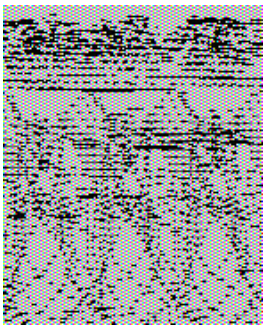

Targeting for Effect

Analytical Framework for Counterland Operations

SCOTT G. WALKER, Major, USAF
School of Advanced Airpower Studies

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Abstract

This study analyzes the use of airpower against enemy ground forces. Maj Scott G. Walker assesses current doctrinal definitions of the close air support and interdiction missions as seen by the Air Force and Army, comparing and contrasting the two. In chapter 2 Major Walker examines a typical modern field army, analyzing the various parts of combat and support forces for criticality and vulnerability to air attack. Chapter 3 examines the desired operational effects and tactical results. This examination includes the questions of enemy actions, congruence with overall strategy, and the tactical problem of finding, identifying, striking, and assessing damage to the target. Operational level combat assessment is also discussed. In chapter 4 Major Walker examines the historical development of combined arms warfare and current Army doctrine regarding forms of maneuver, attack, and defense, highlighting areas where a particular ground scheme of maneuver is best supported by a particular air mission, or by air attack on a specific target set. Chapter 5 briefly reviews four case studies in attack aviation, ranging from World War One to the Vietnam War. The final chapter is a recap of the top-to-bottom analysis process, including a graphic depiction of the author's counterland analysis framework. The themes that recur throughout are the need for planning to remain flexible, using the speed and firepower of air attack to concentrate force where needed, and the requirement for good operational and tactical intelligence.

About the Author

Maj Scott G. Walker was commissioned in 1983 from the United States Air Force Academy (USAFA). Graduating from EuroNATO Joint Pilot Training in 1984, he went on to fly F-16s as a flight lead, instructor pilot, and mission commander. Attending the USAF Fighter Weapons School in the fall of 1990, he subsequently served as a squadron and wing level weapons and tactics officer. Major Walker is a senior pilot with more than 2,200 flying hours in the F-16, including 180 combat hours over Iraq and Bosnia with operations Provide Comfort and Deny Flight. He is a graduate of Air Command and Staff College (1995–96) and the School of Advanced Airpower Studies (1996–97). He has a bachelor's degree in astronautical engineering from the USAFA and a master's degree in political science from Auburn University at Montgomery, Alabama. In July 1997 Major Walker was assigned to the USAF Doctrine Center at Maxwell Air Force Base, Alabama, as a military doctrine analyst.

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Chapter 1

Introduction

And this leads up to the point that in a land campaign the primary objectives—that is to say those against which action will lead most directly to a decision—will always be the enemy and forces, their communications and system of supply.

—Wing Comdr J. C. Slessor

In virtually every conflict in which airpower has played a part, it has been used to some degree to attack enemy ground forces. While sometimes taking a back seat to the struggle for air superiority or strategic bombing campaigns, ground attack has always been there influencing the outcome. What ground attack, or "counterland" to use the current doctrinal terminology, has often lacked a systematic analysis of how best to achieve success against the enemy.[1]

I propose one such analytical framework in this study. I do not address the question of the proper role of airpower in war; issues such as the efficacy of strategic bombing or whether air superiority should always be airpower's first priority are beyond the scope of this work. My mission is to present one approach to the effective use of airpower against armies, given that those armies represent valid and vital targets.

The methodology for building this framework is primarily theoretical. I begin with working definitions of the methods for using airpower to attack field armies. Next is a description of the typical components of a fielded army, including combat units, support units, and supporting infrastructure. I then describe various ways airpower can affect such an army, focusing on questions of criticality and vulnerability. Following this is an analysis of synchronizing air and surface forces to achieve the best overall results, an area that airmen (and soldiers) too often neglect. Having established the categories and variables that are critical to the proper use of airpower against an army, I briefly examine four historical cases where airpower was used to attack enemy ground forces. These case studies are the 1918 Saint Mihiel offensive, the 1944 post-invasion breakout in France, the 1950 advance of the North Korean army to the Pusan Perimeter, and the 1972 Easter offensive in Vietnam. My intention is not to prove or disprove theory or doctrine in these case studies, but simply to examine how airpower was used, and what the results were, based on the variables presented in the theoretical section. My final chapter is a formal presentation of the analytical framework for the use of airpower against field armies, along with a discussion of airpower's limitations.

What is the importance of ground attack? The historical significance of counterland operations has already been mentioned, but what about the future? In today's environment of limited war, a field commander may well find himself restricted from attacking strategic targets deep within the enemy country. It may also be that an enemy army, more than his industrial base or infrastructure, turns out to be his true center of gravity. One can also apply the lessons from this counterland thesis to the ground attack portion of a larger overall air strategy, one that includes other missions such as strategic attack and counterair.

Origins

Attack of enemy ground units has been a mission flown in almost every war since man's first flight. It is interesting to note that the first use of an airplane in anger was a bombing attack by an Italian pilot on Turkish positions in Libya, demonstrating early on the value of the airplane in attacking enemy positions.[2]

As World War I began in August 1914, the airmen of the time saw an opportunity they quickly exploited, "though reconnaissance was the official function, the 'central purpose,' of the airplane in 1914, any number of reports in those first weeks of war indicate it was being converted to another, more offensive use, as airmen pelted enemy troops below with any projectile they could find."[3]

As the use of ground attack became more widespread, early concepts such as "trench strafing" and "ground strafing" grew into the more refined ideas of close air support (CAS) and aerial interdiction.[4] Interdiction, and to some extent CAS, later became central to the combined arms strategy of blitzkrieg.[5] The central question that grew out of World War I regarding ground attack of enemy troops was where to place the main effort—at the point of contact between opposing ground armies, or at the more lightly defended rear echelons. Airpower historian Lee Kennett writes,

> And there was still considerable disagreement in 1918 over the role itself. In theory and in practice, air support aircraft in 1918 had two categories of targets: objectives along the enemy's heavily defended frontal positions, which some generals called the "crust," and a whole range of targets extending twenty miles and more behind that crust. Enemy reinforcements moving up in column were much more visible and vulnerable than front-line troops in field fortifications, and there was less danger of confusing them with friendly ground forces. Then, too, objectives behind the front lines tended to be less fiercely defended—no minor consideration, given the losses suffered by ground attack units. Additionally, excellent targets often lay beyond the effective range of friendly artillery, in a zone where only the airplane could reach them. Toward the end of the war, targets such as dense troop columns and convoys of vehicles appeared in great numbers.[6]

In addition to the question of whether to attack the crust or the rear area, the above passage addresses several areas that are still key to ground attack strategy. Should the combat units themselves or their support be attacked? How does enemy air defense vary with depth behind the front lines? How much more vulnerable are enemy units or supplies while in transit? At what

point does air attack become a greater threat to the enemy than artillery bombardment? How much does the need for friendly identification limit the effectiveness of air attack on enemy troops in contact with friendlies? These are some of the issues that will form my analytical framework for ground attack.

Safety measures for CAS and interdiction evolved as new technology developed. In World War I, visual signals of various kinds were used to identify friendly troops, and a bomb safety line, or "bombline," was defined by identifiable features a safe distance toward the enemy.[7] This marked the closest that bombs could be dropped to friendly troops, since attacking closer targets carried the risk of hitting friendlies. During the Second World War, radio communications allowed closer control of CAS missions, and the bombline was allowed to move closer to friendlies. By the Korean War, close control of CAS had become the norm, and the term *bombline* now came to refer to the delineator between CAS and interdiction, traditionally located at the maximum effective range of the land force artillery.[8] Today, the original bombline concept has evolved into the "risk-estimate distance," but it still means the closest distance to friendly forces that a target can be hit.[9]

In modern doctrine, the boundary between CAS and interdiction is not clearly defined in Air Force or joint doctrine. The term *fire support coordination line* (FSCL) has come into use as a tool for both air-to-ground attack coordination and fratricide avoidance. Although many military professionals consider the FSCL to be the dividing line between interdiction and CAS, we will see that this is not necessarily the case as spelled out in current joint doctrine.

Scope and Limitations

This study focuses on the effects of air attack on an enemy army. By remaining focused on effects, I will avoid the issues of service control of the various platforms involved in CAS and interdiction. I do include such non-Air Force weapons as attack helicopters, and though surface-launched rockets are arguably not "airpower" per se, I do include those systems that can attack deep and thus play a role in interdiction. This study avoids such "turf" issues as whether the Army should have responsibility for the fixed-wing CAS mission, or whether the joint force air component commander (JFACC) should usually be an Air Force officer. The bottom line is that, regardless of what service controls which pieces of the ground attack pie, there probably is still one best way to use those pieces to attack an enemy army.

Arriving at an analytical framework, not a completed strategy, is the goal of this study. The ground attack problem involves many different variables, each of which has different values for each specific conflict. Any complex problem such as this does not lend itself to a permanent solution, but must be resolved with each new set of contextual variables, as new conflicts occur. This study does not hand a solution to the air planner, but it does provide him

with a framework for developing his own solution to a given ground attack problem.

Conventional war, involving at least some level of mechanized forces, is the focus of this work. Although some of the concepts for ground attack presented here carry over to insurgencies and military operations other than war (MOOTW), many do not. In fact one of the hard lessons learned in the limited conflicts of the post-1945 era was just how limited the effectiveness of airpower can be against a guerrilla foe.

In the core of the study, which involves theory and doctrine, modern equipment, and tactics are discussed. Weapons which are already nearing production are included in the analysis. Varying levels of enemy capability, to represent the varied potential threats to the United States, are addressed. In the historical case studies, the equipment and tactics of the time are examined, and areas where significant improvements have been made are noted.

Definitions and Assumptions

Before defining CAS and interdiction according to the various current doctrines, a distinction must be made as to what type of definition we are using. Interdiction is usually defined in terms of operational effects on the enemy, whereas CAS is more often defined in terms of operational procedures that set it apart from interdiction. When the airpower strategist considers CAS, he may think in terms of apportionment decisions and opportunity costs, while the individual pilot thinks of CAS in terms of a set of rigid procedures to both locate the enemy and avoid dropping on friendlies.

Traditionally, both CAS and interdiction have been seen as supporting the ground battle, and that decisive combat does not occur until the armies of both sides have come to contact. A more realistic approach is to view both the ground and air operations as coequally supporting the ultimate objective, in this case the destruction of the enemy army. Since airpower can extend far beyond the reach of ground units, it only makes sense that airpower will usually engage the enemy first. It also follows that, if one's airpower is strong enough, it may be possible to destroy or at least halt the enemy army so that no actual ground combat takes place. It may also follow that ground combat, in many circumstances, will fill the supporting role by either fixing the enemy in place or forcing him to expose himself to devastating air attack, which provides the bulk of the actual killing power. Even within today's United States (US) Army, many ground commanders acknowledge that the attack helicopter may be the most lethal battlefield weapon we own.

The current Joint Publication (Joint Pub) 1-02, *DOD Dictionary of Military and Associated Terms,* defines interdiction as: "An action to divert, disrupt, delay, or destroy the enemy's surface military potential before it can be used effectively against friendly forces."[10] Since joint doctrine is now considered authoritative, all of the US military services are using the standard joint definitions in their service-specific doctrine manuals as well.[11] Note that the

current accepted definition of "interdiction" is very broad, since it allows for several different effects on the enemy. Direct attack of enemy combat forces will "destroy" or "disrupt" them, and can also "delay" their getting to the battle. Attacking support units can disrupt combat forces by denying them needed supplies of petroleum, oils, and lubricants (POL), munitions, and food. Attacking the transportation infrastructure can delay or divert units by forcing them to take alternate, more lengthy routes to the front. Note that the definition of interdiction does not require enemy units to be mobile, so that destruction of emplaced enemy forces as happened in Operation Desert Storm still falls under interdiction, as long as those enemy forces have not yet been engaged by surface units.

A second definition of interest is the specific term *air interdiction*, which Joint Pub 1-02 defines as: "Air operations conducted to destroy, neutralize, or delay the enemy's military potential before it can be brought to bear effectively against friendly forces at such distance from friendly forces that detailed integration of each air mission with the fire and movement of friendly forces is not required."[12]

This definition, specific to air interdiction, includes both an effects definition and a procedural definition. The defined effects are more general, with "neutralize" replacing the earlier divert and disrupt. The added procedural definition about distance from friendly forces will come up later when we examine the fire control measures used for ground attack.

These definitions for interdiction do not differ in substance from the opening 1936 quote from J. C. Slessor, who described attacking the "enemy land forces, their communications, and system of supply." What they do add is specificity as to exactly what effects are sought, especially the first definition which lists the "four Ds" of interdiction: destroy, disrupt, delay, divert (some theorists add a fifth D—demoralize, but I will treat morale as a separate issue).

Recent advances in detection technology, along with the promise of rapid retargeting via real-time digital data link, has led some to speculate that interdiction will soon be able to "halt" an advancing enemy as opposed to merely delaying or disrupting it. While this may fall into the same category as complete "isolation" of the battlefield, an effect which airpower has often promised but never delivered, emerging technology will at least make the delay much longer and the "disruption" much worse.[13]

CAS is defined in Joint Pub 1-02 as: "Air action by fixed- and rotary-wing aircraft against hostile targets which are in close proximity to friendly forces and which require detailed integration of each air mission with the fire and movement of those forces. Also called CAS."[14] The desired effects of CAS are not specified at all, since this definition simply states "air action" and focuses on proximity and procedure. Since CAS is flown against enemy forces that are either already in contact with, or about to be in contact with, friendly ground units, it offers little opportunity for either delaying or diverting the enemy. However, depending on the determination of where the boundary between CAS and air interdiction is drawn, these effects could be achieved on a

short-term basis. In any case, it would seem that the two primary desired effects from CAS are destruction and disruption of the enemy, with fratricide avoidance playing a major role. Also noteworthy is the inclusion of rotary-wing CAS as a mission, since the US Army has traditionally thought of attack helicopters providing "deep fires" in what amounts to interdiction, not CAS.[15]

One final definition is the FSCL. The current Joint Pub 3-0, *Doctrine for Joint Operations*, defines the FSCL as: "A line established by the appropriate land or amphibious force commander to ensure coordination of fire not under the commander's control but which may affect current tactical operations. The fire support coordination line is used to coordinate fires of air, ground, or sea weapons systems using any type of ammunition against surface targets. . . . Attacks against surface targets behind this line [meaning closer to our troops] must be coordinated with the appropriate land or amphibious force commander. Also called FSCL. (Approved for inclusion in the next edition of Joint Pub 1-02.)"[16]

In the narrative discussion of the FSCL, however, Joint Pub 3-0 muddies the issue by stating, "Short of an FSCL, all air-to-ground and surface-to-surface attack operations are controlled by the appropriate land or amphibious force commander."[17] This passage seems to state the intent for air missions short of the FSCL to be controlled by the ground commander, not just coordinated between components. Some interpret this as a mandate that all such missions use CAS procedures, which is overly restrictive. Only CAS provides the ground commander with a front-line representative, normally a ground or air based forward air controller (FAC), who gives final release authority to the ground attack aircraft.[18] However, not all missions flown short of the FSCL will be in such close proximity to friendly ground troops that such terminal control is necessary. Use of such procedures when beyond the "close proximity" distance only restricts the flexibility and effectiveness of airpower, and will only become a greater problem if the FSCL moves deeper as the Army has suggested.

The recently released Joint Pub 3-03, *Doctrine for Joint Interdiction Operations*, sheds more light on the subject. By addressing the issue of CAS versus interdiction short of the FSCL, it states that:

> Interdiction can occur both short of and beyond the FSCL. Attacks on surface targets short of the FSCL during the conduct of joint interdiction operations must be controlled and/or coordinated with the appropriate land or amphibious force commander. While conducting air interdiction short of the FSCL, mission updates through a theater air control system or amphibious tactical air control system agency can help ensure that those targets are still valid, eliminate redundant targeting, and reduce the potential for fratricide. An example of this type of coordinating agency is an air support operations center (ASOC), airborne battlefield command and control center (ABCCC), or Navy tactical air control center.[19]

This passage gives more latitude for what level of coordination or control will be required for interdiction missions flown against targets short of the FSCL, allowing for theater- and situation-specific procedures to be developed.

It also allows for a level of control that falls short of CAS-style terminal control, but does require interdiction missions to check in for a situation update prior to hitting their targets. Joint Pub 3-03 also addresses the issue of what happens when the FSCL is placed too far forward: "Establishment of the FSCL too far forward of friendly forces can limit the responsiveness of air interdiction sorties. Control of air-to-surface operations short of the FSCL requires detailed synchronization, increased communications assets, more restrictive rules of engagement, positive identification procedures, and more key personnel involved in the decision cycle than for those missions conducted beyond the FSCL."[20]

In addition to considerations short of the FSCL, joint doctrine also calls for CAS procedures to be used for fratricide avoidance in those situations where friendly troops are beyond the FSCL, and in close proximity to enemy units being attacked. Such circumstances can arise when an advance moves faster than expected, or when airpower is used to support special forces deep in enemy territory.

Notes

1. Air Force Doctrine Document (AFDD) 2-1.3 (draft), "Counterland Operations," February 1997. Throughout the author uses the more common terms *ground attack* or *attack aviation*.
2. Angelo Lodi, *Storia Delle Origini dell' Aeronautica Militare 1884-1915: Aerostieri, Dirigibilisti, Aviatore dell' Esercito e della Marina in Italia nel Periodico Pionieristico* (Rome, 1961), 93–146 (as quoted by Lee Kennett in "Developments to 1939," *Case Studies in the Development of Close Air Support*, ed. Benjamin Cooling (Washington, D.C.: Office of Air Force History, 1990), 11–12.
3. Lee Kennett, *The First Air War; 1914–1918* (New York: Free Press, 1991), 41.
4. Richard Hallion, *Strike from the Sky: The History of Battlefield Attack* (Washington, D.C.: Smithsonian Institution, 1989), 20.
5. Martin van Creveld, Steven L. Canby, Kenneth S. Brower, *Air Power and Maneuver Warfare* (Maxwell Air Force Base, Ala.: Air University Press, 1994), 49.
6. Lee Kennett, "Developments to 1939," 25.
7. Benjamin Cooling, ed., *Case Studies in the Development of Close Air Support* (Washington, D.C.: Office of Air Force History, 1990), 3.
8. Allan Millett, "Korea, 1950–1953" *Case Studies in the Development of Close Air Support*, ed. Benjamin Cooling (Washington, D.C.: Office of Air Force History, 1990), 350–51.
9. Joint Publication (Joint Pub) 3-09.3, *Joint Tactics, Techniques, and Procedures for Close Air Support (CAS)*, December 1995, G–3:G–4.
10. Joint Pub 3-0, *Doctrine for Joint Operations*, 1 February 1995, GL–7.
11. Ibid., i.
12. Ibid., GL–3.
13. Price Bingham, "Joint Mobile Targeting Engagement, The Key to Successfully Halting an Invasion," unpublished paper, March 1977.
14. Ibid., GL–4.
15. Army Field Manual (FM) 100-5, *Operations*, June 1993, 6–14.
16. Joint Pub 3-0, GL–7.
17. Ibid., III–34.
18. Joint Pub 3-09.3, II–8.
19. Joint Pub 3-03, *Doctrine for Joint Interdiction Operations*, April 1997, II–15.
20. Ibid.

Chapter 2

The Field Army Described

Know your enemy . . .

—Sun Tzu

To develop a practical analysis of how to attack an army with airpower, we must first examine the various components that comprise such an army. While modern armies vary somewhat in form and function, there are certain generalities that exist within all mechanized ground forces. One legacy of the cold war is that many, perhaps most, of our potential targets use former Soviet hardware. With the current economic crunch in the former Soviet Union, it is likely to continue exporting military equipment to anyone willing to buy it. Many of the nations that have purchased Russian weapons have also adopted Russian tactics, organization, and doctrine; whether those nations will subscribe to Russian methods in the future remains to be seen.[1] US and European weapons also equip the militaries of many nations around the world; in general terms, the equipment of the former Eastern and Western bloc nations are similar when it comes to air attack. A laser-guided bomb doesn't care whether its target is an M-60 or a T-72; inability to distinguish between types of vehicles is an ongoing fratricide avoidance problem.

In the days of Alexander and Caesar, armies were considered to have two main branches, the infantry and the cavalry. Supporting fires, such as then existed, were supplied by arrows and slings. With the development of gunpowder, steel barrels, and rifled shells came improved artillery, and supporting firepower came to have a more important role on the battlefield. The twentieth century has seen the growth of the mechanized army, with artillery becoming far more mobile and the armored tank becoming the primary offensive ground weapon.[2] Rockets have supplemented, though not replaced, artillery as a source of long-range concentrated firepower. Army aviation, in the form of the attack helicopter, has added another long-range option for projecting firepower against the enemy.

According to US doctrine, the modern army can be broken into the following combat categories: infantry, armor, artillery, aviation, and cavalry.[3] I will not address cavalry as a separate unit type when attacked from the air, because it does not vary significantly from light infantry other than being more mobile. Like cavalry, infantry can be airlifted by helicopter for greater freedom of maneuver, so this aspect of army aviation must be considered.

Special forces are not addressed separately, as they also possess the same characteristics as light infantry regarding air attack.

Two important supporting unit types are air defense artillery (ADA) and combat engineers. ADA will be considered under the variable of tactical air defense strength. Most of the world's armies have some form of tactical air defense, with rapid-fire cannon and man portable or vehicle-launched surface-to-air missiles the weapons of choice. One of the key considerations determining vulnerability to air attack is how much tactical air defense an army possesses. The Army Field Manual (FM) 100-5, *Operations*, points out that air defense not only protects units from air attack, but from aerial reconnaissance as well, which is often a mandatory prerequisite to actual attack.[4] Engineers provide a ground army with the ability to repair damaged infrastructure, or create new infrastructure if forced to divert from a planned line of communication (LOC).

An important distinction must be made between individual force categories (infantry, artillery, etc.) and organizational composition. Most divisions, for example, have both artillery and infantry assigned to them. Mechanized infantry and armor divisions both have tanks, with armor divisions having a greater percentage of tanks with correspondingly less infantry.[5] Artillery is usually organized into batteries within artillery battalions, which are then assigned to infantry, mechanized, or armor divisions.[6] In this study I focus on the effect of airpower on each force category, not organizational type. It must be remembered, however, that ground forces are packaged this way for a reason, and under many circumstances affecting one force category will hamper the rest. A typical example of this is the reluctance of armor to advance without supporting infantry.

Infantry

Once known as "the queen of battle," infantry comes in five basic types: light, airborne, air assault, ranger, and mechanized.[7] The greatest difference between these types is not how they fight, but how they get *to* the fight. Once in battle the various infantry units fight in a similar fashion, although there are some differences in available firepower and staying power.

Light infantry is the classic "foot slogging" infantry, although in most modern armies unarmored vehicles are used to transport all forms of infantry to the battle area. One notable exception is the People's Liberation Army (PLA) of China, where only the heavy equipment moves by truck.[8] Likewise, a 1996 report credits the PLA with only 100 helicopters of all types, which cannot be considered a serious source of transportation for a 2.2 million man army.[9] Light infantry's combat power can be considered "average" for infantry.

Airborne and air assault infantry are carried into battle by transport aircraft or assault helicopter, respectively. This limits the number of heavy weapons, such as artillery, that they can bring with them to the fight. Airborne units share most of the same characteristics of light infantry once

they are delivered into battle, but air assault units retain added battlefield mobility as a result of their ability for rapid pickup and delivery by lift helicopter. Air assault units also bring the firepower of extra attack aviation units into battle with them, at least in those armies that have large numbers of attack helicopters in service.[10] Both types of air delivered infantry may be at a logistical disadvantage if deployed beyond surface LOCs, and their ability to sustain combat beyond a few days depends on either aerial resupply or linkup with other ground units.[11] One other drawback of most airborne and air assault units is that, once delivered into battle, they lack some of the ground mobility of regular vehicle-transported infantry.[12]

Ranger units are highly trained light forces capable of either special or conventional operations, and when used conventionally they are comparable to light infantry in combat power and equipment. The Russian Spetsnaz unit is roughly equivalent, though current training levels in the former Soviet Union are questionable.[13]

Mechanized infantry is considerably heavier than the other infantry variants. Normally equipped with a large number of armored personnel carriers (APC) or infantry fighting vehicles (IFV), many mechanized infantry units have the option of riding their vehicles into combat instead of dismounting and walking in.[14] Often mounting heavy machine guns, cannon, or missiles, such fighting vehicles pack a heavier punch than the standard infantry weapons. Many mechanized forces train to fight alongside armor, giving that armor the advantage of infantry cover without giving up mounted mobility and survivability. One downside of mechanization is the prodigious quantity of fuel that must be consumed while advancing. Another is the added maintenance requirement—APCs and IFVs are much harder to keep in fighting trim than the "mark one" truck.

Critical to all forms of infantry is that they require some form of transport to get to the battle. A key question for the air strategist is what form of transportation will it take, and where does its vulnerabilities lie. Once in battle, all infantry units will require resupply relatively quickly. Typically, infantry forces can sustain themselves for a few days to a week without replenishment, depending on the level of fighting. The details of transportation criticality and vulnerability will be addressed later.

Armor

According to FM 100-5: "In mounted warfare, the tank is the primary offensive weapon. Its firepower, protection from enemy fire, and speed create the shock effect necessary to disrupt or defeat the enemy."[15] While this may be true in general terms, the tank requires infantry protection on the modern battlefield, which includes modern antitank weapons. The Israelis learned this lesson the hard way when the Egyptian army introduced them to the Sagger antitank missile in October 1973.[16]

While not exceedingly fragile, tanks do experience a fairly high breakdown rate, particularly in the track system. A tank unit moving on its own will

typically suffer a two to 20 percent breakdown rate per hour, with repairs often taking hours. As a result, when armor units move long distances they normally travel via rail or transporter truck. These same considerations apply to mechanized infantry units, although the lighter, less complex APCs and IFVs do not break down quite as often.[17]

When engaged in battle, tanks will use both fuel and ammunition at a rapid pace that requires frequent replenishment. With crews able to fire six to eight rounds per minute, the onboard ammunition supply does not last long. Typical tank cruising speeds are 20 to 30 miles per hour (MPH), with ranges of 200 to 400 miles.[18] This equates to roughly 10 hours between refuelings, and less than that in combat depending on the location of the refueling station or vehicle.

Artillery

Artillery is the surface weapon that typically causes the greatest destruction on the battlefield. Statistics from World War II show that in open terrain about 75 percent of combat casualties were caused by artillery; in mixed terrain this dropped to about 60 percent.[19] Modern artillery is supplemented by various types of battlefield rocket systems, such as the US Army's multiple launch rocket system (MLRS) and Army tactical missile system (ATACMS). Due to the deadly nature of its fire, a ground commander will often request that airpower target enemy artillery as its first priority.[20]

Able to fire a variety of ammunition, artillery is capable of inflicting blast, fragmentation, cratering, penetration, mining, or chemical effects on the enemy. Submunition warheads are increasingly being used for area effects by both artillery and rockets. The primary warhead for both MLRS and ATACMS is a load of several hundred small submunitions, which are scattered over an area a few hundred meters square and provide combined blast, fragmentation, and armor penetration effects. In development for ATACMS is a guided antitank submunition, 13 of which can fit in one round and which possess infrared and acoustic terminal guidance capability with an armor penetrating warhead.[21]

Ranges of artillery pieces vary with caliber and other factors, but in general terms field artillery has an effective range of 15 to 20 miles. The MLRS also has a maximum range of about 20 miles, while the ATACMS ranges considerably further. The initial lot of ATACMS can reach out to 90 miles while the improved Block 1A, which is just entering production, has an extended range of 160 miles.[22] This long range makes interdiction with ATACMS a real possibility, and the air planner should include it in his arsenal.

Artillery comes in two types—towed and self-propelled (SP). Towed guns rely on trucks or heavy lift helicopters for their mobility and provide little protection for their crews or ammunition. SP artillery, on the other hand, is mobile enough to keep up with armor or mechanized infantry, and provides some protection for both crew and shells. A drawback specific to air attack,

though, is the much larger visual and heat signature of SPs compared to towed artillery. Most modern infrared targeting systems can easily locate an SP vehicle in average weather, but locating towed artillery is more difficult unless the actual muzzle flash is seen. SPs also suffer the same reliability problems and track vulnerability as tanks and APCs or IFVs.

The other main advantage of the SP is its ability to move quickly after firing, colloquially known as the "shoot and scoot" maneuver.[23] Modern counterbattery radar can track a shell in flight, and have the firing position located and counterbattery rounds on their way before the original shell impacts its target.[24]

Aviation

The helicopter is a recent addition to the battlefield, but it has significantly added to both tactical mobility and combat firepower. Many armies now rely on attack, scout, and transport helicopters of various sizes and models. I have already addressed the dependence of air assault infantry on helicopter lift, but the other branches also rely on scout helicopters for tactical reconnaissance. Attack helicopters provide fire support to all branches, and the US Army sees the attack helicopter as capable of both close and deep operations.[25] Current US Army doctrine states that the attack helicopter is capable of operating as deep as 100 miles into enemy territory, a capability that makes it an asset for interdiction.[26]

While lift helicopters are often armed only with machine guns, and many scout helicopters are unarmed, the modern attack helicopter is heavily armed and often carries state-of-the-art sensors and fire control systems. Three of the most widely deployed types are the American AH-64 Apache and AH-1 Cobra, and the Russian Mi-24 Hind. All of these carry rapid fire cannon, guided missiles and unguided rockets, and are capable of carrying short-range air-to-air missiles. Night vision goggles and infrared systems give these platforms significant night capability, and the new Apache Longbow will mount a radar on the rotor mast to provide some all-weather attack capability.[27]

Like most other modern weapons, helicopters depend on fuel and munitions to achieve their battlefield success. Most armies employ forward arming and refueling points (FARP), to provide rapid turn around for refueling and rearming. This maximizes the time attack and scout helicopters can spend engaged on the battlefield. FARPs are typically placed just behind the range of enemy artillery, or about 15 to 20 miles on the friendly side of the forward line of own troops (FLOT.)[28] FARPs represent a vital node in attack and scout helicopter operations that can be exploited by airpower.

Support Components

There is much truth to the old saw that "lieutenants study tactics, generals study logistics." Supplies of ammunition, POL, food, and water represent critical parts of the enemy's war machine that can often be attacked more easily than

the combat units themselves. A thorough understanding of the enemy's supply capabilities and disposition is critical to proper exploitation by airpower.

Ammunition is obviously a vital component to any army. Troops and combat vehicles can carry only limited amounts with them into battle, mainly for the sake of tactical mobility. Most armies maintain some form of forward munitions dumps that are fairly close to the front and are connected by LOC to either larger rear depots or to the interior of the enemy nation. Due to the explosive nature of their contents, forward munitions dumps that are likely to be attacked are often hardened and dispersed. The level of dependence on munitions resupply is directly related to the scale of battle, as reflected in an individual unit's rate of fire. In this it does not matter if the unit is mobile or stationary; in fact some studies indicate that rapidly moving units spend less time in contact with the enemy, and thus expend less ammunition. Airmobile units may be forced to rely on helicopter resupply of ammunition, which can deliver less quantity than truck or rail transport.

The amount of ammunition that a particular type of unit carries into battle, known as the "unit of fire," represents the maximum available firepower without resupply. Typically, an infantryman will carry 300 rounds of automatic rifle ammunition into battle, most main battle tanks hold 40 to 50 rounds for their main gun, while artillery batteries carry 50 to 100 rounds per gun.[29]

Fuel and oil are the lifeblood of any mechanized army. Refueling depots, trucks, and pipelines are all possible targets that can have devastating effects on an enemy army if damaged or destroyed. As with munitions, most armies operate from forward refueling points that are themselves supplied from larger depots further to the rear. POL pipelines are often used to bring fuel to the immediate rear area, a process which relies on pumping stations and typically achieves flow rates of three to five miles per hour.[30] Typically, Western armies carry a two to three day supply of fuel into battle; the standard Warsaw Pact doctrine called for four to five days' worth, perhaps pointing to a greater expectation among the Soviets that their supply lines would have been interfered with.[31]

Food and water represent the most basic needs of the enemy soldier, along with other basics such as shelter and sleep. Most troops take only limited quantities of food and water into battle, for the same reason of mobility that affect POL and munitions. Morale is often directly tied to food and water availability, as is simple physical strength and endurance.[32] Even when an army is not heavily engaged or on the move, food and water will be consumed at a relatively constant rate. Air planners must consider the environment and surrounding terrain if planning to attack food and water supplies, for troops that can live off the land will remain effective for long periods under such attack.

Typical replenishment systems often use the same infrastructure for different supplies, such as using the same rail lines for POL tank cars and ammunition trains. Such circumstances increase the value of attacking that infrastructure, causing a "two for one" effect on the enemy's ability to resupply himself. Figure 1 shows a typical modern replenishment system.[33]

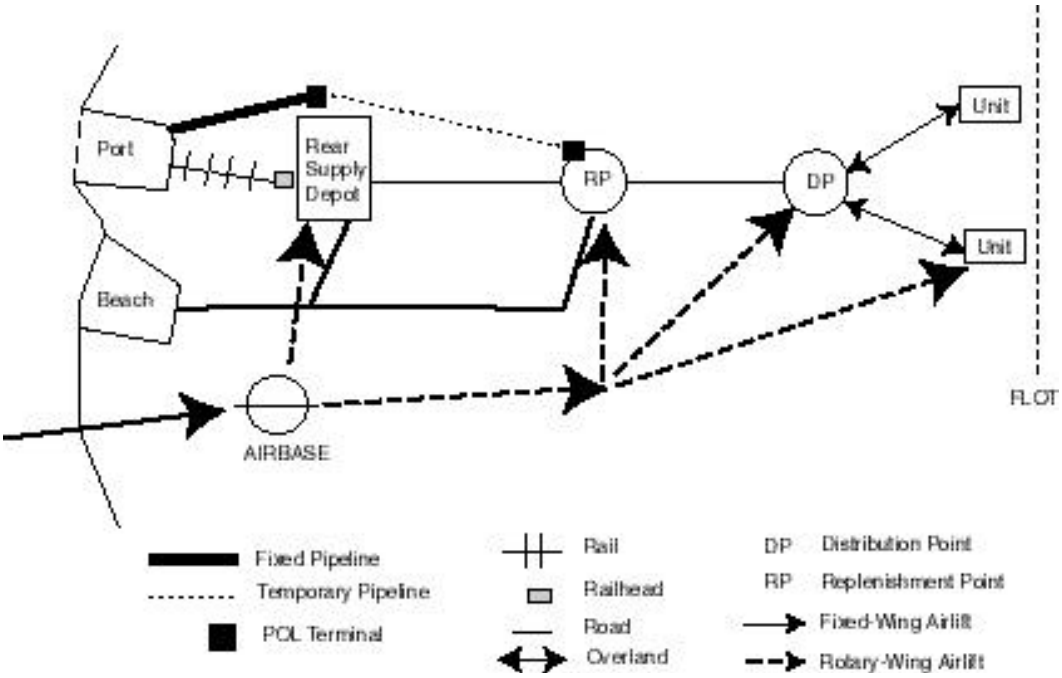


Figure 1. Typical Replenishment System

Some forms of transport, such as ships, are particularly lucrative targets in that a huge quantity of enemy supplies can be destroyed for very little effort. Often a single bomb or missile can do the job, and supplies lost at sea or even sunk in a port are not often salvageable. Ships are also difficult and time-consuming to replace and are usually the only means of moving bulk cargo across large expanses of water.

Some doctrinal concepts, such as the Soviet Operational Maneuver Group, involve deep penetration and require self-sustainment for up to a week or more.[34] Since such operations intend to be cut off from resupply during the battle anyway, the only near-term supply effects that can be achieved are by attacking the tactical resupply vehicles that penetrate alongside the combat forces.

Command and Control (C^2)

This category includes both the physical command echelon of a ground army and the systems by which that echelon exercises command and gathers intelligence. Fixed command centers are often among the most hardened of targets; one example is the Iraqi command bunker that was attacked with the experimental GBU-28 “gun barrel bomb” during the Gulf War.[35] Division, brigade, regiment, and battalion command posts (CP) are rarely hardened, however, due to mobility requirements such command posts are often located in specially equipped vehicles. These may be APCs or IFVs, providing some

protection against blast and fragmentation and are normally equipped with extra communications equipment. In general terms, the lower the echelon, the greater is the reliance on radio and data link in place of cable or wire communications. It is also common practice to have several subsidiary CPs or command vehicles for redundancy in the command chain.[36]

The same advantages and disadvantages discussed above for other tracked vehicles also apply to command vehicles. In addition their use of radio for communications makes them vulnerable to direction-finding equipment, which may ease the target location problem for air strikes. Limited communications and data burst use keep this liability to a minimum.

Regarding C^2 doctrine, it is important to know how the enemy operates before we can anticipate how much disruption he will suffer from C^2 attacks. Armies which practice *auftragstaktik*, or commander's intent, may well be able to operate independently of higher command for long periods without severe degradation. Such armies may have difficulty getting timely battlefield updates back up to higher command, which must accept some "fog of war" as the cost of increased flexibility in the lower echelons. Centrally controlled armies, such as was the case for the typical Warsaw Pact army, will suffer much quicker disruption.[37] The level of disruption also depends on whether the army is executing a scripted plan that it has had time to exercise, or if it is in a reactive mode to our actions. In the former case, we should not expect too much early disruption as the enemy is following a rehearsed game plan. As events transpire, and the battle shifts away from the original plan, C^2 disruption will become more critical.

Disposition

Now that we have examined the major components of a field army, let us briefly examine how it may be used in the field. The three basic dispositions an army may be employed in are the offense, the defense, and the reserve. The reserve, typically one-third of the available combat strength, is normally kept in the second echelon where it is available for rapid deployment forward. Depending on circumstances, it may or may not be within artillery range while holding in the reserve area. Defense is designed to hold territory against enemy attack, or at least to delay him while the bulk of one's army redeploys to new locations. Offense is typically broken into two phases, the breakthrough and the pursuit (or exploitation) phase. Maneuver may be used to achieve a breakthrough more efficiently than raw weight of firepower, and air mobile units have the option of "vertical envelopment" to maneuver in the third dimension into position behind the enemy.

As may be expected, each of these dispositions places different demands on the enemy's combat forces and resupply system. Table 1 shows a 1986 British estimate of how these various phases of battle may be expected to drive requirements for supply. It also shows the greatest use of fuel that occurs in the pursuit, followed by the breakthrough. Very little ammunition is used in the pursuit phase, while the greatest use of munitions occurs on the defense.

Note that, in relative terms, rations take very little of the total weight allocated for resupply (bulk comparisons would be a little more equal, as ammunition and fuel are both denser than food).

Table 1

Soviet Divisional Estimated Requirement Rates Daily (in tons)

	HEAVILY OPPOSED		LIGHTLY OPPOSED		AVERAGE	
	Ammo MR[a]/TK[b]	Fuel MR/TK	Ammo MR/TK	Fuel MR/TK	Rations MR/TK	Spares MR/TK
Break-through	520/480	700/610	280/260	400/370	30/28	120/85
Defense	580/520	320/300	370/330	200/180	30/28	80/50
Pursuit	66/63	900/810	44/40	590/550	30/28	60/40
Reserve	140/120	230/200	88/80	160/140	30/28	35/25

LEGEND:

[a] Motorized Rifle Division
[b] Tank Division

Source: Royal Military Academy, *The Sustainability of the Soviet Army in Battle* (Sandhurst, England: Soviet Studies Research Centre, September 1986), 23.

To get a rough "order of magnitude" idea of how much vehicle support such logistics entails, some brief calculations are in order. Total daily requirement for a Russian motor rifle division advancing against heavy opposition is 1,370 tons, for the same division defending against heavy opposition the requirement is 1,010 tons. The typical Russian heavy division has 2,000 trucks of various types, for a combined total lift capacity of 12,000 tons.[38] The same division has approximately 13,000 troops, of which only about 4,000 will be able to ride their APCs while advancing.[39] This leaves 9,000 troops to be transported by truck, rail, or on foot, in addition to the rest of the division's equipment. The bottom line is that, on defense, a large surplus of trucks available for transport exists. While on the attack, that margin narrows but still exists. In either case, for a truck interdiction campaign to have an effect it literally will require the destruction of thousands to disrupt one enemy division, not counting the supplies the enemy may bring up via rail, pipeline, or replacement trucks.

Notes

1. James Dunnigan, *How to Make War: A Comprehensive Guide to Modern Warfare* (New York: W. Morrow, 1988), 43.

2. Army Field Manual (FM) 100-5, *Operations*, June 1993, 2–22.

3. Ibid., 2–22:2–24.

4. Ibid., 2–24.

5. Dunnigan, 49.

6. Ibid., 103–4.

7. FM 100-5, 2–22.

8. Dunnigan, 50.

9. Dennis Blasko, "Better Late Than Never: Non-Equipment Aspects of PLA Ground Force Modernization," *Chinese Military Modernization*, ed. C. Dennison Lane, Mark Weisenbloom, Dimon Liu (New York: AEI Press, 1996), 132.

10. FM 100-5, 2–22.

11. Ibid., 6–14.

12. Willliam P. Baxter, *Soviet Airland Battle Tactics* (Novato, Calif.: Presidio Press, 1986), 160.

13. Ibid., 159.

14. FM 100-5, 2–22.

15. Ibid.

16. Martin van Creveld, with Kenneth S. Brower and Steven L. Canby, *Air Power and Maneuver Warfare* (Maxwell AFB, Ala.: Air University Press, 1994), 175.

17. Dunnigan, 63–64.

18. Ibid., 82–84.

19. Ibid., 97.

20. LCDR John Nunley, "The Role of the AH-64 Apache in Close Air Support" (Thesis for the US Army Command and General Staff College, 1991), 61.

21. *Jane's Armour & Artillery, 1996–97*, ed. Christopher Foss (U.K.: Biddles Limited, Guildford, and King's Lynn, 1996), 778–82.

22. *Aviation Week & Space Technology Aerospace Source Book* (New York: McGraw-Hill, 1997), 154–55.

23. Dunnigan, 102.

24. Ibid., 101.

25. FM 100-5, 2–23.

26. Presentation by the US Army at Fort Rucker, Ala., on 12 February 1997.

27. *Aviation Week & Space Technology Aerospace Source Book*, 68–71.

28. FM 1-112, *Tactics, Techniques, and Procedures for the Attack Helicopter Battalion*, 21 February 1991, 6–7.

29. Dunnigan, 458.

30. Mark Graper, Andrew Weaver, Stephen Wolborsky, "Petroleum as a Center of Gravity," *Strategic Structures AY 96 Coursebook* (Maxwell AFB, Ala.: Air Command and Staff College, 1996), 628.

31. Dunnigan, 458.

32. Stephen Hosmer, *Psychological Effects of U.S. Air Operations in Four Wars, 1941–1991: Lessons for U.S. Commanders* (Santa Monica, Calif.: RAND, 1996), 184–86.

33. Kenneth Macksey, *For Want of a Nail: The Impact on War of Logistics and Communications* (London: Brassey's, 1989), 190.

34. Richard Simpkin, *Deep Battle: The Brainchild of Marshal Tukhachevskii* (London: Brassey's Defence Publishers, 1987), 61–63.

35. Thomas Keaney and Eliot Cohen, *Gulf War Air Power Survey Summary Report* (Washington, D.C.: Government Printing Office, 1993), 24.

36. Randolph House and Gregory Johnson, "C^2 in a Heavy Brigade to Contact," *Military Review* 71, no. 11 (November 1991): 64–65.

37. Baxter, 87.

38. Dunnigan, 466. For comparison, the average US heavy division has 3,500 trucks for 16,470 tons of lift, while requiring roughly 50 percent greater logistics support.

39. Ibid., 46.

Chapter 3

Attacking the Enemy

You don't hurt 'em if you don't hit 'em

—Gen Lewis "Chesty" Puller

At the heart of affecting the enemy army through air attack lie two questions: Which parts of the enemy's army are most critical to its function, and how vulnerable are those parts to attack. In this chapter the author examines the weapons that airpower brings to bear on the enemy, then looks in detail at the questions of criticality and vulnerability of each component of a typical army.

Airpower Described

The first concern for the ground attack planner is what operational effects are required by the overall strategy. Particular attention must be paid to how the various interdiction and CAS results will affect the ground scheme of maneuver, both for enemy and ourselves. Chapter 4 deals with this in more detail; the author simply states here the need to keep higher level objectives and strategy in mind before proceeding to the targeting level. There are many possible command arrangements to turn operational air strategy into smoking holes in the enemy ranks, but the better ones all keep objectives and flexibility in the foreground.

As a precursor to successful ground attack operations, we will normally establish some level of air superiority above the enemy army. This allows our forces to concentrate on their attacks without fear of interception by enemy aircraft or engagement by enemy surface-to-air defenses. Most armies have some degree of tactical air defense, and this must be planned for during ground attack missions. Strategic surface-to-air missiles (SAM), early warning radars, airfields, and air defense command and control are typically targeted during an air superiority campaign. Joint Pub 3-03T, *Doctrine For Joint Interdiction Operations*, states "localized air or maritime superiority permits successful operations in enemy rear areas. Without that freedom, sustained interdiction operations could result in excessive losses."[1]

Modern multirole fighters such as the F-15E, F-16, and F/A-18 are able to carry a significant load of air-to-air missiles along with their air-to-ground payloads. The F-16, for example, normally carries two radar-guided AIM-120 and two heat-seeking AIM-9 missiles, plus full 20-millimeter (mm) ammunition, along with a normal bombload.[2] This, combined with their

long-range radar, provides modern fighters with a bubble of local air-to-air superiority that can be used to reach high-priority ground targets until more general air superiority is established. Another form of counterair that has recently grown in importance is suppression of enemy air defense (SEAD). Indeed, there are few, if any, countries that can challenge the United States for air-to-air dominance, but even modest third world armed forces can significantly interfere with US air operations through the employment of modern SAMs and antiaircraft guns.[3] Multirole SEAD aircraft, such as the F-16 Block 50, can be used to suppress air defenses on one mission and deliver air-to-ground ordnance on CAS or interdiction targets the next.

There have traditionally been several types of aircraft used for ground attack. The light bomber, the dive bomber, and the fighter-bomber were all identified with attack aviation by the opening days of World War II, but recent developments have produced some changes. Modern technology has increased the lethality and accuracy of fighter payloads and done away with the need for the larger light bomber for interdiction targets such as bridges and rail yards. In today's era of expensive aircraft and force drawdowns, most nations seek to maximize the usefulness of each aircraft, leading to multirole as the norm. Modern attack aircraft fall into two main categories: true multirole fighters such as the F-18 or Mirage 2000, and advanced training/light attack aircraft such as the BAe Hawk or the multinational Dassault Breguet/Dornier Alpha Jet. The United States maintains a large fleet of heavy bombers that can also produce effective results in the ground attack role, such as the B-1 and B-52. A few nations still fly dedicated attack aircraft such as the US A-10 and Russian Su-25, which have advantages under conditions of air superiority and when slow speed for target identification is required.

The types of ground attack missions flown by fixed-wing aircraft can be divided into interdiction, armed reconnaissance, preplanned CAS, and alert CAS (fig. 2). Basic interdiction involves striking a preplanned, fixed target. Note that this use of the word *interdiction* describes a procedural type of mission, which is slightly different than the effects of interdiction described in chapter 1. Due to the requirement for the target location to be known during mission planning, mobile enemy units are not attacked this way. Fixed enemy positions, forces in assembly areas, supply depots, ammunition dumps, C^2 nodes, and resupply infrastructure are all targets that are normally hit via interdiction. Preplanned targets have the advantage of premission target study, which increases the chances of a hit on the first pass and reduces the exposure to enemy air defenses. Preplanned target photos can be carried in the cockpit to further aid target identification and hit rate. A second advantage lies in weaponeering, as a known target composition allows for an optimum combination of munition, fuse setting, delivery pattern, attack axis, and impact angle.

Armed reconnaissance, or armed recce, is flown against interdiction-type targets beyond the FSCL, but without having a precisely chosen target prior to takeoff. Often a designated kill box is used, and the flight is given a prioritized list of target types to look for and attack within that box.

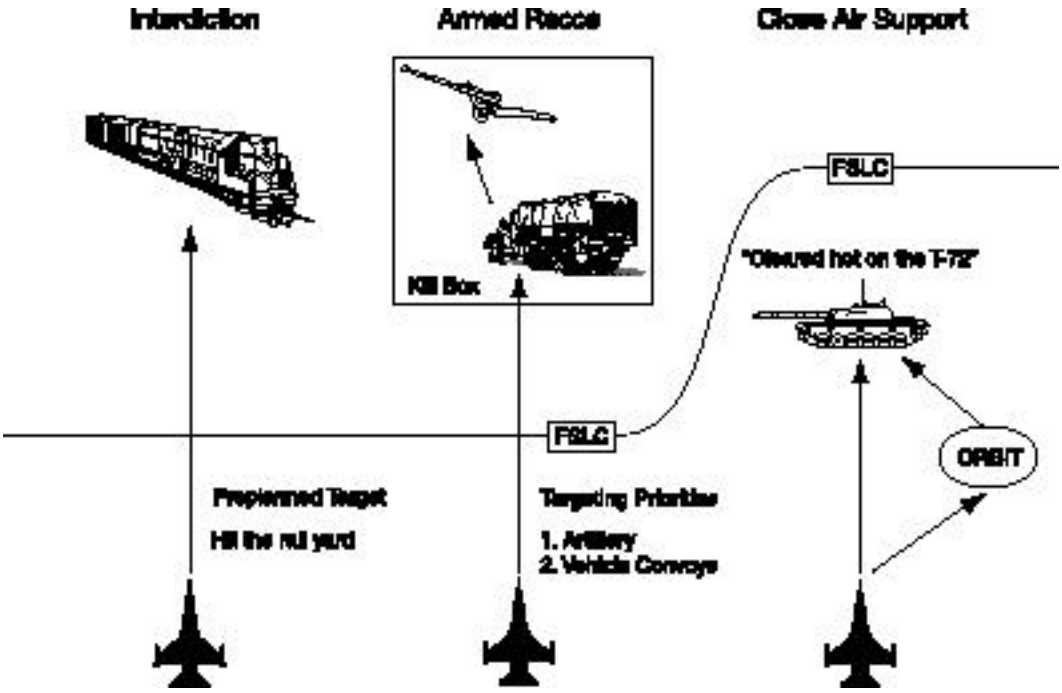


Figure 2. Ground Attack Missions

Sometimes a particular stretch of an LOC is identified as the target area; fighter pilots often call this type of mission "road recce." Finding the target depends on the quality of the onboard sensors, weather conditions, and aircrew proficiency. An aid to locating lucrative targets, variously called "Pineapple" (World War II Italian Front),[4] "Fast FAC" (Vietnam),[5] or "Killer Scout" (Desert Storm)[6] involves using specialized fighters to first sweep the kill box, finding and sometimes marking priority targets for following ground attack flights.

CAS is flown in two variants, preplanned and alert. Both require final clearance to drop from a ground or airborne controller, as a target location aid and fratricide avoidance measure. Preplanned CAS is seldom flown in modern conflicts, but under certain circumstances a close target is identified that cannot be destroyed by artillery or other ground forces. This is most likely to occur at the start of a major offensive when all possible firepower must be brought to bear on the enemy forces. Much more common is alert CAS, in which the aircraft either wait at the home airfield or at an airborne holding point. An option to the airborne hold is known as "push CAS," in which flights are staggered into the holding point at regular intervals. If no CAS target comes up during their hold period, that flight proceeds to a backup, preplanned, interdiction target. This way the sortie is not wasted, an important consideration for the air planner who has a limited number of assets.

CAS reaction times vary with airfield and target locations and aircraft type. Vertical short take-off and landing (V/STOL) aircraft like the AV-8 Harrier can operate from forward fields, reducing the reaction time for strip alert CAS. Helicopters can base much closer to the front than fixed-wing aircraft, but this advantage is somewhat offset by their slow 100–150 knot cruise speeds (fighters cruise to their targets at 300–500 knots). The typical reaction time for modern US airpower is five to 10 minutes for airborne alert CAS, and 20 to 30 minutes for strip alert CAS.

Since all missions flown on the near side of the FSCL are normally CAS, the FSCL location is of importance to the attack pilot. When possible, the FSCL will be located along a recognizable LOC or terrain feature to prevent confusion in the heat of battle. Traditionally the FSCL has been placed at the maximum effective range of artillery, which would put it 15–20 miles beyond the FLOT for today's armies. Since the FSCL is used for two different purposes, fires coordination and fratricide avoidance, there can be a tension between the land component commander, who wants to use a deep FSCL for greater control over airpower, and the air component commander (ACC), who desires the shallowest possible FSCL that will still guarantee fratricide avoidance. It may be that in the future we will go back to the classic bombline to avoid dropping on friendly troops, and a deeper "coordination line" which allows the ground commander some control over shallow interdiction strikes. When the ground commander places the FSCL too far forward, in over anticipation of how far his troops will move in a given period, lucrative interdiction targets will be allowed to escape air attack. Under circumstances in which the enemy is in headlong retreat, the value of pursuing him closely with ground forces must be weighed against the possibly greater destructive power of air attack.

Regardless of mission type, the tactical problem of ground attack can be broken down into four components. For a successful mission, airpower must first locate the enemy, then identify the enemy, successfully target the enemy, and finally assess the results of the attack. Each of these four tasks has particular concerns which the air planner must address. Throughout the process good intelligence is critical, regarding both type and location of potential targets as well as enemy air defenses.

Location

The problem of locating the enemy forces varies greatly with circumstances and the type of mission flown. National systems, strategic and tactical reconnaissance, signals intelligence, and human intelligence all play a part in the initial detection and location of likely targets. The tactical problem involves how to take a particular target and set of coordinates, likely to be of variable accuracy, and get the weapons delivery platform to the target for the attack. Modern sensors can provide quite accurate coordinates for fixed targets, and onboard systems such as ring-laser inertial units and the global positioning system (GPS) make finding fixed targets relatively easy. Even

systems such as the MLRS and ATACMS are being considered for GPS terminal guidance upgrades, which would increase their accuracy against point targets.[7] Locating moving targets, on the other hand, requires onboard sensors such as moving target indicator (MTI) radar or infrared optical systems that detect the heat from engines and operating equipment, or from metal that has been warmed by the sun.

Environmental variables greatly impact the ability to locate targets. The best situation is normally daytime, with flat terrain, no trees, and clear weather. Some infrared systems, however, actually work better at night when the background temperature is cooler. The ability to attack in darkness also removes the sanctuary of night mobility from the enemy, a traditional defense against successful daytime interdiction.[8] At the same time, flying formation and maintaining general situation awareness are more difficult at night, increasing aircrew workload.[9] Adverse weather is more of a problem, as even the best optical and infrared sensors have difficulty seeing through cloud or heavy precipitation.[10] Poor weather forces reliance on either onboard radar systems or use of preplanned coordinates against fixed targets. However, if intelligence can provide accurate enough coordinates, modern GPS and digital terrain systems have a real chance of hitting nonmoving targets in spite of adverse weather.

Moving targets negate the use of preplanned target coordinates, which also makes most unmanned systems unusable against them. However, moving targets are easier to detect by both doppler radar and infrared systems. One airborne platform, the E-8 joint surveillance target attack radar system (JSTARS), is able to detect moving surface targets with great accuracy and considerable range; other systems possess similar, but more limited, capability. Current efforts are under way to provide real-time targeting data to ground attack aircraft from JSTARS, and even the present system can provide near real-time coordinates by voice.[11] A drawback of using through-the-weather radar systems is the current lack of ability to identify target types, although some new systems can identify broad target categories.[12] Lack of ability to distinguish friend from foe on a radar display also means that through-the-weather CAS will remain unworkable for some time to come.

To get a feel for the target location problem regarding vehicles, let us examine the case for a typical Russian motor rifle division. Such a division has 270 tanks and 480 APCs on average, with at best 90 percent of those in commission at any given time.[13] Combining these gives a total of 675 fighting vehicles on the battlefield. The same division also carries 2,500 trucks on its rolls, but for this example we will assume the trucks are to the rear; another possibility is that radar advances will be able to consistently distinguish between vehicle types from long-range surveillance platforms.

If a JSTARS-type platform could locate such vehicles and relay targeting information directly to airborne fighters, it would be possible to concentrate firepower on the advancing enemy. If we assume two kills per fighter per sortie,[14] a total of 338 sorties is the most optimistic minimum number of

sorties required, which represents roughly three days' worth of sorties for a typical three squadron fighter wing at combat sortie rates.[15]

Some obvious drawbacks to the above scenario include the results if the enemy reacts to the initial attacks by not moving when our aircraft are in the area. Loss of moving target indications will make detection much more difficult, and kills will go down. If the enemy does react this way, however, he will suffer delay and disruption (the classic "interdiction dilemma"). There may also be other lucrative targets, such as a vital bridge that half of the division's transport must cross, that will delay the enemy with a much smaller expenditure of sorties. The typical interdiction tradeoff is evident here, with the hard kill coming at greater expense in both detection assets and offensive sorties.

Identification

As the previous paragraphs indicate, target identification is a greater problem with today's technology than target location. This stems in part from the fact that most current systems were designed, some even fielded, during the cold war when the major military concern was a massive conventional war in Germany. Under such circumstances quick detection was critical, and almost anything that was moving west was a viable target. In today's more limited conflicts, with CAS playing a larger role, target identification is more important to avoid hitting friendlies. There were instances in the Gulf War of fratricide from both fixed-wing and rotary-wing platforms, even with good weather and limited threats.[16] Another factor is that, as we continue to drawdown into an ever smaller force, we have fewer assets and must make every bomb and missile count. This requires prioritizing our targets, which in turn requires the ability to differentiate the high-value command vehicle from the standard issue truck. Figure 3 shows a typical infrared imaging picture,

Source: United States Air Force. Still image from public relations video.

Figure 3. LANTIRN Targeting Pod Image

in this case a low altitude navigation targeting infrared night (LANTIRN) targeting pod image of a tank.

The image in figure 3 was taken at the Nellis AFB Range, in clear weather and low altitude. While the target can roughly be identified as a tank, trying to distinguish the type of tank, or identifying markings, would clearly be difficult. At medium altitude, where most modern ground attack missions are flown, even distinguishing a tank from an APC can be difficult.

The issue of target identification is a key reason that airpower strategists prefer interdiction to CAS. The need to follow precise directions from the FAC, and to observe marking smoke or laser spots, coupled with the risk to friendlies should a bomb miss its mark, makes CAS a tedious process. Even with digital data link to reduce the required number of radio calls, the aircrew has many decisions to make while simultaneously keeping an eye out for possible enemy threats.

Attack

Once identified, the target must then be attacked. Air-delivered weapons cause effects through four primary mechanisms. Blast is caused by overpressure from the detonating explosive and is effective against troops and unhardened structures. When combined with a hardened casing and delayed fusing, the weapon can physically penetrate hardened targets to provide internal blast effects. Another form of blast is used by shaped-charge warheads, which form the explosion into a jet of plasma or molten metal that literally bores its way through hardened targets. This kill mechanism is typically used by antiarmor weapons. Fragmentation, or frag, is caused by a frangible outer casing that breaks into hundreds or thousands of high-velocity fragments, effective against troops, unarmored vehicles, or light structures. Cratering results from delayed fuses on weapons dropped on dirt, concrete, or asphalt surfaces. The explosion literally lifts a portion of the underlying earth up and out of the forming crater, and takes with it any bits of roadway, runway surface, etc. that happen to be there. The interservice Joint Munitions Effectiveness Manuals (JMEM) list the optimum delay for maximum cratering effects against various surfaces. The fourth kill mechanism, incendiary effect, relies on explosive combustion which causes the target to be destroyed by burning. Some submunitions, like those found in the CBU-87 combined effects munition, are designed to provide frag, incendiary, and armor penetration effects simultaneously. This makes such weapons more useful in missions where the target type is not known at takeoff.

When addressing direct effects on combat forces, JMEMs divide the results into mobility kill (m-kill), firepower kill (f-kill), and catastrophic kill (k-kill). A m-kill is defined as preventing the target from moving for a specified time period and only applies to mobile targets. M-kills are normally easier to achieve than k-kills, as exemplified by the relative ease of knocking the track off of a tank compared to destroying the vehicle. Sowing an area with mines can also lead to m-kill effects, driven either by the time required to clear the mines or to drive around them. F-kills are likewise easier to achieve than k-kills, and often

involve destruction of a target's immediate ammunition supply as opposed to destroying the weapon itself. Killing or disrupting the weapon's crew can have both m-kill and f-kill effects, but duration of the effect depends on the availability of additional troops to man the weapon or vehicle.

K-kills are traditionally the hardest effect to achieve, although recent improvements in precision-guided munitions (PGM) have made k-kills much easier. Older "dumb" bombs can be counted to land somewhere near the target, hopefully causing some damage. The average miss distance for unguided weapons varies with altitude and type of delivery, but 50–200 feet is a good estimate. Modern PGMs either hit the target, usually killing it, or if they fail to guide properly they often miss by a wide margin. Contrary to the military video footage released during the Gulf War, modern PGMs do occasionally miss, for reasons that vary from weather to weapon malfunctions or pilot error. Experience during the post-Desert Storm era shows that between five and 20 percent of PGMs can be expected to miss their targets.[17] This is especially important for CAS, where even a one-in-ten chance of a wide miss may not be acceptable if that wide miss lands among friendly troops.

A distinction must be made between those PGMs that require guidance corrections while in flight and those that are true "fire-and-forget" weapons. Most targeting systems for laser-guided bombs (LGB) require at least some updating while the bomb is falling, thereby diverting the aircrew's attention from other duties. Other weapons, such as the AGM-65 Maverick, allow for lock on prior to launch. Once fired, the missile follows its targeting lock to impact, but any drift of the missile's lock while in flight will cause a miss.[18] In general terms, "fire-and-forget" weapons are more appropriate for high threat or high workload situations, while man-in-the-loop munitions trade increased workload for increased accuracy.

An important targeting problem for unmanned weapons such as ATACMS and MLRS is the lack of man-in-the-loop terminal guidance. One solution is the use of area munitions, which will do the required damage as long as the target lies within the area covered by the submunitions. Actual areas of coverage vary with weapon type and function altitude, but a general rule for MLRS, ATACMS, and cluster bomb units (CBU) is that they cover areas from 100 to several hundred square meters.[19]

Area munitions also give manned aircraft the option of releasing from higher, safer altitudes, since the corresponding reduction in accuracy is compensated for by the wide coverage area. New weapons such as the CBU-97 Sensor-Fused Weapon provide autonomous target seeking capability, and the only requirement is to release them in the vicinity of the target.[20] The developmental round for ATACMS, known as the brilliant antitank (BAT) submunition, has a similar target seeking capability.[21] These developments allow unmanned weapons to be more effective, since prerelease or prelaunch target coordinates can be less accurate.

Airborne flexibility can be the key to a successful attack, especially for nonpre-planned missions. Most manned aircraft have the ability to adjust the number and spacing of munitions released, which will vary the intensity of blast or the

density of frag or CBU submunitions. Aircrew performing CAS or armed recce, for example, like to have the ability to adjust CBU patterns for attacks on tanks, APCs, or trucks. Most weapons have fixed fuse and function settings, though some offer a primary and backup setting that can be selected from the cockpit. Function height for radar proximity fuses, which affects the size and density of frag patterns, is normally set before takeoff. Contact fuses on most bombs, and some missiles, allow for various function delays; this adjusts the amount of penetration the weapon will achieve, or how deep a crater it will make.

Assessment

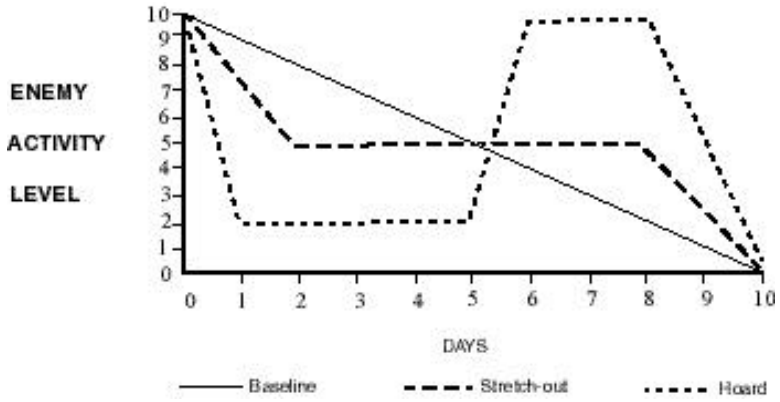
Following the attack, the final part of the process is to determine how effective the attack was. Mission assessment occurs at two levels, tactical and operational. Tactical assessment is known as bomb damage assessment (BDA). BDA has long been a source of consternation for pilots and intelligence officers alike, as physical damage caused by air strikes has historically been overestimated. In Desert Storm, for example, planners downgraded the kill estimates from F-111 mission debriefs by 50 percent and A-10 estimates by 67 percent.[22] The use of onboard videotape recorders is useful for attacks where the system stays locked to the target through impact, but even then the initial blast and infrared (IR) plume from the explosion can look much worse than the actual effects. Immediate assessment is valuable for missions where the wreckage remains largely intact, as images of the target even a few minutes after the attack may show no noticeable damage. This is particularly true of shaped-charge weapons, that may leave a two- or three-inch hole as the only external evidence that the crew or internal equipment of a tank or APC has been destroyed. The chance for following flights to mistakenly reattack such targets is high. Unmanned aerial vehicles (UAV) are becoming more numerous on the battlefield and offer one valuable platform for tactical BDA. This is especially true of systems that can use real-time data link to transmit BDA images. The human operator, of course, still must do the appropriate thing with the data once it comes in. Additional sources of information may prove valuable in tactical BDA, although there is an optimum tradeoff between not enough information and being swamped by data overload.[23]

Perhaps more important, though historically receiving less attention than tactical BDA, is the notion of operational assessment.[24] This form of assessment goes back up to operational objectives, and attempts to determine how effective we have been at attaining them. A traditional problem with this form of assessment is that it is much easier to count bomb craters than to measure the percentage of supplies successfully interdicted, or to determine how responsible air attack is for enemy reverses on the ground. Metrics for measuring the results of air attack are difficult, as airpower rarely operates in a vacuum. This form of assessment is only possible with educated analysts, who are solely tasked with examining operational results. Ian Lesser, a RAND researcher, captures the essence of measuring combat effectiveness in the following passage:

> At the tactical level, it was noted, it is natural to have a material or attrition-based frame of reference. At the operational and strategic levels, however, the emphasis must be on the effects of interdiction on the enemy—delay, disruption, diversion, demoralization, as well as outright destruction. The objective is a reduction in the enemy capacity or, in a slightly different formulation, the neutralization of enemy functions. These may be achieved in various ways: directly, through attrition, through supply restriction, or through the interference with plans. Again, the danger of concentrating largely on the destruction of resources lies in the risk of being "efficiently ineffective," being "good at something that ultimately does not matter." The point of interdiction is not, for example, to destroy the most armor, but rather to destroy (or delay, or disrupt) the right armor in the right place at the right time. This is particularly important in an environment characterized by a scarcity of resources for interdiction and a surfeit of targets. Targeting priorities are necessarily situation dependent. To the extent that attrition should be the aim, the concern should be to inflict catastrophic rather than linear attrition. This point is supported by the observation that all armies prepare for a certain amount of linear attrition; catastrophic attrition is less easily overcome.[25]

The assessment issue highlights a fundamental difference between direct attack of combat forces and indirect attack through striking the support forces or infrastructure. It is relatively easy to count numbers of weapons or vehicles destroyed, and to determine that we have reduced enemy armor by 20 percent or his artillery forces by 40 percent. It is much more difficult to know exactly what the result of bombing his fuel depots will be, or how long he will be delayed by bombing bridges or rail junctions. Since interdiction of LOCs and support forces deals with secondary and tertiary results, the results will never be as predictable as the more linear results from direct attack of combat forces.

Another problem with operational assessment lies in prediction of enemy actions. Planners tend to assume the enemy is a constant, or when they do grant him some flexibility they often mirror-image what they would do in the enemy's place. Figure 4 shows the baseline assumption of constant action by the defender, along with two possible alternative actions.



Source: RAND Study "POL as a Target System," by Caren Kamberg, David Shlapak, and David Thaler, 1944. Even though the study looked specifically at POL, the mathematical model holds true for any form of supply that is consumed in a linear fashion.

Figure 4. Three Models for Enemy Activity Based on Supply Consumption

Figure 4 shows how the enemy can manage his activity, assuming a constant reduction in available supplies due to interdiction. This figure does not account for varying rates of supply use at the different levels. Notice that the area under each curve is the same, indicating the same total amount of supply consumed for each case. The baseline curve is what most combat assessors would probably look for, showing some immediate reduction in activity and a gradual decline toward zero. The enemy may react instead by curtailing some operations, enabling him to operate along the stretch-out curve. A combat assessor might be led to the false conclusion after day two that the enemy only has two days' worth of supplies left, or by day five that the enemy has found some new source of limited supplies, enough to keep his operations going indefinitely at the 50 percent level. This example illustrates that there is some justification to the "interdictor's lament" of "just five more days and we'll have them!" Perhaps the greatest problem for the analyst is the hoarding, or "Battle of the Bulge" scenario where the enemy cuts operations to a bare minimum, saving enough to launch a few days of high-level operations before suffering complete logistics exhaustion. It would take a confident assessor to tell his commander on day seven or eight that "trust me, sir, just three more days and we'll have them."

The problem with this model, of course, is that it assumes a constant attrition of the enemy supply capability. What the assessor can never know with complete certainty is that alternate, undiscovered methods do not exist by which the enemy can adapt to, or work around, the damage we are causing. The bottom line is that it is foolish to build a plan that requires complete knowledge of the enemy, since such knowledge is not a practical possibility. When enough assets exist, a parallel attack against both combat forces and the various supply nodes may yield good results through increased chance of hitting the one or two areas that are truly vital.

Desired Effects

Now that we have examined how airpower can attack an enemy army, let us reexamine the desired operational effects of such an attack. Recalling the four Ds of interdiction, airpower can divert, delay, disrupt, or destroy ground forces. When flown as CAS, these effects are added to the effects on the enemy of the ground battle, and the effects of destruction or disruption are usually sought.

In general terms, there is a relationship between scope, scale, and time of the effects of air attack.[26] Interdiction attacks further behind the front tend to have broader effects, but the effects are delayed in reaching the enemy front line forces until his tactical reserves are exhausted. A key planning factor is an estimate of how many days' supply the enemy has available at the front, because it will take at least that long for deep interdiction of supply to be felt. At the same time, it is rare that interdiction can completely isolate the front from the strategic logistics reserves. We can normally count on some percentage reduction in the forward flow of enemy supplies and troops, and

the more realistic this estimate is, the better. It does little good to destroy 40 percent of the enemy's replenishment capability if he has a 300 percent excess capacity—this qualifies as Ian Lesser's "efficient ineffectiveness." At the other end of the scale, we can expect shallow interdiction and especially CAS to have significant, immediate results in a small area, but those results will not be long lasting. A CAS flight of A-10s may save the day for an infantry platoon pinned down by enemy armor, but the situation is only resolved until the next enemy tank moves into contact.

Another relationship exists between direct and indirect attack. Direct attack of combat forces, whether in contact with our troops or not, leads to fairly predictable, linear results. Planners can quantify the expected results for, say, a flight of two F-15Es with four GBU-12s each, against enemy tanks in open terrain with little air defense. This was exactly the situation in Desert Storm that led to "tank plinking," and the results were fairly consistent. As previously discussed, however, it is another thing to turn "number of tanks killed" into "amount of operational effectiveness degraded." When attacking the LOCs that combat forces use to move forward, a number of other variables enter the equation. How quickly can the enemy repair the damage, or how passable is the terrain around the LOC? Difficult terrain such as swamp, jungle, or mountains typically limits the off-road mobility of tracked and wheeled vehicles, while flat or gently rolling terrain is not much of a hindrance. It has been understood since World War I that air attacks on LOCs is particularly effective if no parallel route exists which the enemy can divert to.[27] If a particular enemy unit is delayed, what other units can the enemy move into position instead? Catching enemy vehicle columns in bottlenecks, such as mountain, defiles has the bonus of direct destruction and blockage of the LOC for other enemy units. Such questions add to the complexity of the equation, and nonlinear results (or no results) often occur.

Attacking troops on the march puts the enemy commander in the traditional interdiction dilemma. He can disperse his forces for survivability, only moving when it seems reasonably safe, but this slows down his advance and may cause the ground war to be lost through lack of reinforcements or operational mobility. By keeping his units on the move to meet a deployment timetable, they may be subjected to prohibitive losses from air attack. The effects of delay and disruption often are interrelated, as forces that arrive late may be thrown into battle piecemeal, and units that are disrupted are less likely to keep to their marching schedule.[28]

Attacking supplies adds even more factors to the problem. Direct attack of supply depots or vehicles may lead to fairly linear results as regards the supplies themselves, but the indirect results on the combat forces are tied up with tactical supply reserves, consumption rates, and alternate supply sources. We have seen how an army on the move consumes more fuel, but one that is fighting in place will often consume more ammunition. This requires a detailed examination of the overall battle plan, and how the enemy is expected to fight and maneuver, before a decision can be made on which supplies are critical. Once the critical type of supply is decided upon, the

infrastructure used to get that particular form of logistics to the enemy combat troops must be analyzed for critical vulnerabilities. It may be that tactical storage areas are the most vulnerable, especially if they fall within range of surface or rotary-wing attack assets. The most difficult case to analyze is the attack of LOCs used by enemy supply assets. Such attacks will have indirect effects on the supplies themselves, which in turn will have an indirect effect on the combat units. Such attacks may have added benefit if enemy combat forces use the same LOCs for their maneuver or movement between front and rear. This is probably the case in most circumstances, so the multiplier effect should not be ignored.

To summarize, the ground attack planner has three levels of complication to consider (table 2). He may plan a direct attack on the enemy combat forces themselves, in which the primary effect works directly on those combat forces. Direct attack of the LOCs used by enemy combat forces for movement and maneuver will have secondary effects on those combat forces, as will direct attack of enemy supplies. Attack of LOCs used for supply will have only tertiary effect on enemy combat forces, and as such is the hardest to predict.[29]

Table 2

Summary of Interdiction Effect Levels

	LEVEL OF EFFECT	DEGREE OF PREDICTABILITY	CHANCE OF CAUSING CASCADING EFFECTS
Direct Attack of Enemy Combat Forces	Primary	High	Low
Direct Attack of Enemy Logistics	Secondary	Medium	Medium
Attack of LOCs used for Combat Force Movement	Secondary	Low to Medium	Medium
Attack of Enemy Logistics LOCs	Tertiary	Low	May be high, but also risks little or no results

One final note on planning for airpower effects deals with over optimism. Just as the fighter pilot is convinced he saw the bridge fall (never mind that it wasn't even hit), the air planner historically overestimates the operational effect his forces will have on the enemy.[30] A truly objective analysis must include room for error, and history shows that it is wise to plan for errors in the enemy's favor.

Deep versus Shallow Attack

In addition to the relative differences in operational effects, the deep versus shallow question has other dimensions. Air defenses vary with depth behind the front lines, especially those that are constructed as integrated air defense systems (IADS). Until the strategic SAMs normally placed around vital rear

areas are neutralized, deep attacks at any altitude may be risky propositions, especially for nonstealth platforms. Such missions normally require suppression assets to limit the SAM effectiveness, which drains resources from the attack role. Once the strategic air defenses have been degraded, or if a particular enemy never had them to start with, deep targets may well be more defenseless than frontline units that possess their own tactical air defenses. Attack helicopters, in particular, try to avoid tactical air defenses since they are unable to operate above the effective altitudes of those defenses.[31] Fighters equipped with high resolution sensors, however, can often operate above the maximum altitude of tactical SAMs and antiaircraft artillery (AAA), as long as the weather permits.

Perhaps the most fundamental question to ask is simply this: Where are the targets? Considerations of optimum sortie efficiency and specific service doctrine should not take precedence over the simple task of finding and attacking the enemy, wherever he is. If the enemy ground force is out of contact in a rear area, he should be attacked there. If the bulk of the enemy force is engaged with our forces, and the ground situation looks bad, then the enemy should probably be attacked close to achieve quick results. It does no good to stop the next week's supply of enemy POL or ammunition if he wins the war tomorrow. In general terms, if the ground situation is being adequately handled by our own ground forces, attacking the enemy at his second echelon and deeper makes the most of our limited assets, due to the wider-reaching effects of deeper interdiction.[32] The flexibility of airpower allows us to shift the weight of our effort almost instantly, as long as we do proper analysis to know where that effort should go.

Specific Vulnerabilities

Once the desired effects have been determined, and the critical areas identified to achieve those effects, specific vulnerabilities to air attack must be exploited. For this the actual airpower planner can refer to JMEMs, or seek assistance from specialized target analysts. For the purposes of this work, however, we will examine a few of the general weaknesses that can be attacked.

Starting with direct attack on combat forces, let us first look at armor. I have already mentioned the vulnerability of the track system, which if damaged can result in an m-kill of the vehicle. Track repair under fire is difficult and dangerous and will often wait until the battle is over. A near miss with general purpose (GP) bombs, such as the 500-pound Mk-82 and 2,000-pound Mk-84, will often result in a thrown track. Air- or missile-delivered mines can also be effective in destroying tracks, although our own ground forces are cautious about advancing over ground that has been seeded with mines or cluster bombs.[33] This requires extra coordination with the ground scheme of maneuver before their use. GP weapons require direct hits to create a k-kill, however, the only way to guarantee a direct hit is to use PGMs. Modern attack aircraft and helicopters carry a wide variety of

precision-guided bombs and missiles that are effective against tanks or APCs. The development of reactive armor has created some concern and may prove to be an effective countermeasure against some of the smaller shaped-charge warheads. As a result, many developmental antitank weapons aim to fly over the tank and explode downward, capitalizing on the thinner armor found above the tank's engine compartment.[34]

Artillery offers different problems for air attack. Standard towed artillery is fairly difficult to destroy completely, which normally requires bending or rupturing the gun barrel. The gun's chassis is more vulnerable, but can often be replaced in a short time if a spare chassis is available. An LGB will usually destroy a gun with a direct hit, but artillery can sometimes be hard to detect and track with onboard sensors. By far the most vulnerable part of an artillery battery is the crew and ammunition, unless they are sheltered in protective bunkers. Even if bunkers are available, modern penetrating bombs can destroy them with relative ease, and CBU scattered over an operating battery will certainly catch many of the crew at their guns and vulnerable. Revetments may provide some protection against blast effects, but with modern sensors the added protection is often outweighed by the added IR or radar signature the revetments provide the attacker. Area munitions may also damage the battery's communications system, limiting its ability to get targeting information from the fire direction center.

One way to achieve effects similar to area munitions is through the use of air-burst, or proximity, fusing on GP bombs. By detonating the bomb 10 to 20 feet above the surface, blast and frag effects are maximized, as is damage to soft targets. One drawback of current LGB bombs is that the laser seeker occupies the nose fuse well, which limits the fusing options to contact and delayed fuses only. The new joint direct attack munition (JDAM) family of bombs, which employ a tail-mounted GPS guidance unit, will be able to use nose-mounted proximity fuses for added weapons effects.

Self-propelled artillery has its own strengths and weaknesses. While not as vulnerable to simple blast and frag as towed artillery, the vehicle itself makes a large target that is much easier to track via IR or radar, especially while moving. A direct hit on the vehicle by modern PGMs will usually result in a k-kill, while SPs have the same track vulnerability as other tracked vehicles.

Infantry in the open is vulnerable to blast and frag effects, and either area munitions or air burst GP bombs are quite effective. Entrenched infantry is more protected from blast, and a dense pattern of area munitions is usually the best method of attack. This applies as well to other entrenchments such as mortar pits and trenches. Regular infantry transports itself in unhardened trucks, which are vulnerable to most weapons from 20-mm cannon to GP and precision-guided bombs. Infantry that is subjected to massive air or artillery attack may lose its ability to fight for a short while due to shock, even though actual casualties are light; this provides a lucrative target for large payload bombers such as the B-52. Such attacks must consider the risk of fratricide if friendlies are nearby, due to the relative inaccuracy of high-altitude level bombing.

Enemy helicopters can be attacked two ways—while airborne or while on the ground. Just as an air superiority campaign is often most effective against ground targets, attacking the enemy support facilities or the helicopters themselves while on the ground should prove effective.[35] Due to the mobile nature of helicopter operations, such facilities as FARPs are unhardened and vulnerable to most weapons, as are grounded helicopters that are between sorties. Airborne helicopters are vulnerable to air-to-air missiles or cannon fire, and ease of detection varies with the amount of terrain masking used. Most modern fighters are able to track and intercept helicopters, and our own attack helicopters have an air-to-air capability as well. One advantage (for the helicopter pilot) is the lack of training against helicopters by most fighter units, who concentrate on the fixed-wing air-to-air battle.[36]

The command and control system is vulnerable to attack at several points. While permanent command posts are usually hardened, their fixed nature ensures ease of location by attacking forces. Modern penetrating weapons can damage or destroy all but the most well-protected bunkers, and even then there is often support equipment or communications links that can be targeted. Tactical CPs, as found in most army units, are often in normal tents and buildings, subject to attack by GP bombs or PGMs. The first expenditure of bombs in anger by a NATO aircraft, in fact, occurred in 1994 against a Bosnian Serb command post.[37] The target was a tent, and it was destroyed by 500-pound GP bombs. Command vehicles suffer all the same strengths and weaknesses as other vehicles of their type. Perhaps the greatest strength is the difficulty of identifying which vehicle among several is the mobile CP, and which is the ordinary APC. When surface communications are used, or ground relay stations are used for radio or microwave communications, there are usually nodes and junctions within the system that can be attacked. Often these are unprotected, but sometimes they are hardened or buried. Specific weaponeering will depend on the actual type of node attacked. Large mast antennas often prove more difficult to destroy than expected, due to their open construction which lets blast effects through the structure without buckling. Cratering the base of such antennas is often the best method of attack.

Command posts often use large amounts of power for transmission and data-processing equipment, so generators and power grids may provide a way to shut down a command post without actually destroying it. Other soft kill measures include communications jamming or intrusion, which seeks to confuse the enemy by giving false commands on his own network. Passive listening may also provide valuable intelligence data, so the combined electronic effort must be coordinated to avoid electromagnetic fratricide. Future developments may result in weapons that can home on communications signals, much the way a high-speed antiradiation missile (HARM) homes on a radiating SAM radar. This will no doubt be countered by data bursting and tight-beam transmission, in the never ending struggle of counter- and countercountermeasures.

Just as combat forces have vulnerabilities, so to do the various parts of the supply system. Most supplies of POL, ammunition, and food are transported by unhardened vehicles. The larger the vehicle the better for the attack planner, because it will still be destroyed by most weapons, with a correspondingly larger loss of logistics to the enemy, and will have a larger signature for easier detection. The largest of all vehicles are ships, which may require specialized antiship weapons, but may well be devastating to the enemy if lost. For wars fought with maritime LOCs, the interdiction planner should look long and hard for vulnerable shipping lanes. Road convoys are best attacked in confined passage areas where no off-road capability exists. Stopping the lead trucks immobilizes the entire convoy, which can then be destroyed by either air- or surface-launched weapons. Likewise, trains are best attacked by hitting the locomotive first, then attacking the stationary supply cars. Locomotive power for trains must also be considered. In many parts of the world trains run on electricity, and knocking out electrical power to rail lines will halt traffic.[38] Aerial resupply by aircraft or helicopter provides air-to-air targets that are not normally difficult to shoot down, but may be escorted by fighters or attack helicopters. As always, good intelligence about enemy operations will pay off.

As an alternative to attacking the resupply vehicles themselves, the LOC infrastructure can be targeted. Roads are easily cratered or mined, but craters are just as easily filled in and the mines cleared. The surrounding terrain may be driveable, which offers an easy bypass to cratered roads. Bridges offer a more lucrative method of stopping road or rail transport, but history has shown that bridges can be repaired or bypassed via pontoon with relative ease. The best bridge targets are long spans over fast-moving rivers, both conditions making the use of replacement bridges difficult. Specific aimpoints and weapons vary with the numerous types of bridge, but all are best attacked with the accuracy of large-warhead PGMs. Rail lines and yards can be attacked by cratering the roadbed and deforming the rails, but as long as repair equipment is available they too can be quickly repaired. A common denominator in all LOC attack is the enemy's repair capability, and how much effort will be required to overwhelm it. In general terms the enemy repair cycle should not be much faster than our reattack cycle, or we risk losing effectiveness. It may be that the repair equipment or facility itself is a critical target, but that moves the effect equation one more level away from direct attack and makes the results that much more unpredictable.

POL is also delivered via pipeline, which offers its own vulnerabilities to air attack.[39] Pumping stations are required to keep the flow moving, and if kept off-line will reduce the flow depending on reserve pumping capacity. Holing the pipeline itself will result in some loss, but shutoff valves that will prevent a substantial loss are common to most systems. Pipeline junctions, where many lines travel through a single node, will likely be worth attacking. The pipeline terminals should be examined for vulnerability at the onloading or off-loading stations, especially if the pipeline itself is buried too deep for direct

attack. Reserve POL is stored in above- or below-ground tanks, and is often vulnerable even to unguided GP bombs.

Morale

Morale represents perhaps the hardest, most unpredictable air attack effect to plan for, but under the right circumstances it can be exploited with significant results. Perhaps the greatest difficulty in predicting enemy morale reaction is that it is entirely human in nature; there are no smoking craters or numbers of knocked-out tanks to count.

During Desert Storm there was some evidence of morale problems among the Iraqis as a result of air attack, but we had no idea that desertions may have been as high as 160,000 before the ground war started.[40]

Several eyewitness accounts from the Gulf War point to the special impact that area bombing from B-52s had on Iraqi troops. The following passage is based on postwar interviews of Iraqi soldiers. A captured Iraqi general "said he couldn't walk to the latrine without wondering if a B-52 would bomb him." One troop commander, interrogated after the war, stated he surrendered because of B-52 strikes. "But your position was *never* attacked by B-52s," the interrogator exclaimed. "That is true," he stated, "but I saw one that *had* been attacked."[41] Other Gulf War observations point to a synergy between physical and morale decay. Troops that were in the worst physical condition, having been cut off by air attack from resupply, were often the first to surrender.[42]

Stephen Hosmer, a RAND researcher, analyzed the psychological effects of air attack in World War II, Korea, Vietnam, and the Gulf War. He derived the following set of recommendations for air commanders regarding creation of reduced morale through air attack.

> Our examination of the Korean, Vietnam, and Gulf wars suggests three conditions that have consistently produced a catastrophic disintegration of enemy resistance and large-scale enemy surrenders and deserters. These conditions were when friendly military operations (1) subjected enemy forces to sustained, effective air and other attacks; (2) deprived enemy troops of adequate food; and (3) exploited the loss of enemy morale caused by (1) and (2) through timely ground operations. Our analysis further suggests that when these conditions were absent, catastrophic disintegration and large-scale surrenders and desertions were absent as well.[43]

It is notable that two of the conditions listed by Hosmer to produce lowered morale also promote reduced physical combat power. Interdiction often results in lowered food supplies, just as fuel and ammunition stocks suffer. This effect occurs most readily where the local environment offers no sustenance, as in a desert. Coordinating air interdiction with the ground war will cause synergistic effects through increased strain on the enemy's logistics, and will also cause increased morale decay as the enemy feels pressure from both the ground and the air. Severe losses in the enemy's resupply system can build adverse morale effects there as well, as truck drivers and train engineers find more excuses not to suffer the fate of their comrades.

Notes

1. Joint Publication (Joint Pub) 3-03T, *Doctrine For Joint Interdiction Operations*, December 1990, III-1.

2. *31 Fighter Wing Weapons Guide*, January 1995, 1–21.

3. Phillip Meilinger, "Achieving Air Superiority: Issues and Considerations," *Air Power* (London: RAF Air Warfare Centre, 1996), 7.

4. Alan F. Wilt, "Allied Cooperation in Sicily and Italy, 1943–1945," *Case Studies in the Development of Close Air Support*, ed. Benjamin Cooling (Washington, D.C.: Office of Air Force History), 218–19.

5. Gordon Nelson, ed., "The Battle for the Skies over North Vietnam," *Air War—Vietnam* (New York: Arno Press, 1978), 144.

6. Richard Hallion, *Storm over Iraq: Air Power and the Gulf War* (Washington, D.C.: Smithsonian Institution Press, 1992), 155.

7. *Jane's Armour and Artillery, 1996–97*, 778–82.

8. Ian O. Lesser, *Interdiction and Conventional Strategy: Prevailing Perceptions* (Santa Monica, Calif.: RAND, June 1990), 10.

9. Joint Pub 3-09.3, *Joint Tactics, Techniques, and Procedures for Close Air Support (CAS)*, 1 December 1995, IV-16.

10. Ibid., IV-17.

11. Bernard Rostker, *Joint Interdiction/Operational Fires: Perspectives from RAND Research* (RAND Study, 1994), 16.

12. Presentation by the US Army at Fort Rucker, Ala., on 12 February 1997.

13. James Dunnigan, *How to Make War: A Comprehensive Guide to Modern Warfare* (New York: W. Morrow, 1988), 469.

14. Desert Storm "tank plinking" missions scored considerably higher rates than this, but those missions were flown against nonmoving targets under conditions of air supremacy. Under less optimum conditions of weather, terrain, threat, and a reactive enemy, two kills per sortie seem legitimate.

15. Calculated at 14 front lines per squadron x 3 squadrons x 3 sorties per day x 3 days = 378 total sorties; many other factors will drive this number up or down (losses, airfield damage, surge rates, etc.).

16. Rick Atkinson, *Crusade: The Untold Story of the Persian Gulf War* (Boston: Houghton Mifflin, 1993), 317–20, 464.

17. Actual circular error probable (CEP) and hit probability for a given weapon and type of delivery are classified and are listed in the JMEMs. Another good source of weapons accuracy data, also classified, is the series of USAF Weapons System Evaluation Program reports known as COMBAT HAMMER.

18. This is true for the A, B, D, and G models of the Maverick. These variants use either TV or imaging IR to provide a targeting picture to the pilot. Once launched, the pilot no longer receives any picture from the missile. The E model guides on a laser spot provided by the launch aircraft (or ground illuminator) and can be updated while in flight.

19. *31 Fighter Wing Weapons Guide*, January 1995, 3–4.

20. USAF T.O. 1-1M-34, *Aircrew Weapons Delivery Manual (Nonnuclear)*, May 1991 (updated May 1993), 1–117.

21. *Jane's Armour and Artillery, 1996–97*, 782.

22. Atkinson, 165.

23. The author personally experienced this during Operation Deny Flight over Bosnia-Herzegovina. The evening after a Serbian-held airfield was bombed by NATO forces, CNN aired footage of runway craters at the target, with Serbian soldiers standing next to them. By clipping and enlarging a still from a videotape of the broadcast, and estimating the height of the Serbian soldiers, we were able to determine the diameter of the craters. This use of "CNNINT" enabled us to confirm our estimates for thickness and material strength of that particular runway, as well as confirming proper functioning of the weapon.

24. David Thaler and John Bordeaux, *"Paralysis" in the Context of Theater Campaigns* (Santa Monica, Calif.: RAND, 1993), 6.

25. Lesser, 13–14.
26. Joint Pub 3-03, II-1:II-2.
27. William Sherman, *Air Warfare* (New York: Ronald Press Co., 1926), 218.
28. Lesser, 18.
29. Ibid., 12.
30. Lesser, 24.
31. FM 1-112, B-2.
32. Lesser, 15.
33. FM 100-7, *Theater Operations*, 5–7.
34. Hans Ulrich Rudel, *Stuka Pilot* (New York: Bantam Books, American edition published 1958), 100.
35. Joint Pub 3-01.2, *Joint Doctrine for Theater Counterair Operations*, 1 April 1986, IV-2.
36. One positive fallout from no-fly zone operations such as Deny Flight is a large number of real-world helicopter intercept opportunities. Although most of these are restricted to ID passes only, they still expose the aircrew to detecting, tracking, sorting, intercepting and visually acquiring low-flying helicopters.
37. "NATO's Use of Air Power in Balkans," *The Stars and Stripes*, 22 November 1994, 2.
38. Lesser, 27.
39. Ibid., 29.
40. Stephen Hosmer, *Psychological Effects of U.S. Air Operations in Four Wars, 1941–1991* (Santa Monica, Calif.: RAND, 1996), 151.
41. Hallion, 218.
42. Ibid., 232.
43. Hosmer, 181.

Chapter 4

Synchronizing Air and Ground Forces

You can reserve your big guns for the battlefields of Europe.
The artillery in this theater flies.

—Gen George C. Kenney

One of the key factors in ground attack planning is ensuring that the right targets are hit at the right time to support the overall strategy. In this chapter I briefly examine the development of combined arms strategy and AirLand Battle, then review current US Army doctrine as stated in Field Manual (FM) 100-5, *Operations*. Combined arms doctrine has heavily influenced current US military thought, and FM 100-5 is the US Army's basic guidance for the operational commander. By understanding the ground force commander's operational and tactical outlook for various situations, the air planner can use his own forces more effectively. The operations discussed in this chapter view airpower in more of a classical supporting role, which may be what airpower shifts into if the enemy army survives to close with our own ground forces. The component commanders and theater commander in chief (CINC) must remain aware that both air and ground forces can support each other to more effectively defeat the enemy.

Origins

One of the first militaries to examine the combined use of mechanized and air forces was the Soviet Union. A leading proponent was Marshal Mikhail Tukhachevskii, a Soviet staff officer who eventually rose to become the chief of general staff.[1] Tukhachevskii developed the concept of "deep battle" in which aviation, airborne infantry, armor, and motorized infantry would cooperate to penetrate into the enemy's rear echelon. There they would inflict great damage on the enemy's operational reserve, airfields, and headquarters.[2] The specific rules of aviation were stated as:

(d) army aviation (light bombers and ground attack units) would be employed on preparation of the break-in and, in depth, on operational co-operation with the development echelon, preventing the enemy reserves from intervening and offering resistance in depth.

(e) front (army group) aviation (long-range bombers) would be tasked to isolate the break-in sector completely from the enemy's strategic depth, and to interdict movement of his strategic reserves.

(f) airborne forces would go in at the depth of the enemy's main supply dumps and army headquarters, with a view to co-operation with the development echelon.[3]

This quote is worth examining in detail. The term *development echelon* refers to a ground maneuver group sent into the enemy's rear area. Note the initial concentration of ground attack forces to assist the penetration, then the shift of those forces deeper to assist disrupting the enemy. The "long-range" bombers are used in a classic interdiction role, which reflects the ground war orientation of the Soviet military. Planning to "completely" isolate the battlefield is too optimistic, but at the time this strategy had never been tried in battle. The aircraft used in this role would more properly be labeled as "medium bombers" in most Western air forces of the period, as nations such as Great Britain and the United States (US) saw a more strategic mission for true long-range bombers. The objectives described for airborne forces would today be attacked by air assault and attack helicopters, but the concept of section (f) is still valid.[4]

Germany was also examining the concept of combined arms warfare in the late 1930s, with a similar focus on supporting ground maneuver with airpower. The emerging "operativ" (operational) and later "blitzkrieg" strategies combined deep, rapid armored thrusts with fighter and bomber support.[5] The blitzkrieg, especially, relied on speed and surprise to keep the enemy from reacting, and aimed for deeper objectives than the Soviet deep battle approach. The Germans emphasized initiative among the lower-echelon commanders, which would enable the advance to continue as local weaknesses presented themselves. Flexible airpower hit local enemy strongpoints, as well as causing general confusion and disruption in the enemy rear.[6] CAS was de-emphasized in favor of interdiction, and the Luftwaffe and Wehrmacht never developed as efficient a close-control system as the Americans and British later would.[7]

Field Marshal Erich von Manstein, developer of the plan to attack through Sedan that hastened the fall of France, saw preventing a French counterattack as a key mission for the Luftwaffe. Although French strategy made a successful counterattack improbable, the Luftwaffe was prepared for this contingency.[8] By disrupting French reserve forces, and delaying possible counterattacks, the Luftwaffe would have enabled the armored forces to expand their breakthrough and achieve greater gains.

The US Army first coined the term *AirLand Battle* in 1981 to describe an emerging doctrine that promoted joint operations across the spectrum of deep, close, and rear portions of the battlefield. While never included as a formal part of Air Force doctrine, the basic concept was accepted by many Air Force leaders.[9] Some airmen, however, saw AirLand Battle as a bid by the Army for more control of air assets. A new term, *battlefield air interdiction* (BAI), was introduced by the army to highlight what it saw as a need to concentrate on the shallow interdiction battle to shape the battlefield for the ground war.[10] This term has since fallen out of use by the United States, and it is now

accepted that a CAS mission can lead to shallow interdiction effects. The following passage captures the essence of AirLand Battle: "According to current doctrine, the Army views the battlefield as one battle having three distinct areas—rear, close-in, and deep. However, the three areas of the battlefield are inextricably linked. As there is only one battle, the corps commander must have the means to control and influence the rear, close-in, and deep areas of the battle. Service forces must be synchronized (integration of tactical assets) into the land commander's maneuver scheme."[11]

Current joint doctrine differs in that, instead of all services supporting the land commander's maneuver scheme, all component commanders support the joint force commander's (JFC) overall plan. Command arrangements notwithstanding, the main theme of AirLand Battle is that events all across the battlefield influence one another, a concept which has clear origins in deep battle, operativ, and blitzkrieg.

Current Doctrine

The current FM 100-5 gives the airman a good perspective of how the US Army plans to fight. Specific sections of interest include planning and executing operations, fundamentals of the offense, and fundamentals of the defense.

The doctrinal objective of "deep operations" is interesting, as it sounds very similar to the various definitions of interdiction. "The deep battle is designed to nullify the enemy's firepower, disrupt his C^2, destroy his supplies, and break his morale. A well-orchestrated deep battle may help cause the enemy to be defeated outright or may prevent him from achieving his intended objectives."[12] Later in the same section, FM 100-5 states of deep operations: "These operations enable friendly forces to choose the time, place, and method to fight the close battle."[13] This sentence harkens back to the AirLand Battle notion of interrelated effects across the battlefield.

Chapter 7 of FM 100-5 addresses the offensive. Army doctrine defines the offensive in two different ways—the type of attack and the form of maneuver used. I will address each separately, as the two approaches each have lessons for the airman.[14] Chapter 7 also addresses "movement to contact," which brings ground forces into contact with the enemy. This section briefly mentions "preliminary diversionary actions and preparatory fires" as happening before actual contact takes place, but the air planner recognizes that airpower can be used throughout this phase to great effect.[15] Army aviation and long-range rockets may also be available during this phase, but the ground commander normally likes to conserve his assets until the ground fighting begins. The ground commander sees a use for airpower, especially his own helicopters, to screen ahead and to his flanks during movement to contact to prevent any surprises by the enemy.[16] If two opposing forces encounter each other while on the move, a "meeting engagement" occurs. When this happens, airpower can be used to great effect by quickly concentrating heavy firepower against the enemy.

A “hasty attack” is generally considered to be an attack launched with less than 24 hours of preparation.[17] It may result from a meeting engagement, or from sudden enemy action that forces us to attack ahead of schedule.[18] A hasty attack emphasizes agility at the risk of losing synchronization. If possible, the use of CAS during a hasty attack should be minimized due to limited coordination time, a greater chance of our own ground forces overrunning the FSCL, and resulting increased risk of fratricide. If the attack is being made quickly to catch the enemy off guard, primary targets include enemy command and control (C^2) to prevent him from reacting to our attack. Enemy reserve forces, or the LOCs they would transit into battle, may also be critical targets to keep the enemy from plugging the gap our forces hope to make.

A “deliberate attack” is made when an ample amount of planning time exists, and our forces may even have had time to exercise the battle plan.[19] This form of attack makes synchronization easier, and CAS can be more safely employed. The enemy will also have had more time to plan, so a key factor may be keeping the tempo of the attack faster than the enemy’s likely reaction. Initial attacks can rely more on preplanned targets to maximize destructiveness, but as the attack develops more flexibility will be required.

A “spoiling attack” is launched from defensive positions to disrupt an expected enemy attack.[20] Heavy use of airpower can significantly increase the disruption of the enemy, allowing fewer ground forces to be committed against him. Airpower disruption of enemy follow-on forces may persuade the enemy to postpone his attack, as he loses the ability to exploit gains made by his first echelon. Enemy forces preparing to attack are particularly vulnerable to air attack while marshaling in assembly areas or moving up to the front, so we should remain alert for quick retasking opportunities to attack such forces.

“Counterattacks” are conducted after the enemy has launched his own offensive, and seek to exploit enemy weaknesses created by his own advance.[21] Attacking C^2 targets may keep the enemy from reacting to our counterattack, especially against an enemy that practices centralized control. Good intelligence on enemy command doctrine is important to knowing just how much priority to give to C^2 targets.

When our own offensive progresses to the exploitation or pursuit phases, our ground forces will be operating deeper into enemy territory.[22] This raises the risk of fratricide, since the FLOT is fluid, and good coordination is required to keep the FSCL in the right place. Too deep an FSCL can be just as bad, as it reduces the opportunity to hit nearer interdiction targets without going through the less efficient CAS procedures. If our ground forces can handle the enemy units in direct contact, our best airpower targets are enemy C^2 and reserves, again to keep him from reacting to our offensive. Airborne and air assault units inserted behind enemy lines may have the greatest requirements for CAS, since they will often be out of range of friendly artillery support. Coordination of airpower with the air mobile scheme of maneuver is therefore especially critical. Helicopter-borne FACs may provide

a flexible control authority for CAS under these circumstances. Another concern for the air planner is how far the army plans to advance. Potentially targeted LOCs may be more valuable to our own troops than to the enemy, so trade-offs must be made between hurting the enemy and hindering our own advance.

Turning to the various forms of maneuver, the army prefers, when possible, to find a weak point in the enemy line through which to "envelop and encircle" This entails pushing forces around the flank of the enemy, driving into his rear echelon, and ultimately linking up to complete the encirclement.[23] CAS may be needed to support the initial maneuvers, but the most likely use of airpower is against the enemy's second echelon reserves. These forces will likely attempt to break through and relieve the encircled enemy, but the use of airpower in direct attack of combat forces or their transit LOCs can prevent this.

A "turning movement" is similar to an envelopment, except that the goal is not to encircle the enemy but force him out of his current position. The ultimate objective may be to engage the enemy on more advantageous ground, or to force him to withdraw from the area.[24] Either direct attack of combat forces or attacking tactical supplies may assist this, and it is important to remember that the enemy needs an escape route or he won't be able to move. Dropping all of the bridges behind the enemy, for example, may force him to stand his ground, which is exactly what we don't want.

"Penetrations" and "frontal attacks" are the least preferred methods of advance, as they involve heavy fighting against prepared enemy positions with resulting potential for heavy casualties.[25] If these options are used, however, the best initial use of airpower will be to help open a breach in the enemy front line, to allow the quickest possible breakthrough. Detailed coordination with ground maneuver and artillery is required, and the enemy combat force, particularly artillery, is a priority target.

Two forms of defense exist in US Army doctrine, the "area defense" and the "mobile defense."[26] Mobile defense uses fire and move tactics to disrupt the enemy advance, and requires enough room for mobile action. This option requires that our forces have greater agility than the advancing enemy, so airpower will likely be used to slow the enemy down. Vehicles, tactical fuel supplies, and LOCs are good targets that will produce delay, diversion, or disruption effects. Area defense is more static, and involves more direct confrontation with the enemy. Mobility in this case is not as critical as destroying enemy combat power, so direct attack on enemy combat forces becomes the priority. If our forces can withstand the initial onslaught, targeting follow-on forces may be the best use of airpower assets.

In either case, but especially for mobile defense, enemy C^2 becomes a more important target as the battle wears on. This is particularly true of centrally controlled enemy forces, who will likely have rehearsed their first moves but will rely on new orders as the fighting develops. Cutting such units off from higher headquarters can severely degrade their effectiveness, especially if initiative is not part of their doctrine.

In this chapter the author has briefly examined the development of combined-arms doctrine and how the US Army plans to maneuver and fight. We have also discussed several ways in which airpower can blend with ground maneuver to provide the greatest influence on the enemy, an influence that is often greater than what air and ground forces can accomplish in isolation. We will now briefly examine four case studies that help to highlight the development of air and ground synergy, over a timespan from 1918 to 1972.

Notes

1. Richard Simpkin, *Deep Battle: The Brainchild of Marshal Tukhachevskii* (London: Brassey's Defence Publishers, 1987), 9.
2. Ibid., 40.
3. Ibid., 42.
4. Lt Col Edward McCormick, Air Command and Staff College Army Liaison Officer, interview with author, 21 March 1997.
5. Martin van Creveld, with Kenneth S. Brower and Steven L. Canby, *Airpower and Maneuver Warfare* (Maxwell AFB, Ala.: Air University Press, 1994), 40.
6. Col T. N. Dupuy, *A Genius for War: The German Army and General Staff, 1807–1945* (1971; reprint, McLean, Va.: Nova Publications, 1984), 256–57.
7. Williamson Murray, "The Luftwaffe Experience, 1939–1941," *Case Studies in the Development of Close Air Support*, ed. Benjamin Cooling (Washington, D.C.: Office of Air Force History, 1990), 86–95.
8. Field Marshal Erich von Manstein, *Lost Victories* (First published in Bonn, 1955. Current translation published in Novato, Calif.: Presidio Press, 1994), 34.
9. Robert Frank Futrell, *Ideas, Concepts, Doctrine*, vol. 2, *Basic Thinking in the United States Air Force, 1961–1984* (Maxwell AFB, Ala.: Air University Press, 1989), 551–54.
10. Ibid., 552–53.
11. Col Thomas Cardwell III, *AirLand Combat—An Organization for Joint Warfare* (Maxwell AFB, Ala.: Air University Press, 1992), 50–51.
12. FM 100-5, *Operations*, 6–14.
13. Ibid.
14. Ibid., 7-0.
15. Ibid., 7-4.
16. McCormick interview.
17. Ibid.
18. FM 100-5, 7-5.
19. Ibid., 7-8.
20. Ibid.
21. McCormick interview.
22. FM 100-5, 7-8:7-9.
23. Ibid., 7-11.
24. McCormick interview.
25. FM 100-5, 7-12.
26. Ibid., 9-1:9-2.

Chapter 5

Case Studies

Although airpower made tremendous technological gains during the 54 years spanned by these examples, there are some general truths and lessons that can be gleaned from such a systematic study. Many of today's principles of attack aviation were in place by 1918; much of the subsequent change has simply involved adapting to the vast increases in speed, range, payload, and targeting accuracy. Although air defenses have also improved drastically, the trench strafing environment of World War I was as dangerous to the wood-and-fabric biplanes of the era as the SAM-infested skies over Vietnam would prove to the supersonic fighters of that war. To draw some rough comparisons between the four case studies, I will first review the overall military situation in each and the ground attack doctrine of the time, then examine the desired operational effects of ground attack, the tactical lessons learned, and conclude each study with a look at the actual operational effects achieved and why they differed from the expected results.

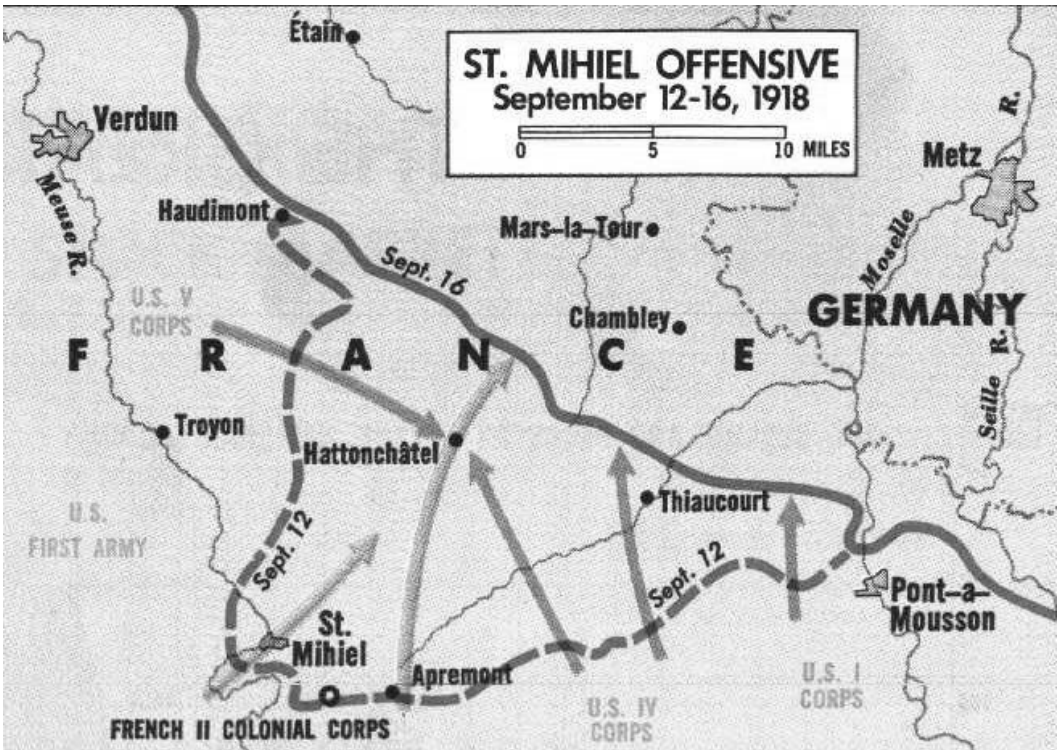
Saint Mihiel, 12–15 September 1918

In March 1918, German commander Erich Ludendorff began the final offensive that was Germany's last shot at victory in World War I. Although the attack made impressive gains and appeared at first to threaten Paris, by mid-July it had exhausted itself after gaining 50 miles of Allied territory on a wide front.[1] The Allies regrouped, and with a growing advantage in men and supplies began the first major counterattack on 8 August. British Gen Sir Douglas Haig had succeeded in wiping out all of the German gains in the North by 3 September, and when his own attack halted the American First Army was ready to attack the southern remnant of the German salient. Bolstered by French forces, American Gen "Black Jack" Pershing led an American Army into battle under an American flag for the first time in World War I.[2]

General Pershing's air commander was Col William "Billy" Mitchell, who would be the operational coordinator for the entire air effort at Saint Mihiel and directly in command of a major portion of it. Mitchell had under his operational control some 1,481 bombers, observation aircraft, and pursuits, of which one-third were American. The remaining aircraft were British or French, attached to the forces that were supporting the offensive.[3] Many of the Allied aircraft fell under the "coordination" rather than command of Mitchell, although throughout the planning and execution of the battle there

was unity of effort.[4] US Air Service organization of the time called for aircraft to be assigned to both armies and corps, so Mitchell had direct command of only those units assigned to First Army and not the subordinate corps.[5]

Map 1 shows the basic Allied plan for the battle, which was a main push from the south that linked up with a second advance from the northwest, trapping many German soldiers in the center. The entire effort to remove the salient took only four days, from 12 to 15 September, and is noteworthy in that the American units sustained low enough casualties to be thrown into the Meuse-Argonne offensive only 11 days later.[6]



Source: United States Air Force Academy

Map 1. Battle of Saint Mihiel

The salient itself was 25 miles wide by 15 miles deep and consisted of hilly terrain with large areas of forest. These conditions made spotting off-road traffic from the air difficult, but also required that any large vehicular movement, including horsecarts, remain on the roads for reasonable mobility. The town of Metz, 30 miles northeast of the salient, provided a good railhead for offloading supplies for the front.[7]

The Allies had come close to achieving air superiority over the front by this time, and Mitchell's concentrated airpower quickly achieved local air superiority over the battlefield.[8] The Germans had only 300 aircraft of all types near the salient, of which only 150 were pursuits.[9] During the period

from 12 to 26 September, which spans the beginning of Saint Mihiel to the start of the Meuse-Argonne offensive, the US First Pursuit Group reported only three losses while claiming 34 German aircraft shot down.[10]

The weather was extremely poor during the first two days of the battle, then cleared for 14–15 September. Maj Harold Hartney, commander of the First Pursuit Group, reported that flying below 100-foot ceilings to attack ground forces was not uncommon.[11]

The US Air Service doctrine at the time was largely based on a paper written by Mitchell titled "General Principles Underlying the Use of the Air Service in the Zone of Advance A.E.F." Mitchell had observed Allied airpower in action against the Germans, and had codified what he thought was the best use of airpower to help win the war. At this time Mitchell stated that airpower would not win the war by itself, and that destruction of enemy forces in the field was required for victory.[12]

Attack aircraft fell into two classes, tactical and strategical. Observation, pursuit, and tactical bombardment fell into the former category, which operated in the immediate vicinity of the front. Pursuit was assigned the primary role of attacking German aircraft, but could also perform missions to "create diversions by attacking enemy personnel on the ground."[13] Tactical bombardment aircraft were charged with destroying enemy material and undermining the morale of enemy troops. Observation aircraft had arguably the most important of all airpower roles in the First World War, and took photographs for artillery targeting and gave corrections to artillery batteries through direct spotting. The maximum effective range of most artillery of the day was 10 miles, and this was set as the maximum distance that tactical bombardment aircraft operated beyond the front. Note that morale effects were highlighted, and the ability of pursuits to cause significant damage through strafing or small (25 pound) bombs was not emphasized.[14]

Strategical bombers operated against targets beyond 10 miles from the front, and hit depots, airfields, factories, lines of communication, and personnel.[15] This target list includes what would later be considered interdiction targets, as well as some truly strategic ones. Operations in 1918 were restricted by short range, and most bombing was limited to close support or shallow interdiction. Bridges were considered very difficult to hit, and the slight damage caused by World War I bombs was quickly repaired.[16]

The notion of synchronizing air attacks with the ground battle was first pushed in 1915 by British Gen Hugh Trenchard, and the concept was firmly in place by 1918.[17] One result of this was Mitchell's use of ground alert aircraft, preloaded with bombs and bullets to act as a quick-reaction operational reserve.[18] Lack of reliable radios led to the use of panels and smoke signals to mark friendly positions, which proved adequate for the dropping of artillery correction information but not for coordinating air strikes. The result was mostly preplanned missions to attack enemy trenches or troops close to friendly positions and a preference for deeper attacks. Armed reconnaissance was used regularly, with pilots being given sections of enemy road and told to bomb or strafe targets of opportunity.[19]

Ground attack's desired operational effects can be seen in the following excerpt from a 7 September 1918 field order issued by First Army:

> Beginning at the commencement of artillery preparation and barrage, the army air service will take the offensive against the enemy with every branch of aviation. The army pursuit aviation will defend the army front from hostile attack, protect its own observation aircraft, and hold itself in readiness to attack troops on the ground in the immediate vicinity of our front. The army observation aviation will carry out all missions, both day and night, ordered by G-2. The bombardment aviation will attack the railroad stations and supply points of Metz, Thionville, Mars-la-Tour, Conflans, Dommary, Stenay, and the most important hostile airdromes.[20]

From this order the desired effects appear to be air superiority, disruption of enemy front line troops, disruption of the enemy through reduction of replenishment, and delay of reinforcements through LOC attack. Mitchell himself, in *Winged Defense*, described the plan for Saint Mihiel as "to interrupt their movement and supply, and force their pursuit aviation to the defensive to keep them away from our troops."[21] The one effect notably absent is destruction of the enemy, likely due to the realization that large-scale destruction of enemy combat power was beyond the capability of First World War aircraft.

Synchronization between ground and air was again demonstrated in a memorandum sent by Mitchell to Pershing during the planning phase of the battle. Mitchell spoke of exploitation as the final phase, during which the weight of effort would shift from preplanned targets to attacks on the expected fleeing German columns.[22] Mitchell knew such forces would be in too much of a hurry to disperse properly, thus exposing themselves to air attack.

Location of the enemy seems to have been relatively easy. Many of the deeper targets were fixed, allowing preplanned map and photo study. Restrictive terrain kept much of the supply and troop columns on the roads, where they were easily spotted. Spotting columns was made even easier by the low altitudes used by pursuit and tactical bombardment pilots. The mobile nature of the German Army, which pulled back as the attack commenced, exposed it to even greater chance of discovery from the air.[23] The British even made several night attacks, claiming quite a few direct hits and secondary explosions at key railroad stations.[24] While verification of results at night is difficult at best, the sheer number leads to the belief that at least some of the night bombers were able to find their targets. The short distances, fixed targets, and almost complete lack of capable night air defenses eased the navigation problem.

The use of ground alert guaranteed that those aircraft would not be tasked until a credible target for attack had been located by friendly ground troops, who reported the latest position of the enemy to the launching aerodrome. These aircraft would then face only 10 to 20 miles, or about 8 to 15 minutes, of flight time to reach the target.

Armed reconnaissance seems to have been successful at finding the enemy, which may have simply been due to placing enough aircraft into a relatively small airspace to guarantee that someone will be there to spot any major

column on the move. Identification of targets was not a particular problem for the interdiction attacks carried out at extremely low altitudes, but the rudimentary communications systems did put some restrictions on direct support, or "trench-strafing," missions. Mitchell's guidance specifically stated that protection attacks against counterattacking German infantry would only be carried out if Allied infantry ground-to-air signaling was effective.[25]

Targeting seems to have worked as well as expected, given that only light to moderate damage was anticipated.[26] Against the hardest targets to destroy such as bridges and railroad crossings, Mitchell used British bombers with the greatest payload capability and largest bombs.[27] Enemy vehicles were routinely hit and destroyed, which in turn blocked the LOCs and made backed up troops an even better target.[28] There were cases of pursuits strafing columns and causing traffic jams, then returning to phone the location in to a local artillery battery that shelled the entire area causing heavy enemy casualties.[29]

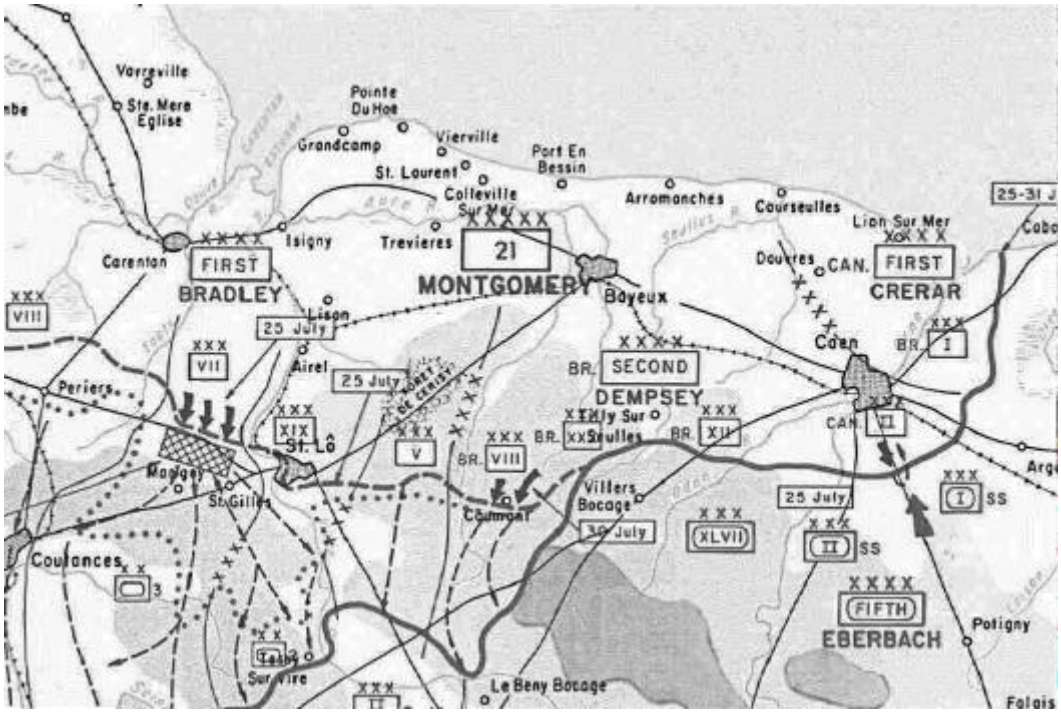
Were the desired operational effects achieved? In this case analysis is difficult, since the entire battle lasted just four days. There do seem to be at least isolated instances of the disruption and delay that were the primary goals; how much disruption was caused by scared, retreating troops as opposed to direct results from air attack is difficult to tell. It may be that the two reinforce one another, as Hosmer would indicate. If the best way to disrupt an enemy soldier is to hit him hard on the ground, force him to withdraw, then strafe him while he does so, the effect was indeed achieved.

Assessing the assessor is also difficult due to the short time period, but it does seem that Mitchell was aware of the coming rout and made a timely call to switch to more armed reconnaissance attacks to maximize chances of catching the enemy while fleeing in the open.[30]

Normandy Breakout, 25 July–19 August 1944

By 1944 the Allied air forces had developed a fairly advanced method of controlling CAS, and the breakout from the Normandy beachhead gave them a chance to combine it with armed reconnaissance and interdiction for a truly effective demonstration of airpower combined with a bold ground scheme of maneuver. There were still some flaws in the system, however, as this study will show.

Prior to the invasion, Allied medium bombers and fighter-bombers attacked LOCs across northern France to isolate the German frontline defenses. By 6 June, rail capacity had been reduced by 42 percent while the miles of usable track had been reduced by 86 percent.[31] After the initial success at Omaha, Utah, Gold, Sword, and Juno beaches, the Allied armies ran into difficulty advancing into the French bocage (hedgerow) county. The hedgerows limited cross-country mobility and funneled the advancing columns into vulnerable bottlenecks.[32] Seeking an "end run" to alleviate the situation, Gen Omar Bradley devised Operation Cobra. Cobra would start with a large-scale attack by fighter-bombers against enemy positions just west of Saint Lô,



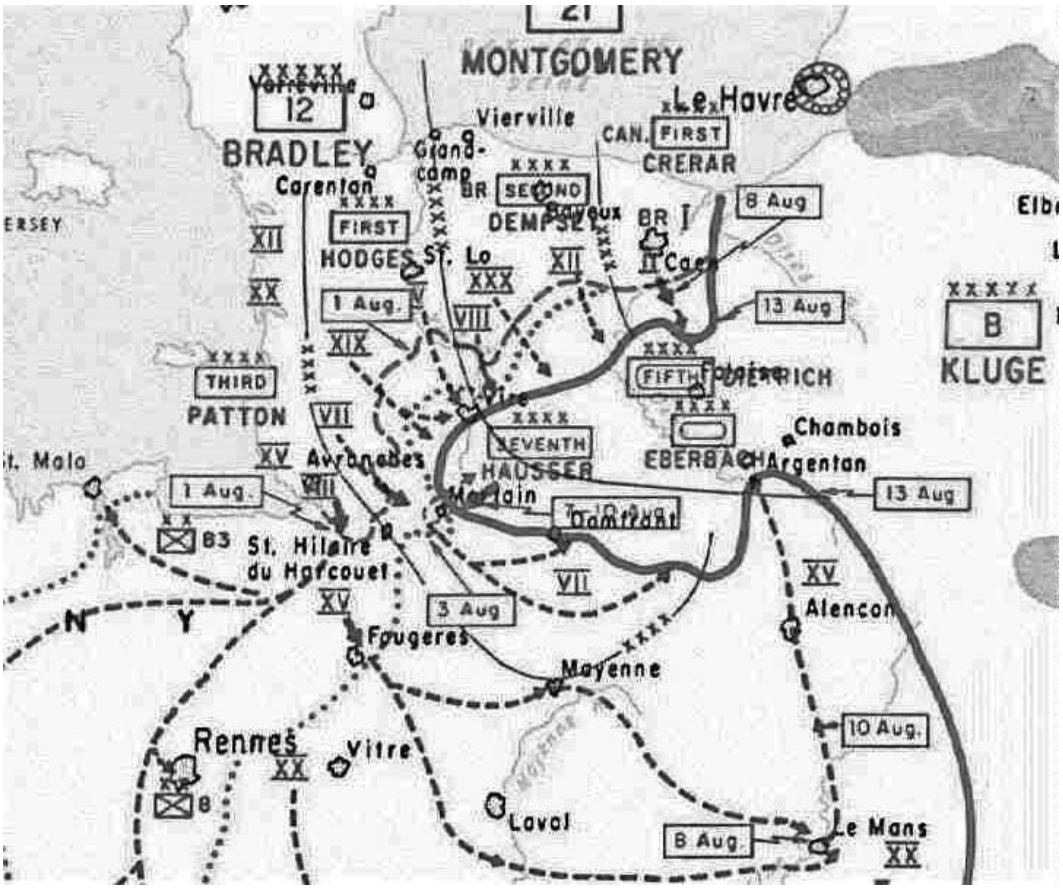
Source: United States Military Academy

Map 2. Dispositions at the Time of Cobra

immediately followed by saturation bombing by heavy bombers of the Eighth Air Force. The intent was to quickly punch through the German positions, then exploit the breakthrough with rapid advances to the south, east, and west (see map 2 for details).[33]

After the breakout was accomplished, US forces raced east attempting to encircle the German Seventh Army. Although his generals urged a retreat to avoid being surrounded, Hitler instead ordered a counterattack against Mortain. This attack was halted in the first twenty-four hours, largely due to the supreme effort of Royal Air Force (RAF) Typhoons.[34] US forces then tightened the noose by pushing north to Argentan, while the British Army slowly advanced into Falaise. That left a narrow ten-mile gap, which was filled with German forces streaming east under heavy air and artillery attack. When the gap was finally closed off, the Germans had lost 60,000 troops killed or captured, and 350 armored vehicles, 2,500 other vehicles, and over 250 artillery pieces had been destroyed.[35] Map 3 illustrates the ground maneuver involved in the breakout and encirclement.

Allied buildups, bombing raids, and German losses to combat and transfer to the eastern front had all combined to give the Allies air superiority over Northern France by the summer of 1944. Although the Luftwaffe still flew small-scale raids, the vast majority of the aircraft over the battlefield were British or American.[36] The German antiaircraft defenses were generally



Source: United States Military Academy

Map 3. Breakout and Falaise-Argentan Pocket

weak, although some units had strong enough defenses to seriously interfere with the work of low-flying fighter-bombers.[37] Other factors included the weather, which was intermittently good and bad, and the level of training in Allied units, which was excellent.

The organization for airpower during the Normandy campaign was not clean, and did not completely correspond to the doctrine of centralized airpower command as dictated by FM 100-20, *Command and Employment of Air Power*.[38] This doctrine had been proven successful in North Africa by both the RAF and United States Army Air Forces, but in Europe the lure of strategic targets kept airpower fragmented. Both the US Eighth Air Force and RAF Bomber Command operated as independent strategic striking forces, and were only grudgingly brought into the ground attack business on an occasional basis. An overall Allied Expeditionary Air Force, headed by Air Chief Marshal Leigh-Mallory, was in charge of air support for the Allied armies in France.[39] The US Ninth Air Force and RAF Second Tactical Air Force were the primary ground support units of the Normandy campaign,

operating a mix of fighters, fighter-bombers and medium bombers. While all fighters occasionally operated as fighter-bombers, the distinction was made between fighters, such as the P-51 Mustang, that primarily flew air-to-air missions, and fighter-bombers, like the Typhoon, that primarily flew ground attack. As the Luftwaffe put in less and less of an appearance, more fighters were used in the attack role to stay gainfully employed.[40]

Ground attack doctrine came a long way in World War II, and was quite mature by the summer of 1944. A functional tactical air control system had been put into use, with a centralized combined operations center that coordinated the activity. Requests for CAS were forwarded to the tactical air forces command chain for tasking, which would in turn task units to fill the request with attack sorties.[41] A more satisfactory system came into use after the initial breakout, which used air support parties, or "Rovers," to control CAS from armored vehicles traveling with the army. This is basically the concept known today as the FAC, and used modified Sherman tanks in the US Army and command armored cars with the British.[42]

Due to the large number of available fighters and fighter-bombers, airborne on-call fighters became routinely available. These aircraft would launch to a contact point without a preplanned target, and if the local ground forces had no targets for them they would press to an armed recce area behind German lines.[43] A further development was armed column cover (ACC). This involved flights of four aircraft, usually P-47s, flying cover over an armored column that was advancing at high speed. Keeping contact with the column's Rover, the aircraft would range as far as 30 miles in front to seek targets of opportunity, detect enemy forces waiting to engage our column, and in general act as an airborne screening force for the convoy.[44] The ACC flight was instantly available for on-call CAS and provided air cover in case the column came under attack by the few Luftwaffe sorties that were flown. The partnership between fighter-bomber and armored column was taken one step further by Gen George S. Patton's Third Army, which used flights of P-47s to screen its right flank during the breakout eastward. By locating and stopping German forces that tried to move north into Patton's right flank, airpower enabled the Third Army to concentrate on its resources on the drive east.[45]

Usual weapons loads differed with aircraft and nationality. The British preferred to arm their Typhoons with rockets, while the American P-47 pilots preferred 500-pound bombs. One reason for the difference was the larger warhead of the British rocket compared to its American counterpart. The eight .50-caliber machine guns of the P-47 could penetrate the weakest areas of German medium tanks, and the four 20-mm cannon of the Typhoon were even more effective.[46] The radial-engine P-47 was more durable when exposed to ground fire, since fighters with liquid-cooled engines such as the Typhoon, Spitfire, and Mustang were vulnerable to catastrophic coolant loss from even a single bullet hole. Medium bombers, normally B-25s or B-26s, carried loads of 2,000-pound bombs that were more effective against large, sturdy targets such as concrete and steel bridges. For this reason, and the difficulty of

performing CAS from medium altitude, these aircraft normally flew shallow to deep interdiction missions.

What then were the desired operational effects of Cobra, and the later breakout phase, regarding airpower? Initially, the intent was for the combined heavy bomber/fighter attack to destroy or disrupt the enemy, allowing an easy advance by US forces. Once the rapid advance began, CAS, armed recce, and interdiction missions were all flown, with interdiction receiving more emphasis as the encirclement tightened and German units exposed themselves to destruction and disruption while fleeing east. Shallow interdiction aimed at delaying the German retreat, causing their capture or destruction by the pursuing Allied ground forces. The deeper interdiction effort moved farther east as the Allied armies advanced, for fear of destroying bridges or fuel dumps that could be exploited by our own troops. The new emphasis was to delay/disrupt German reserves traveling by rail into Paris, which was the major rail hub in France. By 16 August, all bridges to the Belgian and Dutch borders were removed from the target list.[47] Certain critical bridges, such as those leading out of the Falaise pocket, were still attacked during this period.[48] As the noose tightened, interdiction within the pocket was stopped for fear of hitting our own advancing troops, and operations once again emphasized CAS.

Tactical results were excellent concerning damage done to the Germans, but less than sterling regarding fratricide against our own troops. The plan for Cobra had the attacking aircraft fly perpendicular to the front line, attacking toward the enemy from our own side of the lines.[49] This was done to deconflict the hundreds of aircraft involved, but went contrary to established wisdom regarding the traditional danger of short bombs. As luck would have it, the weather forced a reduction in attack altitude from the planned 15,000–16,000 feet to only 12,000 feet, which forced the B-17 and B-24 bombardiers to quickly recalibrate their bombsights. Smoke markers set to mark the friendly positions drifted and dispersed, proving almost useless in identifying them to the heavy and medium bombers.[50] Some crews toggled early, releasing the instant they observed their group lead aircraft drop. Although this technique proved valuable in concentrating impacts on industrial targets, the need to avoid short bombs made it risky during Cobra.[51] An interesting note was the Air Force request that US frontline troops withdraw 3,000 yards to provide a safety margin. The Army, showing more faith in the bombardiers' ability to put bombs on target, wanted to withdraw only 800 yards. A compromise of 1,500 yards was actually used, and it proved inadequate as 102 US troops were killed by short bombs on 25 July, including Lt Gen Leslie McNair.[52] Army troops complained of having a longer distance to fight their way through, and the heavy damage and cratering slowed progress through the target area. Anticipating the problem with craters, fragmentation bombs were extensively used and most GP bombs were fused to detonate instantaneously.[53] As a result, there was little damage done to the hardened bunkers that protected many of the German troops during the attack.

On the positive side, however, there was major destruction and disruption to the German ground units. Lightly armored vehicles were shredded by the flying bomb fragments and debris; even tanks suffered major damage. Many tank hulls were left intact, but suffered m-kills due to track damage. Communications were almost completely knocked out, with the Germans having to rely on runners. The greatest effect was massive disruption through shock to the soldiers themselves. Maj Gen Fritz Bayerlein, commander of the Panzer Lehr Division which occupied the target area, estimated that 70 percent of his personnel were incapacitated and half of his 88-mm guns were made ineffective.[54]

During the breakout phase, tactical results were excellent. The improved CAS control system and ACC gave the armored columns great mobility, and a true air-land partnership developed.[55] Claims of tanks destroyed by air attack were undoubtedly exaggerated, but heavy damage to German forces was confirmed by both sides.[56] During the brief German counterattack in the area of Mortain, large flights of rocket-firing Typhoons destroyed 83 Panzers and damaged 23 more on the first day alone. The air attack was so effective that Gen Dwight D. Eisenhower reported it had "brought the German attack to an effective halt, and turned a threat into a great victory."[57] Once the pocket began to close, the German forces became concentrated and exceptionally vulnerable, with the ensuing destruction so bad that one stretch of road near Falaise was dubbed "the Corridor of Death" by the retreating German troops.[58] Total German losses in the Falaise-Argentan pocket came to 10,000 killed; 50,000 captured; 350 tanks and SPs lost; 2,500 other vehicles destroyed or abandoned; and over 250 artillery pieces lost.[59]

Tactical BDA suffered from the expected claims exaggeration, as every armored vehicle became a tank, and every tank became a top-of-the-line Tiger.[60] The proximity of friendly ground forces aided in proper assessment of results, although dependence on radios and visual aids meant that proximity sometimes caused the fighter-bombers to bomb or strafe friendlies.

Deeper interdiction results were also good, although not as great as would have been achieved had the restrictions on bridge bombing been put in place. The large amount of preinvasion bombing had already severely restricted the ability of the Germans to move men and equipment into Northwestern France, so the decision was probably good in that additional bombing would have delayed the Allied ground advance more than the few German reinforcements did.[61] Another telling factor was the backlog of German locomotives awaiting repair, which by August far outstripped their capacity. From 4 March to 15 July the number of locomotives in France backlogged for repair had skyrocketed from 23 to 2,321.[62]

The combat assessment of the Allies during this period seems quite good, as quick decisions were continually made to rerole missions between CAS, armed recce, and shallow interdiction as the conditions dictated. The tactical failures of Cobra were identified, and the few subsequent CAS attempts by heavy bombers fared better, although some friendly casualties continued to occur.

Actual operational effects seemed close to what was expected, with some variances. Cobra was expected to cause more physical damage, but the disruptive effect allowed the army to advance, which was the overall goal of the operation. Months later, General Eisenhower stated that the advance would not have been possible without airpower.[63] There was a definite synergy between the air and ground forces, as each exploited the opening provided by the other. Air cover allowed armor to advance much faster, knowing that its front and flanks were at least partially protected. Airpower took extreme advantage of the situation caused by the advancing ground forces, which "flushed" the Germans into concentration on LOCs and vulnerability to attack. The benefits of air superiority were also seen, as there was little to interfere with US air operations while the Luftwaffe left our own ground forces almost untouched.

Withdrawal to Pusan, June–September 1950

On 25 June 1950, the communist forces of North Korea attacked the South with almost complete surprise. The South Korean military, and their American allies, were quickly pushed south, abandoning the capital city of Seoul within a few days.[64] Unable to stem the advancing tide, the Republic of Korea (ROK) and US forces withdrew down the peninsula to establish a defensive line around the southeast corner, which came to be known as the Pusan Perimeter (see map 4). The line was established by 31 July, after which the fighting took on a more static siege character. The Red forces tried to break the line at several times, launching a final all-out assault in the last week of August. This was a coordinated attack from both the west and north, and initially broke through the UN lines but was ultimately contained.[65]

Source: United States Air Force Academy

Map 4. Withdrawal to Pusan Perimeter

Following this final attempt to push the UN forces off the peninsula, US forces counterattacked by staging the 15 September landings at Inchon which drove a wedge deep behind enemy lines and precipitated the rapid collapse of the North Korean army.

The North Korean invasion caught the United States and ROK forces unprepared for war. Four understrength divisions were all the ground strength the US had in theater on 25 June, and these troops were trained, equipped, and mentally prepared more for postwar garrison duty in Japan than for fending off the Red onslaught. Task Force Smith, a battalion-size unit that was hastily transported into battle near Osan, was the first American ground unit to engage the North Koreans, and suffered heavy losses. Limited transport, limited ports of entry, and limited preparedness all served to limit the combat strength the US could bring to bear until the perimeter was established.[66]

Things were not much brighter from an airpower standpoint. During the five years since the end of World War II, the Far East Air Forces (FEAF) had concentrated on the air superiority mission at the expense of air-to-ground expertise and equipment.[67] There were no bases in South Korea with long enough runways for the few modern F-80 fighter-bombers to operate from, and the F-80s based in Japan did not possess enough external fuel tanks to give them sufficient range and endurance over the battlefield. To make matters worse, at the outset of the war the F-80s of FEAF lacked bomb racks, so their only air-to-ground punch consisted of rockets and .50-caliber machine gun fire. The F-80 pilots found their 5-inch high velocity aerial rockets (HVAR) to be effective against the North Korean T-34 tank's tracks or lightly armored rear areas, and usually fired them in salvos of up to four rockets per pass to guarantee a hit.[68] Napalm also proved effective against North Korean tanks, with a hit usually guaranteeing the target would catch fire and burn itself to destruction. A few older F-51 Mustangs were available in-theater, and these piston-engine fighters could both operate from the shorter fields available in country and fly missions from Japan that covered all of South Korea with significant loiter time. However, the slower F-51s, with their vulnerable liquid-cooled engines, were less popular with ground attack pilots due to the higher risk of loss to antiaircraft fire.[69]

Also available for use were a number of B-26 (formerly A-26) Invaders, twin-engine bombers left over from the closing year of World War II and capable of carrying a decent bombload over the entire peninsula. The B-26s were the first aircraft to be used seriously at night, with a combination of self- and buddy-dropped flares. Two variants of the B-26 were used—"hard-nosed" B-26Bs which carried forward-firing machine guns in place of the bombardier, and the standard "glass-nosed" version which employed bombs as the primary weapon.[70] Also available were B-29s based in Japan; by early July three groups were stationed in theater. A one-time "very heavy" strategic bomber, by the Korean War the B-29 had been reclassified as a "medium" bomber and did valuable service in theater interdiction. Its high altitude level bombing tactics were not well suited to attacking individual ground army targets, but

carpet bombing against troop concentrations was both possible and practiced.[71] Some experimentation was made with radio-guided bombs, but the 1,000-pound Razon was found to be too small for effective bridge destruction and the 12,000 pound Tarzon was not made available in significant quantities.[72]

The United States Navy and Marine Corps air arms also played a significant role in the use of airpower against the invading North Korean threat. In July the USS *Valley Forge*, assigned to Task Force (TF) 77, entered the fray with its attack-oriented carrier air group. In August, the 1st Marine Air Wing entered combat from escort carriers and land bases. Additional carriers steamed to join TF 77, which eventually grew to a standard strength of four or five fast attack carriers.[73] The Navy employed three aircraft in the attack role during this period: the F9F Panther, the F4U Corsair, and the AD Skyraider.[74] The F-9F was a true multirole fighter, able to handle all adversary fighters short of the vaunted MiG-15, it could also carry a significant load of bombs, rockets, and bullets. The F4U Corsair was a World War II retread, like the F-51 employed primarily as a dedicated attack aircraft. The AD Skyraider, a postwar piston-engine design, was a very capable attack aircraft that could haul large quantities of ordnance to targets at considerable range.

The Marines employed the F4U during the early portion of the war, in much the same dedicated attack role as the Navy. Marine doctrine, however, called for a preponderance of CAS missions to support its ground forces (and still does). This grows from practical necessity, since Marine ground units were by nature light to ensure mobility in amphibious warfare. Light forces lack heavy artillery, however, so Marine doctrine called for air strikes to make up the difference. This had the additional effect of keeping the Marine command and control system for CAS well polished, something that cannot be said for the USAF.

There was little air threat from North Korean airpower, which had to make do with a few propeller-driven Soviet designs that were inferior to the US F-80s, F-9Fs, and F-82s. By 20 July they numbered fewer than 30 operational fighters, and B-29s and other US aircraft were able to operate over North Korea without escort.[75] From this time until the Chinese intervention, UN forces can be said to have had air superiority over all of the Korean Peninsula. North Korean antiaircraft artillery (AAA) was more of a threat, especially to fighters and attack aircraft operating over the front lines or advancing columns, but in general terms US losses remained light.

Korea has some of the roughest terrain in the world, with a relatively small percentage of the land suitable for building roads or railroads. As a result, the North Koreans' LOC came somewhat channelized as they pushed south, making interdiction an easier task to accomplish. Since the US and ROK forces also owned the sea and sky, there was no alternative to overland resupply of their advancing forces. The weather proved fairly cooperative during this period, having little impact on air operations by the United Nation forces. The summer of 1950 was exceptionally dry, making all rivers

except the Han (which flows along the border between north and south, and past Seoul) fordable in numerous places. The steep terrain of Korea also resulted in numerous railroad tunnels along all of the major rail lines, which would provide an important sanctuary for North Korean supply trains during daylight hours. As had been the case in World War II, attack pilots found tunnels very difficult to destroy, but they did perfect techniques of skipping 500- and 1,000-pound bombs into tunnel openings to destroy the trains and supplies hiding inside.[76]

As might be expected when reacting to a surprise attack, the C^2 for American airpower underwent some changes during the withdrawal to Pusan. Lt Gen George Stratemeyer was the commander of the FEAF at the outset of hostilities, and he complained almost at once to higher headquarters that demands for close support were hampering what he saw as the more vital effort, interdiction.[77] Targeting was initially accomplished through an interservice agency, the General Headquarters Target Group. Since this group was dominated by Army officers, the targeting emphasis was seen by Air Force and Navy flyers as too close support-oriented. Stratemeyer proposed, and had accepted, a change to a more balanced Target Selection Committee within Gen Douglas MacArthur's headquarters. This group was more responsive to FEAF requests, and soon resulted in airpower being employed in a more efficient manner.[78] Problems still existed in the coordination of land- and carrier-based airpower, however, and no truly centralized commander for air was established. General Stratemeyer was authorized "coordination control" of TF 77, but that stopped short of true operational control. Another problem was the perceived need for maintaining radio silence while at sea, a procedure probably unnecessary given the limited air and naval strength of the North Koreans, but highly effective in limiting the ability of land and sea forces to coordinate their efforts.[79] A practical workaround was the eventual use of naval air primarily to strike interdiction targets in given geographic zones, which required less coordination than combined strikes or CAS missions.

Doctrine regarding the tactical air control system for CAS had changed little since the Second World War, with the principle of direct radio control of air strikes still forming the basis for most missions. FM 31-35, *Aviation in Support of Ground Forces*, remained in effect after the independent Air Force was created in 1947, and no update had been published by June 1950.[80] What limited early USAF CAS effectiveness in Korea was simply the inattention that had been paid to CAS since the end of World War II. Tactical air control parties (TACP) were undermanned, poorly equipped, and generally seen as a low priority in the nuclear age Air Force. As a result, there were only enough TACPs available to provide service down to the regimental level, and the air strike request process was fairly cumbersome.[81] Air Force CAS was typically flown from strip-alert, which added to the response time (40 minutes was typical during this period).[82] The Marines, on the other hand, kept the importance of CAS alive and were able to field a tactical control system that was more efficient and well practiced, as well as manned in enough strength

to provide TACPs down to the battalion level.[83] The Marines also flew more airborne alert CAS, giving the ground troops a greater feeling of direct support from airpower. In all fairness it must be remembered that the Marines intended for their CAS to stand in for heavy artillery, so it should only be expected that the Marines placed high emphasis on properly manning the TACPs. It must also be pointed out that there simply did not exist enough manpower to fill all the US Army battalions with TACPs, nor were there enough fighter-bombers to fly airborne alert CAS over the entire front.

One solution to the TACP problem soon appeared in the form of the T-6 Texan. This two-seat trainer was pressed into service to replace the less capable L-5 and L-19 airborne FACs, and was capable of carrying more radio equipment and covering larger areas of the battlefield with its greater speed. By providing a link between the TACP and the attack aircraft, the T-6 "Mosquito FACs" were providing control for over 90 percent of USAF CAS missions by the end of 1950.[84] There may have been a cultural attraction for airborne versus ground FACs as well, since the Air Force tended to view FACs with wings as more truly a form of airpower than FACs in jeeps or tanks.

The overall goal of airpower during this period was to stop the momentum of the enemy advance. CAS continued to receive high priority throughout the withdrawal and perimeter fighting, with roughly four times as many CAS sorties flown as interdiction sorties.[85] One factor that influenced this decision was a weakness in heavy artillery among the US and ROK ground forces, a deficiency not made up until after the initial phase of the war.[86] Isolation of the battlefield was the second priority, with initial emphasis being given to dropping the bridges over the Han River. Bomber command's B-29s were directed to hit North Korean LOCs from the Han River north into North Korea, while the fighter-bombers and attacked LOCs in South Korea closer to the front. Principal target types included rail and road bridges, railyards, ports, and supply depots.[87]

Assessment of potential targets and mission results was fairly easy in the north, where much of the infrastructure had been built by the Japanese during their occupation, and details were readily forthcoming. The situation in the south was different, due to the fluid nature of the battlefield and a lack of reliable information about the location of South Korean ground units.[88] An initial lack of adequate reconnaissance aircraft and trained analysts also hurt the assessment process. A strong network of agents behind enemy lines partially offset this, as did the obvious channeling effect of the terrain which made several chokepoints obvious targets.[89]

Tactical results for airpower were generally good, given the shortcomings that had to be worked around during the early months of the war. The F-80 proved to have too little endurance for performing armed reconnaissance missions, which was the best method for interdiction given the lack of adequate intelligence and accurate maps. CAS was likewise difficult for the F-80, as flights would have little time to loiter for the most lucrative targets to be identified by the TACP or air FAC. Some oversize wingtip tanks became

available to extend the range and endurance of the F-80, but there were never enough of these to equip all of the jets during the Pusan fighting.[90] The F-80 did prove a successful fighter-bomber, however, and a particularly effective strike on 10 July led to additional flights being called in on an exposed North Korean column that was stopped behind a destroyed bridge. When the air strikes were complete, claims were put in for the destruction of 38 tanks, 7 half-tracks, and 117 trucks.[91]

The B-26 proved difficult to employ in the mountainous areas of the peninsula, where its high-wing loading and lower power restricted its maneuverability. It nevertheless proved to be a capable night interdiction aircraft, using flares to illuminate potential targets along known LOCs. Lacking radar, the B-26 required visual sighting of the target to either strafe or bomb, depending on the version of B-26 in question. The crews found the standard glass-nose version to be more effective, especially when acting as its own flareship. This was due to the greater lateral offset needed to line up a strafing run than a bombing run, and the increased chance that the target would have gone to cover or have the flare burn out prior to opening fire.

US Navy fighter-bombers and attack aircraft operated from positions that were closer to the enemy than the Japanese bases used by the FEAF, and so enjoyed greater range and battlefield endurance. They became especially adept at bridge-busting, as the communications difficulties led them into semiautonomous interdiction operations. Marine fighters quickly became prized CAS assets, and the USAF received criticism during this early period of the war that the Marines were the only service that truly took CAS to heart.[92]

While the CAS and interdiction effort was spooling up, the enemy did not just sit still and take it. Reports from the early fighting show that the North Koreans were not schooled in how to deal with an enemy that owns the air and knows how to use it. Numerous debriefs described exposed columns being strafed and bombed with little return fire except from the rifles of the infantrymen being attacked. The North Koreans learned quickly, however, and were soon using countermeasures such as hiding trains in tunnels by day and building pontoon bridges to cross rivers where needed. Gaps in the rail lines were crossed by the simple expedient of unloading one train and carrying the supplies across the bombed-out portions to trains waiting on the other side. All of these countermeasures did, however, have the effect of delaying and diverting enemy supplies and troops that were badly needed at the front.

What were the operational results achieved by airpower against the North Korean army? When weighed against the stated objective of halting momentum, not complete destruction of the army or total isolation of the battlefield, the air operation must be considered successful. The Army was generally impressed with the CAS effort, and did acknowledge the affect that the interdiction campaign had on the Red forces. General MacArthur himself credited airpower with buying him the time he needed to get adequate

reinforcements into Korea to hold the Pusan Perimeter while he prepared the Inchon operation.[93]

Some hard numbers exist that point to interdiction as having had a serious effect on the North Korean army. Table 3 is reproduced from *Aerial Interdiction in Three Wars* by Eduard Mark.

Table 3

Average Supplies Received by a Representative North Korean Division, June–September 1950 (in tons)

PERIOD	FOOD	POL	ORDNANCE
25 Jun–15 Jul	18	12	166
17 Jul–15 Aug	9	7	30
16 Aug–20 Sep	2.5	2	17

Source: USAF Historical Division, "USAF Operations in the Korean Conflict," 25 June–1 November 1950, 50.

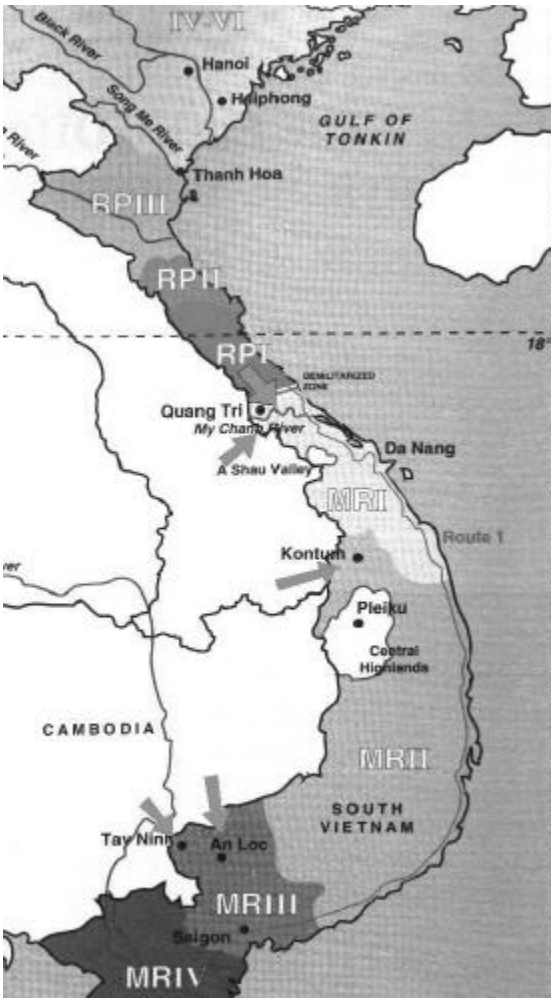
Although many factors led to the decline of resupply to the North Korean army, interdiction played a key role. By forcing the North Koreans to adopt such measures as moving only at night and dispersing their supply stores, airpower had an impact far beyond the actual numbers of vehicles destroyed and bridges dropped. One enemy prisoner stated that it took him a month to make the trip by rail from P'yongyang to the Pusan front.[94] With such delays in moving men and material to the combat area, no mechanized army can hope to maintain fighting pressure on the enemy. Even had the Inchon landing not occurred, there is ample evidence that the North Korean offensive had reached its culminating point and the enemy was going over to the defensive. As part of the larger campaign plan, airpower fitted well with the notion of bleeding the enemy while he advanced, stopping him short of pushing our forces off of the peninsula, and then counterattacking deep behind his exposed LOCs.

Halting the Easter Offensive in Military Region I, March–May 1972

By 1972 Vietnam had seen nearly continuous fighting for 30 years. After rebuilding from the military defeat, but political triumph of the Tet offensive in 1968, the Communist leaders in the North were ready to try a conventional assault aimed at knocking the few remaining US forces out of the war and securing a position for final victory over the South. While the North Vietnamese and Vietcong forces had largely fought a guerrilla war in the past, the Easter offensive would prove to be much more conventional in nature. Tanks were used in large numbers for the first time, and for the first time SAMs were brought into play in South Vietnam.[95]

The Easter offensive was a three-pronged assault aimed at Military Region (MR) I in the northernmost section of South Vietnam, the central highlands,

and the area just north of Saigon in MR III. In the attack against MR I, which this case study focuses on, the North Vietnamese used a two-sided attack from the demilitarized zone (DMZ) and Laos (map 5).[96]



Source: Center for Air Force History

Map 5. The Easter Offensive, March 1972

March 30th was the opening day of the attack that quickly developed into a crisis for the South Vietnamese forces. After several years of "Vietnamization," there was a much reduced US presence in Vietnam. Total American troop strength in Vietnam in March 1972 was 95,000, compared to 500,000 in 1969. The largest reductions had come in ground combat troops, who were now almost exclusively Army of the Republic of Vietnam (ARVN), or in some cases South Vietnamese Marines.[97] Air strength had also been reduced significantly, with the US Air Force maintaining only 76 fighters and attack aircraft in South Vietnam at the time of the attack, down from a wartime high of 350. Also available in Thailand and other Pacific bases were

another 300 USAF aircraft, as well as the carrier air groups from the USS *Hancock* and *Coral Sea*, operating off the coast of Vietnam. The South Vietnamese Air Force had also been built up by this time, and included 150 attack aircraft plus a single squadron of F-5 fighters.[98]

By 27 April all of the ARVN fire bases near the border had fallen to the enemy, and a stretch of bad weather allowed the enemy to advance on the city of Dong Ha without serious interference by airpower. The major city of Quang Tri was next to be attacked, falling to communist forces on 1 May.[99] Two events now occurred which hurt the North Vietnamese severely; one was a clear stretch of weather for the entire first week of May, the second was the replacement of the South Vietnamese regional commander with Gen Ngo Quang Truong. The clearing weather exposed the advancing North Vietnamese to heavy air attack, as the terrain in northern MR I was mostly clear of the jungle canopy that had hindered airpower in other parts of Vietnam. General Truong pulled his troops back to establish a defensive line across the My Chanh River, blocking the communist advance to their next objective, which was the city of Hue. The North Vietnamese made several attempts to force the river line, with the final push of 20 May succeeding in gaining a few crossings. By 29 May, however, the enemy had been pushed back to the north bank of the river and would remain there. In June the initiative had definitely shifted, and the North Vietnamese were eventually pushed back from the gains they had made since 30 March.[100]

General Truong changed the C^2 arrangements by moving the Direct Air Support Center for the region from Da Nang to Hue and installing it adjacent to the army corps headquarters. He also created a new Fire Support Coordination Center designed to coordinate all supporting fires from air, sea, and land.[101] The overall C^2 of airpower in Vietnam was never truly centralized, with the Navy and the heavy bombers always following a chain of command separate from that used by USAF fighter and attack units.

In response to the communist attack, US Air Force, Navy, and Marine airpower was quickly deployed to bolster the defenses of South Vietnam. Two additional aircraft carriers were on station by mid-April, and by the end of the month a total of six aircraft carriers were launching missions into the embattled south. Under Operation Constant Guard, an additional 233 USAF fighters and support aircraft were deployed into South Vietnam and Thailand, with the first units arriving as early as 3 April. Additional B-52 heavy bombers were also deployed to U-Tapao Air Base in Thailand and Andersen AFB in Guam. Eighty-four B-52s were available for missions over Vietnam in March 1972; by 23 May that number had risen to over 200. Similar increases occurred in the number of KC-135 tankers available to support the various aircraft being employed in defense of South Vietnam.[102]

By 1972 the main fighter employed by all of the US air branches was the F-4 Phantom II. The latest version in use by the USAF, the F-4E, had been fitted with a 20-mm cannon to complement the array of radar-guided and heat-seeking missiles that comprised the only armament of earlier versions. The F-4 was a true multirole fighter, being capable of flying both air

superiority and attack missions with ease. Air-to-ground ordnance employed by the F-4 and other attack aircraft in Vietnam consisted of the standard mix of rockets, GP bombs, fragmentation bombs, and napalm used in earlier conflicts. A new development in guided weapons provided pilots in Vietnam with both laser- and optically guided bombs and rockets, which proved to be revolutionary in terms of sorties required versus targets destroyed. The laser-guided bomb (LGB) proved to be the most capable and reliable type and was widely employed during the Easter offensive. First used against bridge targets, this weapon proved useful against a wide variety of targets that required a direct hit for proper weapons effects. The Vietnam-era LGB consisted of a laser seeker and steerable fins attached to standard 2,000 and 3,000 pound bombs, with a laser designator mounted on an F-4 or OV-10 to lase for the bomber. Although the number of targets destroyed per sortie more than doubled, the LGB was not a "one bomb, one kill" weapon by any means. Weather was also a problem, as neither the laser-guided nor optically guided bombs could see through an undercast.

Another innovation developed in the later stages of the Vietnam War was the Wild Weasel. The Wild Weasel dealt with enemy SAM sites, and while not a direct attack asset against the enemy ground units, it did provide a measure of air superiority that was often required for the other attack aircraft to get to their targets through enemy SAMs. By March 1972 the technique had been honed into a tactic called Iron Hand, which involved a single F-105G Wild Weasel paired with two or four F-4s. The F-105 would locate enemy radars that were transmitting through the use of sophisticated onboard detection equipment, then fire a Shrike or Standard antiradiation missile at the site. The F-4s would follow up with iron bombs or CBU to guarantee the site's destruction.[103] Iron Hand proved necessary in MR I as the Vietnamese moved SA-2s south, as well as on interdiction missions into the more heavily defended north.

Also new since the Korean War was the gunship. Originally developed by mounting several miniguns in a C-47 transport, by 1972 the USAF was flying the more advanced AC-119 and AC-130 from bases in Vietnam and Thailand. These aircraft used more sophisticated aiming devices, had some night capability, and carried heavy firepower in various caliber cannons. While not able to penetrate as heavily defended airspace as the fighter-bombers, the gunships proved to be great assets for attacking the enemy on the ground.

A new FAC aircraft was also in use by 1972, the OV-10 Bronco. Mounting twin turboprop engines, the OV-10 was far superior to the lighter O-1 and O-2 that had preceded it in Vietnam. Just as the T-6 had provided a boost for air controlled CAS in Korea, so did the OV-10 provide the airborne FAC with a better platform in Vietnam. The latest version, known as Pave Nail, carried both the long-range air to navigation (LORAN) system and a laser target designator for LGBs.[104] LORAN was also carried by many fighters and attack aircraft, giving a good capability to hit non-pinpoint targets through an undercast.

A combination of Soviet-supplied SAMs and MiG fighters denied complete air superiority over North Vietnam to US airpower, as did a lack of focus on the air superiority mission during the years before the Vietnam War. By 1972 the North Vietnamese Air Force was flying the MiG-21 Fishbed, a good close-in fighter that was difficult to destroy in the restricted rules of engagement (ROE) environment of Vietnam. When the Easter offensive began, the North Vietnamese moved several SA-2s across the DMZ into the south, along with large numbers of AAA pieces.[105] Another new threat that first appeared in April was the SA-7, a shoulder-launched heat seeking missile that was not a threat to fast-moving fighters but could shoot down either helicopters or the slower-moving attack aircraft, several of which were lost during April and May.[106]

General Truong set targeting priorities that illuminate what was expected of airpower. Priorities in order were 1) 130-mm artillery, 2) tanks, 3) smaller artillery, and 4) trucks. Since the North Vietnamese were already in close contact with the ARVN, and appeared to have plenty of supplies and ammunition available at the front, CAS and shallow interdiction took priority.[107] Deeper interdiction missions were flown, however, in an attempt to cut off supplies and weapons from the Soviet Union and China. Initially the ports used by North Vietnam to receive supplies were mined to prevent further imports, and as the North Vietnamese shifted to rail transport from China those LOCs were also targeted.[108] These operations can be thought of as "strategic interdiction," since they impacted the flow of war material into the entire country. The net effect was the same as if indigenously produced weapons had been bombed at the factory.

Interdiction was also attempted in the southern portions of North Vietnam in a more direct attempt to influence the battle in MR I. First called Operation Freedom Train, then Linebacker, these strikes targeted combat units en route to the front, vehicles carrying supplies south, and the LOCs used by each. Armed reconnaissance missions were flown to try to spot vehicles on the move, but few were seen during the first month of the offensive. This helped lead to the conclusion that the North Vietnamese attack was well-stocked and in little immediate need of resupply.[109] Losses to SAMs, AAA, and MiGs were high enough to force the diversion of many fighters to escort, Iron Hand or chaff corridor duty, thereby reducing the number of aircraft that could actually destroy enemy targets.[110]

Inside South Vietnam itself, all of the bridges north of the My Chanh were targeted after that river had become the front line. The desired goal was to slow the pace of enemy supplies and reinforcements, considered reasonable since the enemy was relying on logistics-intensive conventional mechanized warfare.[111]

Tactical results achieved by all forms of airpower seem to have been very good. The LGBs proved to be effective against tanks as well as bridges, although the majority of enemy tanks and artillery were destroyed by older unguided munitions. Even the South Vietnamese Air Force, flying older A-1s and A-37s, proved effective in destroying the enemy.[112] As a testimony to the

part played by airpower, during the months of April and May over 70 percent of the enemy tanks destroyed were killed by fixed-wing aircraft, even though the ARVN was well equipped with its own tanks and antitank weapons.[113] B-52s proved effective even at CAS missions, and in one instance on 24 May over 300 enemy soldiers were killed by B-52s supporting a South Vietnamese Marine advance.[114] Night attacks against pinpoint targets proved difficult, except for the few aircraft equipped with night attack systems such as the gunships and the Navy's A-6 Intruder. As had been the case in Korea, buddy-dropped flares were much more practical than self-illumination, but the air defenses precluded C-130 flareships from operating over much of the battlefield and denied fighters such as the F-4 any real capability to light up night targets.[115]

Coordination between FAC, fighter, and ground units was much improved over previous wars. Capabilities such as the OV-10 lasing targets for F-4 LGB droppers pushed new technology to its greatest effect, as demonstrated on one occasion when a Pave Nail FAC designated two tanks for LGB-dropping F-4s and destroyed both within three minutes of check-in by the fighters.[116] In general terms the CAS provided was the best seen yet, and both the Army and Marines praised the Air Force for responsiveness and accuracy. In fact, a problem arose with an overreliance on airpower, due to large number of air strikes available in a relatively small theater.[117]

The interdiction further north proved harder to assess and was not as successful. The initial operation to mine the harbors was very effective, being called "almost a hundred percent successful in preventing resupply of North Vietnam by sea."[118] The subsequent attempts to interdict road and rail traffic met with less success, as did attempts to stop POL from flowing into North Vietnam via pipeline from China. Roads and rail cuts proved easy enough to bypass, and the large stockpile of supplies further south did not run out prior to the North Vietnamese being pushed back. Well into May, for example, the North Vietnamese were firing artillery shells at the same rate as in March.[119] Even though the North Vietnamese exposed themselves to a much greater need for resupply by launching a conventional offensive as opposed to their earlier guerrilla campaigns, they seem to have planned far enough ahead to have an adequate logistics stockpile. What can only be imagined, however, is what might have happened had the North Vietnamese not been pushed back so quickly. If the heavy fighting had continued longer, the inroads to enemy resupply and reinforcement through deeper interdiction might have proven the decisive factor. As actually played out in the spring of 1972, however, close air support and direct enemy attack in shallow interdiction were the key uses of attack airpower.

Notes

1. Larry Addington, *The Patterns of War since the Eighteenth Century* (Bloomington: Indiana University Press, 1994), 164–67.

2. Ibid., 169.

3. Robert Frank Futrell, *Ideas, Concepts, Doctrine,* vol. 1, *Basic Thinking in the United States Air Force 1907–1960* (Maxwell AFB, Ala.: Air University Press, 1989), 23.

4. Maurer Maurer, *The U.S. Air Service in World War I*, vol. 3, *The Battle of St. Mihiel* (Maxwell AFB, Ala.: Simpson Historical Research Center, 1978–79), vi.

5. Ibid.

6. Addington, 169.

7. Maurer, 1.

8. Richard Hallion, *Strike from the Sky: The History of Battlefield Attack, 1911–1945* (Washington, D.C.: Smithsonian Institution Press, 1989), 17.

9. Maurer, 126.

10. Harold E. Hartney, *Up and at 'Em* (1940; reprint, Garden City, N.Y.: Doubleday, 1971), 206.

11. Ibid, 203–4.

12. Futrell, 22.

13. Maurer, 22.

14. Futrell, 22.

15. Ibid., 23.

16. Eduard Maximilian Mark, *Aerial Interdiction: Air Power and the Land Battle in Three American Wars* (Washington, D.C.: Center for Air Force History, 1994), 13.

17. Ibid., 11.

18. Maurer, 139.

19. Hallion, 22.

20. Maurer, 87.

21. William Mitchell, *Winged Defense: The Development and Possibilities of Modern Airpower—Economic and Military* (1925; reprint, New York: Dover Publications, 1988), 166–67.

22. Maurer, 53.

23. Ibid., 126.

24. Ibid., 567.

25. Ibid., 53.

26. Mark, 12.

27. Ibid.

28. Maurer, 672.

29. Hartney, 203.

30. Maurer, 365–66.

31. AAF Eval Bd/ETO, "Effectiveness of Air Attack against Rail Transportation in the Battle of France," 68. Quoted by Mark, 239.

32. Hallion, 206.

33. Ibid.

34. Ibid., 217.

35. Ibid., 222.

36. Ibid., 190.

37. Ibid., 225.

38. Futrell, 137–38.

39. W. A. Jacobs, "The Battle for France, 1944," *Case Studies in the Development of Close Air Support*, ed. Benjamin Cooling (Washington, D.C.: Office of Air Force History, 1990), 238–40.

40. While the USAAF came to use the P-47 primarily in the attack role and the P-51 as a long-range air superiority fighter, it is interesting to note that the 56th Fighter Group, the Eighth Air Force's only group to fly P-47s to the end of the war, scored the highest number of air-to-air kills while one of the premier P-51 groups, the 4th, scored the highest number of total kills when enemy aircraft destroyed through strafing were included. Both groups lost more of their top aces to enemy ground fire than fighters.

41. Jacobs, 255.

42. Hallion, 241.

43. Jacobs, 273–74.

44. Hallion, 201.
45. Wesley Frank Craven and James Lea Cate, eds., *The Army Air Forces in World War II*, vol. 3, *Europe: Augment V-E Day, January 1944 to May 1945* (Chicago: University of Chicago Press, 1951), 265.
46. Hallion, 202–3.
47. Craven and Cate, 260.
48. Ibid., 261.
49. Ibid., 231.
50. Ibid., 233.
51. Ibid., 234.
52. Ibid., 232–34.
53. Ibid., 236.
54. Ibid., 235–36.
55. Hallion, 223.
56. Craven and Cate, 249.
57. Dwight D. Eisenhower, *Crusade in Europe* (Garden City, N.Y.: Doubleday, 1948). As quoted in Hallion, *Strike from the Sky*, 217.
58. Hallion, 222.
59. Ibid.
60. Ibid., 226.
61. Mark, 239.
62. Ibid., 241.
63. Craven and Cate, 237.
64. Addington, 271–72.
65. Max Hastings, *The Korean War* (New York: Simon and Schuster, 1987), 80–97.
66. Addington, 272–73.
67. Allan R. Millett, "Korea, 1950–1953" *Case Studies in the Development of Close Air Support,* ed. Benjamin Cooling (Washington, D.C.: Office of Air Force History, 1990), 358.
68. Robert Frank Futrell, *The United States Air Force in Korea, 1950–1953* (Washington, D.C.: Office of Air Force History, 1983), 87.
69. Mark, 271.
70. Futrell, *The United States Air Force in Korea, 1950–1953,* 85.
71. Mark, 270–71.
72. Futrell, *The United States Air Force in Korea, 1950–1953*, 320.
73. Millett, 354.
74. Ibid., 355.
75. Futrell, *The United States Air Force in Korea, 1950–1953*, 101.
76. Ibid., 324.
77. USAF Historical Division, *U.S. Air Force Operations in the Korean Conflict, 25 Jun–1 Nov 1950*, 35. As quoted by Mark, 274.
78. Mark, 274–75.
79. Millett, 359.
80. Ibid., 349.
81. Ibid.
82. Futrell, *The United States Air Force in Korea, 1950–1953*, 40.
83. Ibid., 351.
84. Ibid., 364–65.
85. Mark, 274.
86. Millett, 358.
87. Mark, 276.
88. Ibid., 277.
89. Ibid., 277–78.
90. Ibid., 272.
91. *U.S. Air Force Operations in the Korean Conflict,* 25. As quoted by Mark, 273.
92. Millett, 367–68.
93. Futrell, *The United States Air Force in Korea, 1950–1953*, 98.

94. Mark, 283.
95. Gordon Nelson and Norm Wood, ed., "The Battle For the Skies over North Vietnam," *Air War-Vietnam* (New York: Arno Press, 1978), 100–101.
96. G. H. Turley, *The Easter Offensive, Vietnam 1972* (Novato, Calif.: Presidio, 1985), 28.
97. Nelson and Wood, 99.
98. Ibid., 110.
99. Ibid., 145–47.
100. Ibid., 156.
101. Ibid., 149.
102. Ibid., 117–27.
103. Mark, 378–79.
104. Nelson, 137.
105. Ibid., 132.
106. Ibid., 142.
107. Ibid., 149–50.
108. Mark, 375.
109. Ibid., 375–76.
110. Ibid., 378–79.
111. Nelson, 151.
112. Ibid., 154.
113. Ibid., 152.
114. Ibid., 154.
115. Mark, 385.
116. Nelson, 152.
117. John Sbrega, "Southeast Asia," *Case Studies in the Development of Close Air Support*, ed. Benjamin Cooling (Washington, D.C.: Office of Air Force History, 1990), 470.
118. Melvin Porter, *Linebacker: Overview of the First 120 Days* (Project CHECO, 7AF DOA, 27 September 1973), 14–15. As quoted by Mark, 375.
119. Mark, 380.

Chapter 6

An Analysis Framework for Counterland Operations

Power is not revealed by striking hard or often, but by striking true.

—Honoré de Balzac

Now that we have examined the operational and tactical aspects of ground attack, and briefly reviewed some historical applications, a framework can be constructed to assist the airpower planner in his task. This framework is a simple guideline, and there are exceptions to every rule. It does, however, expose the airpower strategist or student to the key considerations for using airpower to destroy, disrupt, delay, divert, or demoralize enemy ground units.

Objectives

As all good planners are taught, we must begin with national level objectives, develop a national strategy to support those objectives, and work our way down through congruent military and theater objectives and strategies. For the purposes of this work, those processes are assumed to have happened at higher levels than that of the operational airpower planner. We start with the theater commander's objectives and strategy, using those to develop an air operation plan that best supports them. The theater operation may move through several campaigns or phases, and the air objectives and strategy will likely need to shift over time as well. Planning factors such as enemy centers of gravity (COG) and decisive points can change as the enemy adapts to the fighting, or new intelligence comes to light. Sometimes simply studying enemy patterns brings unseen weaknesses into focus, which can then be exploited. Whenever the enemy strategy can be determined, there is a good chance of finding a vulnerable point within that strategy.

When the objective is to destroy the enemy army, both air and ground commanders need to keep that objective in mind. Just as the airman must acknowledge that there are times when air interdiction takes a backseat to CAS, the soldier must realize that with modern airpower, the destruction of an enemy army does not always involve ground combat, and when ground combat is involved it may be only in a supporting role. The true key is to concentrate our combat power against the enemy, through whatever means allow us to do so.

Air-Land Coordination

Although the air and land operational plans hopefully grow from the same overall strategy, there is a need for continuous updates as the conflict progresses. The JFACC should use his ground liaison officers extensively to keep up with changes to the ground scheme of maneuver. Known as the Battlefield Coordination Detachment, this group of surface officers is permanently assigned to the air operations center for the duration of the fighting to ensure coordination.[1] A useful tool is the Joint Targeting Review Board, which can act as a targeting oversight committee to ensure that the overall strategy doesn't get lost in the weeds of the air tasking order. Another important task performed at high level is the apportionment, which divides the available air assets according to various methods such as priority of effort or percentage of mission type. This process, if done well, will provide the best mix of airpower missions to support the commander's plan.

Just as ground commanders like to speak of airpower support of surface forces, there may be situations where our ground units act as holding forces to keep the enemy immobilized while airpower provides the primary killing effect. For this type of operation, perhaps to be known in the future as "close ground support," coordination between forces is just as vital as when performing CAS. Likewise, the threat of our own ground units may force the enemy to deploy his own forces forward, exposing them to destructive air attack. Finally, our advancing ground forces may put the enemy into full retreat, where he is also exposed to air attack. All of the above were demonstrated during Desert Storm, where airpower often acted as the primary killing mechanism.

As a continuing process, the coordination of air and surface components is required for true combined arms effects. Timely updates to the FLOT and FSCL are required for smooth operation, as well as realistic assessments of where airpower can do the most good. Airpower effects are best used when concentrated at a few key points; modern PGMs allow high kill rates and a differentiation between concentration of air combat power and concentration of air combat forces.

Another result of this coordination will be a better feel by the air commander for where and when air superiority will be required, and how he should best use his assets for the various missions they are tasked for. If a ground operation appears to be threatened by enemy air action, this information should of course be made known to all players as soon as possible.

The bottom line is that each component must develop its overall strategy in concert with the others. The true goal is for a single, unified strategy to be developed, from which all of the desired operational effects for air, land, sea, and space forces can be derived.

Desired Operational Effects

Once the air, land, and overall strategies have been properly coordinated, the next task is to identify the specific operational effects to be achieved

through ground attack. Quality intelligence becomes extremely important at this level, and remains so throughout the rest of the process.

This is the point to look hard at which of the four Ds will best achieve the operational objectives. If the goal is maximum isolation of the battlefield, then disrupting second echelon forces, or delaying/diverting them through LOC attack, may be best. Under these conditions we should focus on removing the enemy's excess transportation capability, and straining what he has left through increased consumption. If we need maximum concentration at the front line to achieve a breakthrough, CAS against front line enemy combat forces may be called for. If the ground war will not be starting for a while, we may have the opportunity to cut off the flow of supplies to the enemy's front lines, which can result in both physical and morale disruption. If conditions are right, there may even be a shot at the "brass ring" of airpower, namely stopping the enemy before the ground war begins. We should emphasize that conditions such as enemy vulnerability and limited LOCs must be right for such an outcome, and history shows that stopping an enemy army solely through the use of airpower can be difficult.

The key to all of these choices is to look first at what part of the enemy army we wish to affect, then determine what is critical to the operation or survival of that part. These critical nodes, or what some would call operational or tactical COG, represent ways in which airpower can achieve cascading effects throughout the enemy army by only attacking a few vital areas.

A consideration to keep in mind is whether the desired effects are first, second, or third order. Remembering that higher-level effects are less predictable, we must balance expected results with the chances for large payoffs. A realistic assessment must also be made of the expected effects our available assets can provide, given that the next war will be fought with fewer forces than the last.

Time and tempo must also be considered. If we know the expected timetable of the overall operation, we can plan for when the desired effects must manifest themselves, and how long they must last.

As the campaign develops, we must perform critical combat assessment to see if our desired effects are indeed occurring. Knowing that the enemy will probably react to our attacks, we must not give up if our metrics for success are not met at first. We must have a series of branch plans, however, with adequate signposts to tell us when the time has come to modify the operation. Developing concepts such as using JSTARS to provide real-time interdiction targeting will result in added flexibility against a highly reactive enemy, as well as some of the drawbacks of nonpreplanned missions.

Vulnerability

Once the critical target set or sets have been identified, we must look specifically at matching target vulnerability with weapon lethality. This process normally occurs at the targeting cell, or occasionally at the individual

unit mission planning cell. As munitions are expended over the course of a campaign, some targets may become harder to attack due to lack of suitable weapons; good logistics planning may be able to prevent this by keeping the proper stocks available in the bomb dumps.

Just as the enemy will react and try to cancel out some of our operational effects, we can expect him to find ways to reduce the vulnerability of key targets. Hardening, dispersion, camouflage, and increased mobility are all possible actions the enemy may take. Against a smart foe, we ought to plan on a certain reduction in enemy vulnerability as the campaign progresses.

Targeting

The final step in the process is actually flying the missions and hitting the targets. Although this is where the air medals are won, it is only the last step in an important chain of events. One hundred percent destruction of an improper target is just a waste of fuel and bombs, and leads to Ian Lesser's "efficient ineffectiveness."

Feedback, in the form of tactical BDA, is critical. A good way to determine whether the enemy is reacting is by analyzing combat reports. If our aircrews are reporting increased difficulty in finding known targets, or we are seeing less evidence of penetration and secondary explosions, the enemy may be dispersing or hardening the targets. Likewise, large-scale sightings of enemy units moving in the open may mean the enemy ground situation is becoming desperate and are willing to accept increased losses.

Assessment

Assessment begins during the actual mission, with observed results of the attack and enemy activity, and continues up through theaterwide analysis of what the attacks have done to the enemy. Numerous resources are brought into this analysis, from cockpit video to satellite imagery and media coverage. As operational-level results begin to emerge, recommendations can be made to the commander for strategy adjustment to better meet the desired objectives. Throughout the process, analysts should remain alert for possible reaction and adjustment by the enemy. Honest assessment is critical to success. Any operation can devise a set of measurements that show it is succeeding, right up to the day the war is lost (fig. 5).

Conclusion

As the tactics and technology of ground attack have developed, so has the enemy's ability to adapt and overcome. In general terms, however, the various sanctuaries of the ground enemy have been disappearing, with the result that interdiction and CAS have become more disruptive to the enemy. As new methods of detecting, identifying, and relaying information about the enemy mature, enemy vehicles and combat forces are becoming more viable as direct

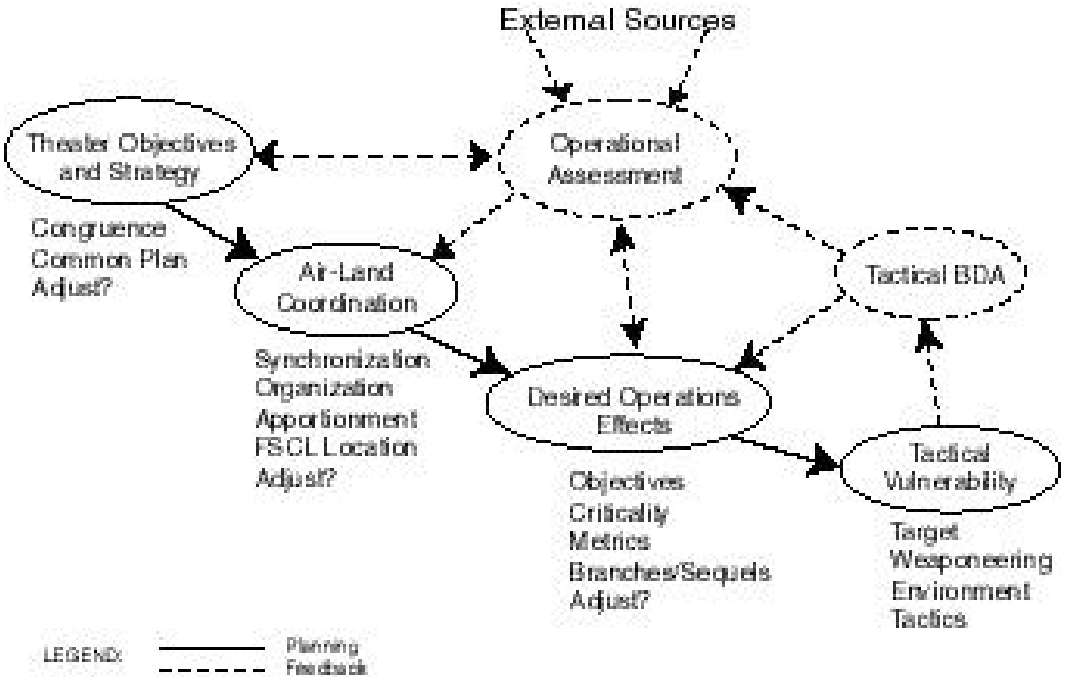


Figure 5. Counterland Analysis Framework

targets. We are becoming less reliant on the secondary and tertiary effects of hitting fixed infrastructure, which means ground attack results are becoming more predictable and targeting decisions can be made in near real time. Planners should not become too enamored with direct attack as the only solution, however, as other targets or target sets may better leverage the limited air assets available. The entire enemy army and supporting infrastructure must still be analyzed for potential critical areas, wherever they may be.

Just as a pilot is allowed to deviate from the checklist if an emergency requires it, no planner should expect success from always following a "cookbook" approach. This type of analysis framework lays out the basics that normally apply whenever airpower is used against an enemy field army. In an actual conflict there would be a host of specific contextual factors to account for, as well as reams of classified analysis and targeting tools that cannot be presented here. The foundation of counterland attack has been covered, however, I would like to close by reminding the reader that a flexible strategy is perhaps second only in importance to good intelligence about the enemy.

Notes

1. Previously known as the battlefield coordination element, the name was changed to highlight the expanded role for this body to coordinate air and surface operations.