Chapter Five

FOLLOWING PATH 3: Introducing Maneuver to Light Forces

IN CHAPTER THREE WE EXAMINED what might be considered relatively conventional solutions to improve light forces, and we assessed their ability to function in the rapid-reaction role (the path 1 option). In Chapter Four we explored both the possible benefits and the limitations of making light forces smaller and more dispersed (the path 2 option), which by some standards might be considered a major departure from the way forces operate today. In this chapter we examine change in the other direction—the path 3 option—introducing maneuver to light forces, thus giving them more capability than they currently have but also making them heavier than they are now.

Although bringing the ideas explored in this chapter to fruition would likely involve a longer overall timeline than some of the other concepts considered so far, perhaps as far out as 10–30 years, RAND's Arroyo Center and National Defense Research Institute are exploring them now. More specifically, this chapter presents analysis that has considered introducing maneuver—combined operational and tactical—into relatively light forces. The concept examined here is considered to be a "vertical envelopment" concept because it relies greatly on air mobility at the operational or tactical level to achieve mission success. Implementing the concepts will inevitably involve making many other changes to light forces beyond those proposed for combat aspects; some of these non-combat-related changes are not addressed in this work. Thus, as was the case with Chapters Three and Four, the research presented here is exploratory rather than final.

As in the previous chapters, we first set up the context for the analysis. Then we present the "soldier-level" view of the analysis, followed by after-action review analyses that elaborate on the outcomes of the scenario.

Context for the Analysis

Analysis Goals

Unlike the previous concepts examined in this book, which involved emplacing a relatively stationary ground force that relied heavily on remote fires for survivability and lethality, the concept examined in this chapter concentrates on adding combined tactical and operational maneuver by introducing a light- to medium-weight family of vehicles within a force to accomplish rapid-reaction mission objectives. As a result, a larger spectrum of missions can be addressed with this kind of force.[1] There are also some situations for which this kind of force might be less applicable (e.g., difficult or complex terrain) than a dismounted infantry-based force. Moreover, this notional force would probably be more of a challenge to deploy. Although streamlined CONUS-to-battlefield positions are assumed in the concept, two major phases were considered in this research: (1) an air insertion of the force and (2) the ground combat itself. Both phases must be successfully completed for overall mission success.[2]

To assess the viability of the air-insertion phase, we used the high-resolution modeling capabilities described in Chapter One. More specifically, CAGIS was used to model terrain, CAGIS Helicopter Advanced Mission Planner (CHAMP) served as the aircraft flight planner, and RJARS was used to assess the air-ground combat interactions. To assess the effectiveness of the ground-combat phase, additional force-on-force simulation tools were necessary, including ASP for distributed sensor representation, the C2 model to determine information processing time and completeness, JANUS as the force-on-force model, MADAM for the simulation of smart munitions effects, and a separate model for assessing active protection systems (APS).[3]

In the air-insertion phase of the analysis, we examined the capability of a notional advanced airframe (roughly a C-130-sized aircraft) to insert a ground force into the enemy rear area under different assumptions and conditions. For the ground-combat phase, we examined three different operational concepts with differing levels of ground maneuver. In all cases, this involved an early-entry neutralization or disruption of a mobile, elite enemy unit located behind enemy lines. All of the concepts were similar in that they employed the aggressive use of long-range attack weapons, such as aircraft delivering standoff weapons like joint standoff weapon (JSOW) and ballistic missiles like Navy and Army versions of the tactical missile system (TACMS). However, the three concepts examined in this research were quite distinct from each other in the level of tactical maneuver and the subsequent application of force. The details of these concepts will be described in the later portion of this chapter.

Scenario Context

The scenario assumes that an enemy force has invaded a U.S. ally and that American forces are mobilized and poised to enter the fray approximately one week after the onset of hostilities. During the first week of battle, enemy forces have managed to advance approximately 200 kilometers, overwhelming the initial allied forces' attempts to halt the invasion. Allied forces have temporarily stopped the invading forces across a broad front, as depicted in Figure 5.1. (The area of engagement shown in the image is several hundred kilometers on a side, with grid lines at 50 kilometers.)

The invading forces, low on fuel and ammunition, have been temporarily stopped by coalition forces and are waiting for their operational reserve to reach the forward line of own troops (FLOT) and punch through the fragile allied defenses. Red's operational reserve is made up of a heavy, elite division advancing with one brigade up and two brigades back, trailed by sufficient logistics, in the form of fuel and ammunition, to reestablish momentum after reaching the FLOT. The vignette chosen for analysis allows for a range of different U.S. military force responses against this elite heavy division. The force's objective is to attack the division en route to front line and thus pre-

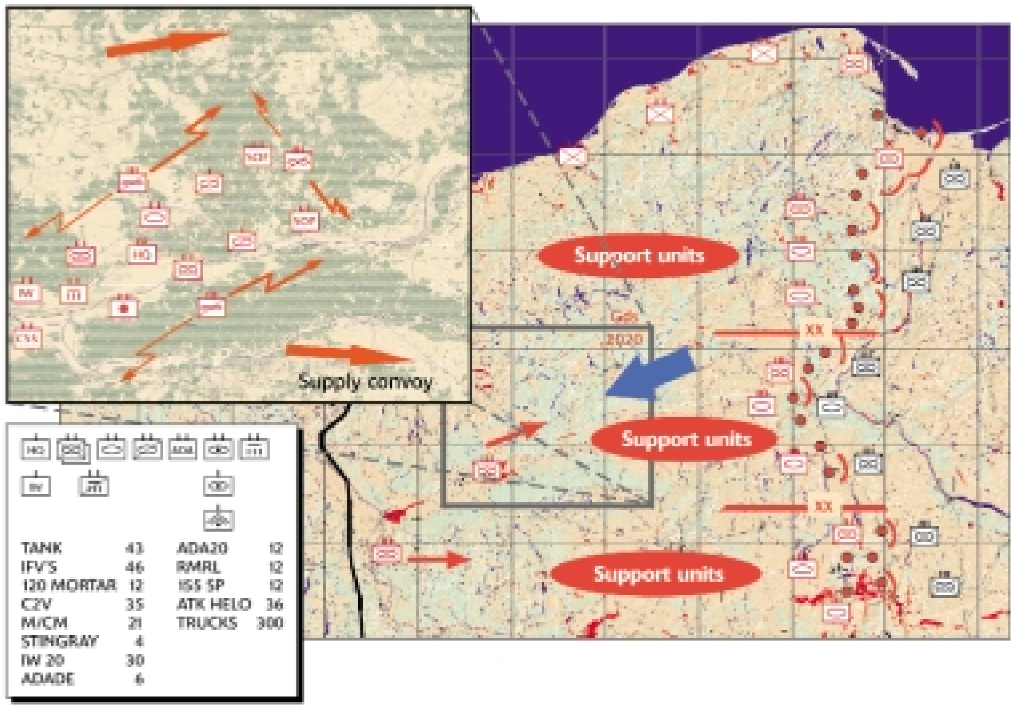


Figure 5.1—Representation of Enemy Advance and Coalition Force Battle Positions

vent it from delivering its much-needed reinforcements.[4] To accomplish its mission, the U.S. ground force will be air-inserted well into enemy-occupied territory but in front of the reserve enemy division. But because of the mixed, foliated terrain, opportunities to engage the enemy are limited. The key requirement for the U.S. force is to destroy, or at least disrupt, the enemy reserve division before it can reach the front and reinvigorate the offensive.

The enemy commander has secured his rear area with lighter infantry units along the northern sea approach, protecting against an amphibious assault on his flank, and he has bolstered his rear area and main supply route (MSR) defenses with state-of-the-art air defenses, ranging from advanced gun-missile combination (2S6) short-range, low-altitude systems to long-range, high-altitude systems such as the SA-17 and SA-12, which protect against airborne and air mobile assaults.

The scale and topography lends itself well to deep attack operations. The battlespace is sufficiently small to provide little warning time for an enemy who may detect approaching aircraft, yet large enough to encourage joint operations, including both interdiction and maneuver. Unlike Operation Desert Storm, the terrain is sheltered enough to provide cover for an advance. Although the scenario is hypothetical, existing digital terrain was used (East Europe) and various organizations such as the Defense Intelligence Agency (DIA) and the National Ground Intelligence Center (NGIC) were consulted in shaping the notional adversary's capabilities, composition, and application of force in this time frame.[5]

Success in this scenario requires the United States to project power well behind enemy lines. Although this would most likely be implausible with today's forces and associated capabilities, it is envisioned that a set of possible "solutions" can be identified through some combination of dominant maneuver—strategic, operational, and tactical—precision engagement, full-dimensional protection, and focused logistics, in conjunction with new or enabling technologies.

The Threat

In terms of the threat, we look at both the enemy air defense threat that the ground force must face during the air insertion and the mechanized enemy division that the inserted light ground force must face after insertion.

Air defense threat. One asymmetric strategy that a future threat is likely to employ to counter U.S. air power is a sophisticated integrated air defense network. The air defenses depicted in this scenario are intended to represent a "high-end" opponent of the 2020 era. Today, the Russian army is capable of fielding the type of air defense system depicted in this research. In coming years, other armies may be able to employ similar integrated air defense systems.

For our threat, we presume that long-range, high-end systems such as Russian SA-12s and SA-17s are emplaced throughout the depth of the battlespace.[6] Since these are relatively mobile, tactical surface-to-air missiles (SAMs), they can accompany the advancing mechanized formation. In addition to these long-range systems, we include medium-range systems such as SA-15s and short-range systems such as 2S6s, SA-18 man portable air defense systems (MANPADS), and anti-aircraft artillery (AAA) in the network. (A more detailed discussion of the actual systems is presented in Appendix C.)

Although these air defenses operate in a stand-alone mode and can be quite formidable, they can become significantly more of a challenge when integrated. More specifically, these air defenses are represented as "partially integrated" in our simulation. A number of early-warning radars (both air- and ground-based) are emplaced throughout the depth of the battlefield. These systems can provide cueing for the SAMs, allowing them to remain quiescent and thus more difficult to find. In some cases, such as with the MANPADS, which tend to be passive systems, it is unlikely that the U.S. force would be able to locate them in the time frame being examined in this analysis.

The enemy air defenses are allocated by echelon. The corps-level, long-range, high-altitude defenses are represented by SA-12 and SA-17 batteries. We assumed the enemy corps depicted on the map is in charge of the enemy's main effort; other forces are off the map to the south and west and would be accompanied by two battalions (a total of six batteries) of SA-12s and two battalions (also six batteries) of SA-17s. By the time this vignette takes place, we assume each battalion has already lost one battery because of U.S. and allied suppression of enemy air defenses (SEAD).

In terms of the air defenses organic to the divisions themselves, the quantities and types of systems were derived from various literature searches, together with input from DIA and NGIC on how many systems regional opponents could have by the 2020 period. Again, we assumed that the enemy's divisional air defenses have suffered losses by the time the vignette takes place. The divisions along the FLOT are assumed to be at roughly 75 percent strength in air defense systems when the vignette starts. In this case, we assume 9 SA-15s, 12 2S6/SA-19s, 48 SA-18s, and 6 SA-13s per division deployed along the FLOT.

Figure 5.2 shows the locations of the high-altitude enemy air defense instituted in the scenario. The lower-quality air defense artillery (ADA) units are along the coast. As the enemy force advanced into the territory of the U.S. ally, lower-quality units (truck-mounted infantry, for example) were deployed along the coast to protect it against a flanking amphibious assault.

The air defense network is partitioned into three sections for analysis: the upper-left quadrangle is the Northern Sea air approach; the lower-right quadrangle is the Eastern cross-FLOT air approach; and the lower-West-Central quadrangle is the ground combat zone modeled in JANUS. Each of these areas was examined separately. The upper-right quadrangle was not considered as an air approach for analysis because of the extreme distances insertion aircraft would need to traverse and because it was assumed to be populated by air defenses of an adjoining enemy unit (not shown).

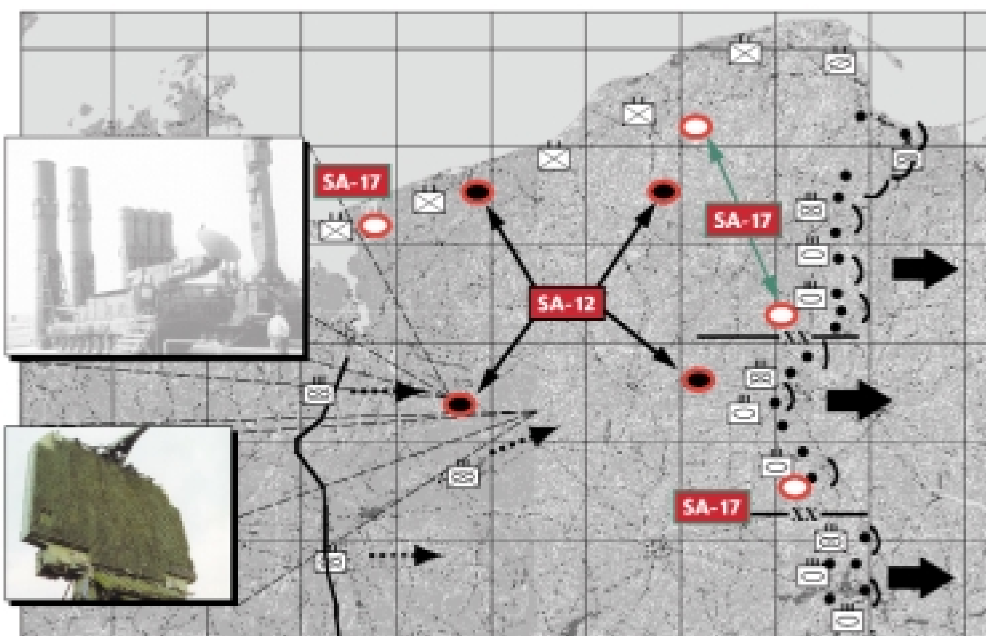


Figure 5.2—Location of High-Altitude Enemy Air Defense Systems

The enemy ground force. The composition of the enemy ground force unit—the lead enemy regiment of the division—is shown in Table 5.1.

Table 5.1—Red Force Mix in the Lead Regiment of Elite Division

Combat Element	Number
Tank	43
IFV	46
120mm mortar	12
C2V	35
M/CM	21
Stingray	4
IW 20	30
SA-15 ADU	6
2S6 ADU	12
RMRL	12
155 SP	12
Attack helicopter	36
Truck	300

This enemy regiment, one of three in the division en route to the front, is intended to be representative of a high-quality threat of the 2020–2025 period. It includes a mix of sophisticated ground vehicles (direct and indirect fire), plus supporting attack helicopters from its parent division. The regiment also includes powerful air defenses in the form of 2S6 and SA-15 self-propelled systems. Some of these air defenses may have been attached from division level.

How the Air Insertion Phase Was Modeled

The air transport modeled in CHAMP and RJARS for this analysis was a relatively large fuselage and employed tilt-rotor technology. Essentially, it was a C-130-sized aircraft, capable of carrying a large payload; see Figure 5.3. The data and input to the simulations was developed by RAND in coordination with the U.S. Army Aviation Research, Development, and Engineering Center and represents a projection of capability assuming appropriate investments in technology.[7]

The air insertion itself was assumed to take place during daylight hours with good weather. A total of 84 aircraft were inserted, with 42 using the northern, sea-air approach and 42 using the eastern, land-air approach. The aircraft were flown in a tight trail formation at approximately 200 feet in altitude and at a speed of approximately 240 knots.

Representation courtesy of Dr. Michael Sculley of Aviation-ARDEC.

Figure 5.3—Notional Tilt-Rotor Air Transport Aircraft

The air defense network operated in a completely autonomous C2 mode (weapons free—no integration). Aviators were given locations of all threats, except for MANPADs (SA-18s) and AAA. Neither tank main guns nor small-arms fire were modeled as threats, nor were anti-helicopter mines included in the threat array. IR countermeasure effectiveness was projected to the scenario time frame based on current technology trends.

Discussions with the Army aerodynamics engineers researching tilt-rotor signature issues led to rough estimates of this class of tilt-rotor transport's optical, IR, and radio frequency (RF) signatures.[8] Transport aircraft have typically not been designed to be stealthy; however, to analytically explore the potential contribution of stealth, we postulated that a prop-driven transport could have the signature characteristics of a low-observable (LO) helicopter.

The analysis entailed varying several key parameters expected to have a significant impact on mission outcome. Each set of aviators generated flight paths based on a given amount of situational awareness (SA) and a specific set of flight tactics. We then varied the level of SEAD and the aircrafts' IR and RF signatures in the RJARS model.

Table 5.2 shows the flight path locations and profiles considered. The aviators who flew the flight paths were a mixed group of RAND analysts and Navy and Army aviators. The run sequence was based on the availability of aviators. The set of flight paths generated enabled RAND to explore a large range of parameters.

Table 5.3 shows the 24 excursions examined during the analysis. Where possible, we first attempted to test either end of the envelope for each parameter before delving into the middle ground, where arriving at a point solution would be difficult at best. Through this process we attempted to draw more general conclusions about which parameters dominated the outcomes. For example, for the medium-level SA excursions, we first examined the baseline and LO signature cases without SEAD and with a high level of SEAD. From those outcomes, we could then determine whether the medium-level SEAD cases would offer additional information to the analysis. Similarly, in the high-level SA excursions, we first examined the baseline signature cases without SEAD and with medium-level SEAD, and from these outcomes we could determine whether the high-level SEAD case would provide additional information to the analysis. The note to Table 5.3 explains the different levels of situational awareness and SEAD.

Table 5.2—Flight Path Locations and Profiles Considered in Air Maneuver Analysis

Flight Path	Path Profile
Baseline	200 feet AGL/240 knots
Low and slow	50 feet AGL/60 knots
Low and fast	70 feet AGL/200 knots
Very low and slow	20 feet AGL/100 knots
Medium altitude	20,000 feet AGL/330 knots

NOTE: AGL is above ground level.

Table 5.3—Excursions Examined in the Air Maneuver Analysis

	Parameters Examined											
	Medium-Level Situational Awareness						High-Level Situational Awareness					
	No SEAD		Medium SEAD		High SEAD		No SEAD		Medium SEAD		High SEAD	
Flight Path Description	Base sig	Low sig	Base sig	Low sig	Base sig	Low sig	Base sig	Low sig	Base sig	Low sig	Base sig	Low sig
Baseline	✘	✘			✘	✘						
Low & slow	✘	✘			✘	✘	✘	✘	✘	✘	✘	✘
Low & fast							✘	✘	✘	✘	✘	✘
Very low & slow											✘	✘
Medium altitude							✘		✘			

DEFINITIONS: Medium-level SA provides intelligence on 50 percent of SAMs (type and location). High-level SA provides 100 percent intelligence. No SEAD means all air defense units are active. Medium SEAD means SA-12s and SA-17s are removed. High-level SEAD means SA-12s, SA-17s, SA-15s, and 2S6s are removed. Base signature corresponds to a large-body aircraft. Low signature corresponds to a notional low-observable helicopter.

How the Ground Combat Phase Was Modeled

In terms of the ground combat phase, we modeled RSTA and C2 capabilities, and the three operational concepts with varying levels of maneuver discussed above.

Modeling RSTA and C2 capabilities. RSTA and C2 capabilities tend to result from interactions of many factors, such as search areas and sensitivities of overhead assets like JSTARS and satellite sensors, inputs from signal intelligence (SIGINT), electronic intelligence (ELINT), and other indicators collected from air and ground platforms, degradations from communications relay delay times and losses, and effects of weather, terrain, and countermeasures. For simplicity, we postulated three parametric levels for RSTA and C2 capabilities, established by expert consensus, allowing us to roughly assess the importance of improvements in each of these. These are shown in Table 5.4.

The lowest level of RSTA was set to be similar to current-day operations. No foliage penetration was assumed, about 40 percent of targets in the open could be detected and

Table 5.4—Assumed RSTA and C2 Capabilities

Assumed RSTA Capabilities			
Level/Measure	**Low Level**	**Mid-Level**	**Near-Perfect**
Coverage foliage/open Accuracy/Discrimination Latency/update interval	0/40% 200m/detect 5 min/continuous	20%/70% 100m/recognize 1 min/continuous	100%/100% 1m/identify real-time/ continuous
C2 Capabilities			
Level/Measure	**Nominal**	**Fast**	**Instantaneous**
Fusion Delay	100% 30 min	100% 5 min	100% None

located, but not recognized, and the time from detection to receipt of the information at the command center is five minutes. It should be noted that enemy vehicles passed through many canopied areas even while they were on roads. The mid-level RSTA improves the low level to 20 percent foliage penetration (FOPEN), 70 percent in the open, recognition rather than detection only, and the time of receipt drops to one minute. The near-perfect case was instituted to determine the extreme case: complete coverage at high accuracy, discrimination, and timeliness.

C2 capabilities also started low, with a 30-minute delay for processing the information, deciding how to engage, and passing commands to a shooter. Fly-out times of the munitions are in addition to this. The mid-level drops the C2 delay to 5 minutes, and the bounding case has no time delay.

Ground operational concepts modeled. The three operational concepts considered vary the overall level of maneuver and type of force application (although all cases rely heavily on the aggressive use of standoff attack). The first concept concentrates solely on standoff attack, using B-2 and F-15 delivered JSOW and Navy and Army versions of TACMS cued by observers on the ground. These long-range weapons attempt to stop the advance of the elite enemy units.

The second concept involves the insertion of a consolidated force (an advanced infantry battalion with two immediate-ready companies (IRCs) to the standoff fires. This insertion requires establishing a lodgment and securing airfields for C-17s. Once in, the force flanks the enemy unit. The hope is that the enemy force will perceive this as a serious threat and turn to attack in response, thus delaying the enemy's march toward the front line to the east.

The third concept changes the picture to one of dispersed U.S. forces inserted deep to disrupt and attrit the enemy force throughout the battlespace. This concept was developed by SARDA but is also shared by TRADOC through its AAN and Mobile Strike Force research. In this particular application, a small ten-team force using three of the seven types of vehicles specified in the SARDA concept were employed. We also considered a variation of this concept, where instead of using the agile maneuver forces against the enemy's combat forces, these forces concentrate on the "softer" logistics and supply vehicles.

Measures of effectiveness. Assessments often concentrate on enemy attrition (and own losses) as the primary measure of effectiveness (MOE) in modeling and simulation. The dynamics of the ground battle in this analysis are such that disruption of the enemy operation—denying him the ability to move or resupply, slowing his progress, dispersing his forces, or degrading his coordination capabilities—may be as important as attrition. Shock effects (heavy losses over short time, in small areas, or of key systems) may also disrupt the advance.

The degree of disruption MOE still needs considerable refinement. Here, we use the simulation environment to help provide context for thinking about the disruption aspect of the mission in our scenario:

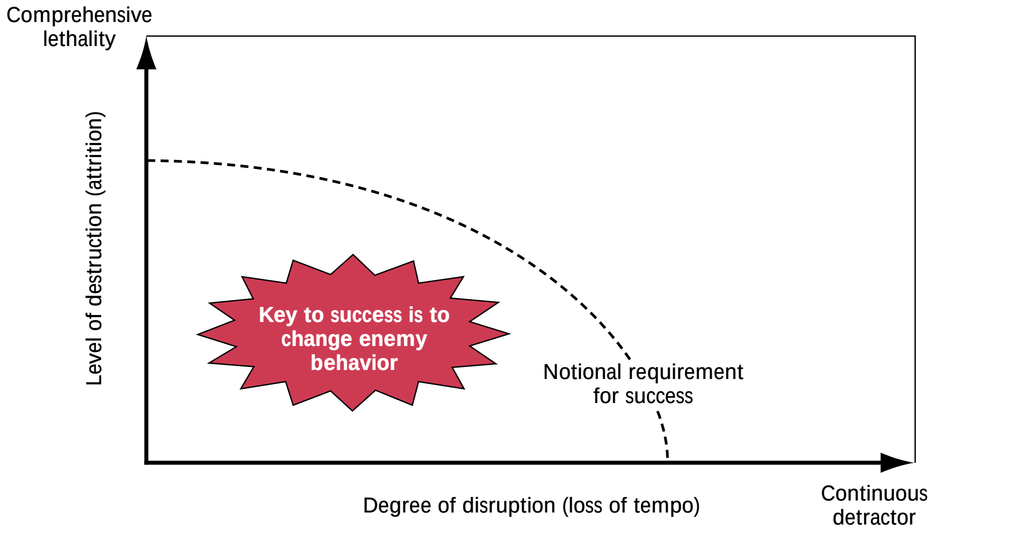


Figure 5.4—Measures of Effectiveness in Analysis

- Can the forces be inserted and extracted?
- Can they find good, soft, "support" targets?
- What is the impact of engaging moving combat-support vehicles?
- Can forces materially influence the effects of long-range fires? (What do "eyes on the ground" add?)
- Can forces do direct attack on enemy combat forces?
- How important are (1) tactical mobility, (2) RSTA, (3) organic weapons, and (4) long-range fire's responsiveness?

Thus, in presenting the analysis results, we attempt to characterize the outcomes of the scenario along two major dimensions: level of destruction and degree of disruption. As shown by the dotted curve in Figure 5.4, some combination of these two factors should be sufficient to change enemy behavior.

Experiencing the Vertical Envelopment Concept

THINGS HAD BEEN REALLY HECTIC. As he sat in his vehicle, the lieutenant wondered how long he had gone without sleep. But now he could rest knowing that it had been a highly successful day.

Many hours earlier, the company commander called the officers and key NCOs together to explain the upcoming mission to them. They all knew the war was now about six days old. Reports indicated that although the enemy had made deep penetrations into allied territory, it was almost certainly losing momentum. The commander said that this was the time to strike. They were to load the wait-

ing air transports for a move against the enemy. The plan called for the Marines to seize a lodgment along the coast into which they would deploy and then attack. The target, they were told, was an enemy division heading toward the front line to try to get the enemy's advance back on track. This would mean that they would have to overfly some parts of enemy airspace to accomplish their mission. Not a pleasant thought. Using a medium-altitude corridor created just recently by an aggressive joint SEAD campaign, they were able to get the transports in without major event. The Weasels were up just in case any emitters came on line.

After a relatively short two-hour flight, the lieutenant's transport augured down into the airfield, located in a small port city. Waiting for them were guides from their unit and some Marines. The Marine Expeditionary Unit (MEU) had seized the port several hours earlier and pushed far enough inland to make sure the airfield was safe from any man-portable air defense missiles. Now came transport after transport, 84 in all, hustling in and out of the airfield as fast as possible.

The captain came over to say that the company was assembling in the fields near the church. All platoons were to double-check their communication gear and plug into the UAV net. Several of the unmanned aircraft had already been vectored off to examine the roads they would take toward the enemy division, which was about 50–60 kilometers to the south. No time to lose: the attack had to get going before the enemy could react to it. As he moved his platoon into the assembly area, the lieutenant heard Marine artillery firing and saw Navy jets streak in over the coast, heading south toward the enemy division.

After less than 30 minutes on the ground, the company was on its way. They passed beyond the Marine lodgment and headed south in platoon groups. Four companies, maybe 50 vehicles, were headed along three different routes. As his vehicles moved along the road, the lieutenant could see their progress on his command digital display. He soon started to see "red" icons on the screen—the UAVs were finding targets. Minutes later, he heard the supersonic roar of TACMS overhead. They had come either from the ships offshore or from his unit's HIMARS that had arrived via air.

After about 30 minutes of road marching, the command display started to light up. The lead company was in contact farther up the road. Minutes later, orders from the company commander arrived, directing his platoon to take a different road, farther to the west, to bypass the fight up ahead. No need to get bogged down there.

Nearly an hour went by. No contact yet—just frightened civilians looking out of their windows as the platoon passed a couple of small villages. Attack helicopters flew overhead, heading toward the enemy. Glancing at his display, the lieutenant could see that the foe now appeared to be about 15–20 kilometers away. The fight was already in progress elsewhere—two companies were in contact. Then a new digital message arrived from the company commander: "1st Platoon assume BP 1 by 1400 hours. 2nd Platoon assume BP 2 at same time. 3rd Platoon prepare to attack the enemy west of BP 3, on order." That meant him—be prepared to attack enemy west of battle position 3. The message was relayed to his four sergeants in the other vehicles. Darting

They all knew the war was now about six days old. Reports indicated that although the enemy had made deep penetrations into allied territory, it was almost certainly losing momentum.

along another road, the lieutenant took his platoon behind a hill about 5 kilometers from BP 3. Still no enemy.

Just as his platoon was getting into its hide position, he heard firing from about 3–4 kilometers away. It was 1st Platoon. A quick glance at the display showed its vehicles. They were in contact. He could see on his screen "info copies" of calls for fire that 1st Platoon and the company commander were generating. For 10 minutes or so, there was heavy firing in the area of BPs 1 and 2. The reports indicated that the company was fighting part of an enemy mechanized battalion—maybe more. Apparently the enemy had been largely taken by surprise to find American light mechanized units so far in his rear area. Now the fight was on.

Suddenly the voice command net came alive. It was the company commander: "Get to BP 3 now and attack the enemy along the road. The UAVs show that the battalion trains of this enemy unit are hung up along that road. I'll keep the head of the enemy column busy from here. You have to be in and out before 1500—fighters are inbound to hit the road after that." A quick message to the four sergeants was all it took to get the platoon moving around the hill toward the road. The rest of the company was now about 5–8 kilometers to the east, engaged with the enemy's combat vehicles. The lieutenant knew that his target was vulnerable trucks and supply vehicles.

Leaving the road, now bounding cross-country, the platoon navigated through the data it was receiving from the overhead UAVs. The fight to the east was clearly shown on the screen. Now he could also see the red icons of vehicles stopped on the road leading back to the west. Only a couple of minutes to go now. He sent two of his vehicles into the woods to pop out as they reached the top of a small ridge overlooking the road. He then led the other two vehicles back down onto the road and headed toward the enemy vehicles. Hopefully they were trucks, not stopped APCs or other fighting vehicles.

As he pulled out onto the road he spotted them. A line of trucks parked up against the trees, just off the road. They were about 900–1,000 meters away. "Gunner, fire at will," he barked into the microphone. "Engaging," was the terse reply he heard on his headset. The 35mm chain gun roared as the lead enemy vehicles burst into flames. The other two vehicles followed him onto the road and opened fire. More trucks went up in flames as they sprinted toward the enemy column, closing the range to less than 500 meters. Troops could be seen piling out of the burning vehicles, running into the woods.

Suddenly, he saw more tracers hitting the column from up on the ridge. It was his other two vehicles coming out of the woods. Raking the enemy column, they maneuvered down the slope to join the rest of the platoon. As they reached the road, there was an explosion on one of his vehicles, inflicted by an enemy soldier with a shoulder-fired anti-tank weapon. The vehicle skidded to a stop. The three crewmen started to get out under covering fire from the rest of the platoon. Meanwhile, the lieutenant called for indirect fire farther down the road.

As the three crewmen climbed aboard one of the other vehicles, the lieutenant ordered the platoon to withdraw. They had been in contact with the enemy for less than five minutes. He took a quick count. About 20 enemy trucks were destroyed, plus a couple of armored command vehicles, and *two towed air defense guns. He had lost one vehicle. The crew had escaped, thanks to the new Kevlar composite internal protection system that gave them excellent personnel protection. Now it was time to get away—the fighters would finish the job.*

By that evening, the task force was returning to the USMC perimeter, which had been expanded while they were off on their mission. The 50 vehicles in his battalion, working with their supporting fighters, helicopters, and missiles from the nearby ships, had hit the enemy division hard in its flank. Probably 250 enemy vehicles of all types had been destroyed, all for the loss of about a dozen vehicles (mostly unmanned robotic vehicles) and three helicopters from his task force.

After-Action Review for the Vertical Envelopment Concept

As we saw in the previous section, once inserted, the notional ground force was very effective in disrupting the enemy regiment by destroying its softer support units. Here, we provide the analysis results for both the air insertion and several different kinds of ground combat with various levels of maneuver.

The Air Insertion Phase

The first challenge for the vertical envelopment operation was the air insertion, in which air transports must penetrate enemy airspace and land in contested areas. Even with the help of future technologies, this is envisioned to be a very difficult mission. Table 5.5 summarizes the results of the 24 air maneuver excursions shown earlier in Table 5.3. A cursory examination of the results of missions requiring penetration of enemy airspace yields the following general observations:

- SEAD is a critical part of the insertion mission.
- Greater SA can improve survivability, except when enemy air defense systems are not disrupted.
- Stealth by itself tends to lose its effect at slow speeds.
- Slower flight speeds allowed lower altitudes to be obtained during penetration of enemy airspace
- Extreme combinations of stealth, SA, SEAD, and flight tactics may be needed to achieve survivability at low altitude.
- With SEAD of high-level enemy air defenses, medium-altitude penetration becomes an option for deployment of force.

While none of the observations proves remarkable or counterintuitive, the results do demonstrate a consistency across all the excursions. Below we show the results of the different flight paths flown by the different operators.

The baseline paths. Figure 5.5 illustrates, for the base case, the attrition of the airframes over time and by air defense system. This figure reveals that in this scenario the SA-12 is the most dangerous threat to the airframes, followed closely by the 2S6 and the SA-15. The two approaches led to the transport aircraft being exposed to different ADA

Table 5.5—Results of Excursions Examined in the Air Maneuver Analysis (Percent Transports Surviving)

	Parameters Examined											
	Medium-Level Situational Awareness						High-Level Situational Awareness					
	No SEAD		Medium SEAD		High SEAD		No SEAD		Medium SEAD		High SEAD	
Flight Path Description	Base sig	Low sig	Base sig	Low sig	Base sig	Low sig	Base sig	Low sig	Base sig	Low sig	Base sig	Low sig
Baseline	0%	0%			0%	25%						
Low & slow[a]	40%	57%			93%	98%	62%	79%	79%	88%	93%	100%
Low & fast							19%	63%	56%	87%	56%	87%
Very low & slow											62%	87%
Medium altitude							0%		100%			

DEFINITIONS: Medium-level SA provides intelligence on 50 percent of SAMs (type and location). High-level SA provides 100 percent intelligence. No SEAD means all air defense units are active. Medium SEAD means SA-12s and SA-17s are removed. High-level SEAD means SA-12s, SA-17s, SA-15s, and 2S6s are removed. Base signature corresponds to a C-130 sized tilt-rotor. Low signature corresponds to a notional low-observable helicopter.

a Over-water-only cases.

systems. The transports flying in from the ocean were well within the range of a SA-12 and several SA-15s before landfall. Roughly 90 percent of the transports were destroyed before they traveled 10 kilometers in from the coast. SA-15s were able to attrit the rest as they progressed inland. The transport aircraft across the FLOT were later shot down by a combination of 2S6s, SA-15s, SA-17s and SA-18s. The 2S6s shot down roughly half the transports flying cross-FLOT.

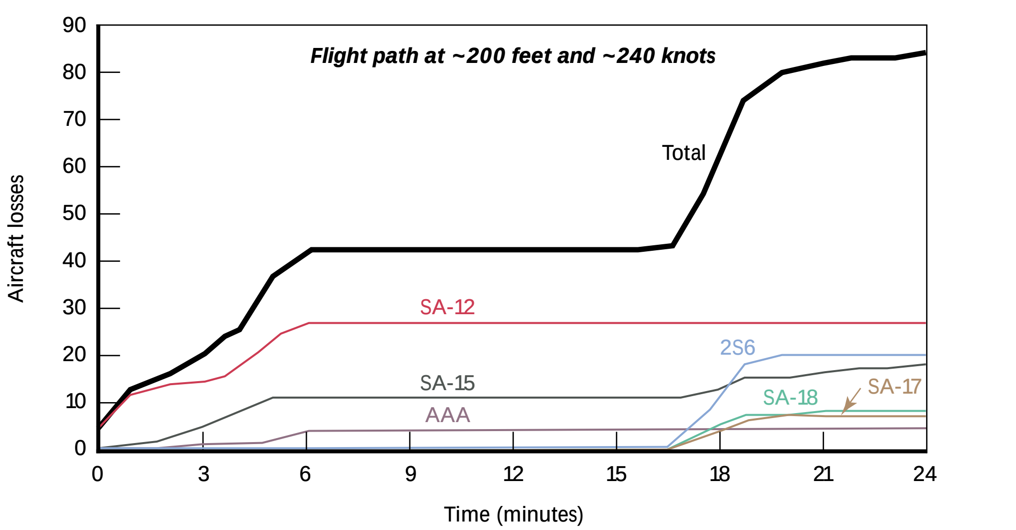


Figure 5.5—Attrition Rate Over Time in Base Case

Running the base case with a notional signature reduction (results shown in Figure 5.6) did not change overall mission survivability.[9] This was because the SAM radars were still able to pick up the signature assumed for the aircraft. The acquisition ranges were limited more by the terrain than by the radar signature of the aircraft. In both assumed signature cases, RF SAM kills occurred at ranges significantly less than the RF missiles' maximum ranges because of the low altitude at which the aircraft were flying.

Thus, increasing the amount of SEAD alone did not tend to change overall mission survivability (in this case, we assumed away all SA-12s, 15s, and 17s). However, it was interesting to note that the base-signature aircraft did survive longer. Again, we used a representative "best case" signature to bound the problem. In this case, we were able to get some realized survivability gains (about 30 percent of the airframes survived).

One other option to increase aircraft survivability is to clear flight corridors for ingress and egress. From an aviation tactics standpoint, all known SAM sites along the flight path would have to be suppressed to make the mission a "Go." We note that even in this case, mission success is not guaranteed. Additional tactics and technology are needed. Combining aggressive SEAD and stealthy aircraft enabled some aircraft to survive the mission. While the attrition rate was high, the notion of combining several survivability-enhancement techniques clearly had merit.

Low and slow paths. To measure the effect of flight paths, we examined how reducing altitude (and speed) would affect aircraft survivability. With these new sets of paths, we started by examining the outcomes of excursions grouped by various SA levels. Here, we noted that increased SA reduced the effectiveness of the emitting SAMs because the pilots were able to avoid or reduce their exposure to known SAM locations. In this case, we examined only the group of transports flying in from the ocean: the low and slow

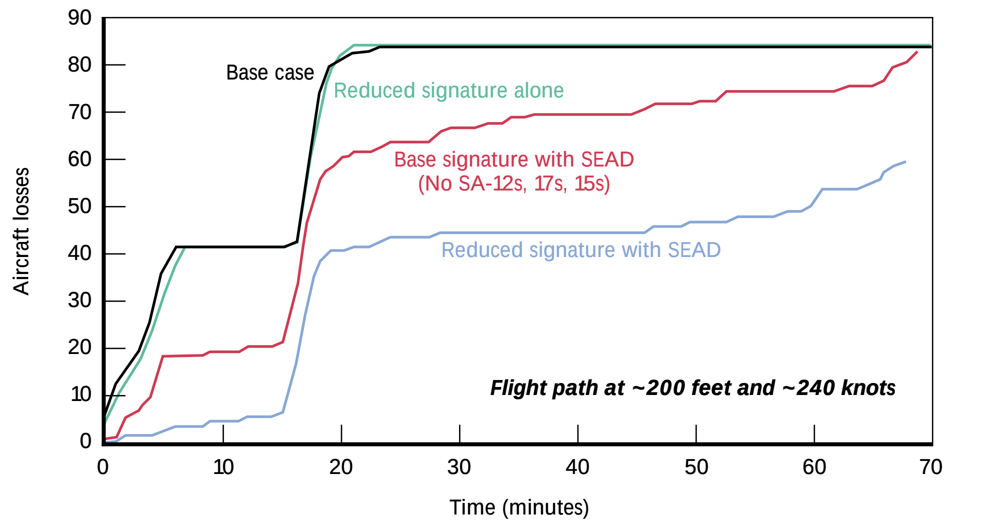


Figure 5.6—Effect of Reducing Signature and Increasing SEAD on Base Case

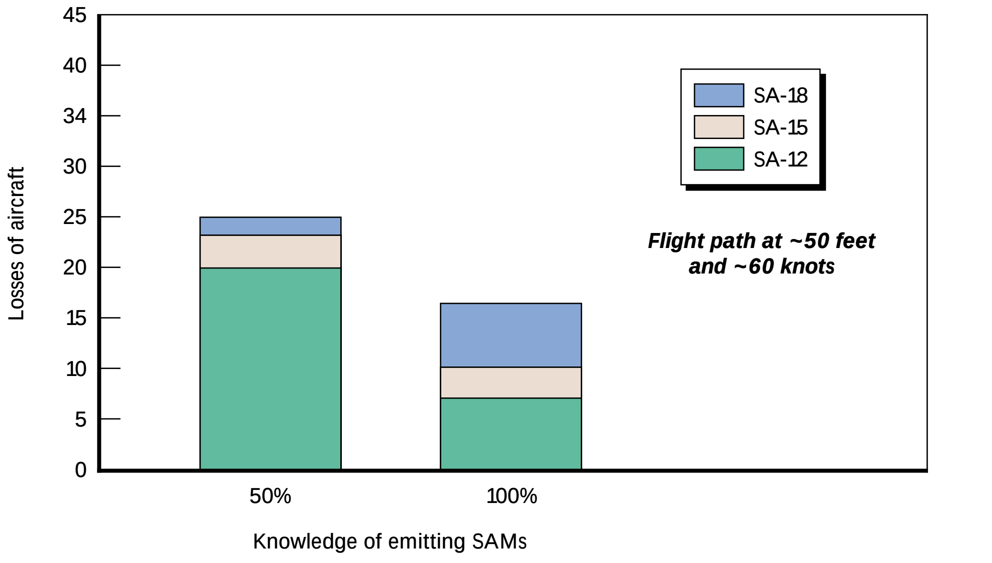


Figure 5.7—Effect of Increasing SA (Knowledge of Location of Emitting SAMs) on Low and Slow Case

case (see Figure 5.7). The pilot attempted to either fly around or under the RF SAM sites that appeared on the flight planning aid (CHAMP).

The limited aerodynamics of the transport aircraft resulted in some SA-12 kills, even when the pilot knew where all the SA-12s were, because the aircraft could not totally avoid two SA-12 missile sites. The SA-12's target acquisition radar can detect a two-square-meter aircraft at over 250 kilometers.[10] SA-12 missiles can engage targets at 100-kilometer ranges. It is therefore not surprising that over a 250-kilometer path traversing enemy-held terrain, active SA-12s have multiple opportunities to engage the transport aircraft examined here.

The next series of runs—shown in Table 5.6—examined the effects of variable levels of SEAD. When the SA-12s, 15s, and 17s were suppressed, mission survivability was significantly increased. The SA-12 and SA-17 are not easily jammed and will, therefore, require an aggressive SEAD campaign. SA-15s can be jammed, but enemy tactics and improved versions of the SA-15 could make jamming of the missile more difficult. Also noteworthy, the use of a jammer against radar may have a countereffect, since it can represent a beacon to cue optically guided ADA such as AAA and IR SAMs. Other ADA assets such as the 2S6 will switch to the AAA mode when jammed. Also, systems like the 2S6 and SA-15 can switch from radar to optical mode, using (conditions permitting) optical target acquisition and engagement when radar emissions have been jammed. There were very few non-RF ADA systems defending the coastline, and as the table clearly shows, only the SA-18s were able to successfully engage the air transports when the high-end SAMs were suppressed.

Table 5.6—Effects of Variable Levels of SEAD on Mission Survivability: Low and Slow Case

Air Defense System	No SEAD	No SA-12, SA-17	No SA-12, SA-15, SA-17	No SA-12, SA-15, SA-17, Stealth
SA-12	6	0	0	0
SA-17	0	0	0	0
SA-15	3	5	0	0
SA-18	7	4	5	0
2S6	0	0	0	0
AAA	0	0	0	0
Total losses	16	9	5	0

42 air transports flying in from the ocean.

Use of stealth further increased mission survivability. The lower-IR signature of the aircraft led to no losses to the SA-18s. The use of very good situational awareness, effective SEAD, and stealthy aircraft makes this type of mission even more feasible. The main challenge would be to locate the majority of enemy active and passive air defense systems as the mission was being planned and then get continuous real-time updates while the aircraft are in flight.

Two distinct observations were noted in conducting the analysis with these flight paths. First, the flight speed was slow, less than 60 knots. In the future, ground vehicles could possibly drive to the landing site in a comparable amount of time. Second, the ADA environment was relatively free of optical ADA systems, not necessarily expected in a mission flying over a front-line enemy division (cross-FLOT).

Low and fast paths. We also assessed the survivability of the air transport force with a faster ingress speed. Presumably, if aircraft must fly over terrain, they will have greater difficulty maintaining low-altitude flight; as a result, they could either fly faster at some cost in altitude or fly much slower. This set of cases focuses on the faster ingress option.

Table 5.7 shows the results of these cases. The cross-FLOT mission was successful in avoiding SA-12s, SA-15s, and 2S6s because of good SA of their location. The large number of SA-18s and AAA, however, limited mission survivability. Stealth significantly reduced the number of aircraft attrited by these systems. Still, a 20 percent attrition rate

Table 5.7—Effects of Variable Levels of SEAD on Mission Survivability: Low and Fast Case

Air Defense System	No SEAD	No SA-12, SA-17	No SA-12, SA-15, SA-17, Stealth
SA-12	0	0	0
SA-17	16	0	0
SA-15	0	0	0
SA-18	15	14	7
2S6	0	0	0
AAA	11	14	1
Total losses	42	28	8

42 air transports flying cross-FLOT.

is likely to be unacceptable. IR jammers and SEAD against AAA sites could reduce the attrition further, potentially to acceptable levels. Small-arms fire, as well as tanks and BMPs, were not included in this model and could significantly raise the number of losses. Tactics and technologies for dealing with the optical and IR air defense threats may need to be developed for these flight paths.

Very low and slow paths. One other approach is to bring the flight paths very close to ground level. Here, the transports are assumed to have capability that would allow them to "hug" the terrain. Paths started out with 42 aircraft punching through one point along the coast and 42 aircraft punching through one point of the FLOT. After the initial ADA penetration, each group of 42 split into 3 groups of 14. Paths were similar to previously presented cases. (Exceptions to this were the 20-foot AGL and 100-knot speed versus the previous case's 240-knot, 70-foot AGL.) Paths from the ocean punch through at the SA-17 site, which was destroyed before the transports entered the area. Cross-FLOT paths went through the city/town slightly in front of the FLOT and between SA-15s on either side of the town.

The aviators from the U.S. Army Aviation School developed TTPs based on the very specific assumptions shown below.

- Extensive reconnaissance prior to the mission.
- All emitters' positions known.
- Some fraction of nonemitter ADA assets known.
- Some fraction of enemy ADA will move during the insertion mission.
- High-end SAMs, C2, and airborne radar platforms are suppressed.
- Real-time intelligence is provided to attack aircraft.
- Aircraft would fly at night/dusk to limit the effectiveness of optically guided ADA.
- All aircraft make maximum use of SIRFC.
- Fixed-wing activity will diffuse the focus of threat ADA.
- Air Force and Navy will be flying tactical and/or operational missions during insertion.
- Flight paths will be 20 feet above the ground and at 100 knots over suspected RF SAM covered/engagement areas.
- Transports will fly in groups of 14 in a tactical trail formation with a 50-meter separation.

The results of the excursions employing these TTPs are shown in Table 5.8 and are comparable to cases already flown and examined (specifically those cases with high SA, high SEAD, and stealth). Again, the limiting factors were the optical and IR air defense threats.

Medium altitude paths. One other method of countering the effects of low-altitude air defense systems is to fly above their engagement envelopes. These sets of paths were

Table 5.8—Mission Survivability Levels: Very Low and Slow Case

Air Defense System	Ocean	Cross-FLOT	Ocean and Stealth	Cross-FLOT and Stealth
SA-12	0	0	0	0
SA-17	0	0	0	0
SA-15	0	0	0	0
SA-18	10	11	5	4
2S6	0	0	0	0
AAA	2	9	0	2
Total losses	12	20	5	6

42 air transports per mission (ocean or cross-FLOT); flight path at 100 knots, 20 feet above ground level over land.

flown above the range of AAA, MANPADs, 2S6s, and SA-15s, generally 20,000 feet or higher.

The strategy of flying above the range of low/medium-range SAMs was used successfully during Desert Storm. As long as the high-altitude SAMs are suppressed, this strategy works. For vertical envelopment tactics performed by Army units, the challenge would occur when aircraft had to descend toward their landing zones. This implies that for a portion of the mission, the aircraft could be in the range of the short-range SAMs, MANPADS, and anti-aircraft guns. If these two problems can be dealt with, (e.g., sterilization of the landing zones), then this medium-altitude ingress is clearly a viable approach.

Summary of Results for the Air-Insertion Phase

Analysis of the data from the ingress excursions yields the following insights:

- With low-altitude ingress and with some situational awareness of emitter locations, the aircraft can avoid SA-12s, and some SA-15s, SA-17s, and 2S6s. In our postulated enemy ADA scenario, not all RF SAM systems could be avoided.
- High levels of SEAD will be needed to countermeasure emitting air defense systems. Even one long-range RF SAM site can inflict significant damage to the AAF squadron.
- Stealth and large amounts of responsive SEAD are required to counter the effectiveness of AAA and MANPADs during low-altitude ingress.
- Flying through areas of higher-density AAA and MANPADs (such as that encountered in the cross-FLOT) will lead to relatively high (approximately 20 percent) aircraft losses.
- Mid-altitude ingress is a viable option if the long-range SAMs can be suppressed and the landing area secured from AAA and MANPADs.

The Ground Combat Phase

We separately examined three different maneuver concepts for the ground combat phase, assuming that the air-insertion phase was successful.[11]

Maneuver Case 1: standoff attack operation. The stages of the first concept are delineated in Figure 5.8. Generally, a joint-SEAD (JSEAD) operation aided by Special Operations Forces (SOF) opens air corridors to the target units. Army aviation is used to bolster the coalition defense along the forward edge of battle area (FEBA). Naval missile fires from the amphibious ready group (ARG) concentrate on the lead and northern enemy units, while air strikes (B-2 and F-15 with JSOW) attack the lead and southern units. The primary objective is to attrit the units sufficiently so that they cannot close with the units in contact.

Specific phases of the battle plan are as follows:

- U.S. air/helicopter/ground assets combine with coalition SEAD to open air corridor(s). SOF are inserted to provide human intelligence (HUMINT) and BDA.
- Army attack helicopters destroy a motorized rifle regiment (MRR) in center tank division along FEBA. U.S. infantry conducts infiltration in support along with limited air support and field artillery (FA). Marine expeditionary unit (MEU) seizes a beach on the north coast. U.S. air attacks are intended to attrit and slow lead and northern MRRs (priority on lead).

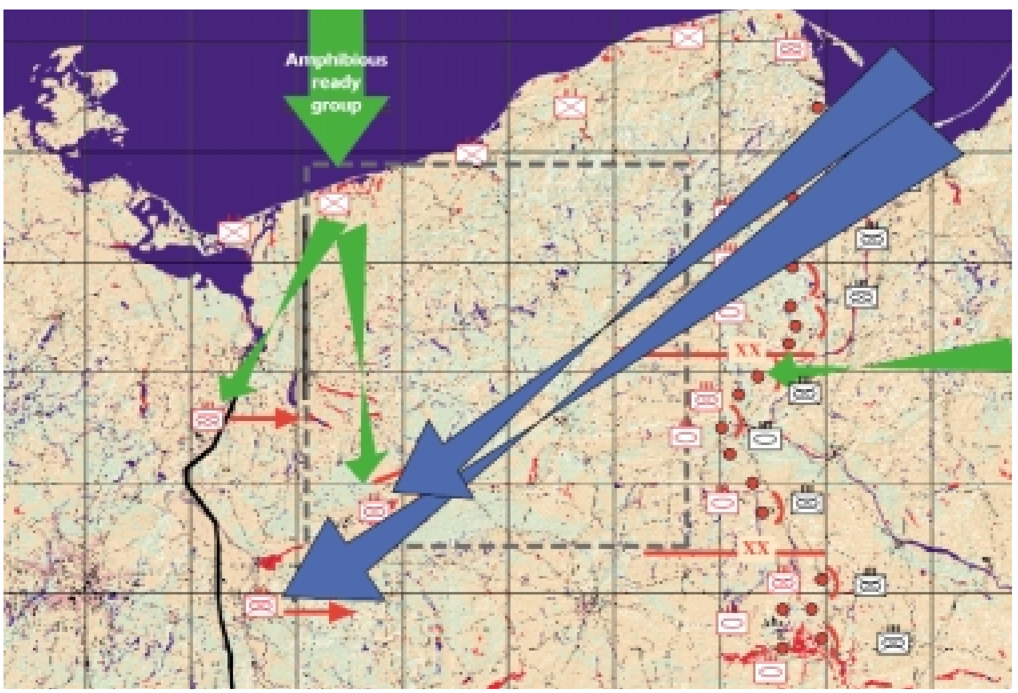


Figure 5.8—Depiction of Maneuver Case 1: Standoff Attack Operation

- MEU attacks to defeat northern MRR. U.S. air shifts priority of attack to defeat southern MRR (80 percent) and continues to attack lead MRR.
- MEU continues attack on northern MRR. Air attack continues against southern MRR.

For Case 1, the planners set up separate engagement zones for aircraft and missiles. This was done to ensure deconfliction of the assets. The aircraft launch their JSOW canisters from as much as 70–80 kilometers away, but this is still in the envelope of the long-range, high-end air defense systems, such as SA-12 or SA-17. Accordingly, we assume JSEAD is successful against these systems. The planners still have a difficult task targeting the smart munitions, since there are only limited open areas between covering foliage and some amount of lead must to be programmed into the targeting points to compensate for the weapon's long (10-minute) fly-out time.

The TACMS missiles also have difficulty with overhead cover and have a similarly long fly-out time, since they are typically fired at almost maximum range. These weapons, equipped with brilliant submunitions, home in on the louder targets, such as tanks and BMPs.

Table 5.9 shows the conditions for TACMS engagements for six different Case 1 excursions (A–F) involving the different levels of RSTA and C2 shown earlier in Table 5.4. Each excursion varied the level of detection probability (low, medium, and high) in both foliage and open areas. The timeliness of information (latency), engagement method decision time, and time of flight were also varied in each excursion. Only in cases of perfect information (high) was BDA used in target planning.

Targeting methodology included the following steps:

- Decide: location and number of missions fired determined by expected high-priority target (HPT) consisting of six or more armored vehicles and targets of opportunity.
- Detect: track all HPTs or targets of opportunity for engagement in open areas along the three major avenues of approach.
- Deliver: fire missions into target areas with calculated lead time to interdict HPT or targets of opportunity. Each JSOW contained two submunitions.

Each fire mission used two TACMS per engagement with multiple submunitions.

Table 5.10 shows the results of the six excursions in Case 1. Terrain and composition of target sets had a significant effect on TACMS efficiency. Advantages from better intelligence on enemy forces were hindered by suitable target areas (open terrain) and ineffective destruction of vehicles with low acoustic signatures (combat support (CS) vehicles). However, more TACMS were fired in cases with better intelligence because the target methodology was used to engage HPTs and targets of opportunity. All told, the percentage of total kills (both combat and CS) was much higher for the TACMS than for the JSOW, ranging from 33 percent to 80 percent versus 28 percent to 30 percent.

Table 5.9—Conditions for TACMS Engagements

Excursion	Prob (Tree)/ Prob (No Tree)	Latency (min)	BDA	C2 Delay (min)	Time of Flight (min)	Total Lead Time (min)	Remarks
A	0/.4 (Low)	5	No	5	10	20	Sensor to HQ to shooter
B	.2/.7 (Med)	1	No	5	10	16	Sensor to HQ to shooter
C	1/1 (High)	0	Yes	5	10	15	Sensor to HQ to shooter; BDA used
D	0/.4 (Low)	5	No	0	10	15	Sensor to shooter
E	.2/.7 (Med)	1	No	0	10	11	Sensor to shooter
F	1/1 (High)	0	Yes	0	10	10	Sensor to shooter; BDA used

Table 5.10—Results for JSOW and TACMS Engagements

Excursion	JSOW Fired	JSOW CS Kills	JSOW CBT Kills	Total JSOW Kills	TACMS Fired	TACMS CS Kills	TACMS CBT Kills	Total TACMS Kills
A	144	33	7	40 28%	40	2	16	18 45%
B	144	34	6	40 28%	60	1	19	20 33%
C	144	33	7	40 28%	68	2	21	23 34%
D	144	34	6	40 28%	40	3	29	32 80%
E	144	34	6	40 28%	48	1	25	26 54%
F	144	33	10	43 30%	68	4	32	36 53%

As shown in Figure 5.9, the greatest effect on the enemy appears to be in excursions D–F (shortest lead times), when the Red combat vehicle force was degraded by more than 12 percent. However, although the combination of improved intelligence and shortened "lead times" significantly improved the TACMS targeting effectiveness, the level of total Red attrition from TACMS and JSOW kills never rose above 15 percent. Under the most advantageous conditions, the maximum level of attrition in Case 1 was not sufficient to prevent Red forces from conducting future MRR-level combat operations, in which Red should be able to continue toward its objective.

It should be noted that standoff attack might be improved by using other tactics, such as riskier, low-altitude delivery of weapons, or by using orbiting alternative munitions. These options were not examined in this study, but we would expect them to be complicated by issues of SEAD, survivability, and deconfliction.

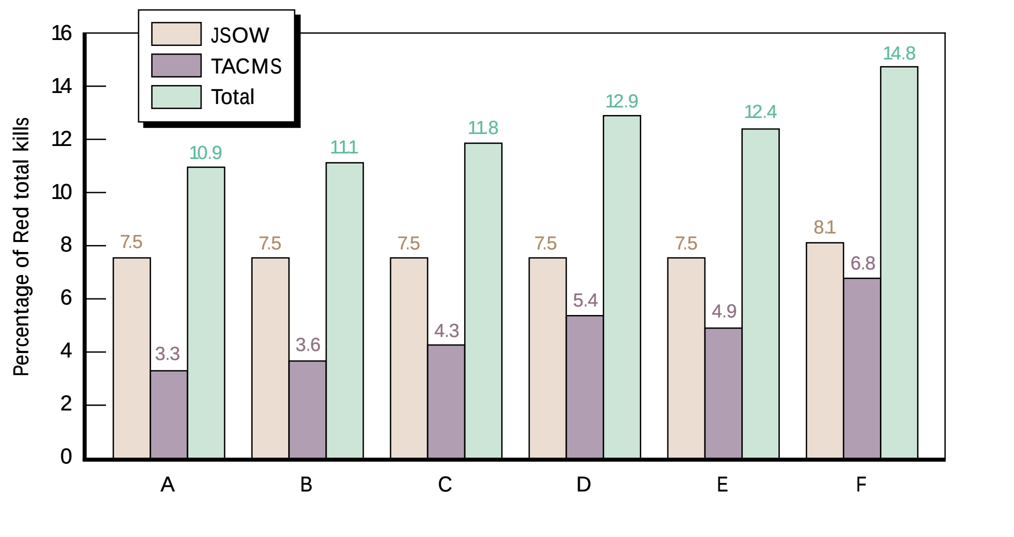


Figure 5.9—Total Percent of Red Kills in Each Case 1 Excursion

Standoff attack did poorly in this scenario. This cannot be attributed to RSTA and C2 capabilities, however, because even in the bounding case (comprehensive information, high level of accuracy, continuous update, no time delay), an average of less than one kill per weapon was achieved. This inefficient performance could be traced to many underlying factors, several of them scenario-related, such as the degree of threat dispersion (ability of the threat to "reshape itself" to appear to be a less lucrative target) and the level of foliage on the terrain. Most of the factors had to do with the relatively long time-to-target associated with the use of these weapons at range. Others had to do with the logic associated with multiple submunition weapon systems.

Figure 5.10 summarizes the results of Case 1 by plotting the outcome on the destruction/disruption axes discussed earlier. We find that standoff attack achieved a limited amount of attrition (killing 62 to 79 of the 550 enemy systems in the lead regiment, broken out in Table 5.2). This level of attrition was found to increase strongly if foliage was omitted. We found, for example (in a separate "bald earth" run) that 195 kills were obtained. On the other hand, enemy countermeasures such as the use of decoys, active protection systems, and force dispersion could reduce the number of kills below that achieved earlier.

In all these cases, the enemy might suffer little disruption. The standoff strikes seldom hit specific, high-value vehicles, such as C2 or bridging assets, and do not have a localized "shock" effect. Rather, they attrit sporadically along the column, and the hulks would be expected to provide little obstacle to movement, particularly in this trafficable terrain. Only in the case with no cover would significant disruption be expected. These results suggest that firepower alone, operating in the absence of friendly maneuver units, would be limited in its ability to stop a rapidly advancing enemy force.

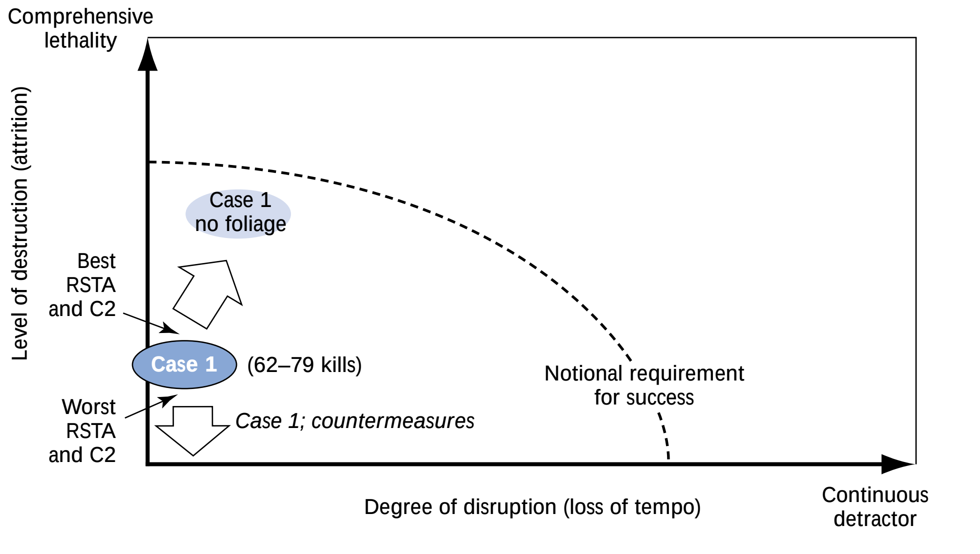


Figure 5.10—Summary of Case 1 Results

Maneuver Case 2: standoff weapons and ground insertion to block key reserve division. As shown in Figure 5.11, Case 2 also carries out the JSEAD and standoff attack missions, but it adds the insertion of a cohesive ground force. The ground force is made up of a MEU and an airborne infantry battalion augmented with future systems such as EFOG-M, LW-155, Outrider (a small tactical UAV), and ADAS. The airborne battalion is augmented by two immediate-ready companies (IRCs), which together have 4 M1s and 4 M2s. The MEU first establishes a lodgment at the coast, enabling the Army ground force to be inserted to the flank of the lead elite enemy regiment. By enhancing their apparent size with deception devices, the IRCs try to provide a sufficient threat to turn the lead regiment. If successful, they use a combination of fire and maneuver to try to attrit and disrupt the enemy attack. In this case the U.S. ground force was assumed to have been inserted in the enemy's rear area via C-17 aircraft. The previous analysis indicated the potential danger of overflying enemy territory with transport aircraft. The case described below could, therefore, be thought of as an instance of such a force being inserted into either the enemy rear or flank, depending on the effectiveness of the opposing air defenses.

Specific phases of the battle plan are as follows:

- Battle begins with JSEAD and SOF insertion. Air begins attrition of lead MRR. MEU lands to establish lodgment and FAARP to the north. IRC expands lodgment.
- Airborne battalion establishes battle position north of lead MRR route of advance. IRC maneuvers to flank lead MRR.
- Combination of ground forces, helicopters, and fixed-wing aircraft attack MRRs to delay and then defeat.

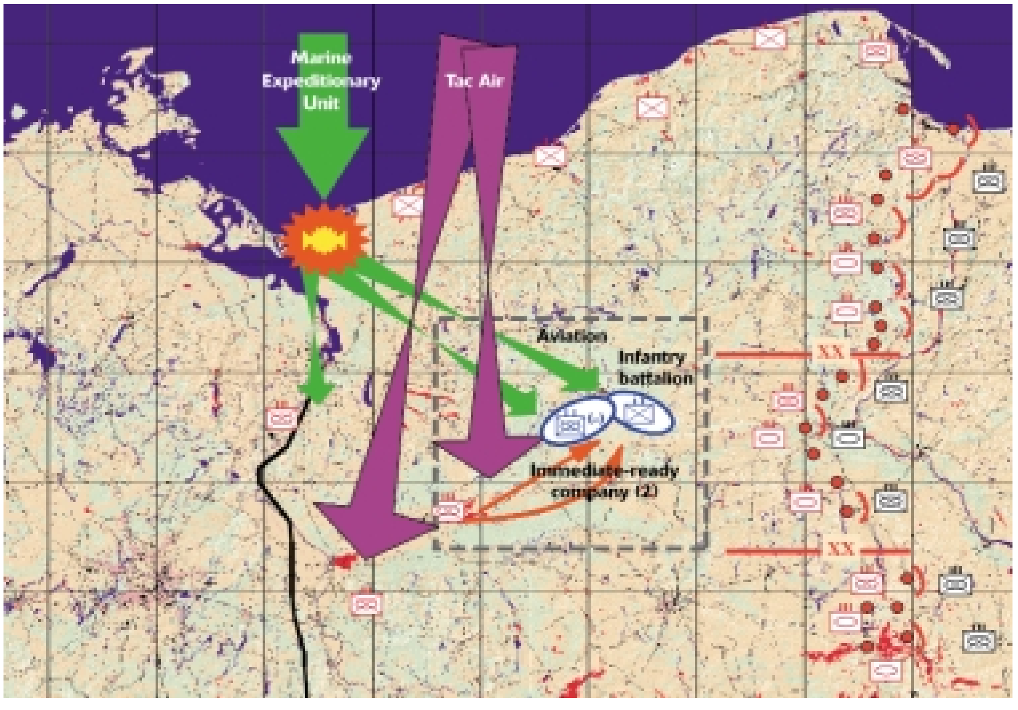


Figure 5.11—Depiction of Maneuver Case 2: Standoff Attack and Ground Insertion to Block Key Reserve Division

- Dilemma is created for the enemy commander by threatening his operation with a ground unit capable of physically interdicting lines of communication (LOCs) and destroying combat units.

Case 2 changes the situation dramatically, but only if Red chooses to turn and attack the battalion-sized force.[12] Even with two IRCs, the limited tactical mobility of this force renders it a relatively stationary, defense-based force.

Once in, the U.S. force should have sufficient firepower to (1) present a serious threat to the enemy, (2) effectively engage (or at least delay) the enemy armor, and (3) successfully disengage and egress. If the force is bypassed, it does not accomplish its mission.

Assuming that the enemy turns to attack, when simulated, the results suggest that ground force could substantially improve on the lethality obtainable by standoff fires alone. However, part of the cost of this additional lethality comes in losses to the ground force.

The results of Case 2 are summarized in Figure 5.12. In addition to increasing the lethality of the U.S. response, Case 2 also increases the force's robustness, where weapons in close proximity (e.g., direct fire) can be significantly more difficult to countermeasure. Nonetheless, since once in place, this force lacks mobility on par with the enemy, it can be bypassed. Even if the enemy chooses to engage this force, depending on the circumstances, it can opt to either fight with its overwhelming numbers or break off a smaller unit to contain this force. The lack of tactical mobility of this U.S. force is significant.

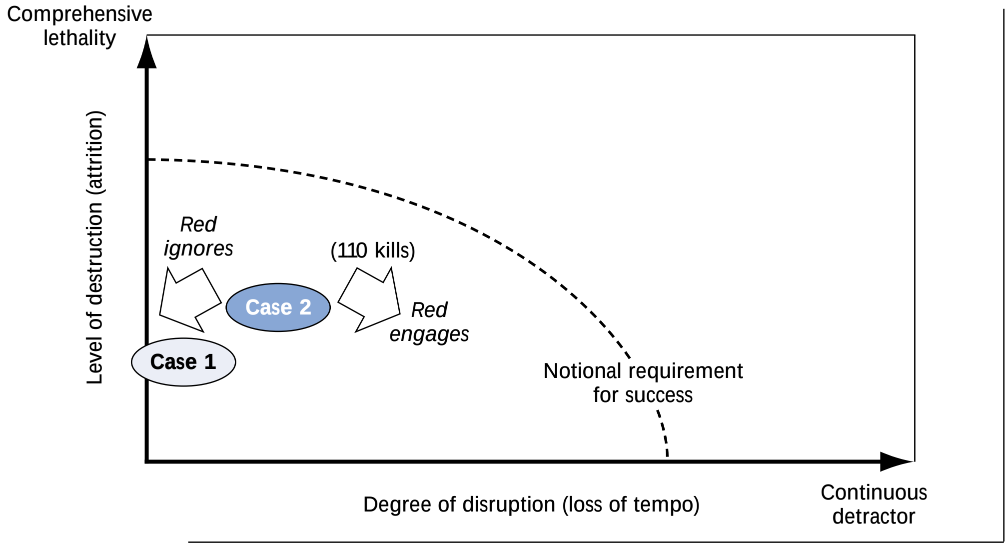


Figure 5.12—Summary of Case 2 Results

Maneuver Case 3: standoff attack and agile ground maneuver to engage key reserve division. As shown in Figure 5.13, in Case 3, standoff attack and quick-deploying maneuver forces are used to attrit and disrupt the enemy operation at many points. The JSEAD operation hits air defense sites throughout the region and, at the

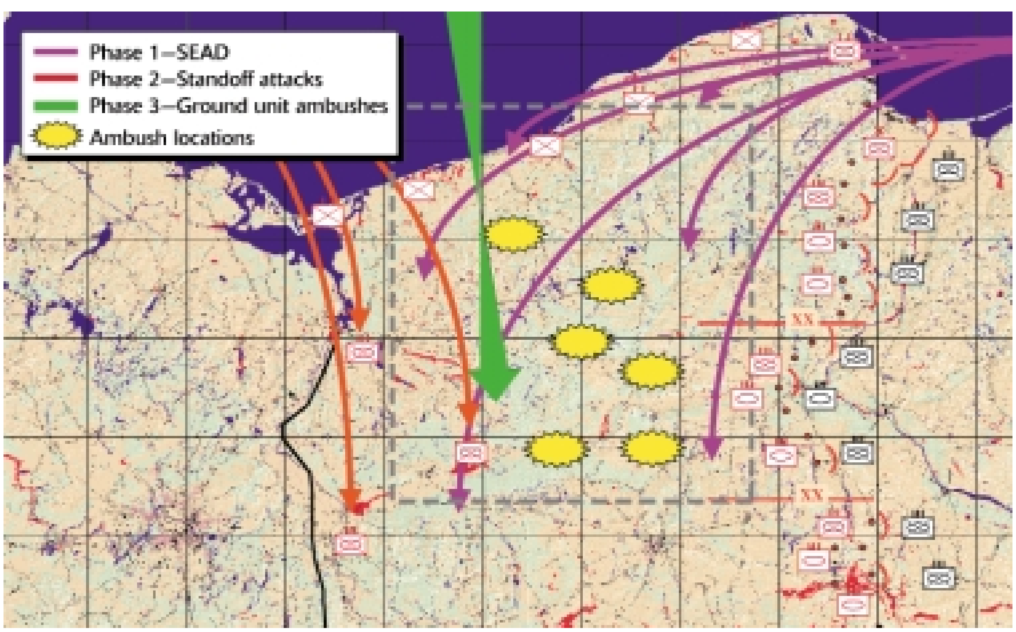


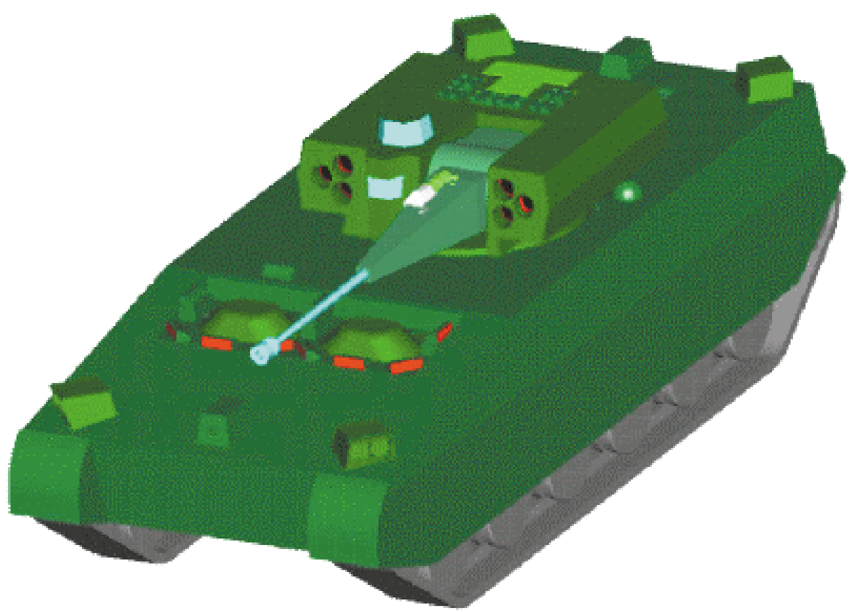
Figure 5.13—Depiction of Maneuver Case 3:
Standoff Attack and Agile Ground Maneuver to Engage Key Reserve Division

same time, cuts a corridor through for an insertion. Standoff attacks target all the elite units, while the ground units are deployed along the enemy's routes of advance. Here, specially designed, highly agile ground vehicles are used (see Figure 5.14). The ground units set up ambushes and plan for egress routes to their next attack points. Three types of enhanced medium-weight vehicles are used: future combat vehicles with LOSAT direct-fire kinetic energy (KE) systems, fire support vehicles with advanced (30-kilometer) fiber-optic guided missiles, and robotic vehicles that can call in fires during the ambush and in the egress phase, in which they may be left behind. All these systems can be airlifted by C-130s.

Specific phases of the battle plan are as follows:

- U.S. air/helicopter/ground assets are combined with coalition JSEAD to open air corridor(s). SOF are inserted to provide HUMINT and BDA.
- Long-range standoff attacks conducted by Joint Task Force assets (both aviation and artillery).
- Light, highly maneuverable ground force conducts direct-fire ambushes to destroy the lead regiment.
- Air attack continues against northern and southern MRRs.

Case 3 represents a departure from the way a conventional ground force might operate today. Here, there is a deep insertion of advanced maneuver forces, which attack the enemy forces at many points, carrying out ambushes and moving to the next en-



SOURCE: SARDA briefing, *Enhanced Alternative Strike Force*, 1998 (provided by Dr. John Parmentola).

Figure 5.14—Exemplary Future, Lightweight Ground Combat Vehicle Associated with Enhanced Strike Force

gagement opportunity. This is done in concert with standoff fires. The maneuver forces make use of a family of roughly 20-plus-ton tracked and wheeled vehicles that are airliftable on C-130s. Of the seven platforms currently envisioned for this notional force, we chose a subset for use in the scenario. Each of the ten teams in our organization has seven direct-fire future combat vehicles, four fire support vehicles, two robotic scouts, and one air defense vehicle. The 140 total vehicles make up two battle units, roughly a third of a full battle force.

The aircraft engagement zone is as before, but the missile engagement zone is shifted to the middle column of the enemy advance. In this way, the large-footprint submunitions from standoff fires will not overlap onto friendly forces.

Again, SEAD is critical to the mission. Enemy air defenses endanger the aircraft lofting JSOW, the transports inserting the ground forces, and even the TACMS missiles targeting the center column. Current levels of RSTA and C2 are probably insufficient to carry out this operation. The insertion requires extensive, up-to-date knowledge of enemy strength and locations. We only instituted "moderate" and "high" levels in these runs.

Given a successful insertion, we found that the combination of standoff fires and organic direct and indirect fires was very effective. Some losses were sustained by the U.S. ground forces, but the overall lethality of the combination of fires was far greater than for standoff weapons. One enemy countermeasure to this operation is to react to the ambushes by placing fire on likely further ambush locations. We found that this increased Blue losses but did not significantly change the outcome. Other enemy countermeasures should also be explored.

We noted earlier the difficulty of inserting a ground force deep in the enemy rear, given that Red would be expected to have a capable air defense network. Some alternatives to a direct, low-altitude insertion were also considered.

The first possibility assumes good intelligence on planned enemy movements, along with an opportunity to insert before the invasion. The Blue maneuver force is stealthily inserted, waits for the attack, is bypassed, and initiates the ambush.

The second alternative, deployment from the ground, involves tactical air insertion to a region outside the enemy air defenses. For example, the Marine MEU might seize a lodgment on the coast into which Army forces are quickly deployed via C-130. Once safely on the ground, the highly mobile Army force leaves the amphibious lodgment area and heads toward the flank of the targeted enemy force. Maneuver vehicles then must move quickly and stealthily to the engagement areas and may require in-route refueling points. As an option, refueling may perhaps be accomplished using fuel bladders delivered by powered parafoils using GPS guidance.

Deployment from the air, finally, may be achieved using several means. The SEAD campaign may open several corridors, or there may simply be some weak points in the enemy perimeter. A set of airfields may be secured and multiple insertion areas established. The flight profile may entail high-altitude overflight (above the radar SAMs) followed by circling in on the landing areas.

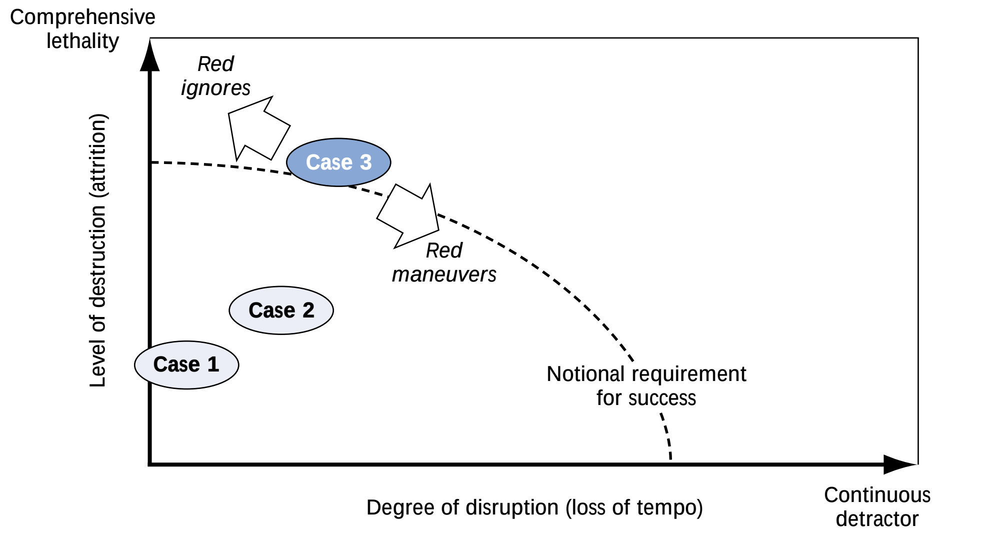


Figure 5.15—Summary of Case 3 Results

Figure 5.15 summarizes the results of Case 3. Standoff with agile maneuver, in this scenario, achieved sufficient lethality to likely stop the Red force, even if disruption were not considered. Disruption was also present because of the shock associated with the ambush,[13] because of the ability of the direct-fire and organic indirect-fire systems to target specific high-value targets, and because the presence of a capable force threatening the enemy rear may force the opponent to change his plans.

Red countermeasures will likely reduce the impact of this force, but the effects should be limited because there are many different targeting mechanisms in Case 3. These include long- and short-timeline systems, autonomous and man-in-the-loop control, seekers using different spectra, and direct-fire systems able to sweep the battlefield. Standoff systems alone, on the other hand, utilize only a few different targeting modalities and thus would be expected to be more easily countered.

Variation of Case 3: standoff attack and agile ground maneuver to engage deep, soft targets. This variation of Case 3, referred to as Case 4 for simplicity, represents another way to use the same agile maneuver force. As shown in Figure 5.16, the concept is the same as the previous case, in which highly agile ground maneuver forces are inserted to stop the deep elite enemy unit. However, these forces are positioned further to the west to directly engage the enemy logistics and supply vehicles (more specifically, these include resupply trucks, C2 vehicles, and self-propelled artillery units), which in this scenario, because of the great levels of dispersion, follow well behind the lead combat units. These "softer" targets are seen as highly desirable because any engagement of these forces would likely create havoc for enemy movement, while minimizing the risk to the attacking U.S. force (since these enemy units have substantially less combat power). However, because the agile U.S. forces will need to get past the enemy combat

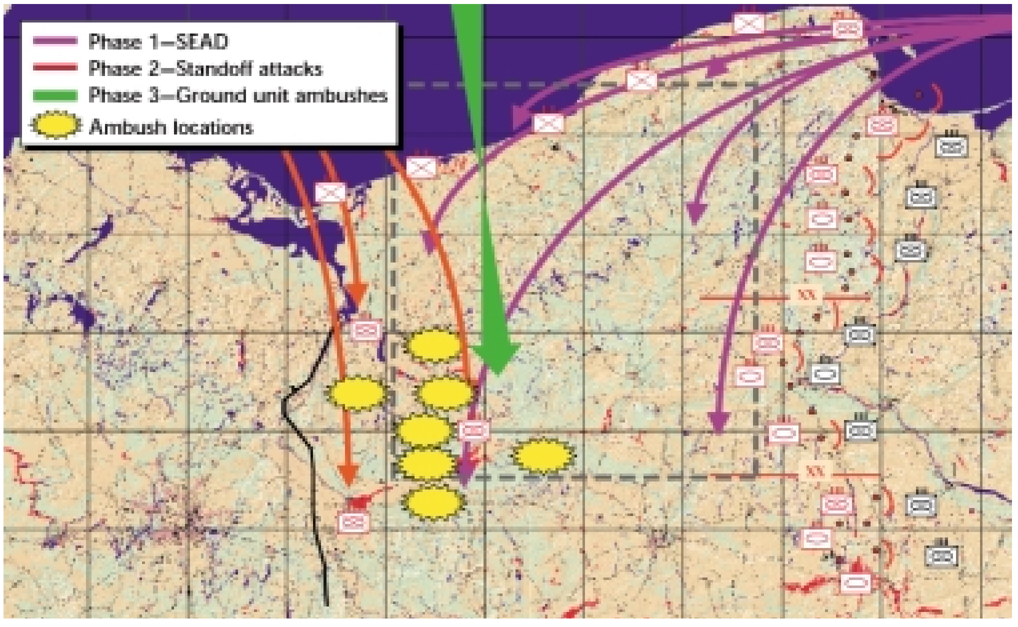


Figure 5.16—Stages of Maneuver Case 4: Standoff Attack and Agile Ground Maneuver to Engage Soft Targets

units to get to these soft targets, a certain level of "stealthiness" may be required. Additionally, good, real-time situational awareness might allow an advancing U.S. force to bypass enemy combat formations and instead maneuver toward more vulnerable enemy supply, air defense, and command elements that are far less able to defend themselves in a ground battle.

One shortcoming of the agile maneuver force is its vulnerability to massed direct fires. This may be avoided by attacking less dangerous elements such as resupply vehicles, C2 centers, air defense sites, assembly areas, and artillery units. These attacks should have a major impact on the enemy advance, yet result in few U.S. losses, provided the agile maneuver units can extricate quickly after striking. Special excursions with such a maneuver showed an order-of-magnitude fewer losses than when attacking similar-sized armor units.

Figure 5.17 summarizes the results of Case 4. Since the agile ground forces were competing with long-range standoff fires for the same more lucrative logistics and supply vehicles (CS targets), overall lethality was not as high as seen in the earlier case. However, because there was considerably more focused lethality on a specific target set, where all of the additional kills were directed against the soft logistics and supply vehicles, the effect of disruption would be significantly, perhaps exponentially, higher.[14] How much higher remains to be quantified. (To some extent, this may reinforce the notion that simulation tools, including the ones used here, tend to focus on attrition effects, which tend to be much more measurable. Other effects such as reduction in

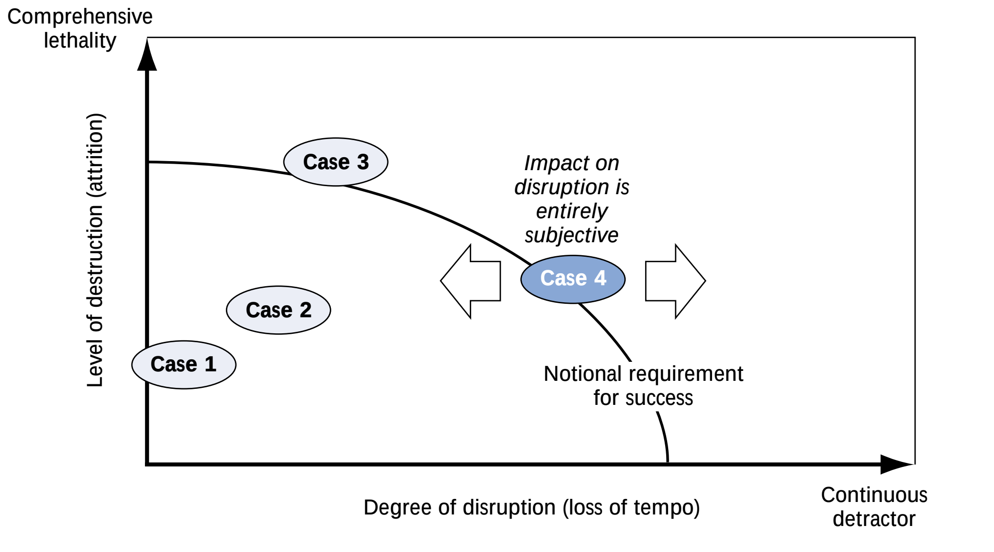


Figure 5.17—Summary of Case 4 Results

morale because of significant losses in short periods, for example, tend to be unaccounted for.)

Figure 5.18 summarizes the results of the analysis of the three different concepts (four cases). Case 1, which involved the aggressive use of standoff fires, resulted in a respectable 12 percent attrition against the overall enemy force. One advantage of this concept was that because direct exposure to the enemy was minimal, no losses occurred—assuming high-altitude JSEAD was successful. Case 2, which involved both standoff fires and what might be considered a conventional ground force insertion, provided increased lethality (and robustness), but at the cost of considerable losses to the U.S. force.

Case 3 represented a substantial increase in lethality over Cases 1 and 2. The two sets of numbers for Case 3 show different enemy reaction to the concept. If Red ignores the ambush and presses on, about 6 percent of the Blue force is lost, primarily the direct-fire fire support vehicles. If Red reacts to the initial ambushes by stopping (resulting in significant delay) and directing fire support missions into ambush locations, U.S. losses increase to about 12 percent. Organic direct and indirect fires each contributed as many kills as standoff fires. In fact, because of the shock of the ambush, enemy losses of less than 50 percent may well be sufficient to disrupt the enemy march. If so, fewer direct-fire ambushes may need to be triggered, reducing U.S. losses further.

Case 4 represents a significant departure from the way we think about assessing force effectiveness. Rather than a force-on-force engagement analysis, this tends to be a force effects analysis, where most of the effects may not be based on attrition. Thus, to some extent we have only begun to characterize the effects of this concept.

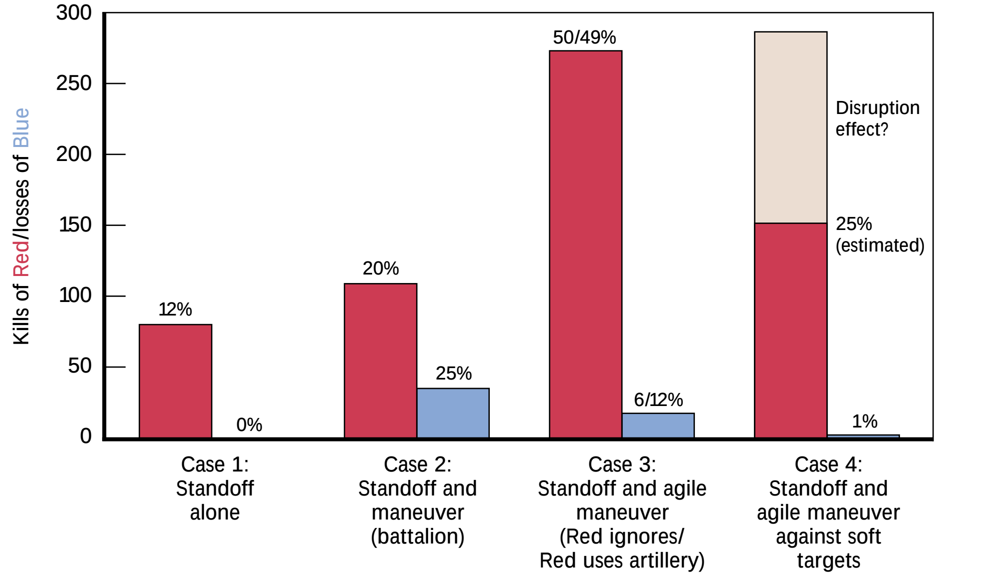


Figure 5.18—Summary of Four Cases

Overall, we found that standoff attack, using long-range ground, naval, and air-delivered weapons, had limited effect. Weapons were seen to be poorly matched to the targeting opportunities that presented themselves in this mixed terrain. Even near-perfect levels of RSTA and C2 could not overcome the combination of long weapon fly-out times and short enemy exposure opportunities.

Ground forces, however, were more responsive and selective in their fires. In combination with standoff weapons, they were able to decisively defeat the enemy force. Of course, this comes at a cost. Some of the agile maneuver vehicles were lost to enemy fires, and the insertion itself may be extremely difficult.

We also found that improved RSTA and C2 were far more important to ground force operations than to joint standoff attack, the opposite of what one might expect. Comprehensive, up-to-date information was a requisite for the deep insertion, setting up the ambush, targeting local indirect fires to isolate the ambush, and disengaging and egressing from the area. Much less information appeared to be necessary to target the large-footprint, autonomous-acquisition standoff weapons.

Finally, a key decision is how much of the fight should be assigned to the different weapon systems. The long-range fires were effective only in open areas against sizable units. The local indirect-fire units were lethal, but had limited resupply. The direct-fire systems were selective but open themselves up to return fire if gaps are not provided by the other weapons.

Chapter Summary

In this chapter, modern adaptations of vertical envelopment were explored and assessed. The specific concepts studied applied both aggressive precision fires and a range of different levels of tactical and operational maneuver. And while the concepts were initially conceived for a number of different purposes and time frames, they have clear applicability for resolving the current rapid-reaction shortfall.

Although the value of precision fires has been shown in Desert Storm, their limitations were brought out in Kosovo. The research conducted here reinforces the significant value but also the inherent limitations of future precision-fire capability against a sophisticated adversary in difficult terrain. At the same time, the research highlights the value and limitations of bringing maneuver into rapid-reaction missions.

In particular, the benefit of agile maneuver (depicted by Cases 3 and 4 with specialized ground vehicles) was seen to be multifold. First, it provided a means for overall mission success, in cases where only limited maneuver cases (Cases 1 and 2) resulted in mission failure. Second, maneuver provided a much larger scope of operations that could be performed within the rapid-reaction force (e.g., limited attacking engagements were possible), with emphasis on exploitation.

The positive outcomes seen with maneuver—illustrated in the various scenarios in this work—will not represent a major surprise to the ground warfighting community at large. Nonetheless, the *viability* of creating such a force capability still remains to be resolved. Obvious challenges that still remain for enabling the vertical envelopment concepts include the following: (1) the technological feasibility of creating relatively lightweight, lethal, and survivable ground vehicles, (2) the ability to operationally deploy such a force without unacceptable losses to enemy air defenses, and (3) the ability to support and resupply this force. While new technologies offer some promise, it is still too early to determine definitively how applicable many will be. As more research and experiments are conducted, better assessments of both the viability and the utility of maneuver for rapid-reaction missions can be made.

CHAPTER FIVE ENDNOTES

1 Conducting offensive missions is more likely with a force that has maneuver capability.
2 The air insertion phase is treated here with much more attention because a mounted force will likely require much greater "access" to the airspace than the dismounted infantry-based force assessed in the previous chapters.
3 See Chapter One and Appendix B for more detail on the modeling and simulation tools.
4 The U.S. forces could operate conventionally, helping to shore up the coalition defense by establishing a safe haven offshore in the northeast and deploying additional heavy forces and air power. Unfortunately, this would require excessive time for buildup, and the coalition force is near breaking.
5 The points of contact were MAJ David Steen from DIA and Mr. Stephen Proctor from NGIC.
6 Both the quantity and quality of enemy air defenses can have a significant impact on air-mech viability or on other vertical envelopment concepts.
7 Specific information was taken from a research paper, *Advanced Airframe and Attack Aircraft Platform Concepts,* produced by Dr. Michael Sculley, October 1997. This work was developed as technical input for the Army After Next, Tactical and Operational Mobility Integrated Idea Team.
8 The values of these signatures are comparable to those of a multiengine transport plane.
9 Roughly the estimated signature for a small-sized, low-observable helicopter; as unlikely as it would be to achieve such a signature in a transport aircraft even two decades from today, it was used analytically to represent a lower bound.
10 Reference to SA-12 performance is given in *Jane's 1998–1999, Land-Based Air Defence,* Jane's Information Group, Surrey, England, 1998.
11 In the first option, very little insertion is required because no combat vehicles were involved. The other three options involved significant air insertion demands.
12 One option available to the U.S. forces might be the use of electronic warfare (EW) methods to increase the signature of this relatively small force. Increasing the signature might help to force an engagement with the enemy force.
13 Once the local ambush began, a large proportion of the kills were achieved within a relatively short time, roughly five minutes.
14 The additional lethality was focused on the same target, neutralizing the enemy's active capability in one area, in this case resupply. Enemy CS losses were roughly 8 percent for Case 1, roughly 30 percent for Case 4.