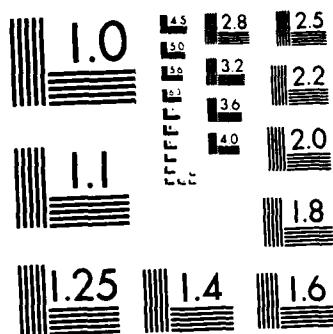


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Apportionment and Tactical Airpower in AirLand Battle--
An Evaluation of CAS, BAI and AI from an Operational Perspective

by

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<p>This monograph examines the relative effectiveness of three key Air Force ground support missions: Close Air Support (CAS), Battlefield Air Interdiction (BAI), and Air Interdiction (AI). The costs and benefits associated with each mission are examined in light of the mission's ability to influence the outcome of major operations and campaigns rather than local tactical engagements.</p> <p>The various missions are examined with respect to their ability to disrupt enemy operations by delaying, diverting, and destroying forces. They are also evaluated in light of the degree to which they complement or supplement ground force power.</p> <p>The study concludes that while there are no fixed rules to govern apportionment decisions, there appear to be some basic principles which (continued)</p>				
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ABSTRACT

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This monograph examines the relative effectiveness of three key Air Force ground support missions: Close Air Support (CAS), Battlefield Air Interdiction (BAI), and Air Interdiction (AI). The costs and benefits associated with each mission are examined in light of the mission's ability to influence the outcome of major operations and campaigns rather than local tactical engagements.

The various missions are examined with respect to their ability to disrupt enemy operations by delaying, diverting, and destroying forces. They are also evaluated in light of the degree to which they complement or supplement ground force power.

The study concludes that while there are no fixed rules to govern apportionment decisions, there appear to be some basic principles which one can apply to the apportionment process regarding the relative utility of the three stated missions.

APPORTIONMENT AND TACTICAL AIRPOWER IN AIRLAND BATTLE--
AN EVALUATION OF CAS, BAI AND AI FROM AN OPERATIONAL PERSPECTIVE

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INTRODUCTION

FM100-5, the U.S. Army's keystone doctrinal manual, reduces operational art to three basic functions. They are: (1) defining the military condition to be produced to achieve strategic goals; (2) determining the sequence of actions required to achieve that defined military condition; and (3) determining how best to apply available resources to achieve the desired military condition.¹ The manual further explains that in applying available resources operational planners will be required to make decisions affecting the employment of air as well as ground forces. Indeed, as the manual states, the Army's fighting doctrine "is called AirLand Battle in recognition of the inherently three-dimensional nature of modern warfare"² This doctrine recognizes the fact that at the operational level land and air battles are mutually supporting, inseparable elements of the theater commander's effort to achieve operational objectives. Indeed, AirLand Battle doctrine is built upon the assumption that "all ground actions above the level of the smallest engagements will be strongly affected by the supporting air operations of one or both combatants."³

Through the apportionment of air assets operational level planners determine how a significant--perhaps decisive--portion of a theater's combat power will be applied. In order to apply that combat power most effectively, planners must bring to the apportionment process an educated judgment built upon a solid appreciation of how the various Air Force missions serve to complement the power of ground forces. This appreciation, in turn, must include a thorough understanding of the capabilities and limitations of three of the basic "ground support" missions: Air Interdiction (AI), Battlefield Air Interdiction (BAI), and Close Air Support (CAS).

When making apportionment decisions, planners will probably be working in an environment marked by a limited amount of air resources and an unlimited number of mission requirements. In this situation apportionment decisions will be made with the knowledge that, given limited air assets, a sortie flown in one category of operations is one less sortie available for another category. For example, insofar as aircraft are multi-role, BAI applications come at the expense of CAS and AI. Therefore, operational planners seek to employ the limited air assets available in a manner that achieves maximum effect from every sortie flown.

In seeking the most effective employment of available air resources, planners must examine the relative merits--costs and benefits--inherent in the various mission categories. At the operational level the merits of each mission category are weighed in terms of influencing the outcome of major operations rather than individual tactical engagements and battles; for it is on the basis of desired operational rather than tactical results that the planner makes his apportionment decisions.

This paper aims to examine the relative operational merits of the three tactical air missions previously listed. Based on this examination, the paper aims to provide some of the appreciation required for making apportionment recommendations and decisions based on an educated judgment.

This paper will analyze each mission in light of its capacity for thwarting the enemy's ability to conduct operations and facilitating the conduct of friendly operations. Each mission will be analyzed in terms of what it might be expected to produce. It will also be appraised based on historical experience and proven performance. From this analysis conclusions will be put forth regarding the employment of the various categories of air missions in supporting the attainment of operational objectives.

This study does not examine the utility of the three listed air missions throughout the spectrum of conflict. It is primarily designed to examine the impact of the stated mission categories in a mid-to-high intensity conflict between relatively modern forces. The study is not designed to address the use of airpower in a low intensity environment.

THE ROLE OF AIRPOWER

As Clausewitz observed, in war "one has to see the whole before seeing each of its parts."⁴ In this study the whole is the role of tactical air operations at large and the manner in which they influence ground operations. Each part is the individual mission category: BAI, AI, CAS. We must begin, therefore, with a brief examination of the 'Air' in AirLand Battle.

The first point to be considered in analyzing the role of airpower in AirLand Battle is its function. Just what is tactical airpower supposed to do? FM100-5 states that the paramount "consideration in employing air forces is gaining and maintaining the freedom of action to conduct operations against the enemy."⁵ Air Force Regulation 23-10 offers a somewhat more detailed description by explaining that tactical air operations involve

the employment of tactical air power..to..gain and maintain air superiority...inhibit movement of enemy forces...seek out and destroy enemy forces and their supporting installations...[and] directly assist ground or naval forces to achieve their immediate operational objectives.⁶

Friendly air forces help gain and maintain freedom of action by reducing the effectiveness of the enemy's ground and air forces. They achieve this reduction in effectiveness by restricting the amount of force the enemy can bring to bear in any given engagement or battle, and by attacking enemy forces in contact. In essence, airpower disrupts the enemy's ability to conduct operations.

If the 'whole' of tactical airpower is disruption, the 'parts' are diversion, delay, and destruction. Airpower disrupts an enemy's operations by diverting valuable resources from critical points on the battlefield--in terms of both time and space. It also disrupts operations by delaying the arrival of men and materiel that are critical to sustaining operations. Lastly, airpower contributes to the disruption of enemy operations by destroying the sources of the enemy's combat power. This destruction may be aimed at those systems that directly apply combat power or those systems that command, control, and sustain the continued application of combat power.

In supporting ground operations, airpower may be used in one of three ways. It may be used in a fashion that magnifies the power of the ground forces it supports, i.e. in a supplementary fashion. It may be used in a way that expands the power of ground forces, i.e. in a complementary fashion; or it may be used in a fashion that offers some combination of supplementary and complementary effects. To understand the difference between these concepts one must understand the important difference between the terms supplementary and complementary.

SUPPLEMENTARY...means increasing the effect of one weapons system or arm with the similar effects of other weapons and arms. For example, the effects of mortars and artillery may reinforce or supplement each other in an integrated fire plan. Engineers may enhance the protection of armored vehicles by digging in those vehicles with engineer equipment.

COMPLEMENTARY...arms, by contrast, have different effects or characteristics, so that together they pose a more complicated threat, a dilemma for the enemy. The defender may place a minefield so that it halts an enemy force at a point where observed artillery or antitank fires can attack that enemy as he clears the minefield. The defender has thus integrated the different weapons to provide a much greater effect than any one by itself could achieve.

When used in a supplementary manner airpower adds to the combat power of the forces being supported. It simply makes ground forces more powerful ground forces. It does not expand the capabilities of those forces, it only reinforces the capabilities already present.

When used in a complementary manner airpower multiplies and extends the combat power of the forces being supported. It does so by bringing to the battle capabilities which ground forces do not possess and exploiting the characteristics unique to air forces. Complementary airpower serves to combine with groundpower to offer the joint force commander an air-ground system with capabilities that neither ground nor air forces alone possess.

Ideally, then, air power should be used to complement ground power to accomplish theater objectives. Using airpower in a role that supplements ground power should be the occasional exception.

To measure the relative merits of a given category of air mission this paper will use four primary standards, namely: diversion, delay, destruction, and finally disruption. Mission categories will also be examined in light of the manner in which they complement rather than supplement ground power.

THE MISSIONS

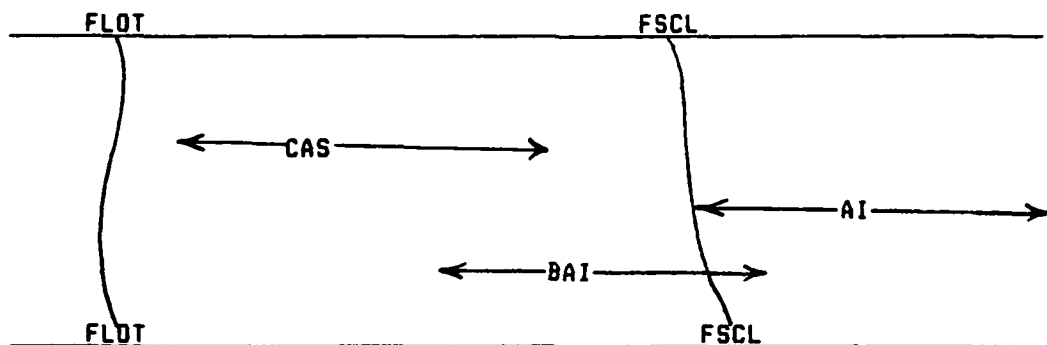
An examination of the relative merits of the three stated mission categories must necessarily begin with a definition of those missions. FM 101-5-1 provides an official definition of all three:

AIR INTERDICTION--Air operations conducted to destroy, neutralize, or delay the enemy's military potential before it can be brought to bear effectively against friendly forces. It is conducted at such distances from friendly forces that detailed integration of each air mission with the fire and movement of friendly forces is not required.

BATTLEFIELD AIR INTERDICTION--Air action against hostile surface targets which are in a position to directly affect friendly forces and which requires joint planning and direct coordination. While BAI requires coordination in joint planning, continuous coordination may not be required during the execution stage.

CLOSE AIR SUPPORT--Air action against hostile targets that are in close proximity to friendly forces and that requires detailed integration of each air mission with the fire and movement of those forces.

Figure 1 illustrates the relationship between these three missions and ground formations.



	CAS	BAI	AI
TARGET	Directly affecting friendly operations		Indirect bearing on friendly opns
AREA	In contact or close proximity to friendly forces	Either side of FSCL but not w/in close proximity of friendly forces	Beyond FSCL
COORDINATION REQUIRED	Detailed integration with fire & maneuver of friendly forces	Joint planning/coordination	
		At corps level	Above corps level
CONTROL	Positive or Procedural	No control required	

FIGURE 1

Source: Allied Tactical Publication-27 (B), p. 2-6

The two distinguishing characteristics associated with each mission are category are distance from engaged forces and timeliness of effects.

As stated, CAS is flown in close proximity to friendly forces. While there is no fixed distance from friendly forces at which CAS becomes BAI, many consider the outer limit of CAS to be the direct fire range of the unit receiving the support. Some consider CAS to be any action directed against targets visible to the unit being supported. Others say that air operations flown close enough to the FLOT to put friendly troops at risk in the event of a mistake--hence the requirement for detailed integration--qualify as CAS.

Since CAS is flown to support engaged units, its effects are expected to near term. It is expected immediately to influence the outcome of an engagement.

BAI is flown against those targets which are operating on the battlefield but have not yet closed to such a distance that they can become engaged in fighting. It is normally flown beyond the range of CAS and is flown out to both sides of the corps established Fire Support Coordination Line (FSCL).

Because BAI is flown against targets which are 'in a position' to affect friendly forces, effects achieved will not be felt as immediately as those of CAS. While BAI does not affect the immediate outcome of local engagements, it does, in the near term, influence the outcome of large engagements and battles. Essentially BAI affects the fortunes of enemy units already arrived (or arriving) on the battlefield but not yet engaged.

Whereas BAI is designed to hinder the movement of forces within the battlefield AI is designed to hinder the movement of forces to the battlefield. Hence it is normally flown beyond the limits of corps areas of responsibility. Traditionally, the FSCL has been used to define the minimum limits of AI. It has no maximum limits in terms of distance.

Because AI is flown against resources which are not yet in the area of operations, it influences the battle indirectly. Because of its indirect

nature, its effects are not immediately felt. Often times the results of effective AI operations are not felt until weeks or months later.

DIVERSION

Air power causes the enemy to divert critical resources away from the battlefield by threatening vital assets that lie outside the area of immediate operations. The results of operations designed to divert enemy combat power may be seen in many forms. For example, diversion may take the form of moving anti-aircraft assets away from the front lines or it may result in a shift of industrial priorities from tanks to interceptor aircraft.

Operationally significant diversion is a benefit associated almost exclusively with interdiction operations. Specifically, diverting a significant amount of actual or potential combat power is brought about principally through AI operations, although BAI can achieve a lesser, principally tactical, effect.

In World War II one of the most significant results of AI operations against Germany was the requirement for enemy resources to be diverted from the 'front line' battle to protect critical installations such as industrial centers, fuel facilities, and transportation systems from aerial attack. This diversion of resources was expressed in a variety of ways.

The ability to strike at critical elements of Germany's war making effort caused the enemy to devote more industrial output towards air defense than he would have had there been no serious air threat to those to those vital systems. The allied bomber offensive against transportation centers, military industries, fuel depots, and power plants required the Germans to produce and use 20,000 flak guns that could otherwise have been used as anti-tank guns.⁹ Had one half or even one quarter of those 20,000 guns been available to German forces defending against the Normandy invasion or in the

attack through the Ardennes the outcome of those battles might well have been decidedly different.

Not only did AI operations divert industrial resources, they diverted ammunition, men and critical supplies. Every round of ammunition fired at an aircraft attacking a rail center in the enemy's rear was one that couldn't be fired in the area of operations of ground forces. Every individual required to man an air defense system protecting a rail junction or fuel depot was one more man who wasn't available in the forward combat zone. Again, the German experience in World War II testifies to the ability of effective AI operations to divert valuable resources from the front lines. As Albert Speer explained

...we had to keep a million men at home to defend against [allied air strikes].... Other thousands of people were required as fire fighters and to repair damaged factories. Those men and munitions could have provided another 60 divisions for use against Russia or to oppose your invasion in France.¹⁰

Other sources are more conservative than Speer in their estimates of forces diverted to deal with allied bombing. However, even the more conservative of these place figures of diverted troops in the hundreds of thousands.¹¹

Similar diversions were noted in Vietnam where labor forces devoted to the maintenance and repair of North Vietnamese road and rail systems included an estimated 500,000 troops and militia. Another 175,000 were dedicated to the country's air defense system. These were troops who could very well have been in combat units if not diverted to these other tasks.¹²

While a significant portion of these results were brought about by strategic bombing, tactical air forces played a crucial role in diversion operations. In World War II, Korea, and Vietnam tactical air power was used not only to reinforce the damage inflicted by strategic bombing, but also in many cases as the principal means of conducting AI--especially in Korea and Vietnam.¹³

Even in short wars AI operations have demonstrated a capacity for diverting large amounts of combat power away from the battlefield. In the Yom Kippur War of 1973, the Israelis used AI to force the Syrians to divert vital defenses away from the Golan heights to protect against Israeli air raids being flown deep into Syrian territory.

Two days after the outbreak of hostilities, the Israeli Air Force (IAF) began conducting large air raids against oil storage tanks, electric power stations, oil terminals, and critical defense installations including the Syrian Ministry of Defense. "The purpose of these raids was to...force the Syrians to redistribute their air defense assets."¹⁴ As these strikes became larger and more damaging, the Syrians were forced to divert badly needed air defenses away from the battles on the Golan Heights. Thus, by diverting air defense assets away from the battlefield, the Israelis were better able to establish control of the battlefield both in the air and on the ground.¹⁵

Except in rare circumstances, BAI and CAS do not divert significant amounts of combat power from its intended use. The reason for this is quite obvious. Since BAI and CAS are flown in the combat zone, they offer little opportunity for diverting, indeed they are not designed to divert, forces away from the battlefield.

Using air forces to divert essential enemy resources away from the battlefield clearly illustrates the concept of using air power to complement ground power. By successfully attacking important targets well to the rear of the front line battle, AI visibly poses to the enemy the complicated threat, the dilemma, that is the hallmark of complementary operations. The enemy must either divert resources away from the front to counter the threat to his vital installations, thereby detracting from the amount of force available to the combat zone, or he must accept the damage inflicted on those installations.

DELAY

Air power influences ground operations by delaying the timely arrival of critical forces and resources at the points on the battlefield where they are needed. By delaying the arrival of a particular force, air power can greatly hinder the ability to reinforce success or stave off failure.

The ability of air forces to delay the movement and distribution of vital resources has proven to be of decisive importance both operationally and tactically ever since World War II.

One unidentified German commander testified to just how decisively airpower delayed efforts to move reinforcements to the Normandy beachhead in the Germans' desperate attempt to defeat the Allies' invasion of Europe.:

The tanks of one division left Abbeville by rail on 9 June intending to make the trip to the front by way of Paris. The locomotives were hit so many times by Allied fighter-bombers that the tanks finally had to finish the journey by road. It was not until 18 June that 80 of the 120 tanks that originally started finally limped into the line around Caumont, having taken almost ten days to travel about 300 miles.¹⁶

The commanding General of the 116th Panzer Division offers another account of the decisiveness of the air force's ability to impede the timely movement of forces:

...The superior enemy air force paralyzed every movement on the battlefield, especially those of the tanks. This...decisively delayed any quick shifting and transfer of reserves to the point of attack..¹⁷

Field Marshal Von Rundstedt, commander in chief of German forces in the West, noted that delays caused by the destruction of several key bridges "devastatingly contributed to the halting of the Ardennes offensive."¹⁸

A.A. Sidorenko eloquently testifies to the ability to defeat Soviet type offensives by delaying the arrival of the second echelon. According to Sidorenko, the Soviets learned in the Great Patriotic War that

...second echelons were the basic means of exploiting success and conducting an attack at high rates and to a great depth. Where they were weak or were not committed in time,¹⁹ the attack developed not only slowly, but even died down. (emphasis added)

In the Korean War a massive interdiction effort forced communist forces to limit any large scale movement of men and materiel to night. This greatly cut the ability of both the North Koreans and Chinese to resupply and reconstitute those units involved in the major offensives of June, 1950 and the winter of 1950-51. In analyzing the Chinese attack across the Yalu, one study concludes that "the constant attacks on the communist supply system and the requirement to move at night over secondary roads..forced the enemy attack to falter."²⁰

Similarly decisive interruptions in the timely delivery of fuel and ammunition to Syrian forces were noted by UN observers on the Golan Heights in the 1973 Yom Kippur War.²¹

Most analysts agree that the ability to delay the arrival of follow-on forces and materiel will be even more important in future conflicts than they have been in the past. As Air Vice Marshal M.J. Armitage noted, "the rapid movement forward of enemy reinforcements and second echelon formations is likely to be far more important to the advance than in any previous war."²²

In seeking to delay an enemy's follow-on effort one should, ideally, attack the enemy's transportation system throughout the depths of both the combat and communications zones. In war, however, the ideal tends to be the exception rather than the rule. Given a limited amount of air resources and a nearly unlimited number of requirements for airpower, operational planners will be required to determine which air operations offer the greatest delay per sortie flown. In seeking to retard the movement of forces and supplies, planners will often be forced to chose between one or more of the various air missions simply because there aren't enough resources to conduct delay operations as completely as desired.

In seeking to delay the arrival of enemy resources at a critical point one may rule out CAS altogether. The reasoning is quite simple. By virtue of the fact that CAS is flown against those forces already engaged in battle their arrival cannot be delayed. They are already home. Delay lies, therefore, in the realm of AI and BAI.

To evaluate the ability of a given mission category to inflict delay on the enemy, one must first determine what causes delay. One causes delay by reducing the enemy's ability to transport a given commodity over a given distance. This reduction in transportation capability is caused by damaging either one or both of the two critical elements of a delivery system--the transportation network itself or the instruments that use it.

One can damage the transportation network itself by attacking road bridges, railroad bridges, rail switching terminals, airfields, highway choke points, etc. One can damage the instruments that use the transportation system by attacking highway convoys, trains and locomotives, transport aircraft, barges and ships, etc.

To determine which air mission offers the greatest opportunity for effectively delaying the enemy, one must understand the relationship between the two stated elements of a transportation system and the distance from the FEBA at which these elements are attacked.

To determine whether AI or BAI yields the most effective delay one must examine the quality of the transportation infrastructure over which the enemy moves his forces and supplies. If the infrastructure is well developed and the enemy's transportation options are plentiful, BAI probably offers the best chance of delaying the foe. If, however, the transportation is relatively primitive and the enemy's transportation options are limited, AI probably pays the greatest dividends.

Figure 2 illustrates how, in a theater with a well developed transportation system, one's movement options narrow as he moves closer to the FEBA.

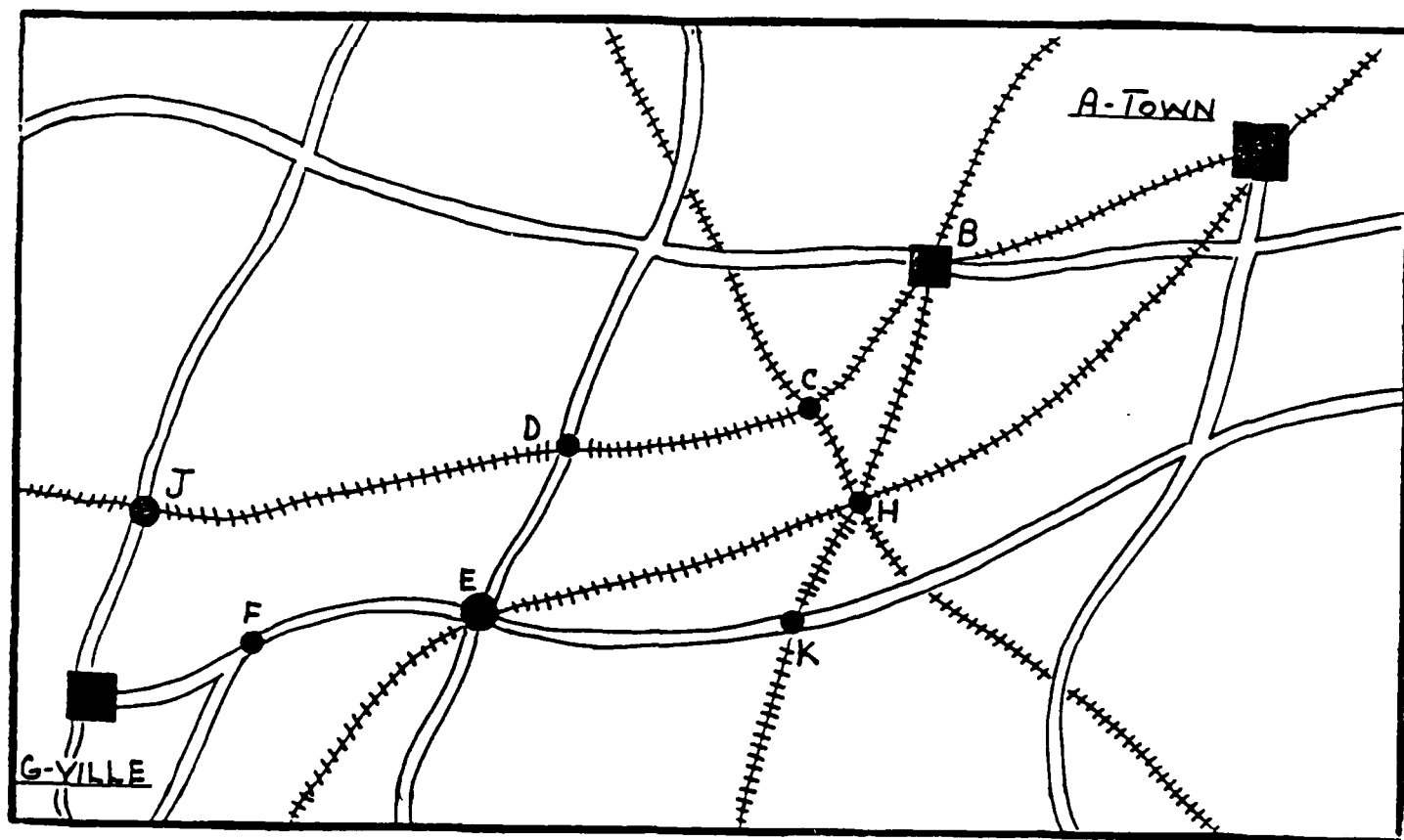


FIGURE 2

Assume that the enemy wishes to move a given force or quantity of supplies from A-Town to X-ville. Between A-town and the RIPL, the enemy has 13 different routes/combinations of transportation modes available to him. If one particular junction gets knocked out he can still bypass it with relative ease. For example, if the enemy had planned on moving by rail from A-to-B-to-C-to-D and by road from D-to-E-to-F-to-G, and C gets destroyed he can switch to any one of 10 alternative routes and continue movement by either rail or road.

Notice, however, that the number of routes available to him decreases as he approaches his destination. Once he passes E he must either go through F to get to his final destination, X-ville, or take a long detour which involves not only an increased travel time but the inevitable delays associated with moving in and out of adjacent units' areas and transportation networks. Given this situation, it is evident that attacking the enemy while he is in the BAI bracket would be more effective and more efficient than attacking him at ranges normally associated with AI. Graphically, the opportunity to delay an enemy in a theater of this nature may be represented as shown in figure 3.

LTC Steven Canby reflected the thoughts of some analysts when he concluded that "the difficulty of blocking a dense transport net" with AI operations using conventional munitions is so great that it will impose only insignificant extra costs and delays to an attacking force.²³

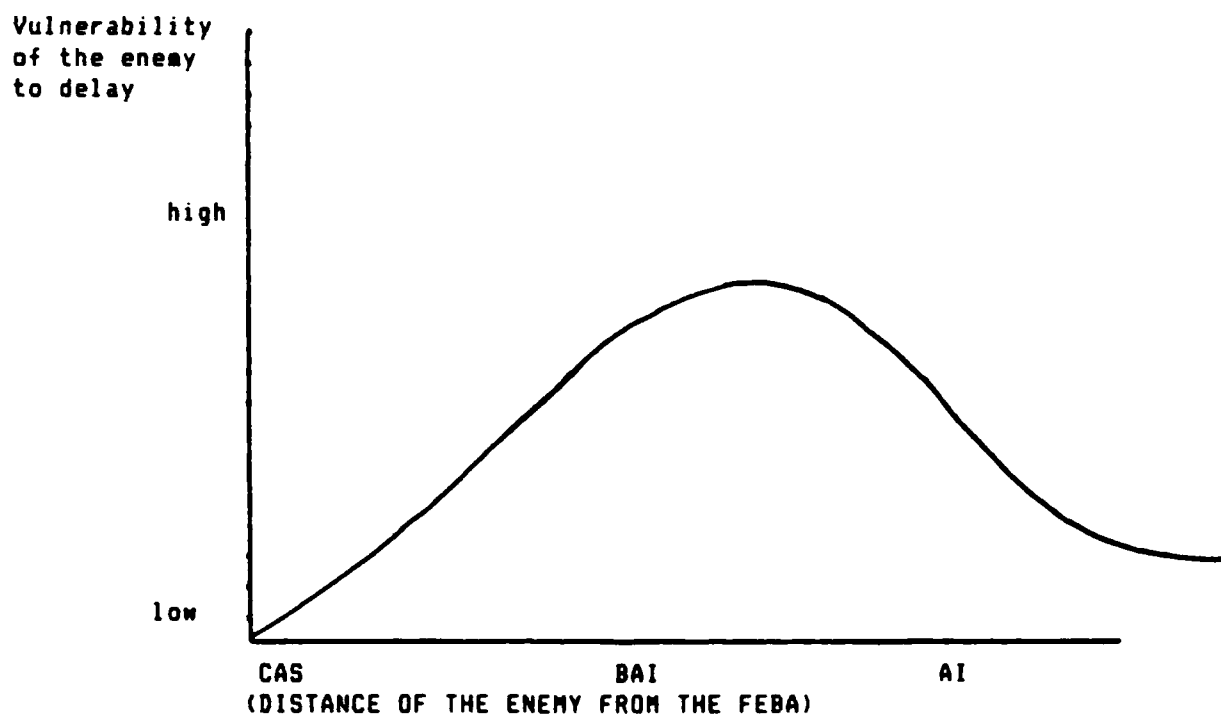


FIGURE 3

As shown in Figure 4, in a theater with a very limited transportation network routing options are few throughout the theater and do not tend to decrease significantly as one approaches his destination.

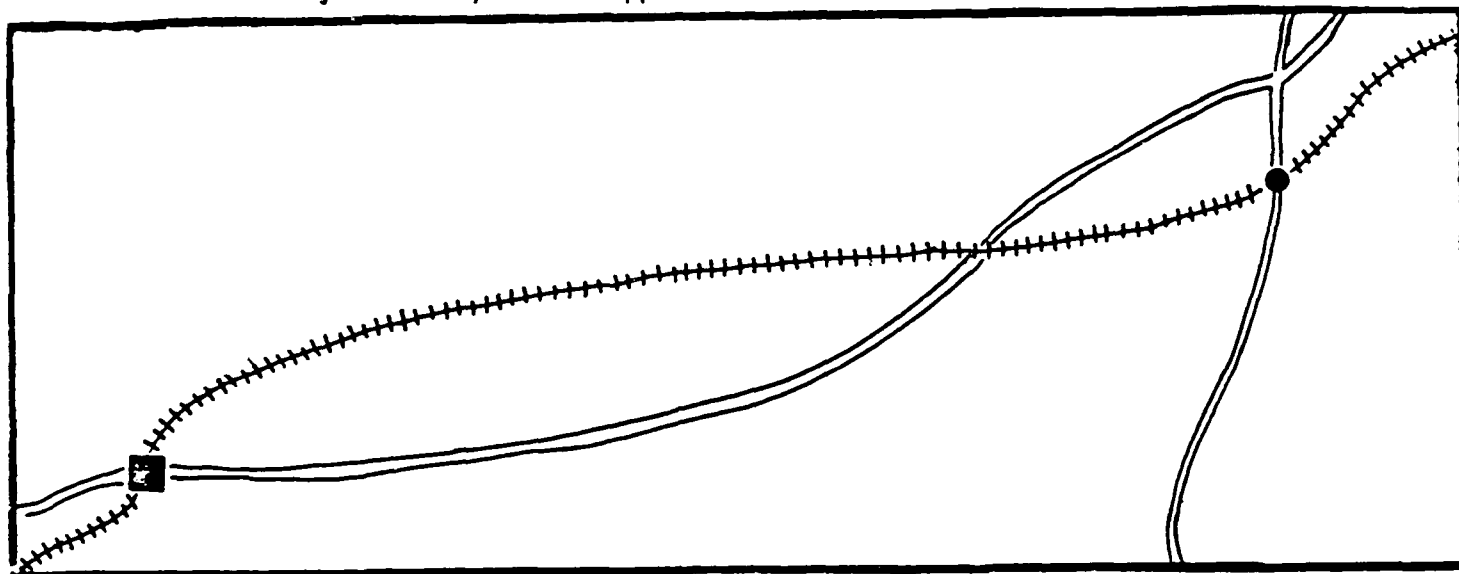


FIGURE 4

The German Army recognized this early on in the 1941 Summer offensive against Russia. Hence, deep interdiction was to be the preferred use of airpower. According to General der Fleiger Paul Deichmann, "the German command realized at an early stage that during large-scale army operations [in the Soviet Union]....air action to prevent enemy movements to the front represented a highly effective means to influence the course of combat operations."²⁴ The Germans quickly realized that, given the near primitive nature of the Soviet's transportation network, AI operations could delay the arrival of supplies and forces almost indefinitely.²⁵

Similarly, the British RAF was able to use AI very effectively in preventing Rommel from bringing desperately needed resources into the battle in North Africa because Axis forces were tied to their base of support by a single, vulnerable supply route. Consequently, any damage done to that route anywhere in the theater could be bypassed only with great difficulty.²⁶

Given the evidence, one may conclude that the sophistication of the enemy's transportation system is a factor of paramount importance when selecting a mission category for delaying the enemy. One may state roughly that as the transportation network supporting the enemy improves, the capacity of AI operations to effectively delay him declines and the importance of BAI operations increases. Again, CAS may be excluded from consideration altogether.

DESTRUCTION

When reduced to the most basic level airpower influences a battle by destroying things. It delays movement by destroying bridges and locomotives. It causes assets to be diverted from the battlefield by destroying critical installations. It disrupts the enemy's ability to sustain his efforts by destroying command and control elements, supply columns, and troop trains. It achieves air superiority by destroying aircraft and airfield facilities. In the final analysis airpower gains its ability to influence the fight by destroying or threatening the destruction of things and people.

To determine which of the three missions--CAS, BAI, or AI--should be used to destroy the enemy's forces the following criteria will be used: efficiency and proficiency.

EFFICIENCY

The efficiency of any operation may be determined simply by comparing the costs and gains associated with it. In the case of efficiency, the gain is simply the number of enemy--people, tanks, supply trucks, armored fighting vehicles, etc.--destroyed. The costs may be measured in two currencies; sorties flown and aircraft lost.

The enemy's susceptibility to destruction by air depends largely on two factors: (1) his posture at the time of the air attack, and (2) the ease with

which friendly aircraft can engage the target. The first factor, target posture, depends largely on distance from the FEBA.

It may be considered axiomatic that as a target array becomes denser it becomes more vulnerable. Indeed, dispersion is considered to be an absolute requirement for survival on the modern battlefield.²⁷ There is a natural tendency to disperse forces as formations approach the battlefield. This dispersion for survival reduces target density and makes an enemy force more difficult and more expensive to destroy the closer it gets to the front. An examination of combat forces in a typical Soviet division in the attack illustrates the principle.

In a typical attack, a Soviet Motorized Rifle Division (MRD) would be arrayed as shown in Figure 5.

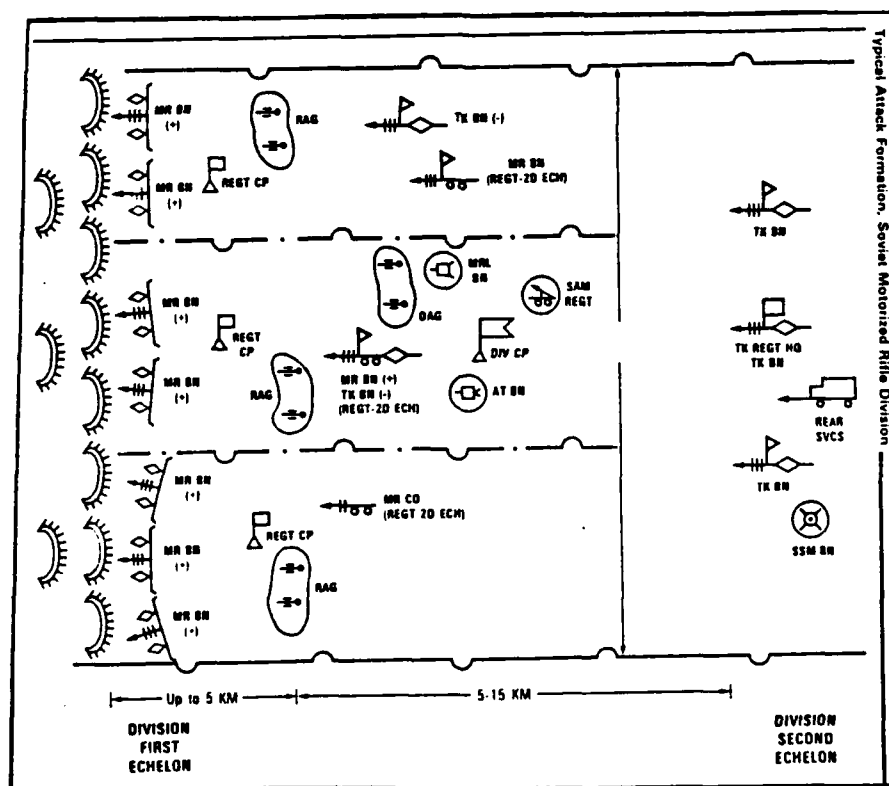


FIGURE 5

Source: FM 100-2-1, p. 5-20

The seven reinforced Motorized Rifle Battalions (MR Bn) in the first echelon are in an attack formation. They assume this posture at 300-1000 meters from the enemy. In the attack formation, a reinforced MR Bn with some 52 combat vehicles occupies about 840,000 square meters. This works out to a density of .00006 combat vehicles per square meter.²⁸

About 20-25 kilometers from the FEBA the battalions of the division's second echelon regiment are travelling in march formation. Travelling in march formation the reinforced tank battalion with about 50 combat vehicles takes up roughly 8,000 square meters of space. In this configuration, the enemy offers a target with a density of .006 combat vehicles per square meter--a one hundred fold increase in target density.²⁹

This increase in vehicle density may be extended beyond the division level to army and front. For example, if the combat vehicles of a Front's follow-on tank division are being railed forward for deployment, the target density of that unit climbs to .10 combat vehicles per square meter while it is loaded on the train--a target density 1,700 times greater than that shown in the battalions at the FEBA.³⁰

Clearly, combat formations tend to become more tightly packed the further one moves away from the FEBA. Thus, they become more lucrative and cost effective targets for air forces. For example, a cluster bomb unit with a kill radius of 800 meters dropped on a formation with a target density of .1 vehicles per square meter should be twice as effective as a cluster bomb with the same kill radius dropped on a formation with a target density of .05 vehicles per square meter. From this particular aspect one may conclude that in terms of enemy kills per sortie CAS is the least cost effective of the three ground support missions. Furthermore, cost effectiveness tends to rise directly as one moves from CAS to BAI to AI.

As with combat forces, support elements become more lucrative targets the further to the rear one moves. This is brought about by the fact that

there is, to a point, a direct relationship between the size of the support unit encountered and the distance to the rear of the FEBA one moves. As one moves further to the rear, he finds in ascending order battalion level CSS units, brigade level CSS units, division level CSS units, corps level CSS units, Army Group level CSS units, etc. Not surprisingly, one sees a dramatic growth in the size of support units as he moves up the chain of command.

Again, the Soviet army in the attack serves as a good example. In the attack a standard motorized rifle battalion (BMP) has a very limited CSS element which is found about 5 kilometers from the FEBA. It consists primarily of a supply platoon with 8 cargo trucks, 2 POL tankers with trailers, and a mobile field kitchen.³¹

A standard motorized rifle regiment (BMP) has a substantial CSS element which is six times as large as that found at battalion level. It includes 30 ammunition trucks with trailers, 15 POL trucks with trailers, and 12 maintenance vans. The entire regimental CSS element consists of an ammunition supply point, repair point, POL supply point, rations supply point, medical point, and vehicle collection point.³² The regimental CSS structure is normally found about 10 to 15 kilometers behind the line of contact.³³

A motorized rifle division (BMP) has a huge CSS element which may be found from 20-40 kilometers from the FEBA. Central to this organization is a supply dump with POL, ammunition, and rations.³⁴ This structure includes no fewer than 189 general purpose cargo trucks--the majority of which are used to haul ammunition, 80 POL trucks with trailers, and 40 maintenance vans. This structure is over 30 times the size of the CSS structure found at battalion level.³⁵

At army and Front level, CSS structures become enormous and relatively fixed and are found as far as 100 kilometers behind first echelon divisions.

Although there is no fixed army organization, a typical combined arms army may field as many as 400 POL tankers and 600 general purpose cargo trucks.³⁶

One indication of the relative size and importance of the various CSS elements discussed is the amount of POL handled and stored at each level of command.³⁷

<u>UNIT</u>	<u>POL IN LOGISTIC BASE</u>
Combined Arms Army	17,500 Metric Tons
Motorized Rifle Division	1,450 Metric Tons
Motorized Rifle Regiment	160 Metric Tons
Motorized Rifle Battalion	11 Metric Tons

As we know only too well in the American Army, the larger the support unit, the lesser the mobility. These two factors combine to offer support targets that, like combat forces, grow in density and inertia as one moves away from the line of contact. Given this tendency planners may apply the same rule of thumb to support elements that is applied to combat forces, namely that in terms of kills per sortie efficiency potentially increases as one moves from CAS to BAI to AI.

Another factor which affects the ability of air forces to destroy enemy combat forces is the proximity of the enemy to friendly troops. In determining the requirements for effective CAS, one Defense Department study noted that the first condition to be met was that "the CAS aircraft must be able to acquire targets quickly and, in particular, differentiate enemy from friendly forces."³⁸ The ability to make this distinction becomes increasingly difficult as hostile units become intermingled in battle. Thus, delivering CAS puts not only enemy but friendly forces at risk--especially in mobile

situations. As David Mcmillan correctly observed,

...in the zone of contact, missions against hostile units are most difficult to control, are most expensive, and are, in general, least effective. Targets are small, well-dispersed, and difficult to locate. In addition, there is always a considerable chance of striking friendly forces due to errors in target designation, ³⁹ errors in navigation, or to the fluidity in the situation.

As one moves away from the FEBA the likelihood of accidentally striking a friendly unit diminishes rapidly. As the opportunity for fratricide diminishes, so too does the requirement for "detailed integration of each air mission with the fire and movement" of supported ground forces.⁴⁰ This allows greater freedom of action to the air forces as they attack the enemy. This greater freedom of action results in a wider variety of attack options which leads to more effective and efficient ordnance delivery. This, in turn, increases the survivability of the attacking aircraft.

Another factor which must be considered in evaluating the cost effectiveness of attacking enemy forces with air forces is the ability of ground forces to do the same job. Using airpower to perform a mission that can be accomplished by ground forces is a waste of a valuable resource. Attacking hostile units in contact is one example.

Ideally airpower should be used to complement the power of supported ground forces. Normally, CAS does not fill that role. When used in a CAS role, airpower simply reinforces the effects of two ground force elements, artillery and aviation.

With the development of advanced combat helicopters ground forces have gained the capacity to provide their own organic close air support. Aviation elements organic to the Army provide ground forces with a fully capable, responsive, all weather close air support force. A comparison between the Army's AH-64 attack helicopter and the Air Force A-10 illustrates the point.

In an excellent study done at the Air Command and Staff College, William Blacklund examined the degree to which the U.S. Army could provide its own CAS. In examining the issue, he compared the AH-64 to the A-10 in several key areas.⁴¹

	<u>AH-64</u>	<u>A-10</u>
Sorties per day	6	4
Turn around time	.3 hours	1.7 hours ⁴²
Ordnance load	5045 lbs.	3312 lbs.
loiter time	2.5 hours	1.7 hours
All weather	yes	no
kills per sortie	34	10
(Max possible)		

Based on this and other data the study concludes that the AH-64 is twice as capable as the A-10 of providing CAS to ground forces. Noting the capabilities of the AH-64 and the numbers of platforms available to corps and division commanders, the study concludes that the U.S. Army is currently capable of fulfilling 87 percent of its own CAS needs. Given this capability, routinely using air forces in a CAS role is not cost effective.

When providing CAS for units in contact, airpower exhibits many of the characteristics of field artillery: It delivers large amounts of heavy ordnance in short periods; its ability to deliver fires is relatively independent of the terrain on which the immediate battle is being fought; and fires are delivered from "over the top" of engaged forces. So similar are the characteristics of CAS and artillery fires, that throughout modern history CAS is frequently referred to as 'flying artillery'. Because of the similarity of the effects of the two systems, it may be accurately claimed that here too CAS supplements rather than complements ground power.

Prior to World War II the Germans recognized the inefficiency of using airpower to perform an artillery mission--providing fire support to engaged

forces. The Luftwaffe's field service regulation, Air Field Manual Number 16, strictly forbade the use of airpower in artillery roles. Paragraph 32 of the Field Manual stated that, "Air action within the range of friendly artillery is only justifiable in cases where the artillery is unable fully to accomplish its mission."⁴³ This restriction came about not because of a 'turf battle' but because the German high command realized the futility of needlessly putting air resources at risk to accomplish a task that could be accomplished by organic artillery assets. The Israelis learned the same lesson after examining the results of the Yom Kippur War.⁴⁴

As stated earlier one of the measurements of a mission category's destruction efficiency is the number of aircraft lost per enemy killed. The dominant factor in determining the number of aircraft losses is, quite obviously, enemy air defense. In modern warfare, the most dangerous aspect of an opponent's air defense is the ground based air defense network.

In the Yom Kippur War, for example, the Israelis had 102 aircraft shot down. Of those only five were lost in air-to-air combat, the balance being lost to ground based air defenses.⁴⁵ In the Falklands fewer than 25% of all aircraft losses could be attributed to air-to-air engagements, the remainder being the result of surface-to-air systems.⁴⁶ In fact, all British Harriers lost in combat were shot down by ground based air defenses.⁴⁷ Although the Israeli experience in their 1982 invasion of Lebanon was contradictory to the established and growing supremacy of surface-to-air systems, the circumstances associated with this operation were unique to that particular situation. Thus, it would be a mistake to apply lessons learned about the relationship between air support and air defense from this experience.⁴⁸

An examination of the surface-to-air threat associated with a representative Soviet army clearly illustrates the magnitude of the ground based threat to friendly air forces. Robert D. Rasmussen examined Soviet air defenses and concluded that ground based defenses achieved an effect equal to 557 F-15s and F-16s in the 'air superiority configuration' flying overhead protection 100 percent of the time!⁴⁹

A.A. Sidorenko notes that

The equipping of the air defense troops with modern armament permits organizing an antiaircraft defense which is capable of assuring the attacking troops freedom of maneuver and combat action and repelling enemy air strikes and thereby creating the necessary conditions for the successful conduct of the offensive.⁵⁰

Given this powerful air defense system, Sidorenko concludes that

The means of troop air defense have now become qualitatively different. Their basis is the antiaircraft missile and antiaircraft artillery complexes which coordinate with the rocket-carrying fighter-interceptor.⁵¹ (emphasis added)

As the enemy's air defense strength increases in terms of numbers, mobility, and capability the number of friendly aircraft losses can be expected to rise and efficiency fall. Not surprisingly, there is an inverse correlation between air defense strength and distance from the FEBA.

Figure 6 shows the layout of the air defense network of a typical Soviet combined arms army or tank army in the attack.

SEE FIGURE 6 NEXT PAGE

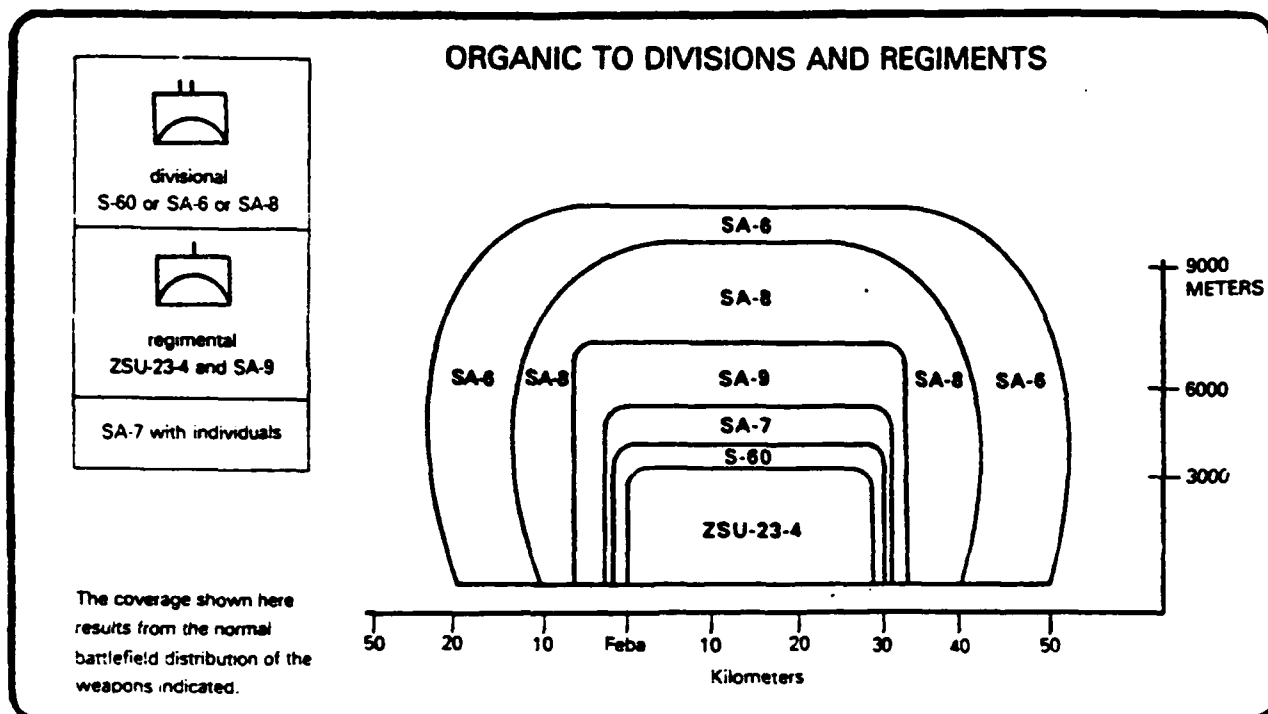
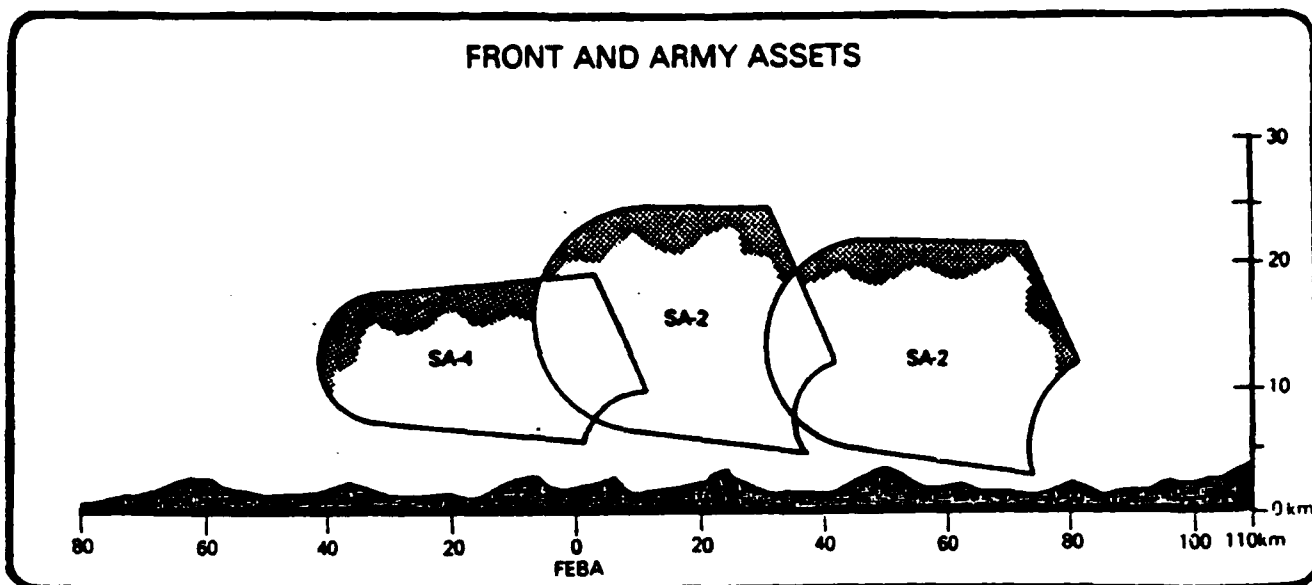


FIGURE 6

Source: Soviet Army Operations. Department of the Army, 1978. p. 5-27

This figure clearly demonstrates the 'front loading' of air defenses. From 0 to 30 kilometers from the FEBA attacking aircraft are confronted with no fewer than 6 types of mobile SAM/AAA systems consisting of 696 missile-launchers and over 90 anti-aircraft guns (including the SA-7 and ZSU-23/4).⁵²

However, from 35 to 50 kilometers from the FEBA air forces face only 3 types of SAM systems with approximately 164 missile-launchers.⁵³ The number of highly mobile ZSU-23/4s and SA-7s decrease significantly as one moves away from the FEBA, and they largely disappear at about 30 kilometers from the FEBA. At the front one also encounters the tremendous number of automatic weapons associated with maneuver units. For example, a single motorized rifle division has no fewer than 350 machineguns that can be used in an air defense role.⁵⁴

One also finds that the mobility of the air defense systems decreases as he moves further to the rear. For example, the SA-2 and SA-4 are much less mobile than the SA-6, SA-8, and the ubiquitous SA-7.⁵⁵

There is an inverse correlation between the density and mobility of enemy air defenses and distance from the FEBA. This correlation may generally be expressed in relationship to CAS, BAI, and AI. As one moves through the areas normally associated with CAS, BAI, and AI he encounters a progressively less capable air defense network. In this instance capability is defined in terms of quantity, mobility, and variety of coverage.

It is important to recognize that aircraft are at their greatest risk when they are 'working', i.e., delivering ordnance, in a given air defense environment. This requires slowing down to identify and locate targets, assuming the profile necessary for hitting the target, and coordinating with local ground forces as necessary. Simply 'making a run' through an air defense system is much safer. One can go as low (or high) and fast as necessary and concentrate solely on enemy air defenses. Thus, making a run through the heavy air defenses at the FEBA to get to the comparatively safe areas in the rear is not nearly as dangerous as attacking targets near the FEBA.⁵⁶

The implication of this relationship is quite clear. Friendly air forces tend to stand a greater chance of being shot down providing CAS than they do providing BAI. They tend to stand a greater chance of being shot down providing BAI than they do providing AI.

One must recognize, however, that while this principle is generally sound, critical installations will probably be heavily protected no matter where their location.

PROFICIENCY

In addition to the efficiency with which enemy forces are destroyed, mission categories can be rated on their simple ability to kill 'things', i.e., their destructive proficiency.

Given the evidence presented thus far, one would expect airpower's ability to kill combat vehicles operating close to the FEBA to be very limited. Such an expectation is well founded. Empirical evidence gained over the last half century indicates that airpower is notoriously poor at killing armored fighting systems close to the FEBA. The effects achieved by the Israeli Air Force (IAF), one of the world's premier 'tank killing' air forces illustrates the point.

In the 1967 Arab-Israeli War the Israelis achieved absolute air supremacy in the first few hours of the conflict by destroying opposing Arab air forces on the ground. Given this air supremacy, the IAF was able to roam the skies freely and attack at will the hapless, undefended Arab ground formations. Even in this ideal environment, the IAF accounted for fewer than 15 percent of enemy armored vehicles killed.⁵⁷

Seven years later during the Yom Kippur War, the Israelis were forced to fight without absolute air superiority, especially during the initial days of

the conflict. During this conflict the IAF accounted for only 2 percent of the armored vehicles killed or seriously damaged.⁵⁸ Interestingly, some 18 percent of armored vehicle kills could be attributed to artillery.⁵⁹ Following the 1973 War the Israeli Defense Force (IDF) concluded that in a CAS environment airpower was an ineffective anti-armor weapon. Based on their Yom Kippur experiences the IDF advocated the acquisition of helicopters for use in an anti-armor role.⁶⁰ They also more than tripled the amount of artillery in the ground forces from 300 guns to almost 1000 guns as a result of the lessons learned about CAS in 1973.⁶¹

It is interesting to note that in the Israelis' 1982 invasion of Lebanon fully 60 percent of armored vehicles destroyed were killed by helicopter gunships.⁶²

Airpower used in an anti-armor role at the front is ineffective for many of the same reasons that it is inefficient: the enemy's combat forces are dispersed for tactical deployment; often times these forces are intermingled with friendly forces and indistinguishable to a pilot moving at hundreds of miles an hour; and potential targets are frequently obscured by smoke and are often indistinguishable from targets already killed.

Moreover, it is at the front that armies deploy air defense assets in their greatest strength. The threat posed by these modern air defense networks makes the concept of multiple passes obsolete. As the U.S. learned in Vietnam and the Israelis learned in 1973, aircraft flying CAS in a high threat air defense environment will probably be limited to a single pass in the same target area if they expect to survive.⁶³

Another significant reason for the apparent lack of effectiveness of airpower in killing armored vehicles lies in the nature of the beast being killed. As was learned and relearned in World War II, Korea, Vietnam, and the

Arab-Israeli Wars an armored vehicle virtually requires a direct hit to be destroyed. The fragmentation and concussion caused by any but the largest of bombs will normally result in minor, temporary damage to armored vehicles--unless the vehicle is directly hit. On the other hand, unarmored or lightly armored systems are very susceptible to being heavily damaged by these effects.⁶⁴

Just as experience tends to demonstrate that airpower is largely ineffective against tactically deployed armored vehicles, it has clearly demonstrated that it is very effective against armored vehicles that are in travelling formations such as march columns or in a semi-deployed posture as in assembly or bivouac areas. It is also proven to be very effective in destroying the thin-skinned vehicles that sustain the armored vehicles. Again, the Israeli experience is illustrative.

As mentioned earlier, in 1967 only 15 percent of Arab armored vehicles destroyed were killed by the IAF. Almost all of these kills were in a march-column configuration.⁶⁵ "Nearly all of (the Egyptian) vehicles destroyed by air action were caught on the Sinai tracks in the course of the general retreat towards the (Suez) canal."⁶⁶ Similarly, "the most dramatic and effective use of aircraft against armor to date", occurred when an entire Jordanian armored brigade was destroyed en route from Jericho to Jerusalem.⁶⁷

In the Yom Kippur War this experience was repeated. The vast majority of the 2 percent of armored vehicles destroyed by the IAF were killed while in convoy. For example, the IAF destroyed an entire Iraqi division while it was moving to the battlefield.⁶⁸ Likewise, in the Sinai and on the Golan Heights the bulk of armored vehicle kills attributed to the IAF were inflicted on units in some sort of travelling formation.⁶⁹ What proved to be the most vulnerable elements of the Arab war machine, however, were the soft-skinned support vehicles.

Support vehicles and systems are more susceptible to destruction by air than armored fighting vehicles for several reasons: They tend to travel in tighter packages; they are susceptible to damage by near misses; and they tend to move in areas with relatively (compared to combat vehicles) porous air defense umbrellas.

Results of air operations in a variety of conflicts testify to the effectiveness of air in an anti-support role. In the Korean War the American Air Force destroyed 82,000 support vehicles as opposed to only 586 tanks.⁷⁰ In Vietnam, so many enemy trucks were destroyed as a result of interdiction efforts that in the period 1970-1972 only 16 percent of the supplies that entered the Ho Chi Minh Trail supply network made it through to the units in the South.⁷¹ In the Yom Kippur War, the Israelis quickly realized that Arab supply columns moving behind the armored formations were particularly vulnerable to air attack. These columns of vital vehicles quickly became the priority for the IAF.⁷²

Just as interdiction proved to be very effective against the sustainment effort, so too has it proven to be effective in destroying the command and control systems necessary to conduct major operations. For example, during the summer months of 1944 an intensive allied interdiction effort was waged against German forces in Italy. The interdiction operation destroyed a large portion of the German command and control network and proved to be a decisive factor in the ground offensive that followed. This destruction of command and control facilities "greatly hindered, and at times paralyzed, the direction of the battle, especially at the Army and Army Group level."⁷³

Lieutenant General Gerhard Schwerin, CG of the 116th Panzer Division at Avranches in August of 1944 noted that,

"The superior enemy air force paralyzed every movement on the battlefield...(and)decisively impeded the command of the conflict on and behind the front by destruction and crippling of technical means."⁷⁴

In 1973 the Israelis found that attacking the command and control facilities of the Arab's ground based air defense system proved more effective than attacking individual delivery systems.⁷⁵

An examination of a Soviet division in the attack shows that the majority of command and control targets are to be found at ranges from the FEBA normally associated with BAI. In an attack, regimental Main Command Posts (CPs) will be up to 5 kilometers from the FEBA, as will division Forward CPs. Division Main CPs will be up to 15 kilometers from the FEBA, while the division Rear CPs will be up to 30 kilometers from the FEBA.⁷⁶ Army and Front level CPs will be even further to the rear.

The susceptibility of these headquarters to destruction by air attack can be discerned by examining the equipment assigned to them. For example, a motorized rifle division headquarters has a total of three lightly armored vehicles in the form of the BTR 50-P. The remainder of the 56 vehicles are trucks and trailers. This critical element is protected by a total of 6 SA-7 shoulder fired SAMs. There are no ZSU 23-4s available to the division headquarters.⁷⁷

Putting all of the evidence together one may conclude that in terms of simple destruction airpower has limited utility in a CAS role. Furthermore, the destructive potential of airpower increases significantly as one moves away from the FEBA and into the areas normally associated with BAI and AI.

DISRUPTION

All of the issues discussed in this paper thus far have centered around the one standard that must ultimately be used to measure the merits of the three mission categories being examined. That standard is disruption. In the final analysis, a given mission category must be measured on its ability to

disrupt or materially contribute to the disruption of enemy operations. As was stated early on, diversion, delay, and destruction are but parts of a larger equation. As was also stated in the beginning, planners at the operational level will base apportionment decisions on the ability of a particular mission category to disrupt the enemy's operational activities rather than influencing local tactical fights.

Given the evidence presented thus far one would expect to find that, at the operational level, CAS is the least disruptive of the three ground support missions. Such an expectation is well founded.

Unlike BAI and AI, CAS neither delays nor diverts enemy resources from the battle at hand. By definition, CAS influences only those enemy forces that have already joined the fight. Its sole function is destruction of engaged enemy forces. Thus its effects are local and its ability to influence operations throughout a theater or zone of operations is very limited.

BAI on the other hand achieves the effects of both destruction and delay, and to some degree diversion. Its effects are not limited to the locale of the air strike but may be felt across a significant portion of the battlefield. By the nature of its design--it is designed to disrupt operations on the battlefield--it effects mainly corps level operations and below.

AI achieves the effects of destruction, delay, and diversion. Because it is conducted deeper than BAI and is designed to disrupt the flow of forces to the battlefield the effects of successful AI operations are felt throughout the zone or theater of operations.

Because BAI is a newly established as a separate category of air operations, it is difficult to distinguish between purely AI and BAI

operations when analyzing past conflicts. There is, however, ample testimony to the decisive effectiveness of disrupting the movement of critical resources to and within the battlefield.

In World War II the Germans learned all too painfully just how decisive interdiction operations could be in modern war. The observations made by Field Marshal Gerd Von Rundstedt attest to how well airpower can disrupt an enemy's operations. In the fight for the Normandy beaches it was, stated Von Rundstedt,

all a question of air force, air force and again air force. The main difficulties that arose for us at the time of the invasion were the systematic preparations by your air force; the smashing of the main lines of communications, particularly the railway junctions. We had prepared for various eventualities...that all came to nothing or was rendered impossible by the destruction of railway communications, railway stations, etc. The second thing was the attack on the roads, on marching columns, etc., so that it was impossible to move anyone at all by day, whether a column or an individual, that is to say, carry fuel or ammunition. That also meant that the bringing up of the armored divisions was also out of the question, quite impossible.

Major General Fritz Bayerlein, commander of the Panzer Lehr division at Normandy, testified to the debilitating effects of interdiction operations when he noted that during one attempt to move his division to the fight,

The first air attack came about half past five that morning...By noon it was terrible; my men were calling the main road...a fighter-bomber racecourse... by the end of the day I had lost forty tank trucks carrying fuel, and ninety others. Five of my tanks were knocked out, and eighty-four half-tracks, prime-movers and self-propelled guns. These were serious losses for a division not yet in contact.

Similar observations are readily found in the writings of German commanders in North Africa, Italy, and Russia. From Rommel's Afrika Korps to Vietinghoff's/Herr's Tenth Army in Italy to Manstein's Army Group South in Russia the same message is found repeatedly. It is through the disruption of movement to and within a battlefield that air contributes decisively to the outcome of campaigns and major operations.

Omar Bradley, commanding general of the 12th Army Group, observed that

In a campaign involving great distances and rapid movement, the means to limit or deny supplies and restrict maneuver in the battle area constituted one of our most decisive weapons. With this weapon, air power made a valuable contribution towards acceleration of the land battle. (emphasis in the original)⁸⁰

In Korea and Vietnam interdiction operations so disrupted the ability of the communists to sustain forces in the field that the enemy could field but a fraction of his potential warfighting capability. In Korea "the Chinese Communist Army was stalemated with more than 1,000,000 reserve troops who could have been thrust into the battle to break the stalemate."⁸¹ It was the ability of massive Allied air interdiction operations to cripple the attempted movement and sustainment of large formations that convinced Chinese leaders not to deploy these forces.⁸²

Only after the termination of U.S. interdiction operations could North Vietnam employ all 20 or so divisions it had at its disposal in the war against South Vietnam. Prior to the end of U.S. involvement the North Vietnamese were only able to support half of their 20 division force in the South. The principal factor in limiting the number of forces the North Vietnamese could sustain was the interdiction effort of the U.S. Air Force.⁸³

In the aftermath of the 1973 War the Israelis found that it was their interdiction effort that had paid the highest dividends in that desperate struggle. On the Golan Heights, for example, over 25 percent of all abandoned tanks had simply run out of fuel.⁸⁴ So effective was the Israeli interdiction effort that many observers concluded that the Syrian advance was not repelled; it simply ran out of steam.⁸⁵

The few UN observers, still trapped in their bunkers on the cease-fire line, for instance, saw little fuel or ammunition coming up behind the armor. The Israeli Air Force had destroyed it. The Syrians did not dare to bring up their

convoys of ammunition trucks and fuel tankers by day. But as ...night fell, the roads behind the Syrian lines were jammed with these vulnerable convoys.⁸⁶ They became the priority targets for the Israeli Skyhawks.

In his excellent work Numbers, Predictions and War Trevor N. Dupuy concludes that interdiction operations are three times as lethal as CAS and much more capable of affecting the outcome of battles and engagements.⁸⁷ Dupuy found that in World War II only 5 percent of engagements were materially influenced by CAS. On the other hand interdiction proved decisive in at least 25 percent of the engagements studied. Dupuy continues to say that evidence "suggests that a sustained interdiction (effort) yielded six times as much result as a close support effort..."⁸⁸ Other analysts go even further and claim that it is a mistaken belief that "the salvation of outnumbered and outgunned armies lies in close air support,... History provides not one single instance of the (decisively) successful defensive use of close air support."⁸⁹ Most analysts would not go so far as to deny any decisive use of CAS, but do agree that the circumstances wherein it has been decisive are the rare exception.

The bulk of historical experience seems to indicate clearly that interdiction missions, both AI and BAI, are much more effective at disrupting large scale enemy operations than is CAS.

This does not mean that CAS has no role to play in the conduct of major operations and campaigns. As was learned in the early stages of the Korean War, CAS may be the only means of countering attacks where the enemy achieves near absolute surprise and/or overwhelming superiority in numbers and firepower.⁹⁰ When faced with a situation similar to that faced by the Israelis on the Golan Heights in 1973, wherein Israeli ground forces were so maldeployed that air support was the only thing standing between the IDF and defeat, the use of massive amounts of CAS was perfectly justified--regardless

of the efficiency or effectiveness.⁹¹ CAS is perfectly suited to provide the fire support necessary during the initial stages of amphibious, airborne, and air assault operations.⁹²

As a rule, however, CAS does not yield the necessary returns to make it a profitable investment of limited air resources. As William Dalecky observed, planners must take every effort to avoid the trap of tying "the conduct of the air war to the fortunes of maneuver units in contact with the enemy."⁹³

CONCLUSION

Over 75 years ago Captain C.J. Burke of the British Army observed that

The aeroplane is a weapon of war...the use of which we have not completely gauged, the value of which we have not fully appraised. So utterly unaccustomed are we to reckon with it in studying war, that we fail to realise its possibilities--fail to realise that success or failure in war may in the future depend on this, the latest weapon forged by man.⁹⁴

Although three quarters of a century, two world wars, and countless lesser conflicts have passed since Captain Burke's remarks the question of how best to realize the disruptive potential of airpower remains unsolved and a matter of significant debate. In both NATO and American doctrine, for example, "there is no priority assigned to any particular role (for airpower), and one of the most controversial questions appearing now in (professional) literature is the priority to be given to the various roles."⁹⁵

Based on an analysis of past experience and current capabilities, one can apply to the apportionment process some 'rules of thumb' for prioritizing the various roles of tactical airpower.

The first 'rule of thumb' is ironclad. The paramount consideration to be brought to any apportionment decision is an understanding of the operational effects to be achieved by airpower. It is from this consideration that all other planning considerations spring. If an operational planner understands this, he has half of the battle won. Only with this understanding can he correctly prioritize the employment of available air forces in an operationally decisive manner.

In determining which of the TACAIR missions to prioritize the operational planner must determine what single effect or combination of effects he expects to achieve through the application of his airpower. As stated earlier, the ultimate goal is the disruption of enemy operations. The particular elements of disruption are delay, diversion, and destruction.

In seeking to delay the arrival of critical enemy resources at the front, one is limited to AI and BAI. If air resources are plentiful and the enemy can be attacked through the depth of the zone of operations AI and BAI should both be used to impede the movement of the enemy. This, however, is rarely the case and one must often choose between one or the other. Several factors determine which of these two missions is appropriate for delaying the enemy

If the enemy is supported by a sophisticated transportation network BAI will probably be more effective than AI in delaying his movements. However, if he is moving over a relatively primitive transportation system it is probably advisable to attack him as far to the rear as possible since his opportunities for bypassing critical junctures are limited.

In diverting enemy operations AI is clearly the preferred mission. Because BAI and CAS are flown in the combat zone, they do little to divert resources away from the battle. One must keep in mind, however, that BAI and

CAS can cause the diversion of tactical forces by threatening the success of what the enemy perceives to be decisively important engagements and battles.

In destroying the enemy BAI and AI offer great rewards in terms of both efficiency and effectiveness. Interdiction operations attack the enemy when he is most vulnerable, when he is massed. They also attack the most vulnerable enemy assets: the soft-skinned support and command and control systems that are vital to sustaining any fight. Additionally interdiction operations are conducted in those areas where the enemy's air defense umbrella is the weakest.

In the area of operations normally associated with BAI one tends to find the majority of command and control systems of both tactical and operational level units. Here, too, are found the bulk of the deployed support nodes that sustain forces engaged in the fight. In the AI zone one tends to find formations and units at their most vulnerable. While travelling on trains, for example, tactical units present target arrays that are nearly 1,700 times as dense as those tactically deployed at the front.

It may also be stated, as a general principle, that interdiction operations--both BAI and AI--complement ground power while CAS supplements it. By striking at areas of the battlefield which are beyond the reach of ground forces, airpower confronts the enemy with problems that simply cannot be generated by army elements. On the other hand, by routinely striking at areas of the battlefield that can be ranged by artillery and attack helicopters airpower simply reinforces the effects of systems organic to ground forces.

History tends to show that this supplemental use of airpower should be the rare exception rather than the accepted rule. For CAS puts at risk extremely valuable weapon systems but, from an operational perspective, achieves very marginal returns on investment.

There are, however, situations for which CAS is the best, perhaps the only answer. CAS may be required to compensate for a lack of artillery or attack helicopters. It is ideally suited to perform as an economy of force fire support system. In the larger picture, however, "close support must be the exception rather than the rule."⁹⁶

APPENDIX A: RECOMMENDED READING

Several studies offer a picture of the relative costs and benefits associated with CAS, BAI, and AI. Some deal with the tradeoffs in a particular historical context while others offer a more theoretical approach. Among the better of these studies are:

A. "The 'Air' In AirLand Battle" by James B. Henderson. This is an unpublished master's thesis completed at the U.S. Army Command and General Staff College, Fort Leavenworth Kansas. Henderson offers a broad analysis of the various TACAIR missions and a good look at the Air Force's available aircraft and ordnance.

B. "Battlefield Air Interdiction In the 1973 Middle East War and Its Significance to NATO Air Operations" by Bruce A. Brant. This is an unpublished master's thesis completed at the U.S. Army Command and General Staff College, Fort Leavenworth Kansas. Brant provides a comprehensive analysis of the air effort in the Yom Kippur War. In addition to BAI, he looks into the effectiveness of CAS and AI.

C. "Battlefield Air Interdiction By the Luftwaffe At the Battle of Kursk--1943" by William J. Dalecky. This is an unpublished master's thesis completed at the U.S. Army Command and General Staff College, Fort Leavenworth Kansas. Dalecky offers an in-depth look at how the use and misuse of airpower affected the outcome of perhaps the pivotal battle on the Eastern Front of Europe in World War II. Of particular interest is the similarity of the lessons drawn by Dalecky from Kursk and those drawn by Brant from the Yom Kippur War fought some 30 years and four generations of aircraft later.

D. Air Power In the Nuclear Age, 1945-82: Theory and Practice by Air Marshal M.J. Armitage and Air Comodore R.A. Mason. This book provides a broad look at the continuous--and sometimes discontinuous--development of airpower. Of particular interest is the section on Soviet airpower. Perhaps the best part of the work is its excellent bibliography.

APPENDIX B: AIRCRAFT CAPABILITY

For a good examination of the capabilities and characteristics of the Air Force's various aircraft see:

1. Student Text 100-2; U.S. Air Force Basic Data (U.S. Command and General Staff College, Fort Leavenworth Kansas, 1985), appendix B.
2. Offensive Air Support Mission Analysis, Volumes I-III. (U) (SECRET), (Aeronautical Systems Division, Wright-Patterson Air Force Base Ohio, 1977)
3. "The Air In the AirLand Battle", James Henderson (U.S. Army Command and General Staff College, Fort Leavenworth Kansas, 1982 pp.49-54.

An examination of these documents shows that the following aircraft are capable of conducting CAS, BAI, and AI in some combination:

F-4--CAS, BAI, AI (truly a 'jack-of-all trades' aircraft)
F-15--CAS, BAI, AI (primarily an Air Superiority Fighter)
F-16--CAS,BAI, AI (truly a 'jack-of-all trades' aircraft)
F-111--CAS,BAI, AI (primarily a deep interdiction bomber)
A-10--CAS, BAI (primarily a CAS aircraft)**
A-7--CAS, BAI (primarily a CAS aircraft)

**Although designed exclusively for the CAS role, many studies have concluded that given its capabilities, the A-10 is fully capable of performing BAI missions. For a good examination of the capabilities of the A-10 in the BAI role see "A Comparison of the USAF Projected A-10 Employment In Europe and the Luftwaffe Schlachtgeschwader Experience On the Eastern Front In World War II" by Lonnie Otis Ratley III, Naval Postgraduate School, March 1977.

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4. Colonel Hans Gotthard Pestke, "German Training and Tactics: An Interview with Colonel Pestke," The Marine Corps Gazette, October 1983, p. 60. Colonel Pestke is citing Clausewitz as found on page 75 of On War, edited and translated by Michael Howard and Peter Paret; Princeton University Press, Princeton New Jersey, 1976.
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6. Department of the Air Force, Headquarters Tactical Air Command, TAC Manual 2-1; Tactical Air Operations (Langley Air Force Base, Virginia: U.S. Government Printing Office, 1984), p.1-1. TACH 2-1 is quoting Air Force Regulation 23-10.
7. Jonathan M. House, "Towards Combined Arms Warfare: A Survey of 20th-Century Tactics, Doctrine, and Organization," Research Survey Number 2, Combat Studies Institute, U.S. Army Command and General Staff College, Fort Leavenworth, Kansas, 1984, pp. 4-5.
8. Headquarters, Department of the Army, FM 101-5-1; Operational Terms and Symbols (Washington, D.C.: U.S. Government Printing Office, 1985), pp. 1-2, 1-10, and 1-15.
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11. Arthur William Tedder, Air Marshal, Air Power In War (London, Hodder and Stoughton, 1948), p. 103.
12. William Momyer, Air Power in Three Wars (Washington, D.C.: U.S. Government Printing Office, 1978), p.190.
13. Momyer, pp. 105-118, 140-165, 70-86.
14. Bruce A. Brant, "Battlefield Air Interdiction In the 1973 Middle East War and Its Significance to NATO Air Operations," Unpublished Master's Thesis, U.S. Army Command and Staff College, Fort Leavenworth, Kansas, 1986, p. 74.
15. Brant, pp. 73-74.

16. Susan M. Jones, James W. Mathews, and Rock P. Moran III, Historical Effects of Interdiction (U) (Secret) (Tactical Fighter Weapons Center, Nellis Air Force Base, Nevada, 1980), p. 14.

17. Jones, Mathews, and Moran, p. 14.

18. Wesley Craven, The Army Air Forces in World War II, Volume Three: Argument To VE Day (Chicago: University of Chicago Press, 1951), p. 705.

19. A. A. Sidorenko, The Offensive: A Soviet View (Translated and Published Under the Auspices of the U.S. Air Force, Washington, D.C.: U.S. Government Printing Office, 1970), p. 98.

20. Jones, Mathews, and Moran, p. A-40.

21. The Insight Team of the London Sunday Times, The Yom Kippur War (Garden City, New York: Doubleday and Company, 1974), p. 182.

22. Air Vice Marshall M. J. Armitage, "Airpower In the Central Region," Journal Of the Royal United Services Institute for Defence Studies, December 1979, p.37.

23. LTC Steven L. Canby, "The Interdiction Mission--An Overview," Military Review, July 1979, p.25.

24. General der Fleiger A.D. Paul Deichman, German Air Force Operations In Support Of the Army (U.S. Air Force Historical Division, Research Studies Institute, Air University, 1962), p. 96.

25. Deichman, pp.110-118

26. For a good description of the problems associated with limited supply lines encountered by Rommel in North Africa see David Irving's The Trail of the Fox, pages 101, 112, and 113. Also see The Rommel Papers edited by B.H. Liddell Hart. London, 1953, pp.282-286.

27. FM 100-5; Operations, pp. 13 and 62.

28. Headquarters, Department of the Army, FM 100-2-1; The Soviet Army: Operations and Tactics (Washington, D.C.: U.S. Government Printing Office, 1984), pp.5-8 thru 5-11. also Headquarters, Department of the Army, FM 100-2-3; The Soviet Army: Troops, Organization, and Equipment (Washington, D.C.: U.S. Government Printing Office, 1984) pp. 4-24 and 4-14.

The figure of .00006 combat vehicles per square meter is the result of dividing the number of combat vehicles, 52, by the number of square meters occupied by 3 reinforced rifle companies in a mounted wedge attack formation. A company in a wedge formation will typically occupy an area 700 meters wide by 350 meters deep. It is assumed that the battalion is on line with 200 meters between companies. Calculations are as follows:

- 1) $700 \times 3 + 200 + 200 = 2500$ meters
- 2) $2500 \times 350 = 875000$ meters squared
- 3) $52 \text{ vehicles} / 875000 \text{ meters squared} = .00006 \text{ v/m}^2$

29. FM 100-2-1; The Soviet Army: Operations and Tactics, pp. 5-3 and 5-19 to 5-20 also FM 100-2-3; The Soviet Army: Troops, Organization, and Equipment, pp. 4-14 and 4-24

The figure of .006 vehicles per square meter results from the same type calculations noted in endnote number 28. In making the calculations, the following assumptions were made:

length of vehicle = 2.5 meters
width of road = 3.0 meters
interval between vehicles = 50 meters
interval between companies = 150 meters

Calculations are as follows: 1) $2.5m \times 52(\text{vehicles}) = 130\text{meters}$
2) $(50 \times 50 + 130 + 150 + 150) = 2930 \text{ meters}$
3) $2930 \text{ mtrs} \times 3 \text{ mtrs} = 8790 \text{ square meters}$
4) $50 \text{ vehicles}/8868 \text{ square meters} = .006v/m^2$

30. FM 100-2-3; The Soviet Army: Troops, Organization, and Equipment, pp. 4-14 and 4-24.

The figure of .10 vehicles per square meter results from the same type calculations noted in endnote numbers 28 and 29. In making the calculations, the following assumptions were made:

length of vehicle = 2.5 meters
width of train = 2.5 meters
distance between vehicles = 1.0 meters
2 vehicles per train car
distance between train cars = 1.0 meters

Calculations are as follows: 1) $2.5m \times 52(\text{vehicles}) = 130 \text{ meters}$
2) $50 \text{ spaces} \times 1.0 \text{ mtrs} = 50 \text{ meters}$
3) $23 \text{ spaces} \times 1.0 \text{ mtrs} = 23 \text{ meters}$
4) $130m + 50m + 23m = 203 \text{ meters}$
5) $203 \text{ mtrs} \times 2.5 \text{ mtrs} = 508 \text{ square meters}$
6) $52 \text{ vehicles}/508 \text{ square meters} = .10 v/m^2$

31. FM 100-2-3; The Soviet Army: Troops, Organization, and Equipment, pp. 4-24 and 4-7. Also Headquarters, Department of the Army, FM 100-2-2; The Soviet Army: Specialized Warfare and Rear Area Support (Washington, D.C.: U.S. Government Printing Office, 1984), p. 13-6.

32. FM 100-2-3; The Soviet Army: Troops, Organization, and Equipment, pp. 4-27 thru 4-30, 4-19, 4-20, and 4-21. Also FM 100-2-2; The Soviet Army: Specialized Warfare and Rear Area Support, p. 13-6.

33. FM 100-2-2; The Soviet Army: Specialized Warfare and Rear Area Support, p. 13-6.

34. FM 100-2-3; The Soviet Army: Troops, Organization, and Equipment, pp. 4-33 thru 4-40, and 4-80 thru 4-90.

35. FM 100-2-2; The Soviet Army: Specialized Warfare and Rear Area Support, p. 13-6.

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37. FM 100-2-2; The Soviet Army: Specialized Warfare and Rear Area Support, p. 13-10.

38. Barbara de Florio and Bernard Korhaner, The Value of Close Air Support (U) (Secret) (Washington, D.C.: Office of the Secretary of Defense, Program, Analysis and Evaluation Office, 1976), p. 125. For an excellent description of the problems that a modern fighter encounters simply in trying to identify targets and differentiate between friendly and enemy systems see James Henderson, "The 'Air' In AirLand Battle," Unpublished Master's Thesis, U.S. Army Command And Staff College, Fort Leavenworth Kansas, pp.70-71 and p.44.

39. David Mcmillan, "Technology; the Catalyst for Doctrinal Change," Air University Review, November-December 1977, p. 28.

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44. Brigadier General A. Bar-David, Israeli Army in an interview with The Field Artillery Journal, May-June 1978, page 15. Also see Richard A. Gabriel, Operation Peace for Galilee (New York: Hill and Wang, 1984), pp.19-21. See also Brant, p. 97.

45. Robert Rasmussen, "The Central Europe Battlefield; Doctrinal Implications for Counterair-Interdiction," Air University Review, July-August 1978, p.4

46. United Kingdom, Secretary of State for Defence, Report to Parliament, The Falklands Campaign: The Lessons (London, England: Her Majesty's Stationery Office, 1986), p. 45.

47. R.A. Mason, "Hay For The Hobby Horses: Reflections On the Air War In the South Atlantic, 1982," Journal of the Royal United Services Institute for Defence Studies, December 1982, p. 36.

48. D.J. Alberts, Deterrence in the 1980s: Part II; The Role of Conventional Air Power Adelphi Paper Number 193 (London: International Institute For Strategic Studies, 1984), pp.26 and 52.

49. Rasmussen, p.17.

50. Sidorenko, p. 48.
51. Sidorenko, p.48.
52. FM 100-2-1; The Soviet Army: Operations and Tactics, pp. 11-1 thru 11-9. Also FM 100-2-3; The Soviet Army: Troops, Organization and Equipment, pp. 4-34, 4-118, and 4-107. For a consolidation of available systems see Rasmussen, p.14. Note that FM100-2-3 says that the S-60 is no longer found in front line Soviet divisions.
53. See figure 6. See also FM 100-2-1; The Soviet Army: Operations and Tactics, pp. 11-1 thru 11-9. The SA-7 and ZSU-23/4 are found in maneuver regiments and are thus found most frequently at the front. However, a regiment in a follow-on role retains its organic air defense assets. Thus, some SA-7s and ZSU-23/4s will be found to the rear of the FEBA. Recognize, however, that many of these systems will be travelling and not deployed for action.
54. FM 100-2-3; The Soviet Army: Troops, Organization and Equipment, p. 4-27. Also see TACM 2-1; Tactical Air Operations, p. 2-5.
55. FM 100-2-3; The Soviet Army: Troops, Organization and Equipment, pp. 5-89 thru 5-104.
56. James Henderson, "The 'Air' In AirLand Battle," Unpublished Master's Thesis, U.S. Army Command and Staff College, Fort Leavenworth Kansas, 1982, pp. 72-77. Also Interview with Major Blair Davis, U.S. Air Force, Tactical Fighter Command, April, 1987. Also interview with U.S. Air Force Section, U.S. Army Command and General Staff College, February, 1987. See also
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