THE WRIGHT FLYER PAPERS

Electronic Combat Support for an Expeditionary Air Force

The Lessons of History

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Air Command and Staff College
Wright Flyer Paper No. 15

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Foreword

It is my great pleasure to present another of the *Wright Flyer Papers* series. In this series, Air Command and Staff College (ACSC) recognizes and publishes the "best of the best" student research projects from the prior academic year. The ACSC research program encourages our students to move beyond the school's core curriculum in their own professional development and in "advancing aerospace power." The series title reflects our desire to perpetuate the pioneering spirit embodied in earlier generations of airmen. Projects selected for publication combine solid research, innovative thought, and lucid presentation in exploring war at the operational level. With this broad perspective, the *Wright Flyer Papers* engage an eclectic range of doctrinal, technological, organizational, and operational questions. Some of these studies provide new solutions to familiar problems. Others encourage us to leave the familiar behind in pursuing new possibilities. By making these research studies available in the *Wright Flyer Papers,* ACSC hopes to encourage critical examination of the findings and to stimulate further research in these areas.

John T. Sheridan, Brig Gen (Sel), USAF
Commandant

Preface

I began this paper a few months after a US F-117 was shot down over Belgrade, Yugoslavia, wondering to myself "why?" Why was the United States Air Force (USAF) so resistant to the idea of dedicated suppression of enemy air defenses and electronic countermeasures support for its strikers? Why had they given the electronic combat (EC) mission almost entirely to the *Navy?* Was the technology of stealth really the driving force, or was there more?

While studying for an Air Command and Staff College examination, I literally stumbled over the answer. As I suspected, it wasn't just money—although that had a lot to do with it. As a naval officer flying EA-6Bs, I had never heard of the "bomber will always get through" controversies of the 1930s or the initial failure of unescorted daylight bombing during World War II. As I studied these things, I began to get a sense of the organizational culture of the USAF. I saw how the external and internal environment that influenced the US Army Air Corps of the 1930s had been responsible for the problems of early World War II. Moreover, I saw this same organizational culture at work in the late eighties and nineties, leading to what I perceived as a shortfall in EC capability. The names had changed, but the elements were the same. People had ideas and theories of their service and how it could radically change the history of modern warfare. They needed money and technology to make them work. In short, I found the four elements of the model I propose in this paper.

Abstract

The United States Air Force (USAF) currently faces a shortfall in the type and number of electronic combat (EC) aircraft capable of operating with an Aerospace Expeditionary Wing (AEW). This has a direct impact on the USAF's global attack core competency and undermines the combat power of any deployed AEW. Why have EC assets been allowed to deteriorate to this state?

The answer begins with people, who have a flawed understanding of the theory of airpower. Because the theory is not understood correctly, money is not dedicated to the needed technology. Because the technology isn't developed or is lacking, that community—if you will—fails to get representation at the higher levels of leadership. This cycle of organizational behavior repeats itself over and over until acted upon by an outside force—in this case the shootdown of a US F-117 during the Kosovo action.

This is not the first time that the USAF has been through this cycle of organizational behavior. The almost exact same scenario played out in the famous pursuit versus bombers debates of the 1930s. Pursuit lost out and thereby lost money, technology, and people in key leadership positions. It was not until the horrific bomber losses of 1943 that leaders fully realized the mistake they had made.

This paper explores the connection between the two stories, looks at the current state of EC, and offers some suggestions for the future.

Introduction

To say that having command of the air means to fly in the face of an enemy who has been prevented from doing likewise means to have the ability to fly against an enemy so as to injure him, while he has been deprived of the power to do likewise.

—Giulio Douhet
The Command of the Air

As the twenty-first century begins, the United States (US) faces an unprecedented limitation on its ability to project combat airpower worldwide. That limitation is not the number of aircraft available to drop bombs but the number of aircraft and crews available to provide suppression of enemy air defenses (SEAD). Constrained by budget decisions, force structure, and improper paradigms, the electronic combat (EC) capabilities crucial to perform effective SEAD are barely sufficient to support and protect US strike forces adequately in one regional conflict. A second simultaneous regional conflict would be nearly impossible to fully support.[1]

What has allowed joint airpower to reach this point? Why are its capabilities and utilization now driven by the force structure of the EC community? This paper attempts to gain some insight into those questions.

The theory behind the application of airpower—at least as it involves the suppression and/or destruction of enemy air defenses (SEAD/DEAD)—is flawed. The proven mindset of offensive, one of the nine principles of war, has given way to a passive view of the electronic battlefield. According to current theory, stealth gives the attacker the ability to strike without fighting for and winning command of the air. This misguided view—combined with an organizational culture that favors fighters and bombers at the expense of support aircraft—has led to the budget, procurement, and personnel decisions that have left joint airpower in its current vulnerable state.

The following definitions of electronic warfare (EW) terms are found in *EW Definitions* by the Association of Old Crows.[2]

Electronic warfare (electronic combat). Any military action involving the use of electromagnetic and directed energy to control the electromagnetic spectrum or to attack the enemy. The three major subdivisions within electronic

warfare are electronic attack, electronic protection, and electronic warfare support.

Electronic attack. That division of electronic warfare involving the use of electromagnetic or directed energy to attack personnel, facilities, or equipment with the intent of degrading, neutralizing, or destroying enemy combat capability.

Electronic protection. That division of electronic warfare involving actions taken to protect personnel, facilities, and equipment from any effects of friendly or enemy employment of electronic warfare that degrade, neutralize, or destroy friendly combat capability.

Electronic warfare support. That division of electronic warfare involving actions tasked by, or under direct control of, an operational commander to search for, intercept, identify, and locate sources of intentional and unintentional radiated electromagnetic energy for the purpose of immediate threat recognition.

Suppression of enemy air defenses. Involves neutralizing, destroying, or temporarily degrading enemy air defense systems through either physical attack or electronic warfare.[3]

Background

Would Douhet have supported the use of airpower assets to perform SEAD in the pursuit of command of the air? That is the fundamental question that faces students of the subject today. After all, though a small amount of controversy exists on exactly who influenced whom and when, the theories underlying the US use of airpower are still his.[4]

Most readers remember Douhet for his staunch advocacy of a single type of aircraft, the strategic bomber, and fail to remember that he also argued for the achievement of air control—or command of the air as he phrased it—by destroying the enemy air force on the ground.[5] Only "after achieving air superiority," could the bombers then "wreck the enemy's vital centers."[6]

Douhet's strength lies, not in execution, but in his simple verbalization of some of the basic foundations of the employment of airpower. To understand Douhet's work, one has to understand that air superiority is made up of

two equally important halves: the ability to injure the enemy and the ability to keep from being injured by the enemy. The history of US airpower is a study of newer and better ways to fly against an enemy and injure him. What has often been neglected until conflict was already under way is the ability to deprive the enemy of the power to injure friendly forces.

A Framework for Study

Organizational culture has been defined as "the common set of assumptions, beliefs, and values that has developed within the organization *to cope with the external and internal environment*" (emphasis added).[7] If one looks at the development of airpower theory with an eye to the external and internal environment of the Air Force, a pattern forms.

There is a natural flow to the development of any theory, war fighting or otherwise. It starts with the people, who want something. They may want to win the next war, win a game of football, or make more money. In order to achieve their goals, someone comes up with a theory. These theories are no good, however, without money, so the people have to procure some. Maybe they need money to buy equipment, maybe they need to pay other people, or maybe they need to develop a new asset or technology. Regardless, money is necessary. Once money is secured, the people can develop technology, which they then use to apply and refine their ideas, create new ideas, request more money to improve their technology, and so on.

People drive this process, and it is a pretty healthy one so long as there are no shortages. Plenty of people turn out plenty of theories which, combined with plenty of money, produce plenty of technology, and so on. A shortage in any one area, though, causes shortages throughout the model, often with unanticipated results. As a shortage in one factor causes a corresponding shortage in the next and so on, the entire loop begins to neck down. This continues until a decisive external event shakes up the model and forces input of new theories, people, money, or technology to make the model grow back to its proper size. That is the story of this paper (fig.1).

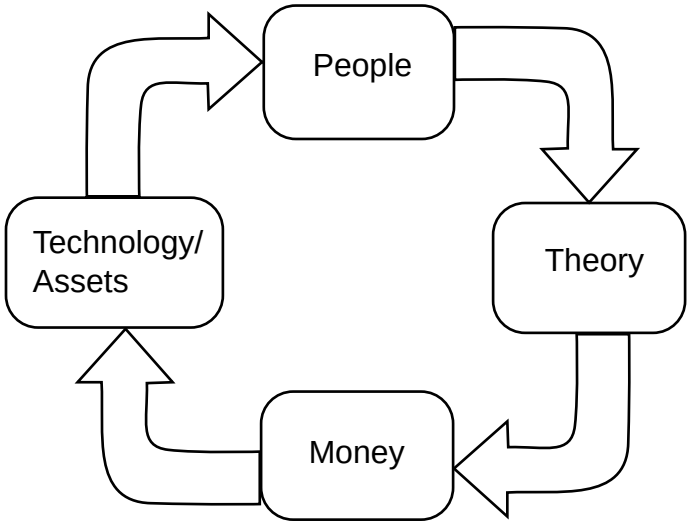

Figure 1. From People to Technology

This model will be used as a lens through which two case studies in US airpower theory are discussed—the use of long-range escort for strategic bombers during World War II and the use of EC assets to escort strike aircraft during recent contingencies. Though 50 years separate the two case studies, the principles of airpower remain the same. The fighter threat has given way to surface-to-air missiles (SAM); but the attacking force must have a plan, even for a short period of time, to establish air superiority so that the bombers can do their job.

"No Escort Needed"

We believe that a bombardment unit, worth its salt, is imbued with determination that it will penetrate any pursuit force in the world.

—Capt Ralph Snavely
Bombardment Course
Air Corps Tactical School, 1939

Books have been written about the famous bomber versus pursuit debates of the interwar period. Presenting yet another report on that controversy is not necessarily the

focus of this paper. However, when used as a lens to view the rise and fall of EC capabilities in the post–Vietnam Air Force, the similarities are fascinating.

Why did the Air Corps leadership allow their service to enter World War II utilizing the tactic of unescorted long-range bombing? The simple answer is that they believed that the technology embodied in the four-engine strategic bomber was unmatched by any threat, either in pursuit aviation or antiaircraft artillery.[8] But the real answer is more complex. Referring to our model, it involves people, ideas, money, and technology.

People

Any business school will teach you that the kind of people you bring into an organization has a direct impact on the culture and doctrine of that organization. "Human resources provide the creative spark in any organization . . . Without effective people, it is simply impossible for an organization to achieve its objectives."[9] By the late 1930s, the objective of the US Army Air Service was autonomy. The vehicle for this objective was the strategic bomber, and people were the driving force. Unfortunately, while pursuing the objective of autonomy, the people in question skewed the otherwise sound theory of airpower toward bombardment at the expense of all other forms of aviation. They ultimately controlled the money and technology available to the Army Air Corps as the United States entered World War II.

During the interwar period, the focal point of US airpower research and theory was the Air Corps Tactical School (ACTS). What began as a relatively balanced debate between pursuit and bombardment advocates gradually gave way to the "Bomber Mafia." Officers such as Robert Olds, Kenneth Walker, Donald Wilson, Harold Lee George, Robert Webster, Haywood Hansell, Laurence Kuter, and Muir Fairchild filled key positions on the faculty and espoused Gen William "Billy" Mitchell's theories of an independent air force founded on bombardment aviation.[10] Each of these officers was destined to become an influential general during and after World War II. With the leadership

of the Army Air Corps firmly dedicated to bombardment, other forms of airpower had insufficient advocacy to command any sort of attention when the time came to divide up the budget for research and development (R&D). This underrepresentation would ultimately prove disastrous for the prosecution of high-altitude daylight precision bombing.

Leading the fight to recognize the contributions of pursuit aviation was Claire L. Chennault. As a senior instructor in fighter tactics at ACTS, he waged a valiant—but ultimately fruitless—battle for the development of pursuit that eventually forced him into early retirement. "With the retirement of Claire Chennault from the Air Corps in 1937," writes Hugh G. Severs, "the pursuit advocates lost their leader and staunchest spokesman."[11] Severs further states, "With Chennault gone, the Air Corps' focus turned towards bombardment, and the pursuit advocates, perhaps recognizing that the future of the Air Corps and its officers was linked to strategic bombardment, were unwilling or unable to change this focus."[12]

The Bomber Mafia spilled over into the establishment of the General Headquarters (GHQ) Air Force in 1935. The first commanding officer of GHQ Air Force was Gen Frank M. Andrews, a bombardment advocate who brought a group of bomber-minded officers with him to form his staff. By 1941 even Gen Henry H. "Hap" Arnold noted that "frankly, fighters have been allowed to drift in the doldrums."[13] It would take a war to force the Army Air Corps to rethink its position on the theory of airpower.

Theory

After World War I, theorists began to debate the relative merits of the different uses of airpower. In particular the works of Douhet and Mitchell are exceptional.

General Douhet of Italy represents perhaps the extreme view of the bomber advocate. He was a former artillery officer who became convinced of the decisiveness of airpower. He postulated that war centered on "command of the air."[14] Command of the air, of course, implied destroying the enemy's air forces.[15] His idea of establishing command of

the air was through the use of strategic bombers to strike and destroy the enemy's aviation facilities on the ground.[16] The first edition of his book—*The Command of the Air* published in 1921—made allowances for the existence of pursuit squadrons to perform a secondary role of homeland defense.[17] By 1927, in the preface to his second edition, Douhet admitted that he had only included the pursuit aircraft in his original work in an attempt to avoid alienating the rest of the Italian military. He was sure that heavily armed bombing aircraft could prevail over what he considered to be ineffective ground defenses.[18]

Back in the United States, US Army Air Corps's General Mitchell was formulating his own theories of airpower. Much as Douhet, Mitchell's initial position recognized a need for a balanced force of pursuit and bomber aircraft; but he later changed his position, calling for an air force based largely on bombardment.[19] Two factors drove this reversal: the fight for an independent Air Force and money.[20]

Money

In the post–World War I US military, the fight for funding was literally a fight between the US Army (USA) and the US Navy (USN) for the survival of their war-fighting capabilities. For aviation, the first part of the four-part people-theory-money-technology loop to face a shortage was money.

In 1923 the Lassiter Board recommended a 10-year expansion of the USA air arm, a balanced force of attack, and pursuit and bombardment aircraft that would cost a total of $90 million a year.[21] This outrageous request for more than one-third of the Army's budget was, of course, impossible to fully fund. Between attack, pursuit, and bombardment, something would have to give. As the influence of the bombardment advocates grew at ACTS and throughout the Air Corps, what little money there was for R&D began to flow towards heavy bombers. Maj Robert Eslinger—in his paper "The Neglect of Long-Range Escort Development during the Interwar Years (1918–1943)"—notes that "the battle between the bomber radicals and the handful of fighter advocates grew more bitter as the competition for money got stiffer."[22]

As a result, the development of pursuit aviation began to go wanting. It was decided—conveniently as it turned out for the bomber advocates—that a single-engine pursuit aircraft could never catch, outgun, or outperform a heavy bomber. "Fighters Are Obsolete" proclaimed the Office of the Chief of the Air Corps. To them funds spent on pursuit aircraft were a waste, and so their development and procurement were greatly restricted.[23]

Technology

This decision led to the restriction of the third phase of the model—technology. By the late 1930s, the advent of the monowing and all-metal construction had led to the development of the XB-299, which would become the famous B-17. By contrast, pursuit development had stagnated somewhere around the P-26 and P-39—both all-metal monowing fighters—but both underpowered, underarmed, and unprepared to meet the threats they would face in the skies of World War II. What money was available for pursuit research became bogged down in an unproductive subcontroversy concerning multiseat versus single-seat fighter aircraft.[24]

Summary

By the eve of World War II, then, the Air Corps had come full circle. People (Mitchell and others) with a vision (an independent Air Force) espoused theories ("the bomber will always get through") that drove money decisions (develop bombers, not pursuit aircraft) and influenced the development of technology (progressive bombers versus inferior fighters). This, in turn, led to more prestige for the people involved in bombardment, which led to enhanced theories of strategic bombing (daylight precision) and so forth. The closed loop of the airpower model was about to be acted on by some outside influences, namely the air defenses of the Luftwaffe.

Probably the biggest shortcoming of Douhet's theory was the failure to take into account the development of radar. Radar gave an opponent the capability to find the

bomber formations and position his pursuit aircraft accordingly. Once this "domino" fell, others followed. Fighter aircraft finally developed engines and armament that allowed them to climb, chase, and fight successfully with the heavy behemoths. Antiaircraft weaponry developed proximity fuses for their shells, which made them deadly to the bomber formations.

By 1939 even General Arnold was pressing for the development of a long-range escort fighter for bomber formations, but by then it was too late.[25] Eighth Air Force bombers would have to sustain heavy losses before the Air Corps could deliver them fighters capable of protecting them from the enemy defenders.

One would think that these lessons, written in blood, would be an example of what was to be avoided in the future—a template of how not to close the minds of the service to pragmatic viewpoints; but it was not to be. The organizational culture that had been built on the theory of strategic bombing was unable to define itself in any other terms. As soon as the war ended, US Army Air Forces leadership began to put distance between themselves and the fact that the unescorted strategic bomber had met with only limited success, at the cost of very heavy casualties. In *The United States Strategic Bombing Surveys*, among the exuberant proclamations of the success of airpower, the reader finds one tiny paragraph that mentions that fighter aircraft might have been a problem: "Until then it had been believed that unescorted bombers, heavily gunned and flying in well designed formations, could penetrate this deeply [into Schweinfurt] over the Reich. At least, *so far as a small force was concerned*, this was proven wrong" (emphasis added).[26]

The advocates of "the bomber will always get through" theory managed to qualify the strategic bombing surveys, making it sound like larger, heavier formations would have worked. The lesson that command of the air has to be aggressively established for bomber aircraft to do their job would have to be learned again. The people-theory-money-technology model would come into play again 45 years later, advancing and countering the same arguments.

Air Superiority through Stealth?

Stealth aircraft do not require fighter escorts and defense suppression aircraft and electronic warfare aircraft to reach their targets.

—Sen Kay Bailey Hutchison
Senate B-2 debates
30 June 1994

There was nobody at the table to argue [for electronic combat]—and there is a huge debating society that argues priorities and argues relative importance and argues for ideas and for resources . . . The natural consequence of that was for the resources to go away, and we've made a serious misstep. I don't know how to build that back.

—Gen Michael J. Dugan, USAF, Retired

Stealth offered the first real change in airpower doctrine and thinking since World War II. For the first time, the development of radar—the "eye in the sky" that helped the defender detect bombing formations and place their defending fighters—was possibly a moot point. If this was true, then the bomber really could get through. It was déjà-vu.

People

By the early 1980s, a revolution of sorts was taking place within the USAF. The Bomber Mafia of World War II and the postwar Strategic Air Command (SAC) was being overtaken and replaced by the highly decorated fighter combat veterans of the Vietnam War.

As we look at the rise of the fighter generals,[27] it is interesting to note how many of them had any kind of experience in EC. As is suggested by the data in table 1, only seven of the 208 rated generals on active duty in 1997 had any operational experience in the field of EC. Assuming for a moment that each of these seven generals was a die-hard supporter of SEAD and EC capabilities (a stretch, to say the least), that would leave them with only 3.4 percent of the service's rated general officers. By comparison let us assume that the service's bomber generals were all firmly in support of the development of the theory of stealth and the B-2. Their combined 31 voices (14.9 percent of all rated general officers) were certainly louder than the SEAD

advocates. A further assumption that the 59 percent who fly fighters would give their support to the development of the F-22, at the expense of other programs, could certainly explain how that fighter became the Air Force's number one funding priority. EC, as a whole, ranked 17th.[28]

Table 1

Rated General Officers—1997

	Fighters	Bombers	Transport/ Helicopters/ Other	EC Operational Experience	Any EC-Related Exposure
Pilots	121	30	52	7	16
Navigators/ EWO	2	1	2	0	1
Total/% of Total Rated	123/59.1%	31/14.9%	54/28.4%	7/3.4%	17/8.2%

Source: Official Biographies of USAF General Officers, Air Force Personnel Command, 1997.

A brief discussion about methodology is appropriate here. Of the 314 general officers on active duty in the USAF in 1997, 208 of them were rated (i.e., pilots or navigators). For the sake of this paper, the assumption is made that nonrated officers would not have the operational experience one way or another to be effective advocates or detractors from tactical EC. Therefore, only the 208 rated officers are considered in the table. To have EC operational experience, an officer had to have on his or her record an operational tour flying an EC aircraft, namely an F-4G Wild Weasel, EF-111 Aardvark, or an F-16CJ. By expanding that category somewhat the "any EC-related exposure" generously gives EC credit to any officer whose record mentions that the officer has flown in, been checked out in as a wing commander, or otherwise somehow been around any electronic aircraft.

The original hypothesis of the survey of general officers was that it would uncover a significant deficiency in the numbers of generals who had had operational experience in EC. The null hypothesis, of course, would be that there would exist high-ranking generals who had flown EC or

SEAD aircraft. The hypothesis was found to be only partially correct.

The numbers were, in fact, small. As noted, only 3.4 percent of the rated general officers had had operational EC tours. However, the small numbers were compensated for by the importance of some of the EC alumni. For instance, then head of the Air Combat Command, Gen Joseph W. Ralston, was an F-105 Wild Weasel pilot. Additionally, an assistant vice chief of staff, Gen David L. Vesely, was commander of an EF-111 squadron. One would think that these two officers would have had some input into, say, the decision to retire the EF-111. It is almost as if the organizational vision of a time when stealth aircraft could attack targets with impunity was so tantalizing, it could cause years of experience to fall by the wayside. In his book, *Setting the Context: Suppression of Enemy Air Defenses and Joint War Fighting in an Uncertain World*, Lt Col James R. Brungess makes an impassioned argument for development of a joint SEAD capability. But even this veteran EF-111 electronics warfare officer manages to note that "by being 'invisible' to radar and infrared detection, the F-117 pilot needs only know where the target is in order to attack it."[29] In the early nineties, stealth was more than technology; it was a mind-set. So, while Gen Michael J. Dugan's comments that EC was not well represented at the top are partially true, there would seem to be more pieces of the puzzle for the researcher to find. A good place to begin is the theory behind stealth precision engagement.

Theory: Stealth Meets Douhet

EC can be thought of as a triad, consisting of support jamming, lethal SEAD, and platform self-protection.[30] As authors John Knowles and Zachary Lum noted in the *Journal of Electronic Defense:* "Similar in concept to the nuclear triad, the EW triad relies on redundancy to defeat the evolving nature of threat systems . . . when threat technology progresses to where it can defeat one particular capability, such as platform self-protection, technology

developments in another capability, such as support jamming or lethal SEAD, will serve to defeat the threat."[31]

As decision-making personnel within the Air Force became more and more convinced that the new (stealth) bomber would always get through, less attention was paid to the support jamming and lethal SEAD corners of the triad. The radical thing about stealth is that it negated the years of work that had been done to develop ways to achieve command of the air during an air strike. Attacking aircraft were, supposedly, no longer vulnerable to radar and integrated air defense systems (IADS). This had obvious money implications. If one no longer needed to spend money on EC and SEAD aircraft or the crews who flew and maintained them, mountains of money could be made available for the development of projects that would ensure the primacy of the USAF into the next century. Immediately, theory began to be restricted and even changed. Air Force thinkers began to clamor for a new doctrine based on the fact that US forces no longer had to establish air superiority in order to prosecute an attack. As Maj Kevin Kennedy noted in 1992:

> Air Force doctrine says "aerospace control assures the friendly use of the environment while denying its use to the enemy." Broken down into two components this says first, our aircraft will be able to use the environment as they desire. This means the enemy is not able to stop us from using it as we desire. The second component of aerospace control is denying this free use to the enemy. This means we have the ability to physically hinder his air operations. *With stealth aircraft we have free use of the environment; the first half of the aerospace control equation.* (Emphasis added)[32]

Remember that one of the nine principles of war is offensive. In the past US forces had gained command of the air through offensive means—finding enemy radar and missile sites and either jamming their frequencies or attacking them with ordnance. This new theory essentially gives up the aggressive-minded offensive means to establish air superiority. No longer would a strike lead have to build a sanctuary and then fly in it, air defenses would be unable to keep the stealth aircraft from prosecuting their attacks. Notice how this thinking mirrors the "bomber will always get through" theories of the interwar Bomber Mafia.

Money

If the above theory was true, it had enormous financial possibilities, especially in the lean budget years of a protracted defense drawdown. In the same way that the Air Corps of the lean 1930s chose not to develop the fighter, the Air Force of the 1990s would no longer have to devote resources to the development and procurement of EC aircraft, either for support jamming or lethal SEAD. That money could be poured into the more popular bomber and fighter programs, particularly the F-22.[33] It was an invitation to a party that few top Air Force officials could not afford to attend. By February 1991, Secretary of the Air Force Donald B. Rice was claiming to Congress that eight F-117s with precision-guided munitions "could do the work of 75 nonstealthy planes."[34] His inference, of course, was that no strike package was necessary to help the bomb droppers fight their way into the target. This effectively conceded air superiority to the enemy, while relying on stealth to enter their territory, execute the mission, and retire safely.

In an eerie repeat of the "Fighters Are Obsolete" slogan of the 1930s, Air Force planners began to do everything in their power not to have to spend money on EC so that they could fund their favorite programs.[35] Part of that attempt was the decision to retire both the F-4G Wild Weasel and the EF-111 Aardvark. A 1996 warning by the General Accounting Office that "DOD's planned actions in the next few years will have a negative impact on SEAD capabilities and may need to be reversed in the future, at much greater expense and effort" fell on deaf ears.[36]

Technology

By 1997 the only SEAD assets that the USAF owned were the modified F-16CJs which carried the admittedly inferior high-speed antiradiation missile (HARM) targeting system.[37] The gamble was that nonstealthy USAF aircraft could rely on the USN EA-6Bs for jamming support until such time as the preponderance of the USAF assets would be stealthy and would not require any EC support.

The original F-4G follow-on was supposed to be a SEAD version of the F-15 Eagle. Called the F-15PDF (Precision

Direction Finding), it would have been armed with the HARM and deployed in great quantities with the capability to do both reactive and preemptive SEAD. Unfortunately, an intercommunity squabble over whether the new aircraft should have one or two crew members eventually detracted enough from the program that it was ended in 1994.[38] Again, organizational culture impeded the development of theory, flow of money, and purchase of assets and technology. In place of the F-15PDF, the decision was made to procure the F-16CJ. A quick-reaction, interim, low-cost solution that was originally supposed to be a stopgap measure while the F-15PDF program reached maturity, the F-16CJ instead became the Air Force's only remaining chance to have a SEAD aircraft.[39] "It's not perfect, but it's good enough," was literally the reaction of the division chief of Air Force policy and requirements in the Pentagon at the time.[40]

Summary

As the United States prepared for conflict in Kosovo in 1999, the Air Force had come full circle. People (the fighter generals or stealth advocates) with a vision (Global Reach—Global Power) espoused theories (stealth equals air superiority) that drove money decisions (retire F-4G, EF-111 without replacements) and ultimately influenced technology development (stealth). This, in turn, led to more prestige for the people involved in stealth programs, which led to enhanced theories of the use of stealth (precision/effects-based targeting, etc.) and so forth.

If this sounds like a word-for-word repeat of a previous summary, you are right. The model had played out exactly as it had in the late 1930s; and like the Bomber Mafia of World War II, the stealth advocates were about to have their assumptions tested in the crucible of combat.

"Into the Readiness Gap"

Until then [future SEAD developments], it's just the F-16 HTS, the EA-6B, and luck.

—Journal of Electronic Defense

By February 1997 the last F-4G Wild Weasel and EF-111s were gone from the active USAF inventory. In their place was an innovative joint initiative to rely on F-16CJs and Navy EA-6Bs to provide defense suppression.[41] At the same time, the Air Force agency responsible for acquiring EC hardware, the Headquarters Electronic Combat Division, was disbanded; its duties were assimilated into the Common Systems Division.[42] This decision would prove disastrous for the USAF's future electronic force structure.

Meanwhile, providing the new joint EC capability were four new EA-6B squadrons, called expeditionary squadrons. Partially funded by the Air Force and staffed with four USAF officers each, these squadrons together with the four US Marine Corps (USMC) Prowler squadrons would cover the three traditional forward deployment sites. EC would be continuously available in Atsugi, Japan; Incirlik, Turkey; and Prince Sultan Air Base (AB), Saudi Arabia. Or at least that was the theory.

There are two problems with the current arrangement. First, the 24 EF-111s in service during the Persian Gulf War were admittedly overtasked, showing their importance to USAF strike planning.[43] Replacing them with only 20 EA-6Bs was a negative equation to start with. Moreover, in the evolving SEAD doctrine of the Gulf War, not all strike packages required jamming support. The loss of Scott O'Grady's F-16 in 1995 and the loss of an F-117 during the 1999 Kosovo conflict have changed that. Today, no strike package goes into hostile territory without EC escort.[44] The 20 Prowlers thus substituted into an environment where commander in chief (CINC) tasking now requires EC support for all aircraft—including stealth—are simply not enough.

Second, after the agreement was settled between the USAF and USN, a fourth forward deployment site was added to the list: Aviano AB, Italy. Covering three sites with eight squadrons was conceivably an achievable goal, but the eight squadrons (four USN/USAF and four USMC) cannot support four deployment sites continuously. By mathematical calculation, this would result in a deployment every six months for each squadron. Obviously, this cannot be done while remaining within Department of Defense personnel tempo guidelines. The answer, therefore, is to substitute fleet EA-6B squadrons, who would

otherwise be engaged in interdeployment training at their home bases, into coverage gaps at the different deployment sites. This has resulted in unacceptable operations tempo for the tasked fleet squadrons. In retrospect, one could say that the Air Force paid for four squadrons and received 14.

This has led to a sort of shell game of EA-6B squadrons attempting to cover the forward deployment sites. VAQ-132's schedule in 1999 is an illustrative example. Flying out of Prince Sultan in early 1999, VAQ-132 was covering one of the gaps in the forward deployment bases. This was in addition to their normal workup and deployment rotation with their aircraft carrier. The squadron was scheduled to come home after 56 days at Prince Sultan AB. (Anything 57 days and over is counted as a deployment; 56 days and under is simply a detachment.) Because of Kosovo, the USMC was unable to support its scheduled deployment to Incirlik in support of Northern Watch/Provide Comfort. To cover the gap, VAQ-134, 132's replacement at Prince Sultan AB, was sent to Incirlik instead. VAQ-132 was extended on station indefinitely. Meanwhile, VAQ-136, the EA-6B squadron based in Japan as part of the forward-based Kitty Hawk battle group, was pulled off the Kitty Hawk and sent to Prince Sultan AB to relieve VAQ-132. VAQ-132 eventually made it home with 70 days of deployment on the books, only to begin preparing for their "real" cruise. All of this left the forward-deployed naval force without any EA-6Bs. One wonders what they would have done if a crisis had broken out in Korea. As the EA-6B wing requirements officer put it:

> During peak operations of Allied Force, 26 EA-6B aircraft—nearly one third of all operational EA-6B aircraft at the time—were deployed in support of Operation Allied Force. At the same time, EA-6Bs continued to support Operations Northern and Southern Watch over Iraq, the North Korean contingency, and three carrier deployments. As a result, the EA-6B community was tasked well beyond the typical deployment schedule, creating significant demands on aircraft, aircrews, and squadron personnel alike.[45]

Obviously, this pace could not continue. With the shootdown of an F-117 and the subsequent CINC requirement for EA-6B support of all strike packages, the newly declared Expeditionary Air Force suddenly found its combat power tied to the availability of about 96 to 104 (on a good

day) 15- to 20-year-old Navy aircraft.[46] Something would have to be done differently.

Future of Electronic Combat

There has to be "a balance between stealth . . . jamming . . . and info warfare. They all play a role in this force-protection business."

—Gen Michael E. Ryan, USAF
Chief of Staff

After a slow start, the joint community is beginning to realize that the capabilities of the EA-6B will have to be improved upon and eventually replaced. Dependence on the internal qualities of strike aircraft (stealth, self-protection) has been shown, at least at the current level of technology, to not work as completely as designers had hoped. Success in future conflicts and command of the air will depend on developing and strengthening all three legs of the EC triad: lethal SEAD, support jamming, and aircraft self-protection. "The idea that stealth could solve all problems was abandoned in favor of an active mix of stealth technology, active air-defense suppression, and electronic suppression."[47]

So, what is being done? First, the USAF has become very serious, very quickly about EC. A classified RAND report on Air Force capabilities is currently making the rounds at senior levels in Washington, D.C. It is said to recommend major changes to the way the USAF approaches EC. If the recommendations are carried out, EW will be elevated to an organizational level with stealth—the offices responsible for setting operational requirements for EW will be reinstated (they were slashed in the early 1990s)—and an EW acquisition office parallel to the stealth acquisition office will be created.[48]

Second, Congress is now actively encouraging the Pentagon to get serious about augmenting and/or replacing the EA-6B. The establishment of a fifth joint Air Force/Navy expeditionary squadron was announced.[49] The new squadron will be made up of aircraft from existing assets in the training or depot (maintenance) pipeline.[50]

Meanwhile, just after the Kosovo conflict, Congress included $10 million in the fiscal year 2000 budget for an

analysis of alternatives to assess follow-on designs to replace the EA-6B Prowler by 2010. Basically, there are five alternatives that are said to be on the table. New EA-6Bs could be built, incorporating the new Improved Capabilities (ICAP) III suite of jammers and transmitters. A smaller version of the ICAP III system could be placed in an existing tactical airframe, such as the F-18F, MV-22, Joint Strike Fighter (JSF), F-22, or F-15E. An entirely new aircraft, such as an EC version of the JSF could be considered. An unmanned aerial vehicle (UAV) containing an EC payload is being considered. Miniature airborne electronic attack munitions could be delivered into the battle space by such systems as the Army tactical missile system or the Navy's Tomahawk.[51]

A "Designed from Scratch" Aircraft

Documents from both the USAF and USN suggest that the idea of building a new aircraft from scratch is not being considered seriously. Lack of funding and the urgency of the requirement are the main arguments against this. "There is not sufficient funding available in the time of concern to build an airborne platform and integrated system from scratch."[52] This would seem to rule out either reopening the long-defunct Grumman EA-6B production line (option one) or marrying into a new airframe initiative (option two). That leaves putting a system on an existing airframe, UAVs, or devices carried on munitions.

Unmanned Aerial Vehicles

The EC mission profile would seem to lend itself to the use of UAVs. EA-6Bs generally fly out ahead of the strikers and establish a jamming orbit that covers the striker's inbound and outbound routes of flight. Flying a UAV into the battle space and setting up a loiter pattern while the strikers hit their targets makes some sense. Thus, the relevant question: "Is the technology there yet?" The development of EC payloads for UAVs faces three obstacles: priority, size, and adaptability.

There are six UAV programs at various stages of development within the US military. They are controlled by the Defense Airborne Reconnaissance Office (DARO).[53] The name of the organization controlling the development of UAVs should give the reader a sense of the current priorities for UAV utilization. Within the military, the CINCs interact with DARO to voice their equipment needs.[54] In the words of one senior US military official: "They're gonna want pictures. Pictures, pictures, pictures."[55] Overall, 13 different payloads have been identified as having potential to be placed in a UAV. They run the gamut from electro-optical/infrared and surveillance approach radar reconnaissance and imaging to communications or data relay and laser designating or range finding.[56] Of the six UAV programs, only two are currently being developed with an EW variant, and these only in terms of signals intelligence, not active jamming.[57] The current focus certainly seems to rest on reconnaissance, although EW proponents are working to change that.

Another barrier to the use of UAVs to perform SEAD is the size of the payload that the relatively small airframes are able to carry. Jamming a radar, literally overwhelming its signal with your own stronger one, takes a lot of power generation capability. The jamming pods that currently hang on an EA-6B weigh almost 1,000 pounds each. In contrast, the maximum payload that can be carried by Predator is 450 pounds. Even the larger Global Hawk, which can carry up to 1,960 pounds, cannot keep up with the EA-6B, which routinely carries 3,000 pounds of jamming transmitters in addition to its internal receivers and signal processing equipment. Equal to the task, leading companies have been working to overcome this limitation. Northrop Grumman is developing a tactical radar jammer (TRJ) as an electronic attack payload to be placed on the Hunter, one of the smaller UAV programs, currently active only for demonstration and testing purposes. With its 100-pound size, TRJ is able to operate with as little as one kilowatt of input, allowing it to be powered by most UAV engines.[58] Ultimately, Northrop Grumman is working to integrate the TRJ with a sensor package.[59] That would then approximate the capabilities of the EA-6B. As the Hunter is too small for this combined package, another

platform will have to be found. The Global Hawk has been mentioned in connection with this concept.

The final barrier to the EC use of UAVs is flexibility. Human intervention is what makes the EA-6B unique. The ability to listen to, display, and evaluate or analyze electronic signals in real time is what gives the electronic countermeasures officers in an EA-6B the crucial edge in combat. This human interaction protects friendly systems from fratricide, ensures compliance with applicable rules of engagement, and enables rapid reaction to the ever-evolving conditions of combat. There is some debate over whether or not a system that is flexible enough to cope with the immediate demands of EW has been perfected yet.

Nonetheless, UAVs seem to be the preferred plan of the future for the USAF, as it does not involve diverting aircraft development money from the F-22. "I don't see another airplane," a senior official said. "We will do something less expensive. I think you will see a decoy or an unmanned aircraft."[60] Current development is taking place at the Air Force UAV Battlelab. There, Air Force developers work to "leverage upon the UAVs strengths of endurance and survivability to perform all aspects of the non-lethal SEAD mission."[61]

Existing Aircraft

The option that has had the most proven success is the modification of an existing airframe to perform the EC mission. Past aircraft that were originally designed for different purposes but proved to be effective war fighters in an EC configuration include the EF-111A, the F-4G, and the EA-6B.[62]

This option has several advantages. It is substantially cheaper, as it builds on a platform that already has a production line open. It is also a known quantity. The manned tactical EW aircraft have proven combat records. With the state of the world today, it might not be the best time to experiment with unproven EW concepts.

This option also has the advantage of timing. Its ready-to-go airframe is beginning to come off the production lines. The US Navy's F-18F—the two-seat version of the

Navy's new multipurpose fighter—lends itself to being crewed with a pilot and an ECO. Indeed, McDonnell Douglas has already built a mock-up, the proposed F-18G. From the reviewed concept briefings, this appears to be the USN's alternative of choice, which would comply with the Navy's traditional advocacy of manned EC assets. Navy officials—such as Rear Adm John Nathman, director of Air Warfare—continue to insist that everything is on the table until the 18-month analysis of alternatives is completed.[63] A survey of recent coverage in various journals, however, will quickly show the reader that the Navy is talking about almost nothing but the F-18G. A joint Air Force/Navy buy of this aircraft, similar to the joint development of the F-4 Phantom II in the 1960s, would solve many problems for both services.

SEAD Munitions

Imagine if instead of sending aircraft into the battle space to suppress enemy air defenses, friendly forces could launch a series of missiles, either from aircraft flying well out of threat range or from a ground-based system. These missiles would autonomously search for, detect, identify, attack, and destroy SAM systems.[64] That is the idea behind the low cost autonomous attack system (LOCAAS). These munitions would, in effect, become miniature Wild Weasels loitering while strike aircraft prosecute their targets, ready to pounce on any SAM system that becomes active.

As envisioned, LOCAAS has a standoff range of more than 90 miles, a search area of 33 square miles, and a turbojet engine capable of powering the munition for 30 minutes.[65] On 17 December 1998 the Air Force Research Laboratory awarded Lockheed Martin a $32 million contract to produce an advanced technology demonstration of the LOCAAS. The expected contract completion date is 10 December 2001.[66]

There are concerns with this approach. The idea of launching an autonomous weapon that seeks out and attacks its own target raises the specter of fratricide. The contract with Lockheed Martin specifies that "the system will be capable of discriminating between classes/types of

targets and between targets and non-combatants."[67] How they propose to accomplish that in a coalition environment where the enemy may very well be operating some of the same weapons systems as friendly forces remains to be seen. Assuming that the selectivity issue could be worked out, a fielded capability is (optimistically speaking) several years away.

Summary

The hodgepodge of platforms and systems that represent the future of EC and SEAD suffers from a lack of funds and attention. While most of the attention over the last decade has been lavished on the USAF's number one funding priority, the F-22, EC as a whole has languished at number 17.[68] Which of the five programs considered will represent the future of EC? No one is seriously considering reopening the EA-6B production line. The design is too old and only marginally survivable in today's battle space. Building a new airframe as an EC platform is almost entirely out of the question, both for the USAF and the USN. UAV programs are so overly concerned with getting good film footage for CINCs and their commanders that EC payloads are almost an afterthought. SEAD munitions are years away from any sort of operational capability.

The most likely scenario involves a two-tiered approach: near term and long range. In the near term, modification of an existing airframe to produce a new combat aircraft capable of both jamming and firing antiradiation missiles is the only option that is going to alleviate the current critical shortage of assets. Joint development is a must. The armed forces of the twenty-first century no longer have the luxury of simultaneously developing their own programs, as with the EF-111 and EA-6B. The USAF and the USN will have to work together to field a platform that can quickly fill crucial joint power projection shortfalls. But the long-range options should not be ignored. The era of cruise missiles and zero-casualty warfare demands further development of the unmanned options.

The future of EC almost certainly lies in UAVs and smart munitions.

Conclusions

I think we all agree it's time for a fundamental review of our electronic warfare posture.

—Gen John P. Jumper, USAF
US Air Forces Europe

By 1941 the Air Corps leadership knew they had a problem. At that point it was too late to do anything about it, and the Eighth Air Force eventually paid the price. Chennault later remarked, "It is in time of peace that we must develop our technical equipment and train our personnel. We cannot do these things after the beginning of hostilities nor can we suddenly shift from one type of vital technical equipment to another after the fighting starts. Our leaders in peacetime should have sufficient imagination, vision, and experience to direct technical development and personnel training upon sound lines."[69] The challenge before the USAF is to recognize the problem that exists today with EC force structure and capabilities and act to "direct technical development and personnel training" before a tragedy is allowed to occur.

According to Capt Kenneth Krech, USN, there are three realities in today's force structure: "First, the level of military presence overseas has not decreased. Second, the need for SEAD has also increased. Finally, the 'savings' of decreased support-jamming requirements are not being realized."[70] Change needs to occur (fig. 2). Looking at the model of people, theory, money, technology, the place where change has to begin is theory. Change will not come easy. The organizational culture of the Air Force is such that it is difficult to admit that technology cannot overcome defenses. Airmen must understand that command of the air is vital. It is not something that can be passively taken for granted, it must be fought for each time a US aircraft flies into hostile territory.

As this paper has shown, World War II and the recent events in Kosovo have both highlighted the importance of command of the air. US forces must "deprive the enemy

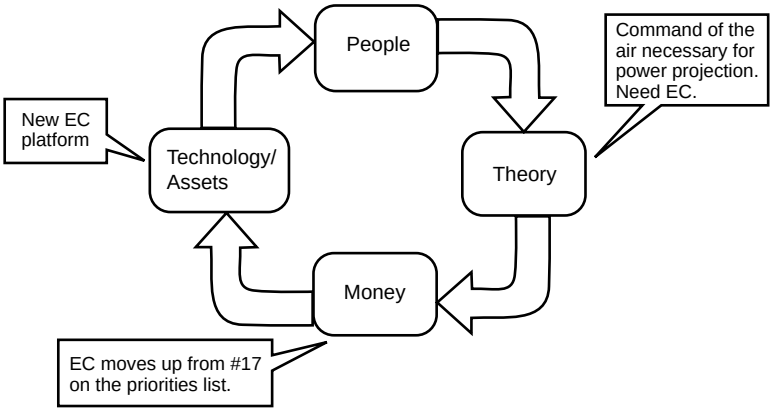

Figure 2. How Change Could Occur

of the power to injure," to put it in Douhet's terms. A strong balance of capabilities must include being able to shoot down the enemy's aircraft, destroy them on the ground, or destroy his SAM batteries. Only then can strike aircraft effectively carry out their mission. In order to leverage the combat power available in the F-117, B-2, and F-22, effective EC capabilities will have to be paid for and utilized. These EC capabilities must include R&D of all three sides of the EW triad: support jamming, lethal SEAD, and self-protection.

Once the people involved are able to overcome the paradigm of stealth and return to the real meaning of command of the air, the theory will change. That has already started. General Ryan's remarks show how the Air Staff is beginning to consider this issue. As Congress continues to take an interest in this issue, money will become available. This will lead to new technology. In the near term, the USAF and USN must work together to field an aircraft that will ensure that US forces will be able to aggressively take command of the air. Long-term goals should include a renewed effort to utilize UAVs and smart munitions. Regardless of the technology eventually developed, it is the theory that is important, not the platform. Nothing less than the US power projection capability in the twenty-first

century depends on a correct interpretation of a theory from the 1920s: Douhet's command of the air.

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