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Defensive Air Strategies

A Monograph
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ABSTRACT

DEFENSIVE AIR STRATEGIES By Major Vickie J. Saimons, USAF, 46 pages.

Current U.S. Air Force doctrine promotes offensive air operations as the primary means of gaining air superiority and then exploiting that success by attacking enemy forces/LOCs/logistics, etc. on the ground. Such reliance on the offense begs the question whether a thinking enemy could successfully counter that offense through planning and technological investment in a defensive air strategy.

This monograph examines whether future technological advances in air warfare justify a shift in U.S. aerospace doctrinal emphasis from offense to defense. To justify a shift in doctrinal emphasis, future technological advances must enable an air defense system to: (1) detect and track incoming aircraft and missiles, (2) identify aircraft and missiles as friend or foe. (3) engage and destroy hostile aircraft and missiles (preferably before they strike their targets), and (4) protect and reconstitute itself.

First, the theories of Clausewitz, Douhet, and Warden are examined to demonstrate how technology, in the form of the aircraft, altered the theoretical primacy of the defense over the offense. Second, historical examples are used to illustrate how in actual practice technology changed the relative balance of the offense and defense. The historical examples demonstrated technological advances strengthened the defense temporarily, but in the end the offense prevailed.

The third portion assesses whether current air defense technology meets the essential capabilities of an air defense system. The study found current technology does not meet those capabilities; nor will technology meet those capabilities in the foreseeable future. The monograph concludes current U.S. Air Force doctrinal emphasis on the offense is correct.

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INTRODUCTION

Current U.S. Air Force doctrine emphasizes the offense over the defense in the employment of air power in war. AFM 1-1, Basic Aerospace Doctrine, claims that "aerospace forces take greater advantage of their characteristics and their operating medium through offensive actions."[1] AFM 1-1, quoting Marshal of the Royal Air Force, Lord Tedder, states, "Of air warfare, if anything, is the old adage true-that offence is the best defence."[2] According to AFM 1-1, the main purpose of the defense--when circumstances dictate its use--is to regain the offense.[3]

The U.S. Air Force's strong emphasis on the offense raises the issues of whether current doctrine is correct and whether an enemy could capitalize on this one-sidedness. World War I (WWI) illustrates the disastrous consequences of going to war with the wrong doctrine. As Michael Howard, noted military historian, stated regarding WWI:

> Every army of all the belligerent Powers shared a common doctrine, of the dominance of the offensive and the inevitability of rapid and decisive campaigns.[4]

However, defense and stalemate--not the offensive and the decisive campaign--characterized WWI. Unfortunately, discovering the inappropriateness of offensively dominated doctrine took a long time. In the meantime, two and a half million Germans, French, and British died as a result of battle.[5]

To prevent the disastrous consequences of wrong doctrine in the future, military leaders should continually assess military doctrine to determine its validity. This study assesses the viability of the U.S. Air Force's doctrine. Specifically, the monograph examines whether future technological advances in air warfare justify a shift in aerospace doctrinal emphasis from offense to the defense.

The foundation of the defense in an air war is the air defense system. A viable air defense system is able to: (1) detect and track incoming aircraft and missiles; (2) identify aircraft and missiles as friend or foe; (3) engage and destroy hostile aircraft and missiles (preferably before they strike their targets); and (4) protect and reconstitute itself. The more a system exhibits such capabilities, the stronger the air defense. In answering the monograph's central question, this study uses the four preceding capabilities as the basis for examining theory, history, and current air defense technology.

The monograph comprises five major parts. First, the theories of Clausewitz, Douhet, and Warden demonstrate how technology, in the form of the aircraft, altered the theoretical primacy of the defense over the offense. Second, historical examples illustrate how in actual practice technology changed the relative balance of the offense and defense. The third portion assesses whether current air defense technology meets all four of an air defense system's essential capabilities. The next section offers conclusions concerning whether technology alters the balance in air warfare to favor the defense. The final portion offers recommendations regarding the U.S. Air Force's doctrinal emphasis on the offensive use of air power.

THEORY

The military theorists Carl von Clausewitz, Gulio Douhet, and John A. Warden, analyzed the issue of the offense versus the defense in war. Clausewitz, writing before the advent of the airplane, considered the defense as the stronger form of war. However, Douhet advocated and Warden continues to advocate the offensive employment of air power.

CLAUSEWITZ

Clausewitz described the defense as "the parrying of a blow" with its characteristic feature as "awaiting the blow."[6] Once the blow arrives, however, the defense takes on offensive characteristics. As Clausewitz explained:

> Even in a defensive position awaiting the enemy assault, our bullets take the offensive. So the defensive form of war is not a simple shield, but a shield made up of well-directed blows.[7]

Clausewitz believed the defense involved not simply absorbing an enemy's blows, but also returning them.

In deciding whether the offense or defense is stronger, Clausewitz selected the defense. He claimed, "The defensive form of warfare is intrinsically stronger than the offensive."[8] In supporting this conclusion he sited three factors at the tactical level leading to decisive advantages: surprise, the benefit of terrain, and concentric attack.[9]

Clausewitz's claims that the defender benefits most by surprise, terrain, and concentric attack are not necessarily true in air warfare. Regarding surprise, Clausewitz believed the benefit goes to the defender through the "strength and direction of counterattacks."[10] Currently, a well planned offensive air campaign will first destroy or neutralize a defender's early warning radars through direct attack or electromagnetic jamming. Lacking early warning radars to pinpoint the location and movement of attacking fighters, a "counterattack" by defending fighters is very difficult. Attacking aircraft ingress at an extremely high speed, release their ordnance, and egress at an equally high speed. Consequently, the window of opportunity for a "counterattack" is very limited. Therefore, the attacker probably enjoys the benefit of surprise in air warfare.

The second advantage Clausewitz granted to the defender was the use of terrain. "The attack," Clausewitz said, "has to approach on open roads and paths," while, "the defender's position . . . is concealed and virtually invisible."[11] This may not be true in air warfare. Attacking aircraft can conceal their positions by first destroying or degrading the defender's early warning radars. Without this electronic means of locating the attacking fighters, the defender is left with less capable means --such as visual searches--for finding the enemy. Although attacking fighters are not totally concealed, less capable acquisition means increase the time to detect, track, engage, and destroy them. Under such conditions, effectively engaging attacking aircraft may be impossible

The concealment advantages defending ground units gain from terrain may not be applicable to defending air force units. For one thing, aircraft are operationally tied to airfields, which by their nature, are difficult to conceal. Runways are long and flat and do not generally blend in with their surroundings. Usually located in the vicinity of these runways are distinctive airfield structures such as control towers, aircraft hangars, and POL storage tanks. These types of structures reveal an airfield's location. VSTOL (very short take-off and landing) capable aircraft do not require traditional runways, and can operate in very dispersed areas. Lacking such aircraft, the majority of airfield locations are generally well known.

In addition, vital assets--oil production facilities, railroads, ports, and bridges--which a defense tries to protect from air attack, are also difficult to conceal. Some targets in air warfare can be concealed, but many can not. Overall, the advantage of terrain may not always go to the defender in air warfare as Clausewitz claims it does for ground warfare.

The third item Clausewitz discussed concerning the strength of the defense over the offense was concentric attack. In concentric attack the defender envelops the attacker, hits him with cross fire, and threatens him with being cut off.[12] All three actions are also possible in air warfare. One technique for achieving concentric attack with an air defense system is to integrate long range and short range surface-to-air missiles (SAMs), as well as anti-aircraft artillery (AAA). In order to fly out of one air defense weapon's engagement envelope, the attacking aircraft must enter another weapon's engagement zone. A flight of aircraft attacking an enemy airfield without first taking out some defenses, will probably encounter SAMs from several directions, making it difficult to evade all missiles launched. On the other hand, if the attacker destroys or neutralizes the enemy defenses first, or goes where the defenses are not massed, the defender has difficulty concentrating forces against the attacker. The reason for this is the aircraft's high speed and the fact that aircraft remain for only a short time in the vicinity of the target. By the time the relatively slow moving air defense artillery (ADA) assets arrive in the vicinity of the target, the attackers are probably back at their bases preparing for their next mission. Unlike ADA, defensive combat air patrols (CAPs) have the speed to mass, and can contribute to concentric attack in air warfare. Under certain circumstances, though, the attacker may be able to outnumber the defending CAPs.

What seems apparent from the previous discussion is those things which make the defense the stronger form of warfare for ground forces may not apply to air forces. Clausewitz's conclusion that the defense is the stronger form of war was probably appropriate for his time. However, the airplane's emergence prompted more recent theorists to take an opposite view.

DOUHET

Gulio Douhet was one of the first air warfare theorists. In air warfare, Douhet concluded, the offense is the stronger form of war. The attacker's ability to mass his whole air force to strike any single enemy target led Douhet to this conclusion. Further, Douhet disdained the defense. He reasoned that

> to defend effectively all areas threatened . . . would require a defensive force equal to the total combat strength of the attacking Air Force, multiplied by as many times as there are defensive positions to be protected.[13]

According to Douhet, no nation could afford such a large air force. Further, he believed a nation could best use its limited resources in creating offensive air forces. Another reason why Douhet advocated allocating resources toward the offense, rather than the defense, was the inability of a nation to protect itself from air strikes. Keying on possible air targets, Douhet concluded it was "impossible to bomb-shelter entire cities with their rail centers, port facilities, supply bases, factories, and so on."[14] Conceivably, a nation might suffer some blows from an enemy air attack; but, Douhet felt the best defense was a good offense. According to Douhet, the offense's primary aim was to reduce the enemy's offensive capability. The most effective way to do this "is to destroy the enemy's aerial power by destroying his nest and eggs on the ground [rather] than to hunt his flying birds in the air."[15]

Douhet, like Clausewitz, wrote his theories before the occurrences of today's technological aerospace advances. In contrast to both Douhet's and Clausewitz's theories, Warden's theories are more relevant to the nature of contemporary air warfare.

WARDEN

John Warden, a current air power theorist, described his theories in The Air Campaign. Warden, like Douhet, advocated the offense over the defense. Warden listed several problems with the defense. First, the defense normally requires more than one aircraft to destroy another aircraft in the air. Second, the defense passes the initiative to the enemy, making concentration of defensive forces difficult. Third, aircraft waiting for the enemy to attack do not achieve any effects on the enemy. Echoing Clausewitz, Warden believed a defensive strategy's most serious fault is that it does not lead to a positive result. Warden concluded that the offense keeps the initiative, puts pressure on the enemy, makes maximum use of available aircraft, and achieves positive results.[16]

As the preceding discussion illustrates, advancing aerospace technology altered the Clausewitzian balance between the defense and the offense. To date, the offense is the stronger form of air warfare. The following historical examples illustrate technology's impact on the relationship between the offense and defense in aerial combat.

HISTORY

This section examines four air battles with defensive strategies: the Battle of Britain, the defense of North Vietnam, the 1973 Arab-Israeli War, and the 1982 Israeli-Syrian air battle over the Bekaa Valley in Lebanon. The four essential capabilities of an air defense system (1. detect and track incoming aircraft and missiles, 2. identify aircraft and missiles as friend or foe, 3. engage and destroy hostile aircraft and missiles, and 4. protect and reconstitute itself) will be used as analytic lenses to evaluate technology's impact on the defense in each air battle.

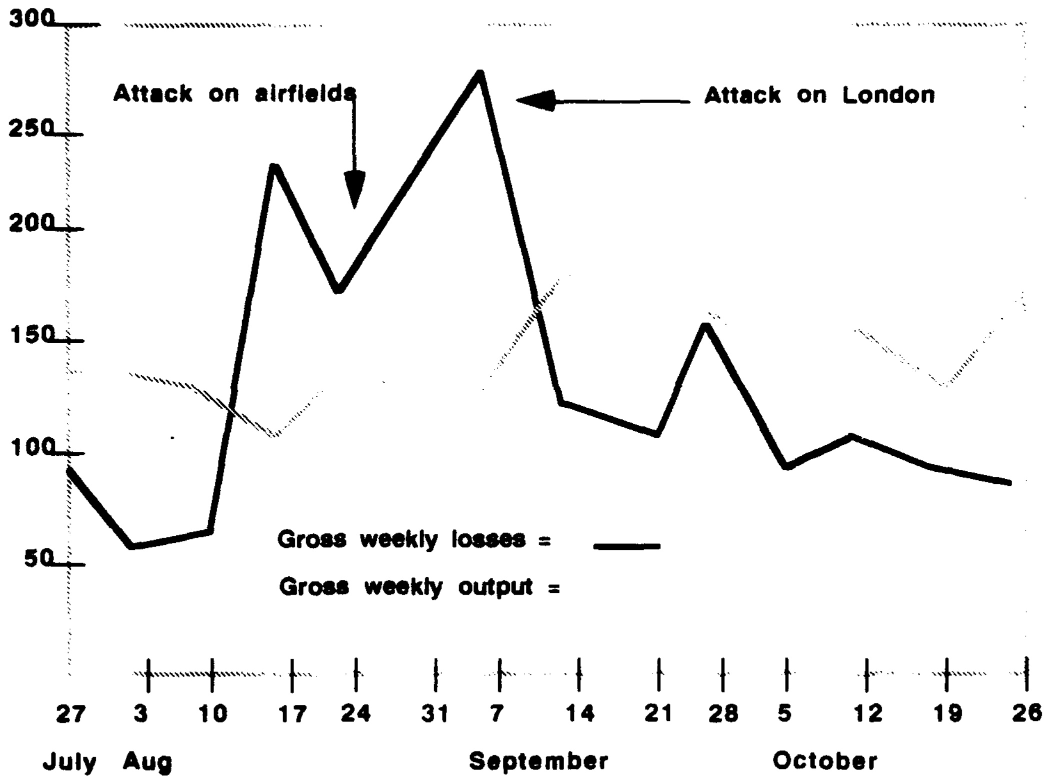
BATTLE OF BRITAIN

Based upon Britain's use of a defensive air strategy and her victory during the Battle of Britain, concluding that defensive air strategies are more effective than offensive strategies is flawed logic. Too many variables exist to establish a simple cause-effect relationship. Britain's success in the Battle of Britain is equally attributable to Germany's faulty offensive air strategy. Specifically, Hitler's untimely shift of Germany's main offensive air efforts to London cost Germany the battle. What is clear from this battle, however, is how Britain strengthened her air defense through technological means. These defenses enabled Britain to hold out long enough for Hitler to shift the Luftwaffe's main effort away from the Britain's airfields. Capitalizing on Hitler's mistake, the Royal Air Force (RAF) replenished its aircraft faster than the Germans could damage or destroy them. The Royal Air Force's resilience caused Hitler to stop trying to achieve air superiority--a vital prerequisite for Germany's cross channel invasion. As a result, the RAF's victory was crucial in preventing a German invasion of the British Isles.

Britain won this battle, but prudence forces one to consider whether her air defense system was a viable one. The first essential capability for a viable air defense system is detecting and tracking incoming threat aircraft and missiles. At the outset of the Battle of Britain, the radar portion of the British air defense system was able to detect out to a range of 100 miles the bearing, approximate height, and number of enemy aircraft approaching .[17] This radar system permitted the British, through their command and control system, to launch and direct intercept aircraft long before German planes approached Britain's shores. This early warning gave defending fighters time to climb to the altitude of the attacking forces. The British established the third capability--identifying friend from foe--when they fitted identification friend or foe (IFF) devices into RAF aircraft in 1939 and 1940.[18]

British success with the third capability--destroying hostile aircraft or missiles before they hit their targets--was not as great. This capability was important for two reasons. First, their homeland was being attacked. Second, and more importantly, the German's had an advantage in the air order of battle. The Germans had a 1.6 to 1 advantage in the number of fighters and a 3.8 to 1 advantage in their total offensive aircraft (bombers and escort fighters) compared to the British defensive aircraft (Hurricanes and Spitfires).[19] Since the German attacks concentrated primarily on airfields (24 of 33 attacks between 24 August and 6 September fell on airfields) any bombers getting through were likely to increase the German advantage.[20] During this period, 295 Hurricanes and Spitfires were destroyed while another 171 were badly damaged. The British could repair or replace only 269 of these 466 aircraft losses.[21] Hough and Richards, authors of <u>The Battle of Britain</u>, calculated "another three weeks at the same rate of attrition, and [the Hurricanes and Spitfires] would be exhausted - even sooner if there were serious damage to the aircraft factories."[22]

Fortunately for the British, the Germans overestimated British aircraft losses and switched their main effort from the airfields to London.[23] Figure 1 (next page) shows the switch to London drastically reduced British fighter losses thereby allowing the British a chance to succeed. Only after the German switch in their main effort was the Royal Air Force able to partially meet the fourth air defense system capability of protecting and reconstituting itself.



Production and Wastage of Hurricanes and Spitfires
July - October 1940

Figure 1[24]

In summary, many dynamic factors led to the overall outcome of the Battle of Britain. The technological advances of the early warning radar system, the IFF system, the Hurricane and Spitfire aircraft, and the command and control system, significantly strengthened Great Britain's defense of her skies. Without such technological advantages, the Royal Air Force would have suffered significantly greater losses in a shorter period of time. Additionally, British fighters might have been depleted before Hitler's shift of his main air effort. What if Hitler had not shifted his main effort? Even though Britain had a strong air defense system, thanks to technological innovations, that system was not succeeding. When the Germans concentrated on destroying the RAF--the proper main effort--the British were on their way to defeat. Although technological advances strengthened the defense, the offense was the stronger form of warfare during the Battle of Britain.

NORTH VIETNAM

North Vietnam had a defensive air strategy throughout the Vietnam War. In contrast, the U.S. had a limited offensive air strategy. Although the North Vietnamese won the overall war, they lost the air war. Technological innovations played a significant role in the battle for the skies over North Vietnam. Throughout the war, technological advances changed the relative strengths of the offense and the defense, but in the end the offense prevailed.

The first component of an effective air defense system is detecting and tracking incoming aircraft and missiles. The North Vietnamese did this using early warning/ground control intercept radar (EW/GCI)[25] Another detection and tracking component of North Vietnam's air defense system was the SAM radar. To counter these SAM radars the U.S. developed and employed the homing anti-radiation missile (HARM). The HARM homed in on the SAM electronic radar emissions and followed them to the radar sites.[26] The North Vietnamese countered the HARM via SAM radar "dummy loads" and coordination between SAM units and EW/GCI radars sites.

SAM units could monitor enemy aircraft locations using reports from EW/GCI units. Consequently, their SAM radars did not have to perform the tracking function. Instead, SAM radars remained in a warm-up mode, called "dummy load" (meaning the radars were on but not transmitting). Upon an enemy aircraft's approach, SAM operators switched from "dummy load" to actively radiating, launched the SAM, and returned to "dummy load." This tactic left the SAM radars less vulnerable to the radar homing missiles since their radars transmitted for a considerably shorter period of time prior to launching the missiles.[27] The U.S. countered this North Vietnamese tactic with an electronic countermeasures (ECM) pod for jamming the North Vietnamese EW/GCI radar. Because of the ECM pods "fighters were able to go relatively unmolested into the target area at altitudes between 10,000 and 17,000 feet."[28] Colonel William S. Chairsell, 388th Tactical Fighter Wing Commander, described the ECM pods' impact:

> Seldom has a technological advance of this nature so degraded the enemy's defense posture. It literally transformed the hostile air defense environment we once faced, to one in which we can now operate with a latitude of permissibility.[29]

An additional ECM asset, the EB-66 aircraft, jammed the SAM and AAA radars in the vicinity of attacking U.S. aircraft. Laying chaff also decreased the North Vietnamese's ability to detect and track incoming aircraft.[30] A corridor of chaff presented its own radar returns while masking those of incoming strike aircraft.

By 1972, U.S. radar jamming, chaff, and ECM on-board the attack aircraft severely degraded the North Vietnamese ability to detect and track incoming aircraft.[31] As the authors of Air War-Vietnam so adeptly put it:

> Within the mechanics of Linebacker [1972 air campaign against North Vietnam] itself, the outstanding contribution was in the defense suppression effort. By neutralizing and destroying the enemy early warning radar, AAA, SAM and MIG threat, the aircraft loss rate was kept at an acceptable level and the Linebacker strike force was able to operate effectively in any area in NVN [North Vietnam]. Thus, air superiority was achieved and sustained.[32]

The second essential capability of an air defense system--identifying friend from foe--did not appear to be a problem for the North Vietnamese. They were able to fire their SAMs well within range of their own MIGs without hitting them.[33] This ability was likely a function of the command and control coordination between EW/GCI radars, SAM units, and North Vietnamese fighters.

The North Vietnamese ability to destroy hostile aircraft or missiles before they hit their targets was poor. Prior to the Gulf of Tonkin incident in August 1964, the North Vietnamese had no air defense fighter or SAM capability, and only about 700 AAA weapons. By June of 1965 the North Vietnamese had 70 MIG-15s and MIG-17s and in December they received their first MIG-21s.[34] By 1 February 1966 "US aircraft found a fully integrated AAA, MIG, and SAM defense system tied together by an effective command and control network."[35] But, as stated earlier, the technological advantages allowed the U.S. to defeat this system.

An important aspect to note here is how defeating one portion of the air defense system affected the rest of the system. Although EW/GCI and SAM radars can not engage attacking fighters, they have a significant impact on the ability of other system components to do so. Since the combination of jammers, chaff, on-board ECM pods, and HARM missiles rendered the radars virtually ineffective, the engagement components (fighters and SAMs) relying on these radars, were likewise ineffective.

North Vietnam's inability to detect, track, and engage effectively, also permitted physical attacks. During Linebacker I and II, U.S. aircraft got through the North Vietnamese defenses (which now numbered 250 MIGs, 300 strategically placed SAMs, and 1500 AAA weapons covering vital targets)[36] and made their way to Hanoi and Haiphong. These attacks eventually brought the North Vietnamese back to the negotiating table.

Reconstitution is the last capability an air defense system must possess. With China's help, the North Vietnamese replenished the SAMs expended during Linebacker I in time for Linebacker II. Photographic reconnaissance indicated over 2,000 SAMs arrived by rail from China.[37]

Although the North Vietnamese defenses were not strong enough to prevent their nation's bombing, the defenses required the U.S. to conduct aerial bombing at considerable expense and with a very lopsided tooth to tail ratio. As early as September of 1965, locating and destroying the SAM sites became a major part of U.S. air operations.[38] By May of 1972, when Operation Linebacker I began, some highly defended North Vietnamese areas required a 5 to 1 ratio of support aircraft to strike aircraft to defeat North Vietnamese defenses.[39] Figure 2 illustrates a typical support package.

8 F-4s for air to air escort
4 F-4s Wild Weasels to find SAMs
2 F-105s and 2 F-4s in SAM/AAA suppression
8 F-4s for MIGCAP
8 A-7s or F-4s for chaff delivery
4 F-4 chaff aircraft escorts
4 F-4 Wild Weasels for chaff layers
4 F-4s of chaff MIGCAP
2 RF-4C reconnaissance aircraft

Typical Linebacker Support Package[40]
Figure 2

The air war in Vietnam indicates the strength of the offense or defense depends to a large degree on the technology at the time and how quickly one nation can counter the other's latest technological innovation. The offense prevailed in this case, particularly because the offense was able to overcome critical components of the North Vietnamese air defense system. The attack on these components had a cascading effect on the rest of the system, significantly decreasing its ability to engage American fighters.

1973 ARAB-ISRAELI WAR

The Egyptian side of the 1973 Arab-Israeli War is an interesting case of a defensive air strategy. The Egyptians chose a primarily defensive air strategy to complement their offensive ground strategy. They did so for some very good reasons. While planning the offensive ground operation, LtGen Shazly, Chief of Staff of the Egyptian Armed Forces, estimated his air force was ten years behind the Israeli Air Force.[41] This technological gap left him unable to use his air force in an unlimited offensive role and hesitant to use it defensively in air-to-air encounters with the Israeli Air Force.[42] The best aircraft the Egyptian Air Force had at the time was the MIG-21. Limited in range, payload, and electronic and weapons sophistication, the MIG-21 was no match for Israeli F-4s.[43] Complementing Israel's technological lead were her well trained pilots. On average, Israeli pilots had about 2,000 flying hours, about twice as many flying hours as the average Egyptian pilot.[44] Finally, uppermost in the Egyptian's minds was the destruction of her precious air force on two previous occasions in the recent past--the British and French destruction in 1956 and the Israeli decimation in 1967.[45] The Egyptians did not want to repeat those experiences a third time.

The Egyptians based their defensive air strategy on a system of surface-to-air missiles. Chaim Herzog, former president of Israel, outlined the Israeli Air Force's challenge:

> The Israeli Air Force was to be dealt with by the creation of one of the densest missile 'walls' in the world, composed of a mixture of various Soviet ground-to-air missiles SAM-2, SAM-3, and SAM-6, in addition to conventional anti-aircraft weapons, which would provide an umbrella over the planned area of operations along the Suez Canal.[46]

As an indication of the emphasis placed on the Egyptian air defenses, General Shazli explained "I discovered . . . that half the engineers in Egypt were in the armed forces, most of them working on our air defenses and the associated electronics."[47] In addition, the Egyptians built 500 concrete aircraft shelters, hardened airfield service buildings, and surrounded main airbases with SAMs.[48] As for the protection of Egyptian population centers, many fell outside the dense ADA umbrella. The Egyptians believed their mere possession of SCUD surface-to-surface missiles, which could hit major Israeli population centers, would be deterrent enough.[49]

During the conflict the Egyptian SAM/AAA umbrella worked quite well--for a while. However, when the Egyptian ground forces ventured out of this protective umbrella to continue the attack, Israeli aircraft hammered them severely. When the 3rd Armoured Brigade of the Egyptian 4th Armoured Division left the air defense umbrella, Israeli ground forces halted it, and Israeli aircraft destroyed it.[50]

In their counterattack, the Israelis realized they could not use their air power decisively without first knocking a hole in the air defense umbrella. In their plan to cross the Suez Canal, the Israelis decided:

> The tanks would . . . begin, in the initial phase, to knock out Egyptian surface-to-air missile sites, thus clearing the air above the bridgehead for the Israeli Air Force. . . . Adan was to cross the bridge on the morning after Sharon's crossing, and sweep southwards on the eastern flank of Sharon's southern sweep. His mission was to destroy the surface-to-air missile batteries in the area, and thus enable the Israeli Air Force to establish supremacy in the air over the battlefield.[51]

In this case the ground force's success depended on the air force. But first, the ground forces had to knock a hole in the air defense umbrella to allow the air force to operate over the battlefield.

Fortunately for the Israelis, the ground forces accomplished their job. Herzog summarized the situation this way:

> The most disturbing element of all as far as the Egyptians were concerned, according to Shazli, was the fact that the Israeli forces had succeeded in neutralizing or destroying the concentrations of SAM missiles west of the Canal to a depth of nine miles and that the Israeli superiority in the air was now coming to full expression in close ground-support.[52]

With a hole in the ADA umbrella, the Israeli Air Force pressed the attack. They destroyed Egyptian tanks blocking the Israeli ground force advance, as well as, all Egyptian crossing equipment. By destroying the crossing equipment the Israeli Air Force prevented the Egyptian forces east of the Suez Canal from withdrawing.[53] The Israelis' position set the conditions for destroying the Egyptian Third Army within a few days. However, United Nations Security Council intervention prevented Israel from doing so.[54]

Initial Egyptian employment of their air defense umbrella was sound. They successfully detected and tracked incoming Israeli aircraft. Since few of their own aircraft were flying, it was simple to identify Israeli aircraft. With the third capability, the Egyptians had some difficulty. At first, the Egyptians could engage most Israeli aircraft before the Israelis hit their targets. The reason for this was the Egyptians' concentrated SAM belt along the Suez. When the Egyptians began their offensive operations, they established a concentrated defensive umbrella, reaching as far as six miles east of the canal.[55] However, the SAMs could not move with the attacking Egyptian forces. Consequently, as the Egyptian ground forces pressed the attack eastward, they left the protective air defense umbrella. The Israelis took advantage of this fact and concentrated their air assets against those Egyptian ground forces that had advanced beyond the protective SAM umbrella.[56]

Regarding the fourth capability of protecting and reconstituting themselves, the Egyptian air defense units had another problem--virtually no protection against tank attacks.

The Israeli tanks concentrated against the Egyptian SAM positions and destroyed them. The ADA units within the umbrella were fairly static and were essentially unable to move to fill in for those already destroyed. Even if they possessed the requisite mobility, Israeli tanks were already in a position to destroy air defense units moving into the area.

The Egyptians came close to achieving the four requirements for a viable air defense system. The Israelis realized this system's strength and at first avoided it. Later, the Israelis set out to destroy this system in certain areas of the battlefield. An important idea derived from this case is the relative strength of the defense is based not only on what the defender does, but also on what the attacker does to counter it. In this case the system broke down under the Israeli's ability to send tanks forward to destroy the SAM units.

BEKAA VALLEY

In 1982, the Palestine Liberation Organization (PLO) in Lebanon threatened the Israelis by continued artillery attacks into northern Israel and terrorist acts. To counter these threats, the Israeli Defense Forces prepared to attack the terrorists and their infrastructure in southern Lebanon. Additionally, there was a significant Syrian Army presence in Lebanon. The Israelis also prepared to destroy the Syrian Army in Lebanon if it attacked the Israeli Defense Forces.[57]

A significant element of the Syrian ground forces in Lebanon was their air defense assets. By June of 1982, the

Syrians had placed 19 SAM batteries in the Bekaa Valley. Since these air defense assets could cause considerable harm to the Israeli Air Force, the Syrians assumed the Israelis would limit their air operations in Lebanese airspace. In contrast to the Syrian assessment, the Israelis felt that unless these SAM units were destroyed, the SAMs "would make total victory difficult, if not impossible."[58] The Israelis decided their first task must be to destroy these SAMs. The Israeli Air Force trained for months to accomplish this task.[59]

In the attack's initial stages, the Israelis launched remotely piloted vehicles (RPVs). These RPVs produced radar returns indistinguishable from actual aircraft radar returns. Since the Syrian air defenders thought the RPVs were attacking aircraft, they launched SA-6s at them.[60] Next, the Israelis attacked the Syrian missile sites along with their surveillance and fire control radars. This attack was a joint effort using not only air strikes, but also long range artillery and Zeev surface-to-surface radar homing rockets.[61] With 17 of the 19 Syrian missile batteries destroyed, the Syrians launched their fighters to defend themselves from the Israeli air attack. The ensuing air battle consisted of 50 Syrian planes and 100 Israeli aircraft. The Syrians suffered a serious defeat, losing 29 MIGs while the Israelis lost no aircraft.[62] With the Israeli Air Force now in full control of the air over the Bekaa Valley, Syrian ground force reinforcement routes were susceptible to air attack.[63]

The Syrians in the Bekaa Valley in 1982, much like the Egyptians in the Sinai in 1973, were very dependent on their air defense umbrella. Both the Syrians and Israelis realized the limitations this umbrella, if left unchecked, placed on Israeli air operations. The Syrian air defense was strong in the sense that it could do considerable damage to Israeli aircraft, but weak in the sense that it did not meet all of the capabilities for a viable air defense system.

The Syrians met the first air defense system capability of detecting and tracking incoming aircraft and missiles. The Syrian's ability to detect and track RPVs demonstrates the preceding fact. Unfortunately, the Syrian system failed in the second capability of identifying friend from foe. Inherent in this capability is the ability to determine, not only if a radar return is a foe, but also if it is a real threat. The Syrians were not able to do this because they could not distinguish an RPV from an aircraft. Although the RPVs were a limited threat in the sense they were collecting intelligence information, they were not significant enough as a threat to warrant Syria's launching of large numbers of SAMs. Because of the SAM reload time, the Syrians were not capable of engaging incoming aircraft or missiles.

The Syrians had difficulty meeting the fourth air defense capability of protection and reconstitution. The Syrians revealed their SAM unit locations when they launched their missiles after the RPVs. Additionally, the radars which had to be on and emitting while the SAMs were launched, gave their own positions away and allowed homing-anti-radiation-missiles and rockets to be used against them. When the

Syrians launched their fighters, the pilots depended on ground control intercept (GCI) controllers to direct them against Israeli fighters. Unfortunately for the Syrians, the communications between the ground controllers and the fighter pilots were susceptible to jamming. The Israelis knew this and jammed these communications, preventing the Syrian fighters from concentrating effectively against Israeli fighters.[64] Regarding reconstitution, there was little the Syrians could do. Israel required only one day to virtually eliminate Syria's air defense umbrella in Lebanon. With Israel in control of Lebanese airspace, any Syrian ground reinforcements were subject to air attack.

In summary, the Syrian air defenses were strong enough that they had to be dealt with before the Israelis conducted air operations throughout the Bekaa Valley. As discussed earlier, these air defenses were based on a system. Unfortunately, the interdependency of the elements in this type of system usually causes a catastrophe if just one portion of the system is defeated. The Syrians' inability to distinguish RPV radar returns from attacking aircraft radar returns resulted in devastating effects. This one inability had a cascading effect throughout the system until the entire air defense system was destroyed.

The purpose of examining these four historical air battles was to demonstrate the impact technology had in actual practice on the relative balance between offense and defense. The impact was analyzed in terms of the four capabilities of a viable air defense system. It appears that technological advances can help strengthen the defense by enabling an air defense system to come closer to meeting the four air defense system capabilities. It also appears, though, that even with technological advances making the defense stronger, the systematic nature of the defense leaves it vulnerable to attack. The absence of at least one of the viable air defense system capabilities normally leads to the air defense system's destruction. This state of affairs indicates that offense is still stronger than defense in air war. This study will now assess if recent changes in technology have had an impact on the relative balance between offense and defense.

CURRENT TECHNOLOGY

The basis for assessing current technology's impact on the relative balance between offense and defense are the four air defense system capabilities. Specifically, this portion asseses whether current technology can enable an air defense system to meet those four capabilities.

DETECT AND TRACK INCOMING AIRCRAFT AND MISSILES

In an air defense system, early warning radars are the primary element for detecting and tracking incoming aircraft and missiles. Early warning radars allow the defender to detect and track an impending attack in sufficient time to alert defending forces, negate the effects of surprise, and prevent the enemy from concentrating his attack.[65] With adequate early warning the defender can launch and vector fighters to intercept and destroy the threat aircraft before they reach their target. Early warning radars also enhance the defenders' ability to employ SAMs against threat aircraft, as well as giving other defenders time to take appropriate protective measures. The four types of early warning radars are ground based, airborne, over-the-horizon-backscatter (OTHB), and high-frequency-surface-wave-radar (HFSWR).[66]

All of these radars are susceptible to some type of attack --whether it be ground attack, air attack, or electronic countermeasures (ECM). Compounding their susceptibility to attack is the fact that radar locations are usually known. Most ground early warning radars are static in nature, although some nations have mobile radars. But even mobile radars, once they begin to emit, reveal their location to enemy electronic intelligence (ELINT) collection assets. If an EW radar remains silent to conceal its position, it is not providing the early warning for which it exists. For the same reason, airborne early warning radars are either susceptible to attack because they are emitting and revealing their position, or their radars are silent and they provide no early warning at all.

Ground radars' susceptibility to attack by special forces is a function of what priority the defender places on the radar's protection. Once an attacker is in the vicinity of the radar, destroying it or rendering it inoperative is relatively easy. Airborne EW radars, such as AWACS, are also subject to ground attack. Sabotage from within an airbase perimeter is a possibility, as is attack by shoulder-fired SAMs while the aircraft are taking off and landing. Obviously, extensive protective measures must be implemented to prevent either. Depending on the nations and ranges involved, surface-to-surface missiles might also be launched against EW radars.

If a radar site is heavily defended against ground attack, it may be preferable to attack it from the air. Aircraft with homing-anti-radiation-missiles (HARMs) are especially effective in completing this task. The aircraft can launch the HARM from a stand-off range and let it follow the radar beam to the target. In the near future, Tacit Rainbow, an air-launched cruise missile (ALCM) with HARM capabilities, will further reduce the risks to aircraft while they are attacking air defenses. Both HARMs and Tacit Rainbow force the radar to either shut down to avoid detection, or be hit with a missile. Some HARMs have residual guidance allowing them to continue the attack even though the radar has shut down.[67]

Airborne EW radar aircraft are susceptible to attack by SAMs and fighter aircraft. To prevent engagement by enemy long-range SAMs, the defender must know the location of those SAMs, and fly outside their engagement envelopes. To provide protection against enemy fighter attacks, combat air patrols (CAPs) are normally dedicated to the AEW aircraft, which normally have no ability to defend themselves.

Another method of attacking radars is by using electronic counter measures (ECM). Stand-off and close-in jamming aircraft are built specifically for this purpose (EF-111 and the

EA-6B). Rendering those radars inoperable by ECM may be just as effective as destroying them. When the radars are inoperative because of ECM, their destruction becomes that much easier. Without the EW radar it is harder for the defender to control fighters and to launch SAMs against the attacking aircraft. To overcome the effects of ECM, nations are continually striving to improve their electronic counter counter measures (ECCM). Radar ECCM can be in the form of radar design improvements such as reduced sidelobes, frequency agility, special circuits, and operator training.[68]

Air defense system radars can also be overcome by using decoys to disrupt and confuse the radar operators. Early warning radars are normally used to allocate defensive fighters or SAMs against the highest threat. By using decoys, fighters may be vectored on decoys while the real threat approaches from another area. As seen earlier in the Bekaa Valley, SAMs were launched against decoys shortly before the real threat aircraft arrived.

Employing stealth aircraft is another method of rendering EW radars ineffective. Stealth aircraft are built with radar absorbing material and reduced radar reflecting angles. These design measures do not allow the EW radar emissions to bounce off the stealth aircraft in sufficient strength to return to the radar receiver. Thus, the radar operator sees no blip on the radar scope representing that aircraft's position.

As one can see from the previous discussion, the need for early warning radars is clear, but there appear to be many ways to destroy those radars or render them ineffective. If a radar site is strongly defended against ground and air strikes, ECM may be the safest alternative. The effectiveness of ECM appears to be a function of which nation is ahead in the technological dialectic.[69] One of the reasons Egypt chose a defensive air strategy in 1973 was because its aircraft were technologically inferior to Israeli aircraft. With so much dependent on the electronic spectrum today, it is likely that a nation which chooses the defense because it is behind technologically, will also have its defenses overcome for the very same reason.

IDENTIFY FRIEND FROM FOE

The primary consideration today in identifying friend from foe is stealth technology. If an early warning radar can not obtain a radar return from an incoming aircraft or missile, the radar operator sees nothing on the radar scope to identify. Defeating the first capability of detecting and tracking can also defeat the second capability of identifying friend from foe.

ENGAGE AND DESTROY INCOMING ENEMY AIRCRAFT AND MISSILES

There are essentially three elements of an air defense system which work together to engage and destroy incoming enemy aircraft and missile: fighters, SAMs, and C^3 (command, control, and communications). Fighters are an integral part of the air defense system. The advantage of fighters as an air defense asset is their ability to concentrate against the greatest threat in a short period of time. Unlike SAMs, fighters can move from one portion of a theater to another in a matter of minutes.

Overcoming a fighter defense depends on many factors, and technology again plays a significant role. If the EW radars are overcome, the defending fighters' effectiveness is reduced, (as happened in the Bekaa Valley in 1982). In considering just fighter to fighter encounters, aircraft can be outnumbered or outclassed. In offensive air operations, attacking fighters generally outnumber the defending aircraft because the offense possesses the initiative and can concentrate where it wants. The defense, on the other hand, is reactive, and can only concentrate to a limited extent--but probably not as much as the offense. This is particularly true when conducting preemptive offensive strikes.

In an air-to-air engagement where the numbers are equal, the outcome often becomes a function of pilot skill and technological advantage. Well trained pilots are more likely to put themselves into a position where they can launch their missiles and the enemy can not. Additionally, aircraft with superior avionics and weapons systems can launch their missiles well before the aircraft reach the enemy aircraft's launch parameters. Depending on the rules of engagement, pilots may have to identify targets before engaging. Any system which facilitates this identification, whether on-board the fighter or within the EW radar facilities or aircraft, will be an advantage. The missiles themselves must also be superior. The missiles must be able to get through the enemy aircraft's anti-missile capabilities (chaff and flares, for example) to strike the aircraft.

The advantage of the offense or the defense involving technologically and numerically equal air forces goes to the offense. The offense has the initiative and can concentrate, while the defender must defend everywhere and react to offensive attacks.

Air defense artillery (ADA) is another essential element working in concert with fighters to "parry the blow" of incoming aircraft. One method a nation might use in employing ADA is placing an air defense artillery belt along its borders, particularly facing the expected threat axis. Unfortunately, a SAM belt has its limitations. Group Captain M.B. Elsam, author of Air Defence and now serving in the Australian Ministry of Defence as Deputy Director of Operational Requirements, explained the problem with SAM belts this way:

> If it is breached, the remaining pre-positioned missiles may be useless. To use SAM alone, then, would mean covering every possible target area with enough missiles to take account of the enemy's known strength. At this stage the cost equation works against the missiles-so many would be needed to give any degree of assurance that no nation could afford it.[70]

There are different ways to overcome the air defense artillery of an air defense system. Indirectly, one can destroy or neutralize the EW radars. This results in less warning time for the ADA systems. Secondly, one can attack using stealth aircraft, thereby negating the EW radar, and simultaneously fly out of range of visually guided ADA systems. Another method is to jam the ADA system either with standoff or close-in jamming aircraft, or fighter on-board jamming systems. A good tactic is to jam the radars, and subsequently physically destroy the radars and launchers. This can be done either with stand-off air-launched weapons or conventional weapons.[71] If the surface-to-air missiles are radar guided, using chaff gives the radar a false return. If the missile is infrared guided, flares provide an alternate heat source for the missile to follow. Elsam stated, "An important disadvantage of the surface to air system is that it is relatively easy to develop a counter."[72] From the preceding discussion of ways to overcome an ADA system, one can hardly disagree with Elsam's claim.

The C^3 aspect of the air defense system is extremely important; it is the nerve center of the entire system. One example of its importance is in vectoring fighters to intercept attacking aircraft. The inability to direct pilots against specific incoming enemy aircraft wastes resources; aircraft can not concentrate where needed most. Additionally, fighter radars do not cover 360^{o}. EW radar operators, through the C^3 aspect of the air defense system, cover the fighter's blind area, particularly while he is engaged on a target. Without effective voice or data communications to the fighter, the radar operators can not warn the engaged pilots of an imminent threat.

Command, control, and communications also facilitates allocating hostile air targets between defensive fighters and ADA assets. C^3 also allows the radar picture of one radar element to share that picture with other radar elements, thus increasing the situational awareness of the area of operations as a whole. One radar site's identification of an aircraft can be passed to other facilities, fighters, or ADA units, thereby increasing the likelihood of engaging hostile aircraft sooner, and reducing the potential for fratricide.

The susceptibility of C^3 assets to ECM depends on the technology at any given time. Great efforts to reduce C^3 susceptibility are occurring. The design of frequency hopping radios (such as "have-quick" radios) prevents the effects of communications jamming. The joint tactical information distribution system (JTIDS) passes data and voice transmissions between air defense system elements with an extremely low susceptibility to enemy jamming. Although the trend is toward anti-jam systems, some elements still rely on very vulnerable systems such as the common telephone system. A well placed attack on a switching center could potentially cause mayhem in the C^3 system. Other assets to attack the C^3 system are airborne communications jammers, which disrupt fighter or air defense system communications.

The ability of an air defense system to engage and destroy incoming enemy aircraft and missiles, is dependent on fighters, ADA, and C^3. The enemy's concentration of forces can overcome fighters; enemy jamming, destruction or degradation of EW radars can overcome ADA; and enemy jamming or strikes at critical nodes can overcome C^3 assets.

PROTECTION AND RECONSTITUTION

An air defense system must be capable of protecting itself. Many aspects of protection have already been covered. As discussed earlier, some methods of protection can render an air defense system inoperable. Fighters housed in shelters can not be immediately used. Radars shut down to conceal their position do not provide early warning or SAM guidance. Radars by their very nature can not shelter themselves in hardened shelters. One method of protecting radars is employing bistatic radars in which the transmitter and the receiver are in different locations.[73] Then, if the radar is attacked, only one portion of it will be hit. This makes replacement less expensive. Another method of protection, as discussed earlier, is making the radars mobile. Radars also need protection from ECM. According to Elsam, however, radars can not be protected from jamming. He claimed, "There is no such thing as an 'unjammable' radar and for every measure taken to improve a system a counter will eventually be produced."[74] From all the preceding discussions, it seems reasonable to conclude, that it is most difficult, if not impossible, to protect an air defense system against an enemy determined to destroy all or part of that system.

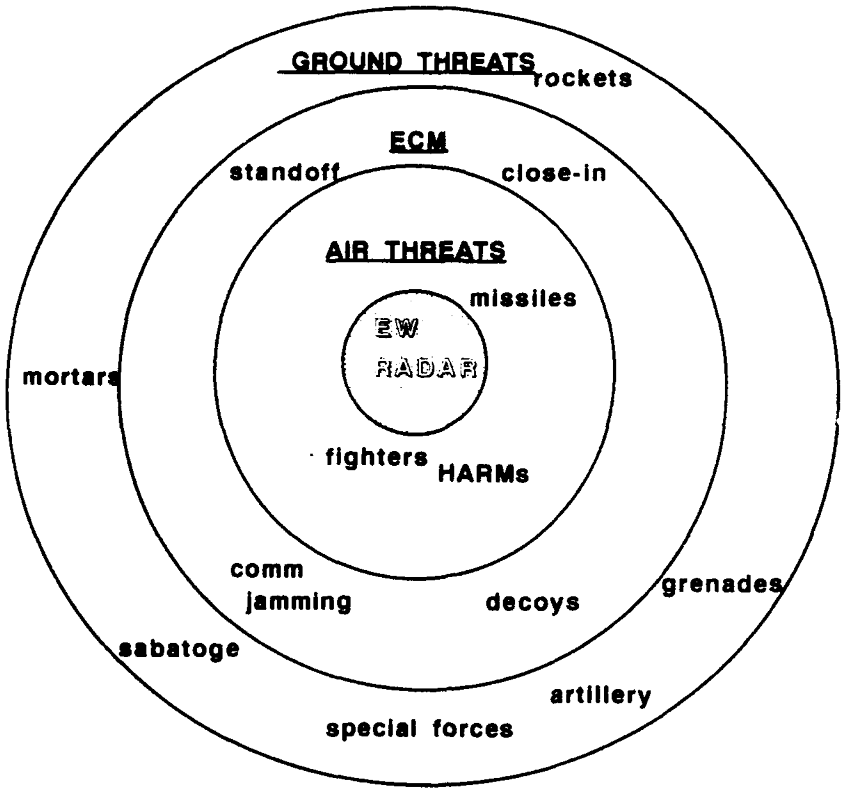
Reconstitution is another capability an air defense system must have. A significant concern is replacing destroyed EW radars. To do so in a timely manner requires airborne EW radar aircraft to fill the radar gaps left by destroyed ground radars. Those aircraft must already be possessed by the defending nation with crews trained to operate the systems. If these aircraft were all destroyed, it is highly unlikely they could be replaced; the lead time to build more aircraft and train crews to operate them is too long. The same reasons apply to replacing fighter aircraft and their crews. The most likely candidate of an air defense system for reconstitution is the ADA, since it is generally less technologically sophisticated than EW radar aircraft or fighters. But even with ADA being on the lower end of the technological sophistication spectrum, it still takes time to build the equipment and train the operating crews. Unless a nation holds air defense system assets in reserve during a conflict, it is not likely those assets could be replaced in a timely manner. However, with the high cost of these air defense assets, and their inherent difficulty of defending everywhere, it is unlikely many assets will be held in reserve.

CONCLUSIONS/RECOMMENDATIONS

Assessing the viability of current U.S. Air Force doctrine was this study's purpose. Specifically, the study examined whether future technological advances in air warfare justify a shift in doctrinal emphasis from the offense to the defense. The study first examined the theories of Clausewitz, Douhet, and Warden. Clausewitz considered the defense as the stronger form of warfare, while Douhet and Warden believed the offense was the stronger form. The theories illustrate how technology, in the form of the aircraft, altered the theoretical primacy from defense to offense.

Second, four historical examples demonstrated how in actual practice technology changes the relative balance of the offense and defense. While technological advances temporarily strengthened the defense, the offense prevailed over time.

Third, the study examined current air defense technology to assess its ability to meet the four requirements of a viable air defense system, and thus, alter the balance from offense to defense. From the analysis of current technology, there are many steps a nation can take to strengthen its air defense system. However, there always seems to be a counter to any technological improvement in an air defense system. Destruction or suppression of any one portion of an air defense system affects the entire system. Any critical node left unprotected is vulnerable to attack and can have devastating effects on the rest of the system. For example, EW radars must protect themselves from ground attack, air attack, and ECM (see Figure 3).



EW Radar Threats
Figure 3

To achieve a successful defense all four air defense system capabilities must be met. If one is lacking, the system is subject to failure. With the dependence on the electronic spectrum, and the ongoing technological advances, it is difficult to imagine a nation being able to meet all four air defense system requirements for an extended period of time without an enemy developing a counter to the current systems.

The use of the term "air defense umbrella" brings to mind some important aspects of depending totally on the defense. An umbrella supposedly prevents the user from getting wet. If only a two inch hole were cut in the umbrella, it could not fulfill its function. Similarly, a corridor cut in an air defense umbrella, leaves the defending nation vulnerable to attack. With the precision guided weapons of today, even a few aircraft attacking through this hole would do considerable strategic damage. The problem, then, is whether a nation can count on this defense to totally achieve its defensive needs. If the nation is wrong, it will not get a second chance.

In the long run offense will likely dominate defense in air warfare because air defense requires a successful system. In the short term technology may upset the balance, but the balance will eventually favor the offense. Air power's mobility allows massing against any particular point in a defensive system. On the other hand, the defense can not be strong enough everywhere to counter the offensive concentration of forces.

Since the offense will likely prevail now and in the future, one can conclude current Air Force doctrine is correct. That doctrine emphasizes the offense over the defense in air warfare and should continue to do so in the future.

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