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THE FOG OF WAR: EFFECTS OF
UNCERTAINTY ON AIRPOWER EMPLOYMENT

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Preface

This project's motivation began about 10 years ago when I, as a young pilot in an operational fighter squadron, heard experienced pilots refer to the *fog of war* during briefings. They used the term to explain the difference between training and actual combat. They would say, "don't expect things to go smoothly or as planned in combat because of the fog of war." That seemed reasonable enough, but I still wondered about the true nature of the fog of war. Thus I set out to try to grasp the fog of war concept as specifically as possible. During the course of my research, I have learned much about this subject so as to fulfill my desire to understand the fog of war (also referred to hereinafter as simply *fog*). I hope it does the same for you.

While this was an individual research effort, I would like to thank my research advisor, Lt Col Ernie Howard, for his guidance and expertise in this subject area. He was able to point me in the right direction while I was struggling to focus my research effort. Without his help, I would still be pouring over documents in the library.

Abstract

This paper addresses the question: Can fog be identified from past air campaigns and applied to make future air combat more effective? The purpose is to educate the reader on fog and to offer techniques for coping with fog in future air combat. The paper is divided into three sections: Defining fog; presenting examples of fog from the air campaigns of World War II Europe and the Persian Gulf war; and recommending ways to cope with it.

This paper defines fog as uncertainty about the enemy, the environment, and friendly forces. Examples will illustrate these uncertainties so the reader can learn to identify uncertainty in the air combat environment. The paper concludes with an analysis of uncertainty, along with recommendations for coping with uncertainty in the employment of airpower. These recommendations are under the five general areas of technology, leadership, training, experience, and planning.

The author believes that the key to coping with uncertainty is to understand it. Thus, the airpower practitioner needs to know what uncertainty is, what it looks like, and how to avoid it, or at least minimize its adverse impacts.

Chapter 1

Introduction

Carl von Clausewitz states that “Friction is the only concept that more or less corresponds to the factors that distinguish real war from war on paper.”¹ In other words, the fog of war—what Clausewitz calls friction—is the main difference between combat and peacetime training. Military commanders today insist that their forces train like they are going to fight to maximize combat effectiveness. This training philosophy is echoed throughout each service, and airpower employment is no different. If fog is the main difference between combat and training, and it is desirable to train like we intend to fight, then fog should be addressed as much as possible in training for combat. To help prepare for combat, can fog be identified from past air campaigns and applied to make future air combat more effective?

To provide an answer, this paper will use a three step method. First, fog will be explained using various authors and sources. Second, the Allied air campaign of World War II Europe and the Coalition air campaign of the Persian Gulf War will be examined for examples of fog. Finally, the paper will analyze fog from these air campaigns and recommend techniques for coping with it in future air combat. The key to coping with fog is to understand it. Hence, the purpose of this paper is to educate the reader on fog as it applies to air combat and suggest techniques for dealing with fog in future conflicts. If

techniques can be applied to ease the adverse effects of fog, then combat efforts should be less hampered, and thus more effective.

While primarily written from the operational fighter squadron perspective, anyone involved or interested in airpower employment may find the paper interesting. The following assumptions apply concerning the presentation of material.

1. The reader is somewhat familiar with the air war in World War II Europe and the Persian Gulf war such that detailed background information is unnecessary.
2. The discussion is focused on airpower as much as possible. References to land or maritime forces will be used as applicable.
3. The reader's knowledge of the fog of war is very basic. The reader knows that the fog of war is a concept that explains why war is different from peacetime training.

Notes

¹ Carl von Clausewitz, *On War*, ed. and trans. Michael Howard and Peter Paret (Princeton, New Jersey: Princeton University Press, 1976), 119.

Chapter 2

Defining the Fog of War

Different authors define fog in various ways. This section will present several views on fog and then categorize them for use in the case study examinations. What are the various views on the fog of war?

The fog of war is a popular phrase used to describe aspects of combat that are different from training and that are difficult to train for in peacetime. Joint Publication 1, *Joint Warfare of the Armed Forces of the United States* states that "...friction, chance, and uncertainty still characterize battle. Their cumulative effect comprises 'the fog of war'."¹ This 1995 document links directly to the 1831 writings of Clausewitz, who gave the first and probably best description of fog. Clausewitz identifies four elements that combine to form the atmosphere of war: Danger, physical exertion, intelligence, and friction. In their restrictive effects, they can be grouped into a single concept of general friction.² Thus, the fog of war term used today started out labeled *general friction*, or simply *friction*.

So if the fog of war is friction, what is friction? Clausewitz' answer is "friction...is the force that makes the apparently easy so difficult."³ Clausewitz elaborates on this somewhat vague explanation of friction.

Everything in war is very simple, but the simplest thing is difficult. The difficulties accumulate and end by producing a kind of friction that is inconceivable unless one has experienced war.

The military machine...is basically very simple and therefore seems easy to manage. But we should bear in mind that none of its components is of one piece. Each part is composed of individuals, every one of whom retains his potential of friction.

Countless minor incidents—the kind you can never really foresee—combine to lower the general level of performance, so that one always falls short of the intended goal.⁴

The second quote can be illustrated by the parlor game during which people pass a verbal message in sequence to each person playing the game. By the time the message gets back to the originator, it usually does not resemble the original message. The same could be true of passing a commander's intent through the chain of command. Depending on the communication system, the message received at the tactical level may not be the same as the commander initiated.

Consider a fighter squadron deploying to southwest Asia (SWA) to illustrate the third quote. The goal is to get 10 jets safely to Saudi Arabia. More often than not, one or two jets break on the ground. Someone in the air traffic control chain fails to obtain an altitude reservation (ALTRV), delaying takeoff clearance. The pallet loader breaks, causing a delay in the KC-10's departure. Frustration sets in. Another jet has to air abort and requires a chase. Did fuel planning account for the extra ground delay? Low hydraulic pressure that number eight overlooked during the rush to a ground spare now falls to zero, requiring an emergency landing in Spain. Due to these countless minor incidents, only six jets arrive at destination, far short of the intended goal of 10.

Another element of Clausewitz' *general friction* is intelligence. He states, "This difficulty of *accurate recognition* constitutes one of the most serious sources of friction in

war, by making things appear entirely different from what one had expected.”⁵ Clausewitz also uses the term *uncertainty* to describe this dilemma of intelligence. Encountering the unexpected has obvious implications in a combat environment.

Clausewitz states that danger, exertion, uncertainty, and chance comprise the climate of war.⁶ These words are still used today in various military manuals to define fog. Armed with Clausewitz’ definition of fog, more contemporary views of fog will be examined.

In studying the U. S. Army Air Corps’ pre-World War II precision bombardment doctrine, Thomas Fabyanic proposed the notion of collective risk. U. S. air planning for the combined bomber offensive (CBO) against Germany was largely predicated on five assumptions: Size and composition of the Air Forces necessary, bombing accuracy, bomb effectiveness, bomber penetration, and the existence and vulnerability of vital targets. In each of these areas, allowances were made to account for the fog of war. For example, under bombing accuracy, if peacetime bombing scores indicated that 30 B-17 groups might be needed to take out a given target, then five times that number (150 groups) would do the job in combat. What Fabyanic suggests is that there is an aggregate accumulation of potential difficulties that are inherent in any set of assumptions.⁷ In other words, when assumptions based on uncertainties are made, there occurs a “synergy of friction,” meaning the sum of all the frictions accounted for in the assumptions is greater than the sum of the individual frictions. Collective risk is illustrated in the earlier squadron deployment example. Even though ground and air spares were available, and the ALTRV request was timely, and the pallet loader was brand new, and each jet’s hydraulic system

was carefully checked the day prior, the cumulative effect of all these individual frictions resulted in only six of 10 jets reaching their destination.

Based on Fabyanic's assertion, not only must general friction be overcome, but the synergy of friction as well. Synergistic friction would likely increase with complexity of the air campaign. The more assumptions that are made, the more opportunity for collective risk to interfere with operations.

Currently, both the U. S. Army and U. S. Air Force have official views on fog. The Army's operations field manual (FM 100-5) states that "Friction is the accumulation of chance errors, unexpected difficulties, and confusion of battle that impede both sides. It can never be completely eliminated, but left unchecked, it can have a devastating effect on unit agility."⁸ FM 100-5 also states that "Loneliness and fear on the battlefield increase the fog of war."⁹ Air Force Manual 1-1 (AFM 1-1, Basic Aerospace Doctrine of the United States Air Force) elaborates much more on the Clausewitzian notion of friction.

The friction of war has physical and psychological aspects. Friction that is the direct result of the physical environment is the more readily perceived. Such friction is caused by darkness; poor weather; terrain and geographic obstacles; physical exertion; degraded or limited command, control, and intelligence systems; complexities of organization and command relations; degradation of logistics, maintenance, and weapon systems; and chance....Although the psychological aspects of friction result from the same causes as the physical aspects of friction, their defining effect is the stress they create on combatants. This stress is produced by the interaction of combatants and the environment of war, which is characterized not only by violence and uncertainty but also by physical exertion and danger. Stress threatens the combat effectiveness of individual combatants, both leaders and followers, and the combat effectiveness of military organizations at all levels of war.¹⁰

The last author to be discussed categorizes the elements of friction under three simple headings: The enemy, the environment, and friendly forces. John K. Setear states

that...The first source of the fog of war is uncertainty about the enemy (enemy intentions, disposition, and strength of enemy forces)...Another source of the fog of war is uncertainty about the environment (weather, geographic data)...The third generator of uncertainty stems from friendly forces (one's own men fail to communicate effectively with one another, leadership knowing how to choose subordinates and how to keep the channels of communication functioning).¹¹

Taking bits and pieces of these various authors and sources, the following is a categorized definition of fog that will be used throughout the remainder of this paper.

The Fog Of War Is Uncertainty About:

The Enemy

- Intentions
- Forces
- Objectives
- Unpredictability/Rationality
- Adaptability/Thinking (reactions, countermeasures)

The Environment

- Weather (darkness, rain, smoke, fog, clouds, haze)
- Terrain (geography, infrared background, topography, political borders)
- Danger (morale influence, fear, stress, surprise, shock)
- Exertion (physical, mental)
- Chance Occurrences

Friendly Forces

- Leadership (decision making, subordinate training, doctrine, tactics, morale)
- Intelligence (BDA accuracy, assumptions, ethnocentrism)
- Planning (target selection)
- Information (imperfect, overload, comprehension, accuracy, concealment, deception, conflicting, ambiguous, incomplete, unreliable)
- Communication (effective, decision execution)

Table 1. Categories of Uncertainty

THE ENEMY	THE ENVIRONMENT	FRIENDLY FORCES
Intentions	Weather	Leadership
Forces	Terrain	Intelligence
Objectives	Danger	Planning
Unpredictability	Exertion	Information
Adaptability	Chance Occurrences	Communication

Clausewitz defined fog 150 years ago as what makes war different from peacetime training. For him, the difference is danger, exertion, uncertainty, and chance. Since Clausewitz, others have defined fog much the same way. Table 1 assimilates various thoughts on fog so it can be as identified as precisely as possible. With the fog of war recognizable, examples from past air campaigns can be examined for educational purposes. Ultimately, learning from past victims of fog can help make future air warriors better prepared for combat, and thus more effective.

Notes

¹ Joint Pub 1, Joint Warfare of the Armed Forces of the United States, 10 January 1995, I-2.

² Clausewitz, 122

³ Ibid., 121

⁴ All three of the block quotes come from Clausewitz, 119.

⁵ Clausewitz, 117

⁶ Clausewitz uses the terms “intelligence” and “uncertainty” synonymously. He does likewise with “friction” and “chance.”

⁷ Lt Col Barry D. Watts, *The Foundations of U.S. Air Doctrine* (Maxwell AFB, Ala.: Air University Press, December 1984), 54.

⁸ Field Manual (FM) 100-5, *Operations*, June 1993, 2-7.

⁹ Ibid., 14-2.

¹⁰ Air Force Manual (AFM) 1-1, *Basic Aerospace Doctrine of the United States Air Force*, vol. 2, March 1992, 17-19.

¹¹ John K. Setear, *Simulating the Fog of War*, RAND Report P-7511 (Santa Monica, Calif.: RAND, February 1989), 3-4.

Chapter 3

Examples of the Fog of War

The air war in World War II Europe offers excellent examples of fog. Realizing that future air combat will probably not be as “primitive” and involve the sheer mass of World War II, the Gulf War will also be examined to provide more modern examples of fog. These wartime examples illustrate the table 1 uncertainties. Not every category will be covered, but the reader can learn to identify fog and understand how it effects combat operations from the examples provided.

The Allied Air Campaign in World War II Europe

...In practice the American daylight strategic bombing campaign would continue to be influenced by operational considerations such as force size, weather, and the unanticipated strengthening of the German air defenses.¹

This statement provides a broad example of all three areas of uncertainty: The enemy (German air defenses), the environment (weather), and friendly forces (force size). The following examples will elaborate on these three categories.

Uncertainty about the Enemy

Intentions. In preparing for the D-Day invasion, the [Allies assumed the] Luftwaffe was certain to conserve its forces in order to strike a massive blow at the invasion forces.² But when and where would they strike? As it turned out, the German Air Force (GAF)

was not able to put up much resistance during D-Day, and thus uncertainties about their intentions were not a big factor in the invasion. Another case of enemy intentions is the following.

A good example...of differing estimates of policy...was the attempt to understand what the Luftwaffe strategic policy was when German resistance was so weak against the raid on aircraft factories on February 20, 1944 as well as the raid on Berlin on March 9, 1944. Were the Germans tactically exhausted on those days? Did weather conditions hinder them? Were they following a policy of deliberate conservation of force, or were they beaten in a more absolute sense?³

Forces. Imagine the uncertainty Allied pilots faced when they saw the Me-262 jet fighter for the first time. What can it do? How fast can it go? Can it be defeated in air combat? While this example shows uncertainty about enemy forces' equipment, other uncertainties involve enemy numbers, tactics, crewmember proficiency, and will.

Objectives. In preparing for D-Day, the Luftwaffe High Command decided that the Russian threat to the Romanian oil fields was more serious than the D-Day invasion and kept over 500 aircraft of the fighter bomber force deployed in the east.⁴ Had the Allies known about this objective early on, the air campaign could have been planned more effectively.

Unpredictability/Rationality. The following example of German ground operations in the Battle of the Bulge is a good illustration of enemy unpredictability.

...Virtually all the steps being taken or ordered [by the Germans] were consistent with the employment of the Luftwaffe in support of defensive ground operations. Given any rational evaluation of the probabilities of success and the consequences of failure of a spoiling attack, a major German offensive made no sense. The failure was not one of not recognizing signs of the impending thrust; rather, the culprit was the wish that the enemy would do as the analysts and commanders thought he should, not as the enemy himself wanted. Field Marshal Bernard Montgomery was right when he stated (ironically, on the day the attack

began) that the German Army “has not the transport or the petrol that would be necessary for [extensive] mobile operations....He was wrong in assuming Hitler would operate under such an assessment.”⁵

Adaptability. As a thinking, adaptive enemy, the Germans were able to counter Allied unescorted bomber formations and their defensive firepower.

By concentrating on one formation at a time, using rockets fired from beyond the effective range of B-17 machine-guns to break up the American bomber boxes, and aggressively pressing home fighter attacks, the Germans demonstrated once and for all that unescorted bombers were not invulnerable to attack by determined, resourceful opponents.⁶

On the ground, the Germans adapted to Allied bombings by dispersing factories, taking defensive measures (camouflage, smoke, dummy factories, flak), and reorganizing the industrial hierarchy for greater efficiency. An enemy who can think, adapt, and react can indeed be a formidable opponent, as the Germans were in World War II.

Uncertainty about the Environment

Weather. Obviously, weather can be a great inhibitor in air combat, both in air-to-air and air-to-ground operations. The following statement by Major General Haywood S. Hansell, Jr. (Retired) sums up the weather factor in World War II Europe.

If the weather at the target area was not suitable to bombing, then a whole mission had been wasted and perhaps the lives of many crewmen had been lost to no effect. If the weather on return to base was “socked in,” then disaster could ensue. As any visitor to England and all members of the Eighth Air Force will recall, England is occasionally hit by dense fog over large areas, and that fog can be so dense that it is difficult to walk from the mess to the operations office—to say nothing of finding hard stands and the airplanes...It was quite possible that the entire Eighth Air Force could be lost on a single afternoon by returning to England and finding all bases “socked in.” And bombing accuracy was heavily degraded by even partial cloud cover of the target. The weather was actually a greater hazard and obstacle than the German Air Force.⁷

Danger. Another obvious fact of air combat is the inherent danger. For example, in order to improve attrition of the GAF fighter force, planners would sometimes deliberately pick routes to engage German defenses instead of seeking routes to avoid them. Such is how bomber pilots began to feel like bait for the Allied fighters to lure the GAF into battle.

Chance Occurrences (The Unexpected). Consider the German pilot who accidentally bombed London one night during the Battle of Britain.⁸ In response, the Royal Air Force (RAF) bombed Berlin. The Germans retaliated with a bombing campaign on London, which relieved pressure on the nearly defeated RAF Fighter Command. Fighter Command recovered and fought off the GAF during the London bombings. Suffering heavy losses, Germany postponed its plans to invade England indefinitely. In this case, the rippling effect of a chance occurrence (accidental London bombing) led to campaign failure.

Uncertainty about Friendly Forces

Leadership: Doctrine. The U.S. began its World War II European bombing campaign with a doctrine of daylight precision bombing. The theory was that a large force of heavily defended bombers could penetrate enemy air defenses unescorted and strike targets important to the enemy's war effort. Rigid adherence to this doctrine cost many airmen their lives. In the second week of October 1943, Eighth Air Force made four attempts to break through the German fighter defenses unescorted. These missions were so costly that the objective of smashing the Luftwaffe had to be abandoned until early 1944.⁹

Intelligence. Clausewitz states that one should only believe reliable intelligence and never cease to be suspicious.¹⁰ Intelligence is based on assessments and assumptions, and one of the key areas is bomb damage assessment (BDA). Although assessing physical bomb damage is easy, assessing mission results are much more difficult.

Suppose a decision is made to take out a plant producing ball bearings; suppose 100 bombers are dispatched and succeed in utterly demolishing the plant. So far as the command and crews are concerned, the effectiveness of the mission is taken for granted to be 100 percent—the given target was attacked and destroyed. But suppose, also, that the ball bearing output of the destroyed plant is never missed by the enemy throughout the war—either because of huge stockpile or alternative sources of supply. In such a case, the *effectiveness* of the mission in speeding up victory *drops to zero*; indeed, the question that arises, when one asks how the 100 sorties might otherwise have been applied, whether or not the mission's effectiveness should be described as a negative (or minus) value.¹¹

Another assumption made during World War II was that German industry, namely aircraft production, was working at 100 percent capacity to support the war effort. The fact that it was not working at 100 percent made it appear resilient under air attack. Even though aircraft factories were being destroyed, fighter aircraft production was increasing.¹² Additionally, the German power system was never a target because it was assumed to be highly developed and redundant. This assumption was incorrect. Generator and distributing facilities were vulnerable and recuperation time was long. Evidence indicates that the destruction of the power system would have had serious effects on Germany's war production.¹³ Intelligence will always be a source of uncertainty in air warfare, and Clausewitz' warning to always be suspicious is sound advice!

Information: Imperfect. Exaggerated kill claims by bomber crews caused great uncertainty in the accurate attrition of the GAF when several different crew members claimed kills for the same aircraft. The result of numerous kill claims was the impression that unescorted raids were accomplishing their objective: GAF fighter force attrition. Thus, the raids continued with high losses. In just four deep penetration raids in October 1943, Eighth Air Force lost 148 bombers—30 percent of its bomber force and 35 percent of its combat effective bomber crews.¹⁴ Allied leaders eventually recognized the problem and established more restrictive kill criteria, but not before being misled to believe that unescorted bomber tactics worked with acceptable losses.

Information: Missing. Lt Col Watts states that “Even the intelligence windfall afforded by ‘ULTRA’ decrypts of high-grade German wireless traffic failed to give British and American bomber commanders the one thing they wanted most: a detailed picture of the actual effects of their efforts on the German war economy.”¹⁵ For example, post-war records show that air raid alerts in 1943 were a more serious cause of the lost production than the actual damage from the raids themselves.¹⁶

Communication. Two-way radio communication was at times a problem on deep penetration raids into Germany. Post launch target changes or mission abort orders issued by commanders in England were sometimes missed because the bombers were out of radio range. Worse yet, some formations would receive a cancellation order and abort, while those who missed it would press on to the target, resulting in smaller formations with less defensive firepower, and thereby greater losses. Enemy intrusion into the communications net was also a source of uncertainty (target change, course diversion, etc.).

Collective Risk. The CBO illustrates how the accumulation of uncertainty about information, leadership, and a thinking enemy caused the Allied bombing campaign to fall short of its intended goal. Inflated kills by bomber crews led commanders to believe that unescorted bomber tactics were working. This inaccurate information, coupled with higher than anticipated German fighter production, resulted in heavy bomber losses. Thinking that these losses were justified by attrition of the GAF, Allied leaders continued with their doctrinal rigidity. Meanwhile, GAF fighters successfully adapted their tactics to counter the unescorted bomber tactics. Heavy losses (30 percent) in October 1943 finally convinced Allied leaders that their strategy was not working. They would have to await the arrival of long range fighter escorts in early 1944 to continue the bombing campaign.

The unfortunate result of this accumulation of uncertainty was that hundreds of airmen were lost.

The Coalition Air Campaign in the Persian Gulf War

As a more contemporary example of uncertainty, the Persian Gulf war provides some valuable education that may be applicable to future air combat.

Uncertainty about the Enemy

The fixed Scud launchers in western Iraq functioned, on the night of 16-17 January 1991, as “decoys” that diverted attention away from the mobile launchers that had already deployed to their wartime “hide” sites....Once Scuds started falling on Israel and Saudi Arabia, the next best option would have been to locate and attack mobile launchers before they had time to fire. Soviet exercise patterns...and Iraqi practice during the Iran-Iraq war indicated that if the Iraqis followed prior practices, there might be enough pre-launch signatures and time to give patrolling aircraft some chance of attacking mobile launchers before they fired. During the Gulf War, however, the Iraqis dramatically cut their pre-launch set-up times, avoided any pre-launch electromagnetic emissions that might give away their locations before launch, and seeded the launch area with decoys (some of which were very high fidelity) and other vehicles.¹⁷

This statement illustrates three Coalition uncertainties about the enemy: intentions, forces, and unpredictability.

Intentions. It was not known until after the fact that Iraq was going to use its mobile Scud launchers to strike Israel.

Forces. In this case, the uncertainty is *where* are the enemy forces? The fact that Iraqi mobile Scud launchers eluded Coalition forces throughout the war illustrates the effects of uncertainty about the enemy.

Objectives. It eventually became apparent that Iraq was attempting to preserve its air force by sending aircraft to Iran. Had this been known earlier, measures could have been taken to destroy these fleeing aircraft before they reached Iran.

Unpredictability. The Iraqi's displayed this quality by the exclusive use of mobile Scud launchers in attacking Israel and by changing their pre-launch operations to minimize detection. The result of this uncertainty was that the Coalition failed to destroy Iraq's mobile Scud forces. Nineteen known mobile Scud launchers survived the war¹⁸ and are still a threat to Iraq's neighbors.

Adaptability. Iraq adapted to Coalition efforts to destroy its air force on the ground by moving aircraft out of hardened bunkers and dispersing them to areas less likely to be attacked (i.e. near cultural monuments, populated areas, etc.). The result was that Iraq still possessed an estimated 300-375 combat aircraft at war's end, more than Coalition commanders would have preferred.

Uncertainty about the Environment

Weather. Even technology cannot always overcome the uncertain conditions that weather can create.

Particularly in the early days of the air war, as many as half of the sorties did not attack or missed their assigned targets because of poor weather. Some aircraft thus had to employ less accurate radar-aimed bomb releases through the clouds; other aircraft, such as A-10s and AV-8Bs, returned with their weapons or did not take off at all. Laser-guided bombs could not be guided if the target lay beneath fog or clouds. On the second and third days of the air war, more than half of the F-117 flights were unsuccessful or canceled because of low clouds over Baghdad; on the following two days in the Kuwait theater, A-10s that normally flew a total of over 200 sorties a day successfully flew a two day total of only 75.¹⁹

Weather not only affected bombing, but also BDA.

The unexpected took place on the first day of the air campaign when weather presented itself as a formidable obstacle to bomb damage assessment. Heavy overcast during the early days of the war prevented adequate reconnaissance of many strategic targets—most were not covered until 21 January, five days after the beginning of the air campaign. This circumstance put intelligence assessments behind from the outset and derailed the prewar planning assumption that imagery of a target would be available to analysts in time for the target to be revisited, if necessary, two days later.²⁰

Terrain

Terrain in the target areas presented several advantages to the attacking aircraft but posed some problems as well. The flat, undifferentiated desert terrain of the Kuwait theater made visual orientation of targets by the attack aircraft quite difficult. The combination of the high altitudes flown by the attacking aircraft, the Iraqi use of decoys and camouflage, obscuring smoke, and conditions of blowing sand complicated both visual and infrared observation of vehicles and equipment.²¹

Danger

Although some crews initially tried NATO-style low-level ingress tactics during the first few nights of Desert Storm, the sheer volume and ubiquity of barrage anti-aircraft artillery, combined with the ability of Stinger-class infrared SAMs to be effective up to 12,000-15,000 feet, quickly persuaded most everyone on the Coalition side to abandon low altitude, especially for weapons release. Coincident with aircrew reactions to the dangers of low-altitude operations, Brig Gen Buster Glosson quickly directed the air force units under his command to shift to medium altitude for ingress, egress, and weapons release.²²

The result of shifting to medium altitude was a sacrifice in bombing accuracy. The move to medium altitude was a reaction to danger that was brought on by the desire to keep casualties to a minimum so that home support for the war effort would not vanish.

Exertion. In Desert Storm, the exertion was not so much physical as mental. Long duration missions (typically 5-10 hours for fighters) every day (or night) afforded pilots little sleep. Flight surgeons cited fatigue as the most pervasive problem facing aircrews, attributing at least two noncombat fatalities to it.²³ The results of fatigue can easily lead to degraded mission performance or even total mission failure.

Chance Occurrences. From the Iraqi perspective, tank plinking offers a good example of chance. Watching their troops getting methodically blown up, Iraqi tank commanders would no doubt ask themselves when their tank was next. The following is a remark made by a captured Iraqi officer during interrogation.

During the Iran War, my tank was my friend...I could sleep in it...During this war my tank became my enemy...None of my troops would get near a tank at night because they just kept blowing up.²⁴

The result of this fear of chance was that Iraqis would abandon their tanks, thus rendering them ineffective.

Uncertainty about Friendly Forces

Leadership: Decision Making. Friction was present by the fact that the Black Hole (e.g. air campaign planners) was set up as a special access organization. Outside organizations, including theater intelligence, were not privy to the Black Hole's concept of operations. This friction was brought on by the need to be secretive about planning the offensive air campaign. Three major repercussions resulted from this friction. First, a rift developed between the Black Hole and theater intelligence. Second, the Black Hole had their own target labeling system that was different from what other organizations were using, causing confusion at times. Finally, the Black Hole turned to national intelligence sources for support because of the dislike of theater intelligence. This was obviously a redundancy and waste of theater intelligence support.²⁵

Intelligence. Uncertainties, gaps, and errors in intelligence about targets have always been the rule, and the Gulf War was no exception.

Some vital information—such as the location of mobile Scud missile launchers—proved to be just too difficult to obtain....Though far from mobile, Iraqi nuclear research

facilities proved nearly as difficult a problem. Coalition intelligence uncovered only eight known or suspected nuclear facilities before or during the war, yet postwar inspections...turned up at least an additional 18. The fact that 16 of the 26 were considered “main facilities” means that at least eight major nuclear facilities escaped detection until after the war.²⁶

Information: Imperfect. Closely related to intelligence, imperfect information is best illustrated by the bombing of the Al Firdos bunker in Baghdad. The Coalition did not know that the bunker, a legitimate military target, also served as a civilian shelter when F-117s attacked it on 13 February 1991. The controversy over the deaths of several hundred civilians resulted in tightened control from Washington of attacks into downtown Baghdad.²⁷

Information: Missing. As mentioned earlier, some vital information (i.e. mobile Scud location) proved to be too difficult to obtain. At other times, information was too slow or even unavailable in the demands of a combat environment.

Unfortunately, pilots often flew with outdated pictures of the target or with no imagery at all. For some units, imagery was not critical. But since imagery was a standard part of mission preparation materials, all aircrews had come to expect it. It was not good enough to read a message that described the target and its surroundings; they wanted and expected to see a picture of it. Although the intelligence community had successfully provided imagery for target folders for crew study in peacetime, the demand in wartime for imagery and imagery-derived products was not met.²⁸

Communication Channels. Passing information to the warfighter can also induce uncertainty into the picture. Planners wished to minimize long term damage to Iraq’s economic infrastructure. As such, they selected targets based on how quickly they could be repaired after the war. For electric power, transformers and switching yards could be

recuperated in far less time than generator halls and turbines. Some flying units were unaware that planners were attempting to limit long term damage and were using generator halls as aimpoints.²⁹ This lack of communication resulted in failure to limit the long term damage to Iraqi infrastructure.

Communication Overload. In order to exercise centralized control, Central Command Air Force (CENTAF) transmitted the complete Air Tasking Order (ATO) via computer to each flying unit. The ATO was important, because if a unit was not on it, they did not fly. Due to the large volume of information contained in a typical ATO, communication and computer equipment became overwhelmed. Some units reported that transmission and printing were taking more than five hours.³⁰ As a result, less time was available for mission planning.

Collective Risk. To demonstrate the synergy of uncertainty in Desert Storm, it was desired that before the ground offensive began, General Schwarzkopf wanted Iraqi equipment in the Kuwait theater attrited to 50 percent. As the air war began, the dangers posed by Iraqi AAA caused aircrews to attack from medium altitude. As a result, accuracy decreased for non-precision weapons. Weather then became a factor. Often times, poor weather at medium altitude caused mission aborts or target obscuration. Thus, equipment attrition was slowed. Also, Coalition information from various intelligence agencies caused speculation about actual attrition. Although the desired attrition was eventually reached, the cumulative effect of these frictions slowed progress and added uncertainty to the actual status of Iraqi forces. Only after the ground war commenced was it realized how badly the Iraqi Army was whipped.

In summary, chapter three has identified fog from past air campaigns. The reader should have an understanding of what fog looks like in combat and the adverse effects it can have on airpower employment.

Notes

¹ John F. Kreis, ed., *Piercing the Fog* (Washington, D.C.: Air Force History and Museums Program, 1996), 172.

² Benjamin Franklin Cooling, ed., *Case Studies in the Achievement of Air Superiority* (Washington, D.C.: Center for Air Force History, 1994), 302.

³ *Ibid.*, 309

⁴ *Ibid.*, 305

⁵ Kreis, 236.

⁶ Watts, 71.

⁷ *Ibid.*, 61

⁸ Major Oliver E. Lorenz, “The Battle of Britain: An analysis in Terms of Center of Gravity, Culminating Point, Fog, Friction and the Stronger Form of War” (Research Project, School of Advanced Military Studies, U.S. Army Command and General Staff College, Ft. Leavenworth, KS, April 1989), 32

⁹ Watts, 62.

¹⁰ Clausewitz, 117

¹¹ Watts, 72.

¹² Kreis, 149.

¹³ The United States Strategic Bombing Surveys (USSBS), *Summary Report (European War), September 30, 1945* (Maxwell AFB, Ala.: Air University Press, October 1987), 33-34.

¹⁴ Watts, 63.

¹⁵ *Ibid.*, 75.

¹⁶ USSBS, 27.

¹⁷ Thomas A. Keaney and Eliot A. Cohen, *Gulf War Air Power Survey Summary Report* (Washington, D.C.: U.S. Government Printing Office, 1993), 86.

¹⁸ *Ibid.*, 87.

¹⁹ *Ibid.*, 172.

²⁰ *Ibid.*, 140.

²¹ *Ibid.*, 170.

²² *Ibid.*, 62.

²³ *Ibid.*, 178.

²⁴ Colonel Edward C. Mann III, *Thunder and Lightning* (Maxwell AFB, Ala.: Air University Press, April 1995), 119.

²⁵ Keaney and Cohen, 129-130.

²⁶ Mann, 151.

²⁷ Keaney and Cohen, 22.

²⁸ *Ibid.*, 136.

Notes

²⁹ Ibid., 71-72.

³⁰ Ibid., 149.

Chapter 4

Coping with the Fog of War

As the preceding examples illustrated, uncertainty is a part of every aspect of an air campaign, from planning to execution to interpreting results. But what can be done about it? The key to coping with uncertainty is to understand it. Once understood, fog can be anticipated, recognized, and countered. The author submits there are five basic areas to consider that can help counter uncertainty: technology, leadership, training, experience, and planning.

Technology

Technology can be a tremendous asset in helping see through the fog of war. State of the art sensors (i.e. synthetic aperture radar, spectral imagery) can virtually eliminate uncertainty about the enemy on the battlefield. For example, Joint Stars was extremely valuable in determining the amount and nature of Iraqi force movement in Kuwait, especially at night.¹ This allowed Coalition commanders to determine the true intent of Iraqi force maneuvers and take measures to defeat them. AWACS provided a more precise picture than previously available of Iraqi fighter disposition, increasing situational awareness and enhancing air-to-air kills through positive identification and control.

Precision Guided Munitions (PGMs) using GPS guidance are just around the corner. Such technology will virtually eliminate weather interference on bombing missions.

Technology has also helped alleviate friendly force uncertainty by enhancing communications and information flow. During Desert Storm, USAF squadrons set up “Constant Source” terminals which received and decoded broadcasts of intelligence information. This data helped pilots locate Iraqi antiaircraft batteries and fighter bases within 10 minutes after detection by signal intelligence satellites and listening posts.²

Computers can be useful in coping with information overload.

C4I systems can automatically gather and display large amounts of information about the battlefield and the disposition of forces. Computers can aid the commander’s decision process by rapidly calculating the probable outcome of various courses of action. Orders can be transmitted to subordinates almost instantaneously, including the commander’s view of the battlefield. Skillfully used, these systems can be a significant force multiplier—information can be analyzed and decisions made and executed before the enemy has time to react.³

Additionally, computers can be used so that commanders can pull required information from a data base vice having information dumped on them.⁴

The quantum leap in technology from World War II to Desert Storm—only 46 years—was phenomenal. One can only imagine what technological marvels lay ahead that will help future airmen deal with uncertainty.

Leadership

Clausewitz states that a successful leader must possess three qualities: perception (of what is right); determination (trust one’s decisions and have the courage to follow them through); and presence of mind (the increased capacity of dealing with the unexpected).⁵

He also states that “a good general must know friction...not to expect a standard of

achievement in his operations which this very friction makes impossible.”⁶ Major Terry Wolff identified five criteria that describe the attributes the operational commander required to handle uncertainty: vision, strength of will and determination, character, intellect, and staff.⁷ Thus, leaders who possess these qualities—vision, determination, intellect, and presence of mind—are more apt to cope with uncertainty and should be considered for key leadership positions.

Leaders must also possess great decision making ability. Studies conducted by the U.S. Army show that under time stress, participants in a warfighting exercise made more conservative recommendations.⁸ While prudent, the study implied that in some situations, conservative decisions may not be appropriate for mission accomplishment. As a remedy, commanders can be sent to warfighting exercises where time-critical decision making skills can be studied, exercised, and improved.

Training

Clausewitz offers that habit and peacetime maneuvers are two ways to deal with friction. He states that habit breeds calm, and advises to plan peacetime maneuvers so that some of the elements of friction are involved.⁹ Daily training teaches habit. For example, handling in-flight emergencies, operating a radar in an electronic countermeasure environment, or delivering ordnance. Once a good habit is formed through proper training, it becomes one less thing to worry about when trying to cope with uncertainty in air combat. To that end, peacetime training must strive to simulate actual combat as closely as possible. Large scale exercises such as Red Flag approach this goal, but

participants are deprived of the mental training that comes from “knowing” it is a peacetime exercise. What if they did not know this?

Suppose an F-15 squadron commander received a phone call one night saying to pack up—there is a situation in Cuba. The squadron was told to deploy to Key West and set up combat air patrols facing Cuba. Such “covert” exercises would be a way to train the mind in thinking it was a combat situation. Of course nothing would happen, but the participants would not know that. They would experience the “going to war” emotion that offers learning that a typical training exercise cannot.

Along those lines, Coalition leaders prepared smartly for Desert Storm. As early as three days before the air campaign started, the Coalition “rehearsed” the opening missions of the war. Participating aircrews conducted missions as they were fraggged in the day one ATO right up to the point of crossing the Iraqi border. This valuable training was conducted to practice rendezvous, air-to-air refueling, marshaling, and emission control. If faced with uncertainty the first night of the war, at least Coalition aircrews had a head start in dealing with it.

On a final note, airmen at all levels should strive to make training as realistic as possible. From a personal experience, some of the best air-to-air training ever conducted was doing—as unpleasant as it sounds—night intercepts in the weather. One experiences training in a similar environment as one might expect during war. It does no good to possess all-weather fighters if the crews are not trained to employ them in adverse weather. There will more than likely be situations in future air combat where life or death mission accomplishment will override weather concerns. This is just one example of how to train in peacetime so that aircrews are better prepared to handle the uncertainties of

war. Naturally, peacetime safety guidelines should apply, but airmen should be given the leeway to train in conditions likely to be encountered in actual combat.

Experience

Clausewitz said there is only one lubricant that can reduce the abrasion of general friction: combat experience.¹⁰ This makes perfect sense. One who has experienced the uncertainties of war not only becomes trained in dealing with that specific uncertainty (should it occur again), but becomes better trained to cope with uncertainty in general. Clausewitz also advocates an “exchange officer program” to gain familiarity with war during peacetime.¹¹ Attracting foreign officers who have seen active service, and sending one’s own officers to observe combat operations of a friendly country at war, are both ways to gain combat experience. Where possible, combat veterans should be kept close to operational units to share their experiences with unit members.

Planning

Planning encounters the most prominent source of uncertainty: intelligence. Planners should determine which intelligence is reliable and use it. While intelligence capabilities have evolved significantly, Clausewitz’ warning to be suspicious of unreliable information should be heeded.

Contingency planning is another way of preparing for the uncertainties of war. Prussian strategist Helmuth von Moltke noted that “you will usually find the enemy has three courses open to him, and of these he will adopt the fourth.”¹² Time permitting, plan for unanticipated enemy reactions. Likewise, alternative target planning (secondary and tertiary) is useful when the primary target is gone, hidden, or obscured.

Keeping-it-simple is a good principle to follow in planning, especially in the opening stages of a war and/or when friendly forces combat experience is low. Desert Storm air planners managed to keep their plan simple enough to ensure thorough understanding by the people who executed it. That there were no blue-on-blue air engagements and no midair collisions attested to the coordination aspect of the process.¹³ Considering the hundreds of daily sorties flown around the clock in Desert Storm, simplicity was a must.

A final consideration when planning is trying to increase the enemy's friction. Since the enemy has to face uncertainty as well, it can be exploited. Planners can assess which areas of uncertainty the enemy may be most vulnerable to and attack it. A classic example of this is the dangerous environment Iraqi troops faced in Kuwait. "The high desertion and surrenders...of the Iraqi troops...resulted largely from (1) poor prewar motivation and morale, and (2) the devastating psychological effects of the Coalition air campaign."¹⁴

Five areas have been presented in which air warriors can attempt to counter uncertainty. Although some of the techniques offered would be fiscally unachievable, budgetary considerations are not part of the research question. Uncertainty about the enemy, environment, and friendly forces will always be present in warfare. If educated about uncertainty, future airpower leaders can apply techniques to minimize the adverse effects of uncertainty on air operations.

Notes

¹ Keaney and Cohen, 109.

² Richard H. Buenneke Jr., "Lifting the Fog of War," *Government Executive* 23, no. 2 (February 1991): 23.

³ Cmdr Kevin B. Leahy, "Can Computers Penetrate the Fog of War?" (Research Project, Naval War College, Newport, R.I., May 1994), 2

⁴ *Ibid.*, 9.

⁵ Clausewitz, 102-103

Notes

⁶ Ibid., 120.

⁷ Major Terry A. Wolff, “The Operational Commander and Dealing with Uncertainty” (Research Project, School of Advanced Military Studies, U.S. Army Command and General Staff College, Ft. Leavenworth, KS, April 1991), 3-5.

⁸ John Leddo, et al., “Influence of Uncertainty and Time Stress on Decision Making” (Research Study, U.S. Army Research Institute for the Behavioral and Social Sciences, Ft. Leavenworth, KS, October 1993), 24.

⁹ Clausewitz, 122.

¹⁰ Ibid., 122.

¹¹ Ibid., 122.

¹² Mann, 88.

¹³ Ibid., 129

¹⁴ Stephen T. Hosmer, *Psychological Effects of U.S. Air Operations in Four Wars 1941-1991* (Santa Monica, Calif.: RAND Corporation, 1996), 157

Chapter 5

Conclusion

The purpose of this paper has been (1) to educate the reader on the fog of war as it pertains to air combat, and (2) to offer techniques on how to cope with uncertainty. A simple definition of the fog of war can be thought of as uncertainty about the enemy, the environment, and friendly forces (table 1). Some, including Clausewitz, call this friction. In the author's view, the various terms are interchangeable. Whatever the reader elects to call it, it is important to understand because these uncertainties are what distinguish war from peacetime training. Technology, leadership, training, experience, and planning can all be used to reduce the adverse effects of uncertainty.

Can the fog of war be identified from past air campaigns, and then be countered to make future air combat more effective? Yes. Several types of friction from World War II and the Persian Gulf War have been presented to help the reader understand fog. If in fact the reader can identify fog, then this knowledge can be applied to future air combat situations. Part of the difficulty in dealing with uncertainty is realizing when and where it exists. If airmen recognize uncertainty, they can take steps to reduce its impact, thus making air combat more effective. Quite simply, always consider uncertainty in the planning and execution of air combat operations. The reader may use this text as a guide to identify and develop ways to cope with the undesirable effects of the fog of war.

Some say Desert Storm accomplished what Douhet and Mitchell advocated in the 1920s and what AWPD-1 tried to do with the CBO in World War II. What made them different was technology. What made them the same is the fog of war. While uncertainty will remain a part of air combat in the future, its adverse effects can be minimized through historical study and preparation. This has been the primary purpose of this paper—to better prepare tomorrow’s air warrior for battle.

Bibliography

Primary Sources

- Air Force Manual 1-1. *Basic Aerospace Doctrine of the United States Air Force*. Washington D. C.: Department of the Air Force, March 1992.
- Clausewitz, Carl von. *On War*. Edited and translated by Michael Howard and Peter Paret. Princeton: Princeton University Press, 1976.
- Field Manual 100-5. *Operations*. Washington D. C.: Department of the Army, 14 June 1993.
- Keaney, Thomas A. and Cohen, Eliot A. *Gulf War Air Power Survey Summary Report*. Washington D. C.: U. S. Government Printing Office, 1993.
- United States Strategic Bombing Surveys. *Summary Report*. Maxwell AFB Alabama: Air University Press, 1987.

Secondary Sources

- Bueneke, Richard H. Jr. "Lifting the Fog of War." *Government Executive*, February 1991, pp. 20-24.
- Cooling, Benjamin Franklin ed. *Case Studies in the Achievement of Air Superiority*. Washington D.C.: Center for Air Force History, 1994.
- Hosmer, Stephen T. *Psychological Effects of U. S. Air Operations in Four Wars 1941-1991*. Santa Monica: RAND Corporation, 1996.
- Kreis, John F. *Piercing the Fog*. Washington: Air Force History and Museums Program, 1996.
- Leahy, Kevin B. "Can Computers Penetrate the Fog of War?" Newport, R. I.: Naval War College, 1994.
- Leddo, John, Chinnis, James O. Jr., Cohen, Marvin S., and Marvin, F. Freeman. *Influence of Uncertainty and Time Stress on Decision Making*. Alexandria, Virginia: Defense Technical Information Center, 1993.
- Lorenz, Oliver E. "The Battle of Britain: An Analysis in Terms of Center of Gravity, Culminating Point, Fog, Friction and the Stronger Form of War." Fort Leavenworth, Kansas: U. S. Army Command and General Staff College, 1989.
- Mann, Edward C. III. *Thunder and Lightning: Desert Storm and the Airpower Debates*. Maxwell AFB, Alabama: Air University Press, 1995.
- Setear, John K. *Simulating the Fog of War*. Santa Monica: RAND Corporation, 1989.
- Watts, Barry D. *The Foundations of U. S. Air Doctrine*. Maxwell AFB Alabama: Air University Press, 1984.

Wolff, Terry A. "The Operational Commander and Dealing With Uncertainty." Fort Leavenworth, Kansas: U. S. Army Command and General Staff College, 1991.

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