

United States Marine Corps
Command and Staff College
Marine Corps University
2076 South Street
Marine Corps Combat Development Command
Quantico, Virginia 22134-5068

Master of Military Studies

TITLE:

The Precious Sortie: The United States Air Force at the Intersection of Rising Energy Prices, an Aging Fleet, a Struggling Recapitalization Effort, and Stressed Defense Budgets.

SUBMITTED IN PARTIAL FULFILLMENT
OF THE REQUIREMENTS FOR THE DEGREE OF
MASTER OF MILITARY STUDIES

AUTHOR:

Benjamin W. Spencer, Major, USAF

AY 08-09

Mentor and Oral Defense Committee Member: Dr. Paul D. Cooper
Approved: [Signature]
Date: 5 March 2009

Mentor and Oral Defense Committee Member: Dr. Douglas E. Strenson
Approved: [Signature]
Date: 5 March 2009

Report Documentation Page				Form Approved OMB No. 0704-0188	
Public reporting burden for the collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to a penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number.					
1. REPORT DATE 2009		2. REPORT TYPE		3. DATES COVERED 00-00-2009 to 00-00-2009	
4. TITLE AND SUBTITLE The Precious Sortie: The United States Air Force at the Intersection of Rising Energy Prices, an Aging Fleet, a Struggling Recapitalization Effort, and Stressed Defense Budgets				5a. CONTRACT NUMBER	
				5b. GRANT NUMBER	
				5c. PROGRAM ELEMENT NUMBER	
6. AUTHOR(S)				5d. PROJECT NUMBER	
				5e. TASK NUMBER	
				5f. WORK UNIT NUMBER	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Marine Corps War College, Marine Corps Combat Development Command, Quantico, VA, 22134-5067				8. PERFORMING ORGANIZATION REPORT NUMBER	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)				10. SPONSOR/MONITOR'S ACRONYM(S)	
				11. SPONSOR/MONITOR'S REPORT NUMBER(S)	
12. DISTRIBUTION/AVAILABILITY STATEMENT Approved for public release; distribution unlimited					
13. SUPPLEMENTARY NOTES					
14. ABSTRACT					
15. SUBJECT TERMS					
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT Same as Report (SAR)	18. NUMBER OF PAGES 33	19a. NAME OF RESPONSIBLE PERSON
a. REPORT unclassified	b. ABSTRACT unclassified	c. THIS PAGE unclassified			

TABLE OF CONTENTS

	Page
DISCLAIMER.....	3
ACKNOWLEDGEMENTS.....	4
EXECUTIVE SUMMARY.....	5
INTRODUCTION.....	6
RIISING COST OF ENERGY.....	7
AGING AIRCRAFT.....	8
A STRUGGLING RECAPITALIZATION EFFORT.....	11
UNCERTAIN FUTURE OF DEFENSE SPENDING.....	14
THE PRECIOUS SORTIE.....	16
INCREASED SIMULATION.....	17
A DIFFERENT APPROACH TO THE FLYING HOUR PROGRAM.....	20
A MORE FOCUSED QUALITY ASSURANCE EFFORT.....	22
CONCLUSION.....	26

DISCLAIMER

THE OPINIONS AND CONCLUSIONS EXPRESSED HEREIN ARE THOSE OF THE INDIVIDUAL STUDENT AUTHOR AND DO NOT NECESSARILY REPRESENT THE VIEWS OF EITHER THE MARINE CORPS COMMAND AND STAFF COLLEGE OR ANY OTHER GOVERNMENTAL AGENCY. REFERENCES TO THIS STUDY SHOULD INCLUDE THE FOREGOING STATEMENT.

QUOTATION FROM, ABSTRACTION FROM, OR REPRODUCTION OF ALL OR ANY PART OF THIS DOCUMENT IS PERMITTED PROVIDED PROPER ACKNOWLEDGEMENT IS MADE

Acknowledgements

First and foremost, I would like to express my appreciation to my faculty mentor, Dr. Paul Gelpi, whose expert advice, tireless assistance, and meticulous attention-to-detail made this effort possible. I would also like to thank Lt Col Kevin Arthur (USAF) who provided critical perspective and background. The spot-on feedback provided by Dr Douglas Streusand and Lt Col Richard Phillips (USMC) during the oral defense served only to enhance this paper. Finally, I want to thank my father, Randy, who spent hours reviewing the text of this paper, finding errors my eyes could no longer discern.

The vast bulk of my gratitude goes to my beautiful wife, Beth, whose unconditional love and support has sustained me throughout and kept me focused.

—Benjamin W. Spencer

EXECUTIVE SUMMARY

Title: The Precious Sortie: The United States Air Force at the Intersection of Rising Energy Prices, an Aging Fleet, a Struggling Recapitalization Effort, and Stressed Defense Budgets.

Author: Major Benjamin W. Spencer, United States Air Force

Thesis: Easing the burden on the fleet in the execution of the day-to-day mission via increased simulation, a different approach to the flying hour program, and a more focused maintenance quality assurance program can go a long way towards mitigating the effects of increasing energy prices, an aging fleet, a struggling recapitalization effort, and a stressed defense budget.

Discussion: Today's Air Force is faced with rising energy prices, the oldest fleet in the country's history, a recapitalization effort that is, at best, stuck in neutral, and defense budgets greatly strained by two wars and a historic economic downturn. There could not be a worse time to be attempting to secure the sizeable resources required to revitalize an aging fleet of aircraft. However, this is exactly the position the Air Force finds itself in. There are no quick and easy solutions in the offing. Because of that, service leaders need to buy time with the fleet they have. Wing-level leaders can buy the service time by finding innovative ways to reduce the stress on the fleet in the execution of daily flying. As sorties become tougher to generate with an older fleet, wings must focus on reducing sortie quantity and boosting sortie quality because treating every sortie as "precious" drives behavior that is beneficial to a smaller, older fleet. First, increased simulation drives down demand for sorties while increasing sortie effectiveness. Second, a new approach to the wing's flying hour program (FHP) strikes at the heart of the flying requirement, reducing unnecessary sorties by focusing on flying as a means to an end, not an end unto itself. Third, a recalibrated maintenance quality assurance effort focuses scarce personnel resources on the actions that directly affect sortie quality. Overall, wing leaders are at the very nexus of the service's flying effort and, therefore, prudent and timely actions on their part can go a long way towards giving the Air Force the time it needs to navigate the challenges ahead while retaining vital combat capability.

Conclusion: Wing leaders are positioned perfectly to establish a new paradigm and promote the cultural shift necessary to reduce the stress on the fleet... right now. Increased simulation, a different approach to the FHP, and a more focused quality assurance effort represent a way ahead. A realization that sorties are no longer "cheap" is critical. The energy to fly sorties will grow more expensive while the cost to maintain an aging fleet will continue its unabated rise. As costs rise, the Air Force is in a fight for resources of a magnitude that it has not witnessed in decades. Funding for recapitalization is not assured as the United States weathers one of the most daunting fiscal challenges it has faced in its history. What does all this mean for the U.S. Air Force? All sorties are precious and the Air Force undervalues them at its own peril.

INTRODUCTION

At a senior leader's conference in June 2008, an Air Force four-star remarked, "We're on an oil platform that's on fire in the middle of a hurricane." In this comment, the general referred to spiraling jet fuel prices combined with the burden of operating a continually older, less efficient fleet of aircraft.¹

Although prescient, a slightly less catastrophic analogy may be more appropriate. Imagine a four-way intersection. At the intersection stands a lone police officer. There is a truck approaching from each direction and, while each may be able to slow down somewhat, none are going to stop. The industrious officer must find a way to get all four trucks safely through the intersection in order to avoid a collision. Obviously, he cannot address just one or two and ignore the others. He must assess the movement of all four since direction given to one impacts the future of the others. Getting these trucks through the intersection will be difficult, but not impossible; assuming the officer properly assesses the speed and distance of each truck and makes wise, timely decisions. Imagine that each of these trucks is emblazoned with a different logo: Energy Prices, Aging Aircraft, Recapitalization, and Defense Spending. Now, picture the officer with the winged star of the U.S. Air Force on his chest and the analogy becomes clear. Energy prices, aging aircraft, recapitalization, and defense spending are all issues bearing down on the Air Force. They have been approaching this fictional intersection for some time. The Air Force knows it cannot stop or reverse these trends. Likewise, it knows none of these issues can be addressed separately as all are impossibly intertwined. As a result, the Air Force is working diligently to avert a nasty pile-up as these four trucks move ever closer to the intersection and time is the enemy.

Air Force leaders are attempting to forge a way ahead; however, it is wing-level organizations that have proven, time-and-again, to be the cradle of innovation. Leadership, and the way forward for the service, in this dilemma, must emerge from its wings. Although the wings cannot stop the fictional foursome of trucks, leadership can beef up the brakes to slow them down and buy the service time.² Easing the burden on the fleet in the execution of the day-to-day mission via increased simulation, a different approach to the flying hour program, and a more focused maintenance quality assurance program will help mitigate the effects of increasing energy prices, an aging fleet, a struggling recapitalization effort, and a stressed defense

budget. In short, the Air Force should fly less, focus on sortie quality not quantity, and treat every sortie precious.

RISING COST OF ENERGY

In order to better understand why wing-level action is imperative, a deeper understanding of the four overarching issues (trucks) is needed. First, and foremost, the cost of energy is a variable cost to the Air Force and one that can wreak havoc. The summer of 2008 provided the service a glimpse of what future energy prices could look like and it was unsettling. A global recession that is slowing demand and driving down oil prices has afforded a merciful, albeit artificial and temporary, reprieve. The Department of Defense is the nation's biggest oil consumer, gobbling up 395,000 barrels per day—approximately equivalent to the country of Greece. The Air Force consumes more than half the military's fuel supply³ with a 1% increase in jet fuel prices costing the service \$23 million per year.⁴ A spike in fuel prices of up to 100% can cost billions and devour not only the Air Force budget but also those of other services and departments. When energy prices peaked in the summer of 2008, service leadership realized the only way to mitigate the impact of soaring fuel costs in the short-term was to slash fuel consumption. For this, it looked to civilian aviation for help in cutting operating costs. Approaches included aircrews flying more commercial air, less use of auxiliary power units, taxiing with only one engine, reducing fuel weights, etc.⁵ In a parallel, long-term effort, the Air Force has pushed to certify its fleet to use synthetic fuel by early next decade. The B-1B, B-52H, and C-17 have all been cleared for "unlimited use." Jeff Braun, director of the Air Force's alternative fuel certification office, noted on 29 September 2008, that the service has certified all of its ground support fueling equipment for unrestricted use too. The fuel blend is a 50-50 mix of traditional JP-8 jet fuel and synthetic paraffinic kerosene (SPK). SPK is derived today from natural gas but can be made via a coal-to-liquid fuel process, as well. The United States possesses an abundant supply of coal, which makes it a highly promising means to reduce the Air Force's vulnerability to oil price surges.⁶ To free itself from the vagaries of the oil market the service is pursuing a public-private partnership to leverage its market muscle to generate enough demand to get plants built. Nevertheless, SPK is a fossil fuel-based form of energy, which may make it difficult for the Air Force to ensure that a sufficient number of plants are built.

Prudent airmen should hope that with fuel prices declining the Air Force will have the foresight to continue with and institutionalize cost cutting measures because of the likelihood that, when the world emerges from the current economic downturn, oil prices will rise. Fareed Zakaria's "rise of the rest" should serve as a warning to the Department of Defense that countries like Brazil, China, and India are growing faster than the United States. That rise will continue to be fed by new foreign fossil fuel power plants and a surging middle-class putting hundreds of millions of new gasoline-powered cars on the roads.⁷ The upward pressure on fuel prices will return. The question for Airmen is whether the Air Force makes good use of the fortunate respite it has been handed by this recession. Overall, the approach of the "energy prices" truck has slowed but it will accelerate in the future.

AGING AIRCRAFT

Aging aircraft is a problem that continues its inexorable creep, year after year, driving up costs of ownership and driving down readiness rates. Aging aircraft means more than aging metal. It also means decreasing capabilities and a dwindling support infrastructure. The Air Force has been on a procurement holiday for nearly twenty years. No significant numbers of new fighters and bombers have entered the force since the Reagan administration. The average age of the service's aircraft now hovers around twenty-five years and it is getting older. The average age of the fleet is expected climb to twenty-nine years by 2013.⁸ By comparison, the average age of aircraft being flown in 1972 was eight years.⁹ Moreover, a rigorous, continual deployment tempo for the last two decades has compounded and exacerbated the problem.

Aggravating the aging aircraft dilemma is that the Air Force has been at war since 1991. For the last eighteen years, the service has had a significant forward presence in the Middle East that began with Operation DESERT SHIELD/STORM. After victory was declared in 1991, the Air Force remained in the region to enforce the northern and southern no-fly zones over Iraq, Operations NORTHERN WATCH and SOUTHERN WATCH; operations the Air Force would conduct until 2003 when IRAQI FREEDOM began. Thus, the Air Force has flown combat missions continually for the last eighteen years. Eighteen years of rotating aircraft and personnel in and out of theater. Eighteen years of flying aircraft in an environmentally menacing region of the world. These extended combat operations, reportedly, are wearing out aircraft at five

times the normal rate of aging; maintenance costs have risen by 87% in the last decade, worsened by rising fuel costs, spare parts, etc.¹⁰ Illustrative of the service's conundrum, Gen Bruce Carlson, Commander of the Air Force Materiel Command, stated that for every year an F-16 is deployed to CENTCOM, it ages between five and seven years due to the taxing nature of the mission.¹¹

Understandably, given the age of the fleet and level of tasking over the last two decades, aircraft reliability has suffered. Cost per flying hour has risen for every one of the fourteen major aircraft types in continuous service since the 1980s, which is aggravated by rising oil prices. All fourteen aircraft types have lower readiness rates than they did in 1991.¹² Aircraft break rate (aircraft landing with non-flyable discrepancies) and cost per flying hour have increased by about 17% just since 9/11.¹³ In the past sixteen months, approximately 450 F-15s, 450 T-38s, 130 A-10s, 21 KC-135Es and 20 B-52s have been grounded.¹⁴ The most spectacular example of a mishap-driven grounding happened on 2 November 2007 when an F-15C broke apart in midair due to a catastrophic structural failure, which speaks volumes about the age of Air Force fighters.

The Air Force fighter fleet has been hit especially hard by the procurement holiday. The average age of fighters rose from less than eleven years in 1986 to more than twenty today.¹⁵ The F-15 fleet averages over twenty-five years of age. The F-15 that broke apart in November 2007 was twenty-seven years old. The current plan is to keep 177 of the F-15C/Ds through 2025, which will make them forty to forty-five years old when they leave the fleet.¹⁶ The F-16 C/D fleet, the Air Force's core fighter aircraft, now averages nearly nineteen years of age.

The bomber fleet is still anchored by the venerable B-52, the youngest of which is over forty-six years old. The B-1B fleet, a troubled program from the start that has never had stellar readiness rates, is now over twenty years old. The B-2 bomber, the youngest of the bomber fleet at fourteen years old, was originally intended for a production run of 132 aircraft that was cut to twenty-one in the early 1990s. When the Air Force lost a B-2 on 23 February 2008 its fleet was reduced by nearly 5%. Along with other low-density fleets, the AC-130 and RC-135, for example, the B-2 presents the Air Force with scenarios in which the loss of one aircraft is significant.

Airlift and tankers are struggling, as well. Eisenhower-era cousins to the B-52, Air Force KC-135s are between forty-six to forty-nine years of age, depending on the model. The last of the KC-135s may not be replaced until they are eighty years old. The Air Force's other tanker, the KC-10, is twenty-four years old. The C-5A was built from 1969 to 1973 and is programmed to fly until 2040, making them nearly seventy years old at retirement.¹⁷ Moreover, the Global War on Terror is hitting the tanker and airlift force especially hard. The newest strategic airlifter, the C-17, is approaching the end of its production run; however, current operations are rapidly using them up. The commander of Air Mobility Command, Gen Arthur Lichtie, stated that the Air Force planned to fly the C-17 "a thousand hours per year... for 30 years."¹⁸ However, usage rates in recent years have shot up to between 1,500 and 1,800 hours per year, which equates to a twenty-two to twenty-five year life span with the oldest C-17s now more than fifteen years old. A fiscal and physical dilemma for the Air Force, the C-17 fleet is not the only one being overused; the C-130 fleet has already flown past 112% of its planned life expectancy with the C-5B at 147%, the KC-10 at 156%, and the KC-135 at 184%.¹⁹

Air Force leaders, saddled with the oldest fleet in the service's history, have been doing everything they can to squeeze every ounce of availability from this aging fleet through such initiatives as the Aircraft Availability Improvement Program, Expeditionary Logistics for the 21st Century (eLog21), High Velocity Maintenance, Air Force Smart Operations for the 21st Century (AFSO21), etc. These are essentially process and resourcing enhancements geared to increase aircraft availability, which are the supply side of the supply/demand relationship. Unfortunately, no course of action can make the basic metal structures on the flightline any younger. A 2003 RAND study on aging aircraft concluded, "One thing is certain. If the Air Force retains its aging fleets as planned and if those fleets' maintenance workloads and material consumption continue to grow with fleet ages...annual maintenance costs will increase and the number of aircraft available for operations and training will decrease."²⁰ Gen Carlson reinforced this point when he stated, "Every weapon system we fly today has some sort of restriction on a portion of the fleet, and that is simply unconscionable."²¹ Perhaps the Air Force's greatest risk, as evinced by the 2007 F-15 mishap, is that some major structural flaw will restrict or ground an entire class of aircraft, limiting Air Force employment

options. Lt Gen Paul Selva, Director of Strategic Planning for the Air Force from 2006 to 2007, articulated the Air Force's predicament best when he noted that, "We're essentially conducting a grand experiment. We've operated most of these airplanes we're flying beyond their originally designed life span."²² The results of this "grand experiment" will continue to surprise the Air Force. Nevertheless, one problem facing the Air Force is inevitable: the "aging aircraft" truck continues to plod toward the intersection at a constant pace. Although it cannot be slowed down, at the current utilization rates of some aircraft, it can gain speed. The only way to slow the encroachment of age is recapitalization of the fleet.

A STRUGGLING RECAPITALIZATION EFFORT

With the oldest fleet in its sixty-one-year history, recapitalization has been, and remains, a top priority for the Air Force. To reduce the average aircraft age, Air Force Chief of Staff, Gen Norton Schwartz, stated the Air Force would have to procure 200 new aircraft per year, approximately ninety more than the service's typical annual purchase.²³ In order to understand best the predicament the Air Force faces, the writings of DOD critic Frank Spinney warrant consideration. In the early 1990s, he was in the Pentagon's program analysis and evaluation directorate. Known for *Anatomy of Decline* and *Death Spiral*, he criticized the Air Force's procurement plan in the 1990s. He concluded that waiting too long to replace aircraft was a dangerous course of action for the Air Force. Maintenance costs would escalate making the aging fleet ever more expensive to maintain while, at the same time, the service would not be able to afford to replace them with ever more expensive, more complex new aircraft. He opined that new aircraft purchases would be cut because they would be too expensive and recapitalization would continually be postponed while aircraft continued to age.²⁴ That is precisely what has happened. In Spinney's words, "costs grow faster than budgets." Aircraft continue to age and the Air Force cannot afford to replace them in numbers large enough, due to per unit cost, to bring down the overall age of the fleet. The 2003 RAND study, *Investigating Optimal Replacement of Aging Air Force Systems*, supports such a view. In it, the RAND analysts state, "...evidence suggests that maintenance costs tend to increase as aircraft age whereas aircraft availability tends to decrease.... At the same time, new aircraft are expensive, so the Air Force cannot and does not blithely replace a system."²⁵ Where replacements systems have been approved and

procurement funds exist, the Air Force has had problems convincing Congress not to cut funding or has been hamstrung by its own acquisition process. Of note are three programs: the F-22 fighter, the KC-X tanker, and the CSAR-X helicopter.

Currently, there is no more contentious Air Force acquisition than the F-22. In the 1990s, the service made a commitment to stealth, which meant curtailment of F-15 and F-16 purchases while waiting for the F-22 and F-35 to enter production. Consequently, proposed annual procurement of all fighter types fell from 140 in 1991 to zero in 1995 with anemic production after that. In 1991, the Air Force projected it would buy 750 F-22s. However, the peace dividend and multiple defense reviews whittled that number down from 750 to 680 to 442 and, finally, to 339 in 1997. Finally, Program Budget Decision 753 in December 2004 slashed that number to 183, which is where the program now officially stands.²⁶ In the past, the Air Force has stood by a 381-aircraft requirement. This has been a source of friction not only within DOD but also between the Air Force and the White House. However, Gen Schwartz recently stated that more than 183 are needed but less than 381. Adm Michael Mullen, Chairman of the Joint Chiefs of Staff, recently told Congress sixty more F-22s beyond the approved 183 would be needed, but that number has yet to be approved by the Secretary of Defense.²⁷ A production price tag of about \$195 million combined with the current "resource-constrained environment" has not won the F-22 many strong supporters on Capitol Hill; and in late 2008, the Air Force began its official review of its F-22 requirement for the incoming administration. As Spinney and others once predicted, the Air Force has found itself with an aged fighter fleet and the number of its high-cost, high-tech replacements reduced significantly. Buying new fighters at such high prices, and, therefore, at such low annual rates, means some 1980s vintage fighters will have to stay in service past 2020 when they will be more than forty years old. Lt Gen Daniel Darnell, Air Force Deputy Chief of Staff for Air, Space and Information Operations, Plans and Requirements testified in April 2008 that a truncated F-22 buy and a major stretch-out in F-35 production would leave the Air Force short of its force structure requirements starting in 2017. By 2024, the service could be short of its 2,250-fighter requirement by 800 aircraft.²⁸ Thus, the fighter procurement holiday of the 1990s will affect the service through the first quarter of the twenty-first century and probably beyond.

A problem of greater magnitude and urgency for the Air Force remains the \$35 billion-effort to recapitalize its aerial refueling fleet, via the KC-X tanker, which has yet to produce a replacement for the tanker fleet. Plagued by acquisition missteps, the high-profile program suffered its first major setback when Congress scuttled the initial plan to lease Boeing tankers and its subsequent investigation resulted in the corruption conviction of Darleen Druyun. The ensuing competition resulted in the selection of the Northrop Grumman/EADS tanker in February 2008, which Boeing protested. In June 2008, the GAO upheld the protest and DOD took over the program. Boeing then stated it needed six months to come up with a revised proposal. Finally, in September 2008, Defense Secretary Robert Gates postponed decision until the next administration.²⁹ Thus, whilst Eisenhower-era tankers continue to fly, the recapitalization effort remains grounded.

Lastly, the service's new search-and-rescue helicopter (CSAR-X) replacement has yet to get off the ground. Initially, Boeing won the contract with its HH-47 Chinook variant but Lockheed-Martin and Sikorsky protested the award with the GAO twice who sustained both protests, effectively halting the program. The Air Force's latest amendment to the request for proposals for the CSAR-X program delayed the aircraft's initial operational capability until summer 2013, at the earliest, and winter 2015, at the latest. It is the seventh amendment issued since the service initially awarded the \$15 billion contract to Boeing in November 2006.³⁰ The service has put off re-awarding the contract to replace 141 aging helicopters until sometime in 2009, yet another example of a major recapitalization effort moving sideways.

An examination of the overarching issues behind recapitalization, specifically the F-22, KC-X, and CSAR-X programs, reveals the two primary issues the Air Force must confront. First, the service finds itself in a difficult position when it attempts to replace an aging, highly utilized fleet with high-cost replacements. Second, when the Air Force does receive recapitalization funds from Congress its own acquisition process gets in the way. All the while, the "recapitalization" truck continues to pick up speed and efforts to slow it down have faltered. Successful recapitalization efforts will depend greatly on future defense spending which promises to be problematic.

UNCERTAIN FUTURE OF DEFENSE SPENDING

With record energy prices, an old fleet, a sputtering recapitalization effort, and seven years of post-9/11 war in Iraq and Afghanistan, along with a national and global economic recession, the Air Force finds itself in, potentially, the worst environment imaginable to address the issues currently confronting it. Hence, the fourth and final issue is a defense-spending environment that promises to grow more, not less, hostile.

For much of the last decade, government spending has been robust. In FY 2008 U.S. defense spending reached \$695B: \$515B in “core” budget and \$180B in emergency supplemental appropriations, a total more than twice that of FY 2000. The core budget has increased by more than 5%, adjusted for inflation, every year since FY 2000. The FY 2008 federal budget deficit was \$455 billion, three times that of the previous year and does not include the \$700 billion bailout (a.k.a. Troubled Assets Relief Program).³¹ Congressional budget analysts estimate the annual deficit will soar to \$1.2 trillion in 2009. As a percentage of the overall economy, it is the largest since the end of World War II.³² Finally, the national debt has skyrocketed \$2 trillion since FY 01, an 80% increase.³³

Not only has government spending risen and the deficit and debt ballooned, it appears the U.S. economy is in the midst of its longest recession in a quarter century, a downturn that officially began in December 2007. The U.S. Commerce Department stated that Gross Domestic Product (GDP)—a measure of US economic wealth that is currently estimated to be around \$14 trillion—declined at an annual rate of 0.5% in the July-September quarter. Some economists believe the decline for October-December could be as high as 6%, the largest quarterly drop since 1982.³⁴

Given projected Air Force shortfalls and a grinding recession, the question being asked inside the Beltway is how much money should be spent on defense. This is not favorable for an Air Force looking to recapitalize. Many pundits, analysts, and authors have taken to discussing military expenses as a percentage of GDP in order to provide a constant measure of the financial burden of defense spending on the nation. There are those who point out that, even in its most expensive year, the Afghan War only consumed 0.3% of GDP and the Iraq War 1.0%. By way of comparison, the Vietnam War’s most expensive year cost 2.3% while World War II outlays peaked at an astonishing 35.8%.³⁵ One can dig deeper, looking past the specific

war costs to the size of annual defense budgets as a share of GDP. In 1944, the most expensive year of World War II, the annual defense budget was a whopping 37.5% of GDP. In 1953, the height of the Korean War, defense share of GDP was 14%. In 1968, the peak of the Vietnam War, it was 9.5%. In 1986, the acme of the Reagan Cold War build-up, it was 6.2%. By comparison, the annual defense budget has not exceeded 4.2% GDP (2008) during the Global War on Terror, while military functions accounted for 20% of 2008 total budget outlays.³⁶ By comparison, federal entitlement programs are the biggest budget eaters, representing 52% of 2008 outlays and 11% of GDP.³⁷ The argument defense proponents make with this line of reasoning is that the United States can afford to spend more on defense and should. Chairman of the Joint Chiefs of Staff, Admiral Michael Mullen, and others have supported a “4% solution,” pegging “core” defense spending—which represents 3.5% of the 4.2% of GDP mentioned earlier—to 4% of GDP annually.³⁸ James Carafano, a leading expert in defense and homeland security at The Heritage Foundation, is one of the foremost proponents of the 4% solution. He states that,

The United States must spend at least 4% of its annual GDP over the next decade to recover from the long post-Cold War ‘peace dividend’ of the 1990s and refurbish the military after years of fighting the long war in Iraq and Afghanistan. To plan to do anything less over the foreseeable future will put both the nation’s security and the lives of our troops in jeopardy.³⁹

Overall, what most advocates are looking for is a commitment to defense in tough economic times in addition to some budget predictability.

Critics of this reasoning counter that while historical GDP comparisons indicate what the US *could* spend on defense, it doesn’t provide insight into what it *should* spend on defense. They contend a more honest way to look at spending is via inflation-adjusted dollars. By this measurement, the U.S. will spend more on defense in FY 09 (approx \$700 billion) than it did during the peak years of the Korean War (1953; \$545 billion), the Vietnam War (1968; \$550 billion), the Reagan-era buildup (1989; \$522 billion). They also argue the United States is already spending more on defense than the next 45 highest-spending countries combined, including 5.8 times more than China (second-highest). Finally, they argue it reduces the government’s budget flexibility.⁴⁰ In that vein, what happens during a recession when GDP shrinks? Will the defense budget also shrink accordingly?

In the end, this argument will probably not turn in the Air Force's favor. John Murtha (D-Pa), influential House defense appropriator, has recently stated, "The next President is going to be forced to decrease defense spending in order to respond to neglected domestic priorities."⁴¹ If Rep. Murtha is a weather vane for Congressional leanings, the "4% solution" will be a bridge too far.

So, a pro-defense spending establishment is strenuously, but probably unsuccessfully, making an argument to nudge core defense spending up to 4% of GDP at a time when the United States could be facing its most severe economic turndown since the Great Depression. Add in the fact retiring baby boomers are expected to generate an increase in entitlement spending from 11% of GDP in 2010 to 14% by 2030. Even more ominous is that entitlement spending and interest on the federal debt will account for two-thirds of government expenditures by 2015.⁴² Because of this, it is quite possible a paradigm shift is underway regarding defense spending. While service budget battles have been rather commonplace in Washington, there was rarely ever a doubt that defense spending would increase annually. The extent of the increase was usually the greatest unknown. Given the country's current and projected fiscal difficulties, the DOD could be facing real budget cuts which will significantly challenge the Air Force's ability to recapitalize. The "defense spending" truck is bearing down on the Air Force. At this point, it appears that spending cuts in non-defense programs, tax increases, or an increase in defense deficit spending are the only ways to slow it down. The Air Force must plan on this truck arriving at the intersection on time.

THE PRECIOUS SORTIE

One can piece together the individual issues of energy prices, aging aircraft, recapitalization, and defense spending to understand the terrain the Air Force is trying to navigate. Each generation of Air Force leaders are buying fewer aircraft, which are increasingly expensive and complex, and must now last longer. Therefore, with each budget cycle, the Air Force has fewer, older, more complex, and more costly aircraft. Wars are exacerbating this cycle by accelerating aircraft wear-and-tear, and an upward trend in energy prices is adding to the cost of ownership. Current recapitalization efforts are struggling and not sufficient to reduce the age of the fleet. Finally, all this is happening against the backdrop of the most severe recession in more than a quarter century which could dramatically impact "business as usual" defense budgeting. From this

analysis, it is obvious there are no silver bullets available to the Air Force. This predicament will take a long time to work through at the highest levels of government. As there is no short-term remedy in the offing, this should be a clarion call for the leaders of Air Force wings. It is vital that flying wings find new and creative ways to reduce the stress on the fleet. It is their creativity and innovation that can ease these conditions in the near term and buy the service time to address the issues it confronts.

The Air Force simply must change its mindset and this starts at the wing level. With a shrinking, aging fleet and declining readiness rates, sorties become increasingly tougher to generate, thereby becoming more valuable. Because of this, wings must take action to reduce the stress on their fleets. There should be a push at the wing level to fly less—something counterintuitive to Airmen—and get more out of the sorties flown. In short, treat every sortie as something precious. The relationship of the wings to higher-level Air Force organizations is similar to that of the states to the federal government. While wings abide by higher level direction, they also issue their own instructions, policies, etc. Wings leaders have quite a bit of flexibility and autonomy. It is just this flexibility and autonomy that can be used to craft innovative, near-term solutions. A three-pronged wing-level approach could consist of driving increased simulation, a different approach to the flying hour program, and a more focused maintenance quality assurance program.

INCREASED SIMULATION

The move to simulators in the Air Force has been afoot for a while and picked up momentum with the spike in energy costs in 2008. Gen Richard Hawley, former ACC commander, referencing the structural life of the aging F-16 fleet stated, “One way to stretch that life is to rely more on simulation and less on live flying. That way we can accumulate those hours on that fleet of airplanes at a slower rate.” Back in 2007, Gen William Looney, then-commander of Air Education and Training Command (AETC), said his vision was to “move as efficiently and quickly as we can” in the direction of simulators for training. He pointed out that simulators are “much more capable than they were just five or ten years ago.”⁴³ One estimate is that advanced simulation may increase the quantity of training accomplished per unit of time in the cockpit by a 4:1 ratio over the quantity available on a live mission.⁴⁴

Gen Looney also stressed balance between simulators and live flying. "We're always going to have to fly...the key is how often do I have to go out in the training program to get that level of confidence and what can I, instead of going out there, hone my skills on in the simulator."⁴⁵ A 2007 RAND study, *Absorbing and Developing Qualified Fighter Pilots: The Role of the Advanced Simulators*, echoed Gen Looney's viewpoint. In their discussion with Boeing experts, the RAND authors emphasized that the limited number of live sorties must be carefully managed to ensure that newly-assigned pilots continue to develop all skills required. This requires units to judiciously balance live and simulator training programs.⁴⁶ Also, when live-fly sorties are in short supply, the limited number of live sorties must be used more efficiently. In one analysis, advanced simulator training reduced non-effective sorties at U.S.A.F Weapons School by 12%.⁴⁷

The civilian sector has led the way with simulation. According to Jim Barnes, a United Airlines pilot who is advising the Air Force in its fuel saving effort, appropriate training and certification have to be moved to simulators. A commercial pilot's first time at live controls is with a plane full of passengers. The training is "100 percent simulator training. The sims are that good," Barnes said.⁴⁸ To be fair, while it is true that major airlines never use aircraft equipment solely to provide live training for their pilots, what distinguishes airline and Air Force training needs is the experience levels of the new pilots. Newly-hired airline pilots tend to have much more experience.⁴⁹ Despite this fact, the service can learn from this model.

Right now, simulation lends itself more to larger, non-tactical aircraft. For example, C-17 pilots are certified after seventy hours in a high-fidelity simulator and only four hours in the actual cockpit. The key is sophisticated, full motion simulators. Due to the complexities of air combat, fighter pilots will need a higher ratio of flying time, for now. The physical stresses of high-g turns simply can't be replicated in a simulator. Despite that, the ratio will still trend to more simulator time. One four-star suggested that F-35 pilots may earn qualification with 35 hours in simulators and 35 hours in the cockpit.⁵⁰

Overall, the largest simulator limiting factor is that there are not enough high fidelity simulators (i.e., mission training centers, distributed mission operations, etc.). Today, only a few platforms have software and hardware deemed suitable to substitute for actual training sorties. As of October 2008, Air Combat Command could provide this level of simulation to pilots of the E-3 AWACS, F-15, and Block 50 F-16.

Currently, 25% of AWACS crew hours are being completed in simulators and F-15 pilots can accumulate as much as 20% of their training in simulators.⁵¹ Given that, the Air Force has work to do in its push for high fidelity simulators.

Maj Shaun McGrath's treatment of high-fidelity simulators in his paper, *Leveraging DMO's Hi-Tech Simulation Against the F-16 Flying Training Gap*, supports the benefits of simulation stating, "the near-term benefit of leveraging these high-tech simulators to close the growing gaps in flying training is real."⁵² Referencing the Air Force's overarching situation, he states, "the only realistic solution is to leverage high-tech simulation in the combat training environment. By no means is this the first time in aviation history that aviators relied on simulation for training assistance."⁵³ The aforementioned RAND study goes a step further stating their analysis led them to the conclusion that high fidelity simulator training "should indeed be credited to the pilots in an appropriate manner and that this training should be included in training requirements...This is the only option we see that can ensure the coordination and integration of the live training the pilots receive with the available simulator training."⁵⁴

The simulator nexus is at the wings and is why wings can make a difference now. On one hand, they have the pilots that require training. On the other hand, they possess the simulators and, by-and-large, manage their maintenance and schedule access. Just as important, they can promote a change in culture that is required for high tech simulators to be successful and, therefore, broadly accepted as a compliment to historically live-fly focused training and exercise. To reduce stress on the fleet, every wing should determine what training must be done in the air. Everything else should go to the simulators. This is not solely because of aging aircraft concerns either. In addition to aging aircraft, many peacetime limitations like training rules, resource shortfalls, technical constraints, and security restrictions also hamper training based solely on live flight. So simply throwing more flying hours at training is not a viable solution for training deficits for many reasons.⁵⁵ Where shortfalls in technical capability or simulator availability exist, wing leaders must be the ones who champion the drive to get the necessary resources. There is no one in a better position to lead the effort to maximize simulator training than wing leaders. There is no more credible voice in the Air Force than frontline wing-level leadership.

There is no stopping the move to increased simulation across the fleet. The move to simulators is no longer about desire, it is about necessity. Wing leadership's innovative use of existing simulators combined with a push to change the culture and their advocacy for bridging simulator capability shortfalls is pivotal to leveraging this technology to minimize stress on the fleet...right now. Being at the leading edge of this effort can only help the Air Force's aging fleet.

A DIFFERENT APPROACH TO THE FLYING HOUR PROGRAM

Simulators decrease the demand for sorties. However, recent high-visibility Air Force efforts have primarily focused on boosting aircraft availability—the supply side of the equation. The service must put the same level of effort to working the demand side—the flying requirements. America's energy policy provides a nice parallel. When supply constricts and prices go up, the U.S. focuses on ways to ratchet up supply. This includes coaxing oil producers to pump more or pushing for more domestic exploration and production. This course reaches a level of diminishing returns and, at some point, demand must be addressed. With that said, while simulators address the demand for flying, the flying hour program (FHP) represents the very core of the flying requirement and, because of that, it too must be addressed.

At its very basic, the FHP is a resource allocation process. In order to fund a wing's flying operations for the fiscal year, the service needs to know how many hours a wing plans to fly so it can budget appropriately. To get these forecasts, wing-level operators estimate their training needs and maintainers project their maintenance capability for the coming fiscal year using a combination of educated projections and historical data. Both of these are expressed in terms of flying hours. Wing leaders meet, reconcile the difference between operations and maintenance, and pass the request up the chain. After a few iterations, the wing receives its official fiscal year FHP, which is basically the amount of hours it is funded to fly.

Troubles begin when the official FHP hits the wing. At that point, the FHP morphs from a resource allocation process into a metric and, obviously, metrics must be met. Falling short (underflying) one's FHP is seen as a big negative. When wing leaders fail to achieve this metric, the belief is that it reflects poorly on their ability to lead. After all, a "good leader" would not allow his/her organization to fall short of its FHP. Capt (ret) Russell Rhea, USN, a Lean Six Sigma Green Belt with twenty-five years of logistics experience,

points out that, "In the traditional world of management, we are enamored with our red, yellow, and green metrics, leading to the ever-present 'self-preservation' paranoia about going forward to management 'red.' Red is bad, green is good."⁵⁶ No wing leader wants to explain a failure to meet the FHP. It is simply easier to do whatever one has to do to ensure the metric is met. So, when the daily, weekly, or annual FHP status slide shows a wing is falling behind its FHP the wing commander's question typically is, "How do we catch up?" That is the wrong question to ask and drives undesirable behavior with an older, smaller fleet. The FHP is supposed to support the mission of qualifying aircrew and keeping them proficient. So, should not the queries be, "We're behind in executing flying hours. So what? Where do we stand with our aircrew training? Are we behind there as well?" The Air Force wings, in general, have allowed the FHP to become completely decoupled from the actual status of aircrew training throughout the year. FHP progress is rarely tied directly to current status of aircrew training in any meaningful way.⁵⁷ It is as if the flying has become an end unto itself instead of a means by which aircrews maintain competency. If a wing is behind in the FHP, but not lagging in aircrew training, yet still exerts an effort to "catch up," it results in flying an aged fleet more than is necessary to meet mission requirements. This is behavior the Air Force can no longer tolerate with a shrinking, stressed, twenty-five year old fleet.

A simple fix is for the wings to experiment with an aircrew training metric that can help put FHP progress into perspective. Decisions should be based on the core mission of training aircrew, not being "green" in the FHP. The service can no longer justify flying unneeded sorties. An aircrew training metric would help to ensure FHP does not drive behavior counterproductive to fleet health. It will also take courage on the part of our wing leaders. Turning back flying hours means not executing funding, a negative throughout much of the federal government. Funds budgeted must be spent or one runs the risk of not getting the same level of funding next fiscal year. This course of action demands a deviation from business-as-usual and that requires bold wing leadership. To facilitate this, senior Air Force leaders should, at a minimum, eliminate the stigma that comes with turning in flying hours and, at best, reward wing commanders that find inventive ways to reduce stress on their fleets throughout the year.

There is one other aspect of FHP execution that requires treatment here and that is average sortie duration (ASD). In order to calculate flying hours needed, the number of training sorties is multiplied by ASD. Simple math states that underflying the ASD means a wing must generate more sorties to fly the same amount of hours. Conversely, overflying ASD results in fewer sorties to fly the same amount of hours. In 2006, Headquarters Pacific Air Forces (PACAF) asked the Air Force Logistics Management Agency (AFLMA) to evaluate the idea of flying more F-15C/D sorties at a reduced ASD. AFLMA's analysis conclusively indicated that,

cost per flying hour (CPFH) will increase as ASD decreases. The analysis indicated reducing ASD can't decrease the cost of aircraft repair parts, which accounts for approximately 70% of the total FHP costs. Reducing ASD and pursuing the same FHP increases the cost of repair parts and significantly contributes to an increased CPFH. This scenario will require more maintenance to generate additional sorties and will require more maintenance effort to repair additional aircraft breaks.⁵⁸

Simply put, projecting a realistic ASD and, subsequently, not underflying it reduces the cost of maintaining the fleet, lessens the number of sorties flown which, in turn, reduces stress on the fleet. Flying fewer sorties has the additional benefit of taking a fixed amount of maintenance personnel and spreading them over a smaller level of sortie production, increasing their effectiveness. So, to reduce wear-and tear on the fleet, to decrease operating costs, and to increase the effectiveness of the maintenance operation, it is crucial that the forecast ASD is not underflown throughout the fiscal year. This will make it easier to meet the FHP while making it more likely that scheduled sorties launch and are effective. Remember, the "precious sortie" is about sortie quality, not quantity. A different approach to the FHP—tying it to actual training requirements during execution and flying the ASD—speaks directly to minimizing sorties while maximizing quality.

A MORE FOCUSED QUALITY ASSURANCE EFFORT

The discussion of FHP referenced the impact maintenance can have on the "precious sortie." Specifically, decreasing sorties allows a finite number of technicians to be spread over a smaller sortie production effort. That maintainer-to-sortie ratio can only increase the chances that a sortie will get airborne and that it will be effective. Sortie quality is about quality aircraft maintenance. The maintenance group

commander's gatekeepers for maintenance quality are those maintainers assigned to Quality Assurance (QA). If a wing is serious about sortie quality, it must change the way it approaches quality assurance.

Normally, Air Force QA inspectors inspect a sampling of maintenance actions/areas each month. The pass rates for these inspections are typically computed and placed on PowerPoint slides so trends can be shown, discussed, and evaluated. QA is essentially using these statistics to paint a picture for leaders and decision-makers. Unfortunately, there is absolutely no statistical science behind the sampling methodology which makes their accuracy highly suspect. With this in mind, it is troublesome that maintenance commanders use these numbers to assess the health of their maintenance operations and, of even more concern, are taking actions, devoting resources, etc. based on what they believe these numbers are telling them.

The primary concern is that QA is not using basic statistical sampling methodology in their inspection processes. Therefore, there is really no way to determine if their results are indicative of the population as a whole. Normal sampling distributions can be assumed if the sample size is large (Central Limit Theorem).⁵⁹ However, the sample size (number of inspections) is usually arbitrary, since it is determined locally, and rarely large enough to assume a normal distribution. Commanders are free to engage QA and adjust the number of inspections up or down depending on perceived areas of need. Areas with high pass rates may have inspections decreased so inspections can be boosted in problem areas. Obviously, this process does not take into account statistical sampling methods. The result is the numbers (i.e. pass rates) that QA produces cannot be assumed to be indicative of the population as a whole as the margins of error are enormous. Nevertheless, having experienced technicians out in the maintenance operation evaluating the maintenance is always a good thing. Their mere presence drives desirable behavior. However, using those pass rate percentages to make predictions about the entire population or to construct twelve-month trend lines is not advisable and could mislead maintenance leaders.

Currently, QA inspections per category are typically low, as they spread themselves a mile wide and an inch deep in an effort to get a look at everything. Frederick the Great once noted about an unsuccessful leader that, "In trying to defend everything, he defended nothing." QA is typically trying to "defend

everything" via their inspection program which results in a lack of focus. One example comes from an F-16 flightline maintenance unit. Maintainers were performing at least 120 thru-flight inspections per month. QA was following up on four. That's 3% of the population. There were, at the very least, 200 basic post-flight/pre-flight inspections being done per month. QA was inspecting eight which is 4%, at best.⁶⁰ A second example comes from a backshop maintenance squadron. QA projected to do 102 monthly inspections of this 500-person squadron. These 102 inspections were spread across no less than forty-one separate sub-categories.⁶¹ In only two sub-categories was the squadron scheduled to receive more than four inspections, despite the fact there may be literally dozens or hundreds of inspection opportunities. This is not atypical of Air Force QA as a whole.

These low sample sizes cause issues when one tries to extrapolate them across an entire population. For instance, if ten maintenance actions, like thruflights, are inspected and eight pass, the resulting statistical pass rate for the entire population computes to 75% +/-20 with a 90 % confidence level.⁶² This means, based on a sample of ten inspections, of which eight passed, the pass rate for the entire population of thruflights could be as high as 95% or as low as 55%. In other words, a maintenance commander can only say, "I'm 90% confident that between 55% and 95% of all my thruflight inspections would meet "Pass" criteria based on my sample." It is clear the sampling of ten thruflight inspections cannot be used to reliably predict the behavior of the entire population. The margin of error is simply too large. But, that is exactly what wings around the world are doing with this information. They are using this sample to draw an inference about the entire population of thruflight inspections and they are tracking trends from month-to-month to follow improvement or degradation in performance.

Using the example above, one can calculate the number of thruflight inspections QA must do to get be able to get a sample size that would be predictive of the entire population. If one assumes a 90% confidence level, an 80% pass rate, and a margin of error of +/- 5%, then 173 inspections must be performed.⁶³ Again, for a maintenance commander to say, "I am 90% confident that between 75% and 85% of my thruflights meet 'Pass' criteria," his/her QA must accomplish 173 thruflight inspections. That is 173 inspections in just a single sub category. Referencing the earlier example, the backshop maintenance

squadron received only 102 monthly inspections which were spread across no less than forty-one separate sub-categories. Using basic statistical sampling methodology, the number of QA inspections required is clearly prohibitive.

It appears the best way to surmount the lack of a sampling methodology is two-fold. First, increase inspections to boost predictive accuracy. Second, create a statistical literacy among inspectors so as to avoid sampling bias as much as possible.

As manpower resources are not unlimited, increasing inspections will require trade-offs. Commanders will have to either pull more maintainers off the line and into QA which could be sustained if the wing is flying fewer sorties because of increased use of simulation and taking a different approach to the FHP that has been discussed earlier. Or, commanders can reduce the number of categories they are evaluating so as to increase inspections in higher priority areas. Both can be beneficial. The first course of action results in more QA personnel out in the maintenance operation evaluating the quality of maintenance. On the other hand, if more manning is not available, the second course of action will require maintenance commanders to prioritize what they are inspecting. That will mean some lower priority items (housekeeping, vehicle status, etc.) are no longer inspected by QA in exchange for increased inspections of higher priority items (on-aircraft maintenance, off-aircraft maintenance, etc.). One can argue that is a good thing. Commanders can use other means to monitor these lower priority areas if they desire. QA resources will always be finite and the "precious sortie" mindset demands an all-out push for quality sorties. What better way to increase the chances that a scheduled sortie will get airborne and be effective than to focus QA personnel on the key processes that facilitate fleet health and lead to successful sortie generation.

Next, statistical literacy is essential to avoid a sampling bias and increase the accuracy of results. QA inspectors should be aware of how their sampling methodology impacts the usefulness of their numbers. At a minimum, when looking at inspections for a sub-category, an inspector should make the effort to understand the demographics of that sub-category. For instance, inspectors should determine when the maintenance actions are typically being performed, who is accomplishing the work, where it is being accomplished, etc. This awareness on the part of QA evaluators can minimize any sampling bias.

In the final analysis, QA simply is not doing enough inspections to allow maintenance leaders to use their numbers to predict the health of an entire maintenance operation with any level of accuracy. QA presence is always a good thing, but leaders must ensure they are not misusing the results QA is providing them and, therefore, possibly misdirecting scarce resources.

CONCLUSION

In conclusion, the Air Force now stands at the turbulent confluence of rising energy prices, an aging fleet, halting recapitalization, and strained defense budgets. This situation did not develop overnight and will not be solved quickly. Therefore, it is essential that wing-level leaders take action to mitigate the stress on the fleet in the near-term in order to buy the service the time it desperately needs to navigate the obstacles ahead. A push for increased simulation, a different approach to the FHP, and a more focused quality assurance effort all demand a new mindset and a cultural shift. Wing leaders are perfectly positioned to make this happen. Sortie quality, not sortie quantity, must become the service's mantra and drive the day-to-day decisions its leaders make regarding the execution of the flying schedule. A realization that sorties are no longer "cheap" is critical. The energy to fly sorties will grow more expensive while the cost to maintain an aging fleet will continue its unabated rise. On the other hand, the Air Force is in a fight for resources the likes of which it has not witnessed in decades. Funding for recapitalization is by no means assured as the United States weathers its most daunting fiscal challenges since the Great Depression. As energy costs, aging aircraft, recapitalization, and strained defense budgets bear down on the Air Force, its greatest asset will be time. Wing leaders can apply the brakes and buy critical time and breathing space for the Air Force only if they understand that all sorties are now precious and that they undervalue them at their own peril.

NOTES

¹ Gayle Putrich and Vago Muridan, "Rising Oil Prices Change USAF Ops," *DefenseNews*, July 14, 2008, <http://www.defensenews.com/story.php?i=3629654> (accessed December 31, 2008).

² This work will focus on the Air Force's manned fleet and not address unmanned aerial vehicles.

³ Jen Dimasco, "The Biggest Oil Guzzler? The Pentagon," *Politico*, July 25, 2008, <http://aimpoints.hq.af.mil/display.cfm?id=27300&printer=yes> (accessed July 30, 2008).

⁴ Vago Muridan, "Oil Prices Reshape How the Air Force Flies," *AirForceTimes*, July 14, 2008, http://www.airforcetimes.com/news/2008/07/federal_fuel_prices_071308/ (accessed September 30, 2008).

⁵ Ibid.

⁶ Michael Sirak, "B-1B Cleared for Synthetic Fuel," *Air Force Magazine*, December 2008, <http://www.airforce-magazine.com/MagazineArchive/Pages/2008/December/> (accessed December 26, 2008).

⁷ Jon Meacham, "The Story of Power," *Time*, December 29, 2008, 34.

⁸ Elaine M. Grossman, "As Tenure Ends, Jumper Is Most Troubled By Aging Aircraft Fleet," *Inside The Pentagon*, September 1, 2005, http://www.defense-and-society.org/grossman/aging_aircraft_fleet.htm (accessed December 23, 2008).

⁹ Carolyn Dryer, "New Air Force Association President Deplores State of Aging Aircraft," *Glendale Star* (Ariz.), October 17, 2008, <http://aimpoints.hq.af.mil/display.cfm?id=28978&printer=yes> (accessed October 18, 2008).

¹⁰ R. Michael Worden, "Developing Twenty-First-Century Airpower Strategists," *Strategic Studies Quarterly*, vol. 2, no. 1 (Spring 2008): 24.

¹¹ Marcus Weisgerber, "Air Force Not Buying Enough Aircraft To Replace Worn Out Force," *Inside the Air Force*, October 10, 2008, <http://www.insidedefense.com/secure/display.asp?docnum=AIRFORCE> (accessed December 31, 2008).

¹² Sydney J. Freedberg Jr., "Aging Aircraft," *National Journal*, vol. 40, iss. 11 (March 15, 2008), <http://www.proquest.com/>.

¹³ Megan Scully, "Needed: 200 New Aircraft a Year," *Air Force Magazine*, October, 2008, 54.

¹⁴ Dryer, "State of Aging Aircraft."

¹⁵ Freedberg, "Aging Aircraft."

¹⁶ Ibid.

- ¹⁷ Marcus Weisgerber, "Air Force Looking At Ways To Improve Reliability of Old C-5A Aircraft," *Inside the Air Force*, August 27, 2008, <http://aimpoints.hq.af.mil/display.cfm?id=27860> (accessed August 28, 2008).
- ¹⁸ John A. Tripak, "Airlift on Thin Ice," *Air Force Magazine*, October, 2008, 33.
- ¹⁹ Ibid.
- ²⁰ Raymond A. Pyles, *Aging Aircraft: USAF Workload and Material Consumption Life Cycle Patterns* (Santa Monica, CA: Rand, 2003), 183.
- ²¹ Weisgerber, "Air Force Not Buying Enough Aircraft."
- ²² Freedberg, "Aging Aircraft."
- ²³ Scully, "Needed: 200 New Aircraft a Year," 54.
- ²⁴ Grossman, "As Tenure Ends."
- ²⁵ Edward G. Keating and Matthew Dixon, *Investigating Optimal Replacement of Aging Air Force Systems*, (Santa Monica, CA: Rand, 2003), 1.
- ²⁶ Rebecca Grant, "Losing Air Dominance," *Air Force Magazine*, December, 2008, 25-29.
- ²⁷ Amy Butler, "USAF Chief Defends F-22 need, Capabilities," *Aviation Week*, February 17, 2009, http://www.aviationweek.com/aw/generic/story_channel.jsp?channel=defense&id=news/F22s021709.xml (accessed February 27, 2009).
- ²⁸ Ibid., 29.
- ²⁹ William Matthews, "Senators Push for Quick USAF Tanker Decision," *Defense News*, December 12, 2008, <http://aimpoints.hq.af.mil/display.cfm?id=30718&printer=yes> (accessed December 21, 2008).
- ³⁰ My-Ly Nguyen, "Helicopter Program Delayed," *Gannett News Service*, December 12, 2008, <http://aimpoints.hq.af.mil/display.cfm?id=30677&printer=yes> (accessed December 21, 2008).
- ³¹ Shaun Waterman, "Pentagon to Tighten Spending," *United Press International*, October 17, 2008, <http://aimpoints.hq.af.mil/display.cfm?id=28995&printer=yes> (accessed October 18, 2008).
- ³² Lori Montgomery, "Congress Urges Spending Restraint," *The Washington Post*, January 8, 2009.
- ³³ Travis Sharp, "Tying US Defense Spending to GDP: Bad Logic, Bad Policy," *Parameters*, vol. xxxviii, no. 3 (Autumn 2008): 14.
- ³⁴ Martin Crutsinger, "Recession 'Will Get a Lot Worse' This Quarter," *Associated Press*, December 24, 2008, <http://www.theglobeandmail.com/servlet/story/LAC.20081224.IBUS> (accessed December 29, 2008).
- ³⁵ Robert S. Dudley, "Hard Times," *Air Force Magazine*, November, 2008, 2.
- ³⁶ Adam J. Hebert, "The 'Four Percent of GDP' Thing," *Air Force Magazine*, August, 2008, 22.

³⁷ Dudney, "Hard Times," 2.

³⁸ Hebert, "The 'Four Percent of GDP' Thing," 22.

³⁹ James Jay Carafano, "National Security Resolutions for 2009," *The Heritage Foundation*, December 31, 2008, <http://www.heritage.org/Research/homelandsecurity/wm2182.cfm> (accessed February 8, 2008).

⁴⁰ Sharp, "Tying US Defense Spending to GDP," 14.

⁴¹ Dudney, "Hard Times," 2.

⁴² Sharp, "Tying US Defense Spending to GDP," 14.

⁴³ Jason Simpson, "Looney: 'We Want to Continue to Push Down the Road of Simulation,'" *Inside the Air Force*, September 28, 2007, <http://www.insidedefense.com/secure/display.asp?docnum=AIRFORCE> (ACCESSED December 31, 2008).

⁴⁴ Richard Marken and others, *Absorbing and Developing Qualified Fighter Pilots: The Role of the Advanced Simulator*, (Santa Monica, CA: Rand, 2007), 24.

⁴⁵ Simpson, "Looney."

⁴⁶ Marken and others, *Absorbing and Developing Qualified Fighter Pilots*, 31.

⁴⁷ Ibid., 27.

⁴⁸ Putrich and Muridan, "Rising Oil Prices Change USAF Ops."

⁴⁹ Marken and others, *Absorbing and Developing Qualified Fighter Pilots*, 30.

⁵⁰ Putrich and Muridan, "Rising Oil Prices Change USAF Ops."

⁵¹ Marc V. Schanz, "Scarce Flying Hours," *Air Force Magazine*, January, 2008, <http://www.airforce-magazine.com/MagazineArchive/Pages/2008/January> (accessed December 24, 2008).

⁵² Shaun R. McGrath, "Leveraging DMO's Hi-Tech Simulation Against the F-16 Flying Training Gap," (master's thesis, Air Command and Staff College, 2005), 2, <http://www.dtic.mil/>.

⁵³ Ibid., 13.

⁵⁴ Ibid., 32.

⁵⁵ Ibid., 4.

⁵⁶ Russell Rhea, "Lean Metrics: Green is Worthless," *The Exceptional Release*, Fall 2007, 32.

⁵⁷ Personal experience as an aircraft maintenance officer in 4 flying wings across 3 Air Force Major Commands, 1995-2008.

⁵⁸ Kevin P. Dawson, "Analyzing Air Force Flying Hour Costs," *Air Force Journal of Logistics*, Summer, 2006, http://findarticles.com/p/articles/mi_m0IBO/is_2_30/ai_n16753038/pri (accessed December 24, 2008).

⁵⁹ Allen L. Webster, *Applied Statistics for Business and Economics*. (Chicago: McGraw-Hill, 1995), 279.

⁶⁰ Personal experience as Maintenance Operations Officer, 51st Aircraft Maintenance Squadron, Osan Air Base, Republic of Korea, May 05 – Jun 06.

⁶¹ 1st Special Operations Maintenance Group Quality Assurance Program, Hurlburt Field FL, Dec 2008.

⁶² Sample size calculator at www.measuringusability.com.

⁶³ Sample size calculator at www.dimensionresearch.com.

BIBLIOGRAPHY

- Butler, Amy. "USAF Chief Defends F-22 Need, Capabilities," *Aviation Week*, February 17, 2009, http://www.aviationweek.com/aw/generic/story_channel.jsp?channel=defense&id=news/F22s021709.xml (accessed February 27, 2009).
- Carafano, James Jay. "National Security Resolutions for 2009," *The Heritage Foundation*, December 31, 2008, <http://www.heritage.org/Research/homelandsecurity/wm2182.cfm> (accessed February 8, 2008).
- Dawson, Kevin P. "Analyzing Air Force Flying Hour Costs." *Air Force Journal of Logistics*, Summer, 2006, http://findarticles.com/p/articles/mi_m0IBO/is_2_30/ai_n16753038/pri (accessed December 24, 2008).
- Dimasco, Jen. "The Biggest Oil Guzzler? The Pentagon," *Politico*, July 25, 2008, <http://aimpoints.hq.af.mil/display.cfm?id=27300&printer=yes> (accessed July 30, 2008).
- Dryer, Carolyn. "New Air Force Association President Deplores State of Aging Aircraft." *Glendale Star* (Ariz.), October 17, 2008, <http://aimpoints.hq.af.mil/display.cfm?id=28978&printer=yes> (accessed October 18, 2008).
- Dudney, Robert S. "Hard Times." *Air Force Magazine*, November, 2008.
- Crutsinger, Martin. "Recession 'Will Get a Lot Worse' This Quarter." *Associated Press*, December 24, 2008, <http://www.theglobeandmail.com/servlet/story/LAC.20081224.IBUS> (accessed December 29, 2008).
- Freedberg, Sydney J., Jr. "Aging Aircraft." *National Journal*, vol. 40, iss. 11 (March 15, 2008), <http://www.proquest.com/>.
- Grant, Rebecca. "Losing Air Dominance." *Air Force Magazine*, December, 2008.
- Grossman, Elaine M. "As Tenure Ends, Jumper Is Most Troubled By Aging Aircraft Fleet." *Inside The Pentagon*, September 1, 2005, http://www.defense-and-society.org/grossman/aging_aircraft_fleet.htm (accessed December 23, 2008).
- Hebert, Adam J. "The 'Four Percent of GDP' Thing." *Air Force Magazine*, August, 2008.
- Keating, Edward G. and Matthew Dixon. *Investigating Optimal Replacement of Aging Air Force Systems*. Santa Monica, CA: Rand, 2003.
- Marken, Richard, William Taylor, John Ausink, Lawrence Hanser and C. Anderegg. *Absorbing and Developing Qualified Fighter Pilots: The Role of the Advanced Simulator*, Santa Monica, CA: Rand, 2007.
- Matthews, William. "Senators Push for Quick USAF Tanker Decision." *Defense News*, December 12, 2008, <http://aimpoints.hq.af.mil/display.cfm?id=30718&printer=yes> (accessed December 21, 2008).
- McGrath, Shaun R. "Leveraging DMO's Hi-Tech Simulation Against the F-16 Flying Training Gap." (master's thesis, Air Command and Staff College, 2005), 2, <http://www.dtic.mil/>.
- Meacham, Jon. "The Story of Power." *Time*, December 29, 2008.
- Montgomery, Lori. "Congress Urges Spending Restraint." *The Washington Post*, January 8, 2009.

- Muridan, Vago. "Oil Prices Reshape How the Air Force Flies." *Air Force Times*, July 14, 2008, http://www.airforcetimes.com/news/2008/07/federal_fuel_prices_071308/ (accessed September 30, 2008).
- Nguyen, My-Ly. "Helicopter Program Delayed." *Gannett News Service*, December 12, 2008, <http://aimpoints.hq.af.mil/display.cfm?id=30677&printer=yes> (accessed December 21, 2008).
- Putrich, Gayle and Vago Muridan. "Rising Oil Prices Change USAF Ops." *DefenseNews*, July 14, 2008, <http://www.defensenews.com/story.php?i=3629654> (accessed December 31, 2008).
- Pyles, Raymond A. *Aging Aircraft: USAF Workload and Material Consumption Life Cycle Patterns*. Santa Monica, CA: Rand, 2003.
- Rhea, Russell. "Lean Metrics: Green is Worthless," *The Exceptional Release*, Fall 2007.
- Schanz, Marc V. "Scarce Flying Hours." *Air Force Magazine*, January, 2008, <http://www.airforce-magazine.com/MagazineArchive/Pages/2008/January> (accessed December 24, 2008).
- Scully, Megan. "Needed: 200 New Aircraft a Year." *Air Force Magazine*, October, 2008.
- Sharp, Travis. "Tying US Defense Spending to GDP: Bad Logic, Bad Policy." *Parameters*, vol. xxxviii, no. 3 (Autumn 2008): 14.
- Simpson, Jason. "Air Force to Craft JSF Pilot Training Coursework Within Six Months." *Inside the Air Force*, August 17, 2007, <http://www.insidedefense.com/secure/display.asp?docnum=AIRFORCE> (accessed December 31, 2008).
- Simpson, Jason. "Looney: 'We Want to Continue to Push Down the Road of Simulation.'" *Inside the Air Force*, September 28, 2007, <http://www.insidedefense.com/secure/display.asp?docnum=AIRFORCE> (ACCESSSED December 31, 2008).
- Sirak, Michael. "B-1B Cleared for Synthetic Fuel." *Air Force Magazine*, December 2008, <http://www.airforce-magazine.com/MagazineArchive/Pages/2008/December/> (accessed December 26, 2008).
- Tripak, John A. "Airlift on Thin Ice." *Air Force Magazine*, October, 2008.
- Waterman, Shaun. "Pentagon to Tighten Spending." *United Press International*, October 17, 2008, <http://aimpoints.hq.af.mil/display.cfm?id=28995&printer=yes> (accessed October 18, 2008).
- Webster, Allen L. *Applied Statistics for Business and Economics*. Chicago: McGraw-Hill, 1995.
- Weisgerber, Marcus. "Air Force Looking At Ways To Improve Reliability of Old C-5A Aircraft." *Inside the Air Force*, August 27, 2008, <http://aimpoints.hq.af.mil/display.cfm?id=27860> (accessed August 28, 2008).
- Weisgerber, Marcus. "Air Force Not Buying Enough Aircraft To Replace Worn Out Force." *Inside the Air Force*, October 10, 2008, <http://www.insidedefense.com/secure/display.asp?docnum=AIRFORCE> (accessed December 31, 2008).

Worden, R. Michael. "Developing Twenty-First-Century Airpower Strategists." *Strategic Studies Quarterly*, vol. 2, no. 1 (Spring 2008): 24.