁰ Thomas G. Mahnken, *Technology and the American Way of War* (New York: Columbia University Press, 2008).

²¹ Ben R. Rich and Leo Janos, *Skunk Works: A Personal Memoir of My Years at Lockheed* (Boston: Little, Brown), 1994.

Annihilating the kill chain with advanced instruments of war is more the norm than the exception in the post-Cold War era U.S. military. The U.S. Air Force embraced this concept more than any other military branch as they developed new fighter and bomber aircraft with increased stealth. Legendary fourth-generation aircraft developed in the 1970s and 1980s such as the U.S. Navy F-14 Tomcat, U.S. Air Force F-15 Eagle and F-16 Fighting Falcon, as well as the U.S. Navy and U.S. Marine Corps F-18 Hornet were all very capable, but none of them could break more than a single link in an enemy's kill chain. As a consequence, these platforms became increasingly dependent on larger support packages for combat missions penetrating into more advanced enemy defense networks, such as those seen in the Balkans and Iraq. The insatiable desire for kill chain annihilation, complete force survival, and the stunning combat successes of stealth aircraft drove the U.S. towards exponentially more advanced equipment incorporating the costly remedy of stealth technology.

In an interview on the F-35 Joint Strike Fighter, previous commander of U.S. Air Force Air Combat Command, retired General Mike Hostage, illustrates the U.S. fixation on stealth technology by remarking that: "In the first moments of a conflict I'm not sending [EA-18G] Growlers or F-16s or F-15Es anywhere close to that [highly contested or defended] environment, so now I'm going to have to put my fifth gen [aircraft] in there and that's where that radar cross-section and the exchange of the kill chain is so critical."²² The U.S. Air Force is not alone in its pursuit of advanced stealth technologies as the F-35 Joint Strike Fighter will replace aging aircraft in the U.S. Navy, U.S. Marine Corps, as

²² Colin Clark, "F-16 Vs. F-35 In A Dogfight: JPO, Air Force Weigh in on Who's Best," Breaking Defense.com. July 2, 2015, http://breakingdefense.com/2015/07/f-16-vs-f-35-in-a-dogfight-jpo-air-force-weigh-in-on-whos-best/?_outbrain (accessed October 9, 2015).

well as those of nine other nations.²³ Additionally, the U.S. Navy aggressively pursued and acquired a new stealthy surface warfare asset dubbed the DDG-1000 Zumwalt class destroyer.²⁴ The fusion of innovative technology in this new advanced class of naval vessels, much like the F-35, facilitates kill chain domination at multiple points.²⁵ However, the cost of producing the technology required to achieve increased kill chain survivability becomes prohibitive and puts the U.S. on a costly vector towards future technological innovation.²⁶

Technology, National Debt, and Avoiding Retrenchment: With an established proclivity for and dependence on advanced quality instruments of war that greatly increase survivability and kill chain disruption, the U.S. must remain cognizant of the associated economic impacts of developing and producing such devices. Defense expenditures since WWII, although varied over time and greater than any other nation, have been tenable. To date, whether by astute forethought or by sheer luck, the U.S. has avoided the economic collapse and associated retrenchment experienced by the Soviet Union at the end of the Cold War. Yet as U.S. national debt grows, such a scenario is not outside the realm of the possible.

The U.S. spends more money on its military than any other nation in the world. In FY 2000 the U.S. spent \$280.8 billion on defense, almost 50% more than all of its allies

²³ Jeremiah Gertler, "F-35 joint strike fighter (JSF) program: Background and issues for congress," Library of Congress Washington DC Congressional Research Service, 2009.

²⁴ Ronald O'Rourke, "Navy DDG-51 and DDG-1000 Destroyer Programs: Background and Issues for Congress," Library of Congress Washington DC Congressional Research Service, 2009.

²⁵ Kable, "DDG-1000 Zumwalt Class Multi-Mission Destroyer," Naval-Technology.com, 2015, <http://www.naval-technology.com/projects/dd21> (accessed November 3, 2015).

²⁶ Daniel Lake, "Technology, Qualitative Superiority, and the Overstretched American Military," *Strategic Studies Quarterly* Vol. 6, No. 4, 2012, <https://nduezproxy.idm.oclc.org/login?url=https://search.ebscohost.com/login.aspx?direct=true&db=tsh&AN=84590800&site=ehost-live&scope=site> (accessed October 23, 2015).

combined, with \$87.4 billion of that going to research and development.²⁷ In 2015 the U.S. spent more than the next twelve highest nations combined (reference figure 3). The FY 2016 Department of Defense budget initially requested \$534.3 billion, an increase of \$38.2 billion from the FY 2015 enacted budget which includes \$69.8 billion for research and development, an increase of \$6.3 billion from the previously enacted FY 2015 budget.²⁸ These substantial numbers indicate a dedication to maintain a formidable military with global projection and push the U.S. further into debt.

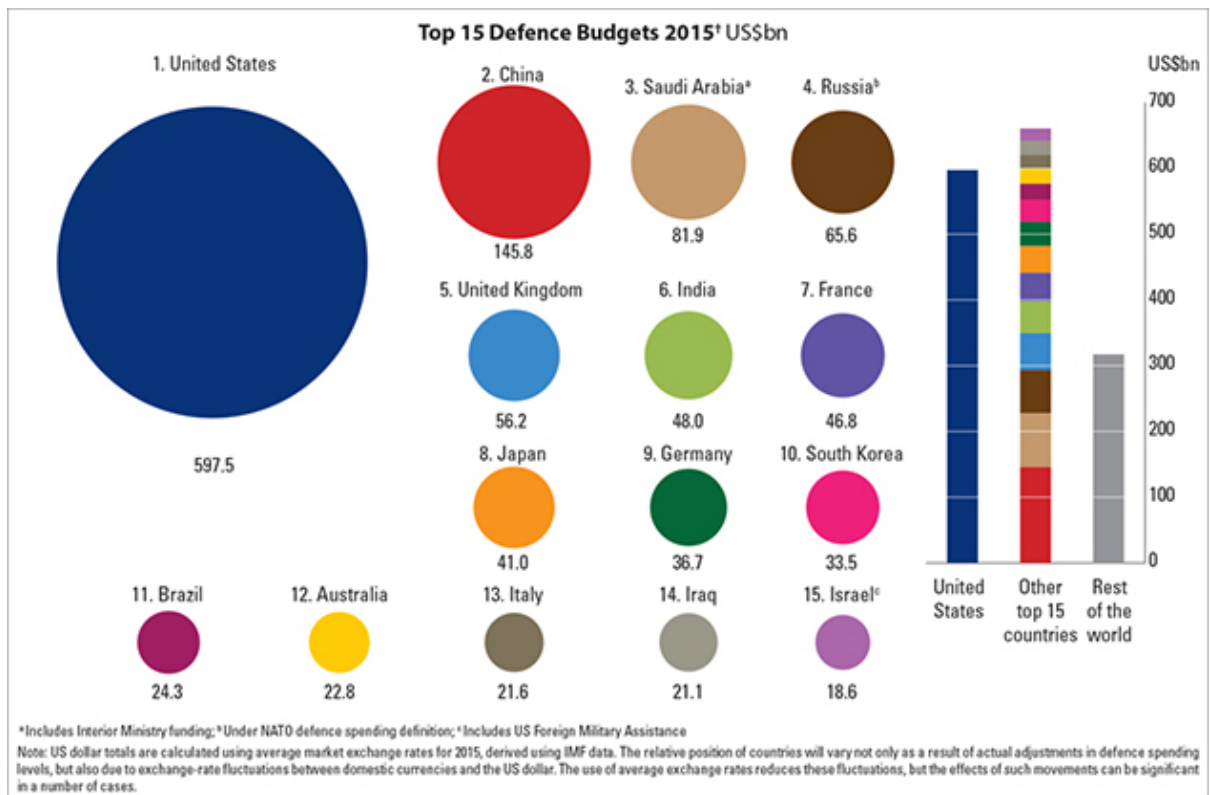


Figure 3: Global Defense Spending ²⁹

²⁷ Ashton Carter, “Adapting US Defense to Future Needs,” *Survival* Vol. 41, No. 4, 1999, 101-123.

²⁸ U.S. Office of the Under Secretary of Defense Chief Financial Officer, “United States Department of Defense Fiscal Year 2016 Budget Request,” http://comptroller.defense.gov/Portals/45/documents-defbudget/fy2016/fy2016_Budget_Request_Overview_Book.pdf (accessed November 20, 2015).

²⁹ The Military Balance 2016: The Annual Assessment of Global Military Capabilities and Defence Economics, *Reference Reviews* (February 9, 2016). <http://www.iiss.org/-/media/images/publications/the%20military%20balance/milbal2016/mb%202016%20top%2015%20defence%20budgets%202015.jpg?1a=en> (accessed February 14, 2016).

U.S. expenditures on defense acquisitions, albeit noteworthy in that they contribute to growing national debt, have not yet forced the U.S. into a period of post-Cold War retrenchment. Although experts debate the validity of recent defense spending levels and the acquisition of costly weapons platforms, the overwhelming dominance of U.S. military capability, not strategy, in recent conflicts in Kosovo, Iraq, and Afghanistan gives some merit to the generous defense allocations. These conflicts, along with many others in Africa, Europe, and the Middle East, demonstrate a calculated U.S. global presence and dedication to ensure, as realists argue, a balance of global power. Successful as the U.S. may be in their endeavor to balance global power, or retain its status as a global hegemon according to others, it is unrealistic to expect future defense spending levels to increase or remain as high as in recent history. Moving forward, the U.S. needs to reassess both defense spending levels and funding allocation.

CHAPTER 3: THE WAY FORWARD

U.S. military dominance displayed across the land, sea, and air domains reflects its dedication to maintain a cache of weaponry that includes mechanisms which are generations ahead of the nearest competitor. The advantage gained by operating ultra-high technology weapons systems in the battlespace from this cache affords an asymmetric conventional advantage. That advantage gap is arguably closing. Whether or not this narrowing gap is acceptable in the face of fiscal uncertainty is at the crux of the decision facing the U.S. Department of Defense. Can the U.S. continue to spend billions of dollars on high-tech replacement platforms for aging fleets across the military services? Realistically it cannot over commit as the Soviet Union did during the Cold War, thus it requires an alternative solution.

Moving forward, the U.S. must balance its desire to maintain an asymmetric conventional force advantage with the threat of spending itself into greater national debt and forced retrenchment. The balance must address a myriad of factors such as rising acquisition and development costs, future threats, kill chain interaction, service parochialisms, political agendas, public opinion, and adversary perception. It is not the intent of this paper to cover all facets of the future acquisition debate, but instead to recommend a way forward that balances technology, cost, and kill chain interaction. As such, the recommended solution is a hybrid of the new, the old, and a merger of the two that slows the trend of runaway acquisitions costs.

The price of technology is rising. Advanced composite materials and infinitely smaller and more powerful electronics create quantum leaps in capabilities but often carry large price tags. Incorporating these materials and electronics into robust and resilient

warfighting instruments is correspondingly expensive. Over the last fifty years one can see an exponential trend for this increasing cost (reference figure 4). In the 1940s the flyaway cost, which only includes the materials and cost of production, not research and development which can be sizable, of most military aircraft remained relatively low, allowing for large production numbers. For example, the P-51 Mustang was approximately \$50,000 while the F-80 Shooting Star, the first U.S. jet fighter, was around \$110,000 and the B-17 Flying Fortress, immortalized by the Memphis Belle in WWII, was just under \$250,000.¹ By the mid-1960s the cost for an F-4E Phantom II, used by all the U.S. services but the Army, had risen to \$2.5 million an aircraft.²

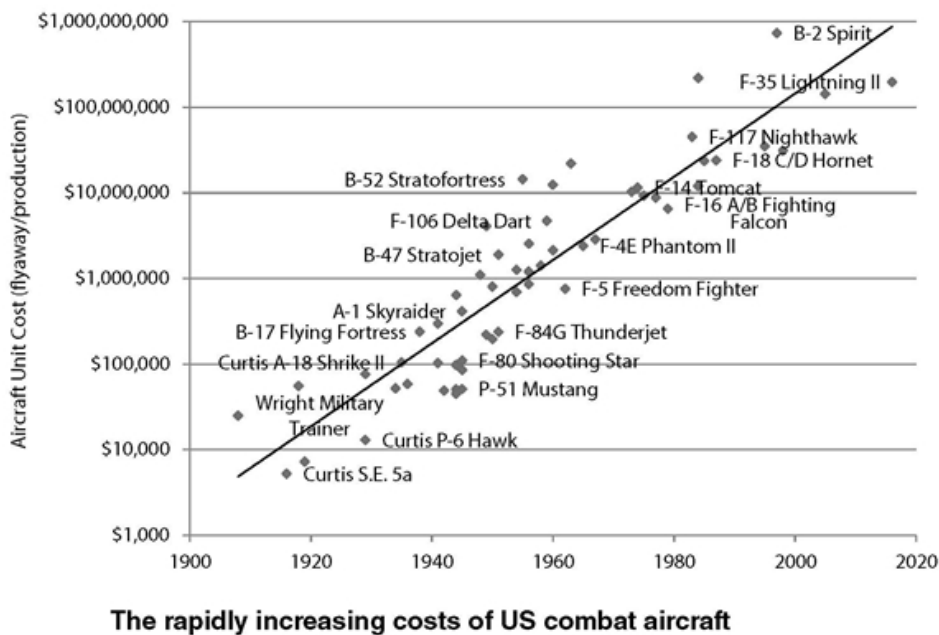


Figure 4: Increasing Costs of U.S. Combat Aircraft³

¹ Daniel Lake, "Technology, Qualitative Superiority, and the Overstretched American Military," *Strategic Studies Quarterly* Vol. 6, No. 4, 2012, <https://nduezproxy.idm.oclc.org/login?url=https://search.ebscohost.com/login.aspx?direct=true&db=tsh&AN=84590800&site=ehost-live&scope=site> (accessed October 23, 2015).

² Ibid.

³ Ibid.

Modern aircraft continue the trend established by their forefathers. The F-16 Fighting Falcon, considered an economical and low-priced fighter, cost just over \$15 million each and the more capable F-15E Strike Eagle carried an associated price of over \$30 million each in the late 1980s and 1990s.⁴ The most recent aircraft projects maintain the exponential relationship as the F-22 Raptor weighed in at over \$150 million each and the heavy hitting B-2 Spirit at over \$900 million an aircraft, and over \$2.1 billion each including research and development costs.⁵ Projected at just under \$11 billion, it would take only five B-2 bombers to pay for the newest U.S. Navy aircraft carrier, the Gerald R. Ford.⁶ This exponential cost trend is not sustainable.

In order to realize U.S. desires for a technologically superior military inventory while avoiding economic collapse and forced retrenchment, the U.S. should adopt a blended solution for future military equipment acquisitions. This solution should involve completing current and viable acquisition programs that have already become a program of record, upgrading already advanced platforms in the inventory with existing and off-the-shelf technologies as they become available and required, and advancing more cost-effective drone programs to include swarm technologies. This is not to advocate that all future research and development projects should disappear; quite the opposite. Along with the balanced approach proposed, the U.S. must still invest in future research and

⁴ Daniel Lake, "Technology, Qualitative Superiority, and the Overstretched American Military," *Strategic Studies Quarterly* Vol. 6, No. 4, 2012, <https://nduezproxy.idm.oclc.org/login?url=https://search.ebscohost.com/login.aspx?direct=true&db=tsh&AN=84590800&site=ehost-live&scope=site> (accessed October 23, 2015).

⁵ Ibid.

⁶ United States, Government Accountability Office, et al., *Defense Acquisitions: Navy Faces Challenges Constructing the Aircraft Carrier Gerald R. Ford Within Budget: Report to the Ranking Minority Member, Subcommittee on Seapower and Expeditionary Forces, Committee on Armed Services, House of Representatives*, US Government Accountability Office, 2007, <http://www.gao.gov/products/GAO-07-866> (accessed November 21, 2015).

development even if it is not for a specific platform. This will keep innovative ideas and concepts moving forward and will safeguard the U.S. conventional asymmetric advantage.

Complete Programs of Record: The U.S. maintains a bullish attitude towards acquiring advanced military equipment. As part of its offset strategies in the past, as well as the current strategy, the U.S. intends to maintain technological advantages in order to dissuade and defeat, if required, its adversaries and reassure its allies.⁷ The technological gap between the U.S. and its adversaries widened quickly in the 1970s and 1980s when tech advocates pushed for such things as precision guided munitions and stealth technology.⁸ The gap remains wide but it is on the verge of narrowing quickly.⁹

The People's Republic of China tested its first true, reportedly, fifth generation stealth fighter dubbed the J-20 Black Eagle in January, 2011 and its F-22-like follow-on, the J-31 Falcon Eagle in October, 2012.¹⁰ The Chinese Navy is also undertaking massive efforts to retrofit its navy and indigenously produce their first aircraft carrier to accompany their only other carrier which was purchased in 1998 in a stripped-down state after originally being built for the Soviet Navy in the Ukraine in 1988.¹¹ The Russian Air Force is also following suit with the development of its initial fifth generation fighter, built

⁷ Who's Afraid of America?; Weapons Technology, *The Economist*, No. 57, June 13, 2015,

⁸ Thomas G. Mahnken, *Technology and the American Way of War* (New York: Columbia University Press, 2008).

⁹ Mackenzie Eaglen and Lajos Szaszdi, "The Growing Air Power Fighter Gap: Implications for US National Security," *The Heritage Foundation* Vol. 2295, No. 7, 2009.

¹⁰ Alexandre Carriço, "The Aviation Industry Corporation of China (AVIC) and the Research and Development Programme of the J-20," *JANUS.NET* Vol. 2, No. 2, 2011, 96-109.

¹¹ Stew Magnuson, "China's Navy Takes a Great Leap Forward." *National Defense Magazine*, April, 2014, <http://www.nationaldefensemagazine.org/archive/2014/April/Pages/China%E2%80%99sNavyTakesGreatLeapForward.aspx> (accessed October 15, 2015).

in cooperation with India, the T-50/PAK FA that first flew in January, 2010 and has a delivery date beginning in 2017 with 300 to 500 aircraft on order.¹²

These few examples, and countless more systems such as defense radars, surface-to-air missiles, jammers, lasers, and anti-satellite technology, demonstrate that U.S. adversaries are on the verge of fielding advanced weaponry that even many U.S. allies cannot produce and do not own. Unlike the Cold War era, China has the ability to keep and even outpace the U.S. in these areas if their economy continues to grow.¹³ It is for these reasons that the U.S. must continue to develop and build equipment in programs of record such as the Lockheed Martin F-35 Joint Strike Fighter, the Northrup Grumman and General Dynamics Zumwalt Class Destroyer, and the new Northrop Grumman B-21 Long-Range Strike Bomber.

The F-35 Joint Strike Fighter, also known as the F-35 Lightning II, has taken well-deserved criticism as a program that is behind schedule and well over-budget. However, the fact remains that the F-35 is still on track to replace multiple platforms such as the U.S. Marine Corps AV-8B Harrier, U.S. Air Force F-16 Fighting Falcon and A-10 Thunderbolt, and the U.S. Navy F/A-18 Hornet.¹⁴ It will be the most advanced aircraft on the planet incorporating the best attributes of all U.S. technologies. The F-35 will combine stealth, the ability to supercruise above Mach 1.0 without afterburner, the world's most advanced radar and electronics suite, and a weapons complement all in a platform

¹² Gordon Yefim and Dmitriy Komissarov, *Russian Air Power: Current Organisation and Aircraft of All Russian Air Forces* (Midland Publishing, 2011).

¹³ Matthew J. Harris, "Strategic Retrenchment and Renewal in the American Experience," *Comparative Strategy* Vol. 34, No. 2, 240, 2015, <http://search.proquest.com.nduezproxy.idm.oclc.org/docview/1685383357?accountid=12686> (accessed September 23, 2015).

¹⁴ Jeremiah Gertler, "F-35 joint strike fighter (JSF) program: Background and issues for congress," Library of Congress Washington DC Congressional Research Service, 2009.

that maintains 80 percent commonality amongst its variants.¹⁵ The aircraft will give the U.S. an advantage in the air domain for decades to come.

The U.S. Navy is waiting diligently for completion of its three new Zumwalt Class destroyers. These destroyers, much like the F-35, will contain technologies far superior to anything else on the high seas. The DDG-1000 Zumwalt destroyers will have stealth technology that reduces their radar signature to that of a life boat while their own advanced radar systems will have pinpoint accuracy on adversaries.¹⁶ The Advanced Gun System (AGS) fires a 24 pound projectile up to 83 nautical miles with an accuracy of 50 meters.¹⁷ The destroyer is powered by advanced engines incorporated into a tumblehome wave piercing hull form, and the destroyer has an unrivaled communications and network suite that enables a reduced crew with greater efficiencies.¹⁸ Initial builds of the DDG-1000 Zumwalt class destroyer are priced at \$7.4 billion per unit, including research and development costs, and stopped after production began on the third vessel as Congress decided the destroyers were cost prohibitive.¹⁹ Although only three of these destroyers will take to the water, the technology developed and contained within will benefit other U.S. defense projects for years to come.

Of the three defense acquisition programs mentioned, the B-21 Long-Range Strike Bomber (LRS-B) is more controversial as it is still in its infancy. After recent programs

¹⁵ Jeremiah Gertler, "F-35 joint strike fighter (JSF) program: Background and issues for congress," Library of Congress Washington DC Congressional Research Service, 2009.

¹⁶ Ronald O'Rourke, "Navy DDG-51 and DDG-1000 Destroyer Programs: Background and Issues for Congress," Library of Congress Washington DC Congressional Research Service, 2009.

¹⁷ Ibid.

¹⁸ Ibid.

¹⁹ Daniel Lake, "Technology, Qualitative Superiority, and the Overstretched American Military," *Strategic Studies Quarterly* Vol. 6, No. 4, 2012, <https://nduezproxy.idm.oclc.org/login?url=https://search.ebscohost.com/login.aspx?direct=true&db=tsh&AN=84590800&site=ehost-live&scope=site> (accessed October 23, 2015).

such as the B-1B Lancer, B-2 Spirit, F-22 Raptor, and F-35 Joint Strike Fighter experienced significant delays and cost overruns, skeptics are quick to critique another advanced aviation acquisition project. Not to repeat the mistakes of the past, the B-21 program will focus on a cleaner and more efficient procurement process than those of its cost and timeline plagued predecessors. More importantly the B-21 will complete a modern, fifth generation aviation fleet that spans all the U.S. military services and incorporates the latest technologies, which will have impacts on future generations of aircraft.

The B-21 Long-Range Strike Bomber will augment and replace an aging fleet of bombers such as the B-52 Stratofortress, originally flown in the early 1950s, the B-1B Lancer from the 1970s, and the B-2 Stealth Bomber introduced in the 1990s.²⁰ The U.S. Air Force has stated its intent to purchase 80 -100 aircraft at an estimated cost of approximately \$550 million per aircraft and a delivery date in the mid-2020s.²¹ It is beyond the scope of this paper to address the pitfalls and focus areas requiring attention in the procurement process of the B-21 in order to deliver the aircraft on schedule and within budget. Having said that, the U.S. Air Force must manage the procurement process more independently and focus on producing a platform with the desired capabilities of reaching and striking targets across the globe.²² Doing so will enable the production of sufficient numbers of the B-21 advanced bomber which will join the diminutive fleet of only twenty operational B-2 Spirits.²³ Additionally, funding for the development of the aircraft will

²⁰ Thomas Donnelly, Anand Datla, and Robert Haffa, "Buying the B-3," 2015, <http://www.aei.org/wp-content/uploads/2015/10/Buying-the-B-3.pdf> (accessed November 19, 2015).

²¹ Ibid.

²² Ibid.

²³ Ibid.

likely produce technologies that may, in the end, not make the cut for the final version of the B-21 but could affect future acquisitions. This point will receive further attention later in this paper.

The U.S. enjoys an asymmetric conventional military equipment advantage over its nearest perceived adversaries, notably China and Russia. The advantage gained required extraordinary efforts and cost more than is fiscally sustainable in the future. After current programs of record reach maturity, such as the ones previously mentioned, the U.S. should take a ‘tactical pause.’ The length of the tactical pause on ‘next generation’ platform development will depend on the assessments of adversary capabilities, both on a like-platform basis as well as an adversary’s ability to influence the U.S. kill chain. The assessments must, if possible, remain free of service parochial biases, from intelligence overstating adversary capabilities, and from attempts to gain business and jobs merely for political constituencies and reelection purposes. The assessment must also consider the potential ramifications to the military industrial base if production lines are shut down, as some experts argue that a cessation in military platform production may lead to an exodus of intellectual capital and skilled laborers that could cost more to regain than maintaining a low-rate production of unneeded equipment.²⁴ In addition to acquiring current program of record platforms and an associated tactical pause, the blended acquisition approach includes upgrading current weapons systems with existing and emerging technologies vice creating an entirely new platform.

²⁴ Mackenzie M. Eaglen and Eric Sayers, "Maintaining the Superiority of America’s Defense Industrial Base," *Backgrounder* Vol. 2276 (2009), <http://www.heritage.org/research/reports/2009/05/maintaining-the-superiority-of-americas-defense-industrial-base> (accessed February 14, 2016).

Upgrade Current Systems with Existing Technology: Given the recent history of Department of Defense acquisitions programs that often run behind schedule and well over budget, such as those just discussed, it is imperative that the U.S. have alternate means for upgrading and updating its fleet of weapons systems. It simply is not possible to continue to buy new advanced platforms off the production line to replace current platforms without spending the U.S. into extreme debt, which is already the trend. A significant cost savings measure places current and emergent technologies into existing platforms in an upgrade scheme that would cost a fraction of what a new instrument would cost to develop and produce. There are tradeoffs to this aspect of the blended solution, but the viability of the practice and cost savings could be substantial.

The practice of incorporating new technology into existing platforms is not a new concept. All the U.S. military services accomplish this in some way, shape, or form. The U.S. Navy improves its surface warfare fleet through the Surface Electronic Warfare Improvement Program (SEWIP) and other like-programs.²⁵ The U.S. Air Force has many initiatives centered on the Multi Stage Improvement Program (MSIP) seen with both the F-15 Eagle and F-16 Fighting Falcon programs. Aircraft receive updates to software loads, radars, electronic warfare packages, and weapons capabilities as funding become available under ‘suite’ or ‘block’ upgrades. The U.S. Army has similar initiatives for the vast inventories of their equipment as seen in their Army Equipment Modernization Plans and Equipment Modernization Strategy.²⁶ All these programs capitalize on incorporating

²⁵ Vern Clark, *Sea Power 21: Projecting Decisive Joint Capabilities*, Department of The Navy Washington DC, 2002, <http://www.dtic.mil/get-tr-doc/pdf?Location=U2&doc=GetTRDoc.pdf&AD=-ADA522296> (accessed October 12, 2015).

²⁶ U.S. Army, *2014 Army Equipment Modernization Plan*, May 13, 2013, <http://www.g8.army.mil/index.html> (accessed November 20, 2015).

existing and innovative technologies, both from the commercial sector and government agencies, in order to update viable platforms already in existence. These relatively minor upgrades greatly enhance the tactical capabilities of these platforms at a pittance compared to new systems acquisitions.

The blended solution does not propose that every platform should undergo an infusion of new technology. Only those platforms that have both sufficient life expectancy and capacity should do so. For example, upgrading the U.S. military High Mobility Multipurpose Wheeled Vehicle (HMMWV) may greatly improve current capabilities, but since Oshkosh Defense System's Joint Light Tactical Vehicle (JLTV) program is in low-rate production, it makes better fiscal sense to hold off on funding such improvements to the old HMMWV.²⁷ However, if the military decides to keep some older HMMWVs in the inventory along with the newer Joint Light Tactical Vehicle, then incorporating off-the-shelf technology may prove beneficial.

Using existing and emerging technology in current platforms is not a novel concept. U.S. Secretary of Defense Ashton Carter spoke on this topic and stated that "Innovation is largely directed towards embedding new capabilities in the old platforms. The important underlying technologies spring from a technology base that is commercial and increasingly global. The trends of commercialization and globalization, if embraced by the DOD, could act to the benefit of U.S. military capabilities in the future."²⁸ As such, a practicable application of this concept is in the upgrade of military communications equipment. As the civilian sector regularly upgrades and expands the capacities of

²⁷ Andrew Feickert, "Joint light tactical vehicle (JLTV): Background and issues for Congress," Library of Congress Washington DC Congressional Research Service, 2012.

²⁸ Ashton Carter, "Adapting US Defense to Future Needs," *Survival* Vol. 41, No. 4, 1999, 101-123.

communications equipment of all varieties, the U.S. military regularly obtains and quickly fields these technologies.²⁹ In 2013, the U.S. Army used commercial technology to upgrade its two-channel Manpack radios with a tenfold increase in ability to communicate with the military's Mobile User Objective System (MUOS) satellite communications system.³⁰ It was a \$5 million contract to upgrade equipment from the original \$306 million 2012 contract for 3,726 radios.³¹ This was a relatively quick and cost-effective upgrade to the existing equipment that produced tangible and immediate results on the battlefield.

As the procurement of new weapons systems within the U.S. military becomes more cost prohibitive, measures such as incorporating existing technology into established platforms becomes a more fiscally palatable alternative. The concept is not new, but its appeal should grow in environments trending towards austerity. Although not yet in an entrenched austerity environment, heavy public scrutiny and sequestration measures have forced the U.S. Department of Defense to reevaluate certain spending trends and habits. In doing so, completing current programs of record and using off the shelf technology in existing platforms comprise two of the three parts of the blended procurement solution triad. The final component is expanding drone technologies.

Expanding Drone Technologies: Unmanned Aerial Systems (UASs) already provide critical capabilities to U.S. military forces across the globe. UASs come in a variety of sizes, shapes, and capabilities. The U.S. Army operates drones such as the

²⁹ Jonathan R. Agre, Karen D. Gordon, and Marius S. Vassiliou, "Commercial Technology At the Tactical Edge," Institute for Defense Analyses, Alexandria VA, 2013.

³⁰ Matthew Cox, "Army Pack Radios to get SATCOM Upgrade. Online Defense and Acquisition Journal, February 8, 2013, <http://www.dodbuzz.com/2013/02/08/army-pack-radios-to-get-satcom-upgrade/> (accessed November 11, 2015).

³¹ Ibid.

hand-launched RQ-11 Raven worth \$170 thousand while the U.S. Air Force operates much larger aircraft.³² At \$222 million a copy, the RQ-4 Global Hawk is at the opposite end of the spectrum from the RQ-11.³³ The RQ-4 has a synthetic aperture radar along with advanced electro-optical sensors and can stay airborne for over 32 hours at an altitude of over 60,000 feet providing persistent battlefield monitoring.³⁴ There are a plethora of drones in between the RQ-4 and the RQ-11 as well as some newer nano-drones that weigh ounces and fit into the palm of a human hand. Many drones are used on the modern battlefield and to such an extent that their flight hours surpass those of manned strike aircraft.³⁵ Drones have already proven their utility in the battlespace and this, along with the relatively lower costs associated with the smaller units, reinforces the desire for increased utilization in the future. Their increased use drives more towards a quantity versus quality mentality, a break from U.S. military tendencies of the past. Using multiple drones in a coordinated swarm also takes a different approach to defeating the enemy's kill chain.

As previously noted, since the conclusion of WWII the U.S. has focused heavily on high quality technology-infused weaponry over lower quality and higher quantity instruments of war. With drones, the quantity versus quality pendulum shifts back towards center. Although many drones do have advanced incorporated technologies, the argument here is to advocate for drones no larger than the MQ-1 Predator which is slightly

³² Flight of the Drones; Unmanned Aerial Warfare, *The Economist*, October 08, 2011, 30-32, <http://search.proquest.com.nduezproxy.idm.oclc.org/docview/896861098?accountid=12686> (accessed November 19, 2015).

³³ Ibid.

³⁴ Ibid.

³⁵ Flight of the Drones; Unmanned Aerial Warfare, *The Economist*, October 08, 2011, 30-32, <http://search.proquest.com.nduezproxy.idm.oclc.org/docview/896861098?accountid=12686> (accessed November 19, 2015).

larger than the F-16 Fighting Falcon and less than one-fourth the cost.³⁶ Although larger drone platforms like the RQ-4 Global Hawk are useful, their price places them in a cost-prohibitive category akin to the F-22 Raptor and F-35 Joint Strike Fighter. With a goal of increasing the overall quantity of drones in the inventory, acquiring RQ-4 style drones quickly becomes counterproductive. Certain commercial off-the-shelf drones in the \$10 thousand range incorporate both GPS navigation and autopilot features in a fairly robust platform, while even more primitive hobby-grade drones with wing spans less than five feet still have GPS and autopilot but cost less than \$250.³⁷ The increased drone quantities advocated enable emerging swarm technologies and open the door to greater strength in numbers.

Breaking the kill chain, discussed earlier, advocates exploiting a vulnerability in the enemy kill chain in order to survive within the adversary's battlespace. With drone swarm technology it is possible to completely overwhelm the enemy to the point where the enemy can no longer defend against every potential threat. The same technology can also aid in providing a formidable defense and kill chain in one's own battlespace. The swarm technology mentioned may seem overly futuristic, but it is here now, if only in its infancy.

Before proceeding further, it is important to define what swarm technology is. To fall into the category of swarm technology, UAVs or drones "must communicate with one another to perform tasks as an intelligent group. UAV swarms can interpret what is happening in real time, self-organize and get the job done."³⁸ Coordinated tasks could

³⁶ Sheet, US Air Force Fact, "MQ-1 Predator Unmanned Aerial Vehicle."

³⁷ Debra Werner, "Drone swarm," *C4ISR*, July 8, 2013, 26, <http://search.proquest.com.nduezproxy.-idm.oclc.org/docview/1418399020?accountid=12686> (accessed November 6, 2015).

³⁸ *Ibid.*

include search and rescue, acting as airborne cell phone tower relays, missile defense, and persistent monitoring of large groups of dispersing individuals.³⁹ Two years ago, a Naval Postgraduate School's Advanced Robotic Systems Engineering Laboratory (ARSENL) team successfully completed a test involving 10 drones flying in a swarm at Camp Roberts near San Luis Obispo, California.⁴⁰ The test significantly advanced swarm technology and helped frame existing challenges to further advancements. It also helped identify a few ethical questions and dilemmas that will require attention before swarm technology receives any great clarity. Dilemmas include the decision to arm swarm drones which could eventually enable autonomous, or man out-of-the-loop, killing scenarios. This type of scenario would require a level of artificial intelligence not available yet, but is likely only a decade or two away.⁴¹ There are numerous other moral and ethical considerations for the use of drones and swarm technology that are beyond the scope of this paper.

With drones executing swarm tactics it is possible to overwhelm an enemy's kill chain. As a Naval Postgraduate Professor conveyed, "No individual high school player could possibly beat Swiss [tennis] champion Roger Federer. But if 50 high school players were lobbing balls onto his court, poor Roger wouldn't be able to defend against that."⁴² The analogy is simple but makes an effective point. Even the most sophisticated Integrated Air Defense Systems (IADS) would struggle to engage and defeat 1,000

³⁹ Debra Werner, "Drone swarm," *C4ISR*, July 8, 2013, 26, <http://search.proquest.com.nduezproxy.-idm.oclc.org/docview/1418399020?accountid=12686> (accessed November 6, 2015).

⁴⁰ *Ibid.*

⁴¹ Laurent Beaudoin, Antoine Gademer, Loica Avanthey, Vincent Germain, and Vincent Vittori, "Potential Threats of UAS Swarms and the Countermeasure's Need," *Proceedings of the 10th European Conference on Information Warfare and Security: The Institute of Cybernetics at the Tallinn University of Technology Tallinn, Estonia 7-8 July 2011*, Academic Conferences Limited, 2011, <http://search.proquest.com.-nduezproxy.idm.oclc.org/docview/1010346779?accountid=12686> (accessed September 9, 2015).

⁴² Debra Werner, "Drone swarm," *C4ISR*, July 8, 2013, 26, <http://search.proquest.com.nduezproxy.-idm.oclc.org/docview/1418399020?accountid=12686> (accessed November 6, 2015).

inbound drones in an autonomous and coordinated attack. Allowing just one drone to cut through the defenses could impact the overall effectiveness of the IADS system. The same could be said for missile defense. Utilizing several hundred drones in a defensive and coordinated swarm could prove very effective against an inbound missile foray. At a minimum, swarm technology enabled drones could saturate surveillance pictures to the point where distinguishing between a low-cost drone and a high-cost fighter-bomber becomes impossible.

Without any significant advancements in swarm technology in the near future, a strong case still exists for increased numbers of lower cost UAVs as part of the blended solution. Lacking the artificial intelligence to operate autonomously, large numbers of drones, albeit individually controlled by human operators, still retain the capability to heavily task and even, depending on the numbers, saturate enemy defenses. Without swarm technology it is a considerably more complicated communications and bandwidth intensive situation, but still within the realm of the possible. It is a far more acceptable scenario to lobby the U.S. political body and public on the use of unmanned aerial vehicles to penetrate and assault a heavily defended and fortified geographic area than it is to send a squadron of manned assets to impending peril. In a risk averse and results oriented society, the former is the more palatable option.

UAVs are the final component of the blended solution triad. As UAVs are already a growing component of the U.S. military, it is necessary to continue to increase the number of drones acquired. Although a ramped up UAV inventory shifts the U.S. more towards a quantity versus quality force, it does not detract from the other two components of the quality focused blended solution. With respect to the kill chain, increased drone

numbers enhance the ability to saturate and overwhelm an adversary's kill chain. Adding advanced swarm technology to the mix enhances the ability to saturate the kill chain in a more coordinated and efficient manner, but that advanced swarm technology does not yet exist. Swarm technologies need urgent and aggressive research and development.

Investment in Research and Development: The decision to invest in research and development (R&D), such as that required for swarm technology, remains a prominent dilemma in the Department of Defense. Military and defense R&D produced products and technologies benefitting both the military and civilian sector on innumerable occasions throughout history.⁴³ The forms and methods of the R&D, varied as they are, continue to produce both tangible and intangible results today. Although pundits may argue for a heavy financial commitment to the R&D sector, others profess that doing so drains vital funding from other critical areas and programs.⁴⁴ The challenge is discerning the appropriate balance between opposing views.

Defense and military research and development has been a significant foundation of technology development in the commercial sector that supports a notable portion of industrial production in the United States.⁴⁵ Broadly categorized, the crossover technologies enable space industries, military and commercial aviation, electric power and nuclear energy, computers and semiconductors, and the internet.⁴⁶ A prime example of this dual-use technology research was conducted by the National Committee on

⁴³ Vernon W. Ruttan, *Military procurement and technology development*, Department of Applied Economics, College of Agricultural, Food, and Environmental Sciences, University of Minnesota, 2005.

⁴⁴ Saadet Deger, "Economic Development and Defense Expenditure," *Economic Development and Cultural Change* Vol. 35, No. 1, University of Chicago Press, 1986, 179-96, <http://www.jstor.org.nduezproxy.-idm.oclc.org/stable/1154149> (accessed October 9, 2015).

⁴⁵ Vernon W. Ruttan, *Military procurement and technology development*, Department of Applied Economics, College of Agricultural, Food, and Environmental Sciences, University of Minnesota, 2005.

⁴⁶ Ibid.

Aeronautics (NACA) in the 1920s and 1930s at Langley Field in their state of the art wind tunnels.⁴⁷ The research conducted benefitted airframe and airfoil designs for both military and civilian use and won NACA numerous awards for their innovations.⁴⁸ Although the benefits of military R&D today may not be as visible as they once were, it is still necessary to ensure that crossover from military to commercial continues.

The methods for military research and development to ensure future dual-use technologies will likely remain consistent with those of the past. More prevalent in earlier military R&D was the research conducted within military organizations themselves, without interaction with the civilian sector.⁴⁹ More ubiquitous was R&D conducted jointly by the military and nonprofit organizations such as universities.⁵⁰ In the previous NACA example, NACA collaborated extensively with Stanford University on their propeller and airfoil designs and testing. A third and growing R&D method, more prevalent today, is ‘procurement by design and technical competition.’⁵¹ In this scenario, the military advertises the type of technology or product desired and private firms assume the majority of the financial R&D burdens in anticipation of winning a lucrative contract to recuperate sunk costs and gain profits.⁵² A few very visible instances of such scenarios include competitions for contracts on the F-16, F-22, KC-46A Pegasus, and the Long-Range Strike Bomber. In an age of increasing modern R&D costs, this type of R&D is now more the norm than the exception. This trend should not signal the death of military

⁴⁷ Vernon W. Ruttan, *Military procurement and technology development*, Department of Applied Economics, College of Agricultural, Food, and Environmental Sciences, University of Minnesota, 2005.

⁴⁸ Ibid.

⁴⁹ Frank R. Lichtenberg, “The Private R and D Investment Response to Federal Design and Technical Competitions,” *The American Economic Review* Vol. 78, No. 3, American Economic Association, 1988, 550–59, <http://www.jstor.org.nduezproxy.idm.oclc.org/stable/1809152> (accessed November 3, 2015).

⁵⁰ Ibid.

⁵¹ Ibid.

⁵² Ibid.

only or collaborative R&D efforts, nor should it dissuade private companies from bringing unsolicited and innovative ideas to the military, as they are both still key components of military research and development.

It is almost impossible to properly address the military research and development question in just a few pages. Suffice to say, military R&D and procurement obtains a high level of public scrutiny and debate. This scrutiny is warranted but should not discourage the overall military R&D effort. Technology and innovative ideas gained in the R&D process are useful. Even if the technology or innovation gained is not used on a current project, the likelihood of that breakthrough adding value in either the military or civilian sector is noteworthy. This symbiotic relationship between the military and civilian research and development sector must continue or the American innovative spirit will slowly wither, leaving only a weakened nation clamoring to copy the creativity of once inferior adversaries.

CONCLUSION

The United States maintains a strong affinity for technology in its military instruments of war. It is a trend which accelerated during the Cold War that witnessed the world superpowers square off against each other. The two nations had opposing offset strategies of military buildup where the U.S. focused on high quality instruments of war infused with advanced technologies while the Soviets focused on mass quantities with lower technology. Both strategies had their merits and pitfalls and associated effects on the kill chain. Notably, both offset strategies placed significant demands on their nation's economy. While the U.S. had a robust and resilient economy able to weather the spending fury, the Soviet Union struggled to do so. The aggressive Soviet offset strategy spending profile contributed to economic collapse at the end of the Cold War and led to a period of forced retrenchment. The U.S. emerged victorious from the Cold War, assumed the role as the global hegemon, and continued its trend of heavily investing in technologically advanced military platforms. It is now facing a fiscally unsustainable acquisition trend. In order to avoid economic collapse and forced retrenchment, akin to the Cold War Soviet Union, yet maintain an asymmetric conventional military advantage, the U.S. should adopt a blended procurement solution for military platforms.

In a Cold War effort to offset the U.S. strengths of intercontinental ballistic missiles and long-range strategic bombers, the Soviet Union focused on producing large quantities of weapons that did not incorporate expensive advanced technologies. The Soviet defense platforms, such as plentiful air defense radars and surface-to-air missiles, intended to prevent Western penetration of vast Soviet borders by breaking single links in the U.S. kill chain. This is not to say that the Soviet defenses were inadequate or that they

produced their war materials on the cheap as it cost the Soviets dearly to produce their numerically overwhelming force. The level of military spending coupled with costly operations in areas such as Afghanistan and paired with a faltering economy, led to an overall economic collapse of the Soviet economy. This started a chain reaction within the Soviet Union that forced marked military reductions, both in funding and external operations. The internal collapse of the Soviet Union led to an internal shift in foreign policy known as retrenchment that approached isolationism.

The U.S. fashioned an offset strategy that was diametrically opposed to the Soviet strategy. The U.S. strategy focused on developing lower quantities of high technology equipment designed to penetrate Soviet defense and obliterate the Soviet kill chain. It was an incredibly costly strategy that required a robust U.S. economy and widespread political and public support. Although major technological breakthroughs such as stealth technology and precision guided munitions did not come to fruition until the end of the Cold War, they began to feed an insatiable U.S. appetite for supreme war machines capable of demolishing enemy kill chains. It is a presumptuous goal that is ultimately unsustainable due to fiscal limitations. In order to avoid economic collapse and forced strategic retrenchment similar to that of the Soviet Union during the Cold War, the U.S. must adopt a blended solution for defense acquisitions moving forward.

The recommended blended solution for future defense acquisitions combines many of the strengths of the previous U.S. offset strategy while offloading some of the associated risks, namely involuntary strategic retrenchment. The first part of the blended solution advocates completing current programs of records such as the F-35 Joint Strike Fighter, DDG-1000 Zumwalt class destroyer, and B-21 Long Range Strike Bomber.

Doing so completes a comprehensive fifth generation fighter and bomber fleet across the services and advances U.S. naval surface warfare stealth technologies. The second aspect of the blended solution upgrades current, or legacy, platforms with current and emerging technological components. As many of the current platforms in the U.S. military inventory are already at or ahead of most peers, component upgrades of these platforms will advance them to the point of being superior again. The final component of the blended solution recommends advancing UAV purchases and drone swarm technology. Although higher end drones such as the RQ-4 Global Hawk are extremely capable platforms, it is the middle and lower end platforms that are sought in this solution.

The blended solution keeps lower quantities of high-end acquisitions like the F-35, DDG-100, and B-21, but offsets this with higher quantities of lower-technology drones. The former tend to obliterate enemy kill chains while the latter, with one swarm caveat, tend to isolate single kill chain links for exploitation. The swarm caveat is that with mass numbers of drones coordinating with each other independently, it is possible to completely overwhelm and essentially annihilate the enemy kill chain. The major dilemma with swarm technology is that it may push the limits of acceptable ethical standards wherein drone swarms may make decisions to target and kill without a man in the decision loop. That dilemma is a topic for further discussion elsewhere.

What prevents swarm technology from achieving practical use and application in the military today is a lack of technological development, which highlights the military research and development dilemma. Although the military R&D machine made quantum leaps during the twentieth century, it faces increased scrutiny in a fiscally constrained environment. Austerity aside, research and development must continue in the military, in

collaborative efforts with the civilian sector, and within the civilian sector alone via competition for defense contracts. Doing so ensures that research and creativity continue to fuel the American innovative machine, producing both tangible products and intangible concepts for future development and to ensure a distinct military edge.

The United States military maintains an asymmetric conventional military advantage over its peers. The advantage is funded by the largest defense budget in the world but the funding trend is not sustainable without potentially disastrous consequences for the U.S. economy. As the global hegemon with an aggressive foreign policy posture and presence throughout the world, the U.S. must accept an alteration to its defense spending course or it could face economic collapse and strategic retrenchment. The alteration to that course has to be guided by a blended solution.

BIBLIOGRAPHY

- AF, "Stealth 'Incredibly Important.'" *Air Force Times*. No. 22 (2015).
<http://search.proquest.com.nduezproxy.idm.oclc.org/docview/1663520254?accountid=12686> (accessed October 10, 2015).
- Agre, Jonathan R., Karen D. Gordon, and Marius S. Vassiliou. "Commercial Technology at the Tactical Edge." Institute for Defense Analyses Alexandria VA, 2013.
- Air Power Australia, "Russian / PLA Low Band Surveillance Radars: (Counter Low Observable Technology Radars)." *Australia Defense Think Tank*.
<http://ausairpower.net/APA-Rus-Low-Band-Radars.html> (accessed September 9, 2015).
- Arrow, Kenneth. "Economic Welfare and the Allocation of Resources for Invention." *The Rate and Direction of Inventive Activity: Economic and Social Factors*. Princeton University Press, (1962): 609-626.
- Bacon, Edwin, and Mark.A. Sandle, eds. *Brezhnev Reconsidered*. Houndmills, Basingstoke: Palgrave Macmillan, 2003.
- Beaudoin, Laurent, Antoine Gademer, Loica Avanthey, Vincent Germain, and Vincent Vittori. "Potential Threats of UAS Swarms and the Countermeasure's Need." In *Proceedings of the 10th European Conference on Information Warfare and Security: The Institute of Cybernetics at the Tallinn University of Technology Tallinn, Estonia 7-8 July 2011*. Academic Conferences Limited, 2011.
<http://search.proquest.com.nduezproxy.idm.oclc.org/docview/1010346779?accountid=12686> (accessed September 9, 2015).
- Brooks, Stephen G., G. John Ikenberry, and William C. Wohlforth. "Don't Come Home, America: The Case against Retrenchment." 2012.
- Carrico, Alexandre. "The Aviation Industry Corporation of China (AVIC) and the Research and Development Programme of the J-20." *JANUS. NET* Vol. 2, No. 2 (2011): 96-109.
- Carter, Ashton. "Adapting US Defense to Future Needs." *Survival* Vol. 41, No. 4 (1999): 101-123.
- Clark, Colin. "F-16 Vs. F-35 In A Dogfight: JPO, Air Force Weigh In On Who's Best." *Breaking Defense.com*. July 2, 2015.
http://breakingdefense.com/2015/07/f-16-vs-f-35-in-a-dogfight-jpo-air-force-weigh-in-on-whos-best/?_outbrain (accessed October 9, 2015).

- Clark, Vern. *Sea Power 21: Projecting Decisive Joint Capabilities*. Department of The Navy Washington DC, 2002.
<http://www.dtic.mil/get-tr-doc/pdf?Location=U2&doc=GetTRDoc.pdf&AD=-ADA522296> (accessed October 12, 2015).
- Cockburn, Andrew. "Defending Defense Cuts; When It Comes to the U.S. Military Budget, the 'Fiscal Cliff' Isn't All That Scary." *Los Angeles Times*, December 4, 2012.
<http://search.proquest.com.nduezproxy.idm.oclc.org/docview/1221325763?accountid=12686> (accessed September 9, 2015).
- Cox, Matthew. "Army Pack Radios to get SATCOM Upgrade." *Online Defense and Acquisition Journal*. February 8, 2013.
<http://www.dodbuzz.com/2013/02/08/army-pack-radios-to-get-satcom-upgrade/> (accessed November 11, 2015).
- Deger, Saadet. "Economic Development and Defense Expenditure." *Economic Development and Cultural Change* Vol. 35, No.1. University of Chicago Press (1986): 179–96.
<http://www.jstor.org.nduezproxy.idm.oclc.org/stable/1154149> (accessed October 9, 2015).
- Donnelly, Thomas, Anand Datla, and Robert Haffa. "Buying the B-3." 2015.
<http://www.aei.org/wp-content/uploads/2015/10/Buying-the-B-3.pdf> (accessed November 19, 2015).
- Eaglen, Mackenzie M., and Eric Sayers. "Maintaining the Superiority of America's Defense Industrial Base." *Backgrounder* Vol. 2276 (2009). <http://www.heritage.org/research/reports/2009/05/maintaining-the-superiority-of-americas-defense-industrial-base> (accessed February 14, 2016).
- Eaglen, Mackenzie, and Lajos Szaszdi. "The Growing Air Power Fighter Gap: Implications for US National Security." *The Heritage Foundation* Vol. 2295, No. 7 (2009).
- Edgerton, David. *The Shock of the Old: Technology and Global History since 1900*. Oxford University Press, 2007.
- Erwin, Sandra I. "Pentagon Mulls Strategy for Next Arms Race." *National Defense* Vol. 99. No. 733 (2014): 6-6.
<https://nduezproxy.idm.oclc.org/login?url=https://search.ebscohost.com/login.aspx?direct=true&db=mth&AN=99889620&site=ehost-live&scope=site> (accessed October 11, 2015).
- Feickert, Andrew. "Joint light tactical vehicle (JLTV): Background and issues for Congress." Library of Congress Washington DC Congressional Research Service, 2012.

- Fischer, Beth A. "Toeing the Hardline? The Reagan Administration and the Ending of the Cold War." *Political Science Quarterly (Academy of Political Science)* Vol. 112, No. 3 (1997): 477-496.
<https://nduezproxy.idm.oclc.org/login?url=https://search.ebscohost.com/login.aspx?direct=true&db=aph&AN=9711061994&site=ehost-live&scope=site> (accessed November 17, 2015).
- Flight of the Drones; Unmanned Aerial Warfare. *The Economist* (October 08, 2011): 30-32.
<http://search.proquest.com.nduezproxy.idm.oclc.org/docview/896861098?accountid=12686> (accessed November 19, 2015).
- Fukuda, Junichi. "Denial and Cost Imposition: Long-Term Strategies for Competition with China." *Asia-Pacific Review* Vol. 22, No. 1 (2015): 46-72.
- Gertler, Jeremiah. "F-35 Joint Strike Fighter (JSF) Program: Background and Issues for Congress." Library of Congress Washington DC Congressional Research Service, 2009.
- Glantz, David M. "The Development of the Soviet and Russian Armies in Context, 1946-2008: A Chronological and Topical Outline." *Journal of Slavic Military Studies* Vol. 23, No. 1 (2010): 27-235.
<https://nduezproxy.idm.oclc.org/login?url=https://search.ebscohost.com/login.aspx?direct=true&db=mth&AN=48253383&site=ehost-live&scope=site> (accessed October 7, 2015).
- Gordon, Yefim, and Dmitrij Komissarov. *Russian Air Power: Current Organisation and Aircraft of All Russian Air Forces*. Midland Publishing, 2011.
- Haas, Mark L. "The United States and the End of the Cold War: Reactions to Shifts in Soviet Power, Policies, or Domestic Politics?" *International Organization* Vol. 61, No. 1 (2007): 145-179.
<https://nduezproxy.idm.oclc.org/login?url=https://search.ebscohost.com/login.aspx?direct=true&db=tsh&AN=24179005&site=ehost-live&scope=site> (accessed October 9, 2015).
- Hagel, Charles. "Opening Keynote Address." Defense Innovation Days, Southeastern New England Defense Industry Alliance. Targeted News Service, September 3, 2014.
<http://search.proquest.com.nduezproxy.idm.oclc.org/docview/1559467703?accountid=12686> (accessed October 10, 2015).
- Haines, Gerald K., and Robert E. Leggett, eds. *Watching the Bear: Essays on CIA's Analysis of the Soviet Union*. Government Printing Office, 2003.
- Ham, Rose Marie, and David C. Mowery. "Improving the effectiveness of public-private

- R&D collaboration: case studies at a US weapons laboratory." *Research policy* Vol. 26, No. 6 (1998): 661-675.
- Harris, Matthew J. "Strategic Retrenchment and Renewal in the American Experience." *Comparative Strategy* Vol. 34, No. 2 (2015).
<http://search.proquest.com.nduezproxy.idm.oclc.org/docview/1685383357?accountid=12686> (accessed September 23, 2015).
- Julian, Cotye, Tana Lucy, and John Farr. "Commercial-Off-the-Shelf Selection Process." *Engineering Management Journal* Vol. 23, No. 2 (2011): 63-71.
- Kable. "DDG-1000 Zumwalt Class Multi-Mission Destroyer." Naval-Technology.com, 2015. <http://www.naval-technology.com/projects/dd21> (accessed November 3, 2015).
- Kennedy, John Fitzgerald. *The Cuban Missile Crisis: President Kennedy's Address to the Nation, October 22, 1962*. National Archives and Records Administration, 1988.
- Kostis, T. G., A. K. Goudosis, G. I. Bezanov, and D. A. Sarkar. Stealth Aircraft Tactical Assessment using Stealth Entropy and Digital Steganography. *Journal of Applied Mathematics and Bioinformatics* Vol. 3, No. 1 (2013): 99-121.
<http://search.proquest.com.nduezproxy.idm.oclc.org/docview/1425248241?accountid=12686> (accessed October 3, 2015).
- Lake, Daniel R. Technology, Qualitative Superiority, and the Overstretched American Military. *Strategic Studies Quarterly* Vol. 6, No. 4 (2012): 71-99.
<https://nduezproxy.idm.oclc.org/login?url=https://search.ebscohost.com/login.aspx?direct=true&db=tsh&AN=84590800&site=ehost-live&scope=site> (accessed October 23, 2015).
- Lichtenberg, Frank R.. "The Private R and D Investment Response to Federal Design and Technical Competitions". *The American Economic Review* Vol. 78, No. 3 (1988): 550-59. <http://www.jstor.org.nduezproxy.idm.oclc.org/stable/1809152> (accessed November 3, 2015).
- Linger, Juyne. "An Analysis of the Navy's Fiscal Year 2015 Shipbuilding Plan." Congressional Budget Office (US Congress) Washington DC, 2014.
- Magnuson, Stew. China's Navy Takes a Great Leap Forward. *National Defense Magazine*. April, 2014.
<http://www.nationaldefensemagazine.org/archive/2014/April/Pages/China%E2%80%99sNavyTakesGreatLeapForward.aspx> (accessed October 15, 2015).
- Mahnken, Thomas G. *Technology and the American Way of War*. New York: Columbia University Press, 2008.

- McCardle, Megan. "A Real Domestic Threat: How Health-Care Spending Strains the U.S. Military." *The Atlantic*. March 12, 2012.
<http://www.theatlantic.com/business/archive/2012/03/a-real-domestic-threat-how-health-care-spending-strains-the-us-military/254350/> (accessed November 3, 2015).
- McDonald, Patrick J. "Complicating Commitment: Free Resources, Power Shifts, and the Fiscal Politics of Preventive War." *International Studies Quarterly* Vol. 55, No. 4 (2011): 1095-1120.
<https://nduezproxy.idm.oclc.org/login?url=https://search.ebscohost.com/login.aspx?direct=true&db=tsh&AN=67057177&site=ehost-live&scope=site> (accessed September 23, 2015).
- McMaster, H. R. "The Uncertainties of Strategy." *Survival* 57, No. 1 (2015): 197-208.
- Mercille, Julien. "Mind the Gap: Security 'Crises' and the Geopolitics of US Military Spending." *Geopolitics* Vol. 13, No. 1 (2008): 54-72.
<https://nduezproxy.idm.oclc.org/login?url=https://search.ebscohost.com/login.aspx?direct=true&db=tsh&AN=31898793&site=ehost-live&scope=site> (accessed October 23, 2015).
- Metz, Steven. "Will the U.S. Military Continue to Win the Innovation Contest?" *World Politics Review*, No. 19446284 (2015): 2-2.
<https://nduezproxy.idm.oclc.org/login?url=https://search.ebscohost.com/login.aspx?direct=true&db=wpr&AN=102595546&site=ehost-live&scope=site> (accessed November 2, 2015).
- Minnick, Wendell. "China Pursues Systems to Keep US Forces at Bay." *Defense News*, September 16, 2013.
<http://search.proquest.com.nduezproxy.idm.oclc.org/docview/1437599306?accountid=12686> (accessed September 21, 2015).
- Obama, Barack. *2015 National Security Strategy*. Washington, DC. February, 2015.
https://www.whitehouse.gov/sites/default/files/docs/2015_national_security_strategy.pdf (accessed October 3, 2015).
- O'Rourke, Ronald. "Navy DDG-51 and DDG-1000 Destroyer Programs: Background and Issues for Congress." Library of Congress Washington DC Congressional Research Service, 2009.
- Parent, Joseph M., Paul K. MacDonald. "The Wisdom of Retrenchment." *Foreign Affairs* Vol. 90, No. 6 (2011): 32-47.
<http://search.proquest.com.nduezproxy.idm.oclc.org/docview/900490463/2A62E200D56D4F72PQ/1?accountid=12686> (accessed October 9, 2015).
- Pendleton, John H., Suzanne Wren, Steven Banovac, Kristine Hassinger, Joanne Landesman, Carol Petersen, Michael Silver et al. *Littoral Combat Ship: Deployment*

of USS Freedom Revealed Risks in Implementing Operational Concepts and Uncertain Costs. No. GAO-14-447. Government Accountability Office Washington DC, 2014. <http://www.gao.gov/products/GAO-14-447> (accessed October 9, 2015).

Peters, Ralph. "The Counterrevolution In Military Affairs: Fashionable Thinking About Defense Technology Ignores the Great Threats of Our Time." *The Weekly Standard*, No 11.20 (February 6, 2006): 18.
<http://search.proquest.com.nduezproxy.idm.oclc.org/docview/233025119?accountid=12686> (accessed November 3, 2015).

Prados, John. "Certainties, Doubts, and Imponderables: Levels of Analysis in the Military Balance." *Intelligence & National Security* Vol 26, No. 6 (2011): 778-790.
<https://nduezproxy.idm.oclc.org/login?url=https://search.ebscohost.com/login.aspx?direct=true&db=tsh&AN=69838642&site=ehost-live&scope=site> (accessed October 23, 2015).

Reagan, Ronald. "National Security Decision Directive Number 75: US Relations with the USSR." 1983.

Reed, John. "Boeing Testing Drone Swarm Tech." *Defense Tech*. August 19, 2011.
<http://defensetech.org/2011/08/19/boeing-testing-drone-swarming-techniques/> (accessed November 19, 2015).

Rich, Ben R., Leo Janos. *Skunk Works: A Personal Memoir of My Years at Lockheed*. Boston: Little, Brown, 1994.

Roland, Alex. "Technology, Ground Warfare, and Strategy: The Paradox of American Experience." *The Journal of Military History* Vol. 55, No. 4 (1991): 447-468.

Ruttan, Vernon W. *Military procurement and technology development*. Department of Applied Economics, College of Agricultural, Food, and Environmental Sciences, University of Minnesota, 2005.

Shala, Andrea. "Lockheed F-35s Finish At-Sea Test Flights as US Navy Warms to New Jet," *Reuters*, October 10, 2015.
<http://uk.reuters.com/article/2015/10/10/lockheed-fighter-idUKL1N12A00T20151010> (accessed November 19, 2015).

Sheet, US Air Force Fact. "MQ-1 Predator Unmanned Aerial Vehicle."

Singer, P. W. "The Future of War." *Popular Science* Vol. 287, No. 1 (2015): 46-51.
<https://nduezproxy.idm.oclc.org/login?url=https://search.ebscohost.com/login.aspx?direct=true&db=mth&AN=103431995&site=ehost-live&scope=site> (accessed October 23, 2015).

Stalin, Joseph V. "The Tasks of Economic Executives." *Problems of Leninism* (1931): 519-31.

Stockholm International Peace Research Institute. "Global Military Spending." <http://econhist.econproph.net/wp-content/blogs.dir/2/files/2013/12/global-military-spending-1024x785.jpg> (accessed November 7, 2015).

Tirman, John. "How the Cold War Ended." *Global Dialogue* Vol. 3, No. 4 (20010: 80-90. <http://search.proquest.com.nduezproxy.idm.oclc.org/docview/211508216?accountid=12686> (accessed September 21, 2015).

Tzu, Sun. *The Art of War*. London: Oxford University Press, 1971.

United States. Government Accountability Office, Paul L. Francis, Karen Zuckerstein, Lisa L. Beradi, Diana Moldafsky, Moshe Schwartz, and Alyssa Weir. *Defense Acquisitions: Navy Faces Challenges Constructing the Aircraft Carrier Gerald R. Ford Within Budget: Report to the Ranking Minority Member, Subcommittee on Seapower and Expeditionary Forces, Committee on Armed Services, House of Representatives*. US Government Accountability Office, 2007. <http://www.gao.gov/products/GAO-07-866> (accessed November 21, 2015).

U.S. Army. *2014 Army Equipment Modernization Plan*. May 13, 2013. <http://www.g8.army.mil/index.html> (accessed November 20, 2015).

U.S. Department of the State: Office of the Historian. "1945–1952: The Early Cold War." <https://history.state.gov/milestones/1945-1952> (accessed November 20, 2015).

U.S. Department of the State: Office of the Historian. "1953–1960: Entrenchment of Bi-Polar Foreign Policy." <https://history.state.gov/milestones/1953-1960> (accessed November 20, 2015).

U.S. Office of the Under Secretary of Defense Chief Financial Officer. "United States Department of Defense Fiscal Year 2016 Budget Request." http://comptroller.defense.gov/Portals/45/documents/defbudget/fy2016/fy2016_Budget_Request_Overview_Book.pdf (accessed November 20, 2015).

Werner, Debra. "Drone swarm." *C4ISR* (July 8, 2013): 26. <http://search.proquest.com.nduezproxy.idm.oclc.org/docview/141839902?accountid=12686> (accessed November 6, 2015).

Wettig, Gerhard. "The Last Soviet Offensive in the Cold War: Emergence and Development of the Campaign against NATO Euromissiles, 1979-1983." *Cold War History* Vol. 9, No. 1, 79-110. <https://nduezproxy.idm.oclc.org/login?url=https://search.ebscohost.com/login.aspx?direct=true&db=tsh&AN=36677755&site=ehost-live&scope=site> (accessed October 17, 2015).

- White, Jonathan and Sean Filipowski. "Know The Environment, Know The Enemy, Know The Target." *United States Naval Institute Proceedings*, No. 7 (2014): 30-35.
<http://search.proquest.com.nduezproxy.idm.oclc.org/docview/1555349284?accountid=12686> (accessed October 7, 2015).
- Who's Afraid of America?; Weapons Technology. *The Economist*, No. 57 (June 13, 2015).
<http://search.proquest.com.nduezproxy.idm.oclc.org/docview/1688011216?accountid=12686> (accessed October 19, 2015).
- Williams, Edie and Alan R. Shaffer. "The Defense Innovation Initiative." *JFQ: Joint Force Quarterly*, No. 77 (2015): 34-43.
<https://nduezproxy.idm.oclc.org/login?url=https://search.ebscohost.com/login.aspx?direct=true&db=mth&AN=102583698&site=ehost-live&scope=site> (accessed November 23, 2015).
- Worden, Roy Michael. "The Rise of the Fighter Generals: The Vietnam Era and the Problem of Air Force Leadership (1945-1982)." Duke University, 1993.
<http://search.proquest.com.nduezproxy.idm.oclc.org/docview/304030550?accountid=12686> (accessed October 21, 2015).
- Work, Robert. "Convocation Speech." National Defense University 2014 Convocation. Lanham, United States. Federal Information & News Dispatch, Inc., August 5, 2014.
<http://search.proquest.com.nduezproxy.idm.oclc.org/docview/1551186984?accountid=12686> (accessed September 21, 2015).

VITA

Lieutenant Colonel Bryce Silver was commissioned into the United States Air Force from the U.S. Air Force Academy in 1996 as a pilot. His operational tours include service as an F-15E Strike Eagle pilot in combat-coded squadrons in both the United Kingdom and the United States as well two tours teaching in the Strike Eagle Formal Training Unit, one as the squadron Director of Operations. He served as a Royal Air Force aggressor pilot for one assignment in the United Kingdom and as a staff officer on the AFCENT/A3 staff in Qatar. His most recent assignment was as the Commander of the 336th Fighter Squadron at Seymour Johnson AFB, NC. Lieutenant Colonel Silver holds a Master's Degree from Trident University.