



A-10A Thunderbolt II aircraft flies over target area during Operation *Desert Storm* (U.S. Air Force/Fernando Serna)

The Urgent Necessity to Reverse Service AirLand Roles

By Price T. Bingham

Current U.S. military joint and Service doctrine assigns U.S. Army forces, supported by U.S. Air Force forces, the role of being responsible for defeating an opposing mechanized army. But now, thanks to significant advances that have been

occurring over the last two-and-a-half decades in the Air Force's surface surveillance and precision attack capabilities, it is time to reverse these roles.¹ Role reversal is an urgent necessity because it would give the Armed Forces the ability to defeat an opposing mechanized army faster with far less risk to U.S. personnel, while significantly reducing the amount of resources the United States needs to devote to countering this threat. Understanding why reversing roles can provide these

important advantages requires examining the continuing validity of prevailing assumptions regarding Service roles in defeating such a threat. This examination begins by identifying the rationale behind today's Army force structure.

The Army's current force structure can be traced to the way great captains and effective armies have learned to use rapid movement to create important advantages over their opponents.² Exploiting the advantages that rapid movement can create despite advances in

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firepower explains why, during the 20th century, mechanization transformed the way armies were structured and fought. This transformation made it necessary for armies to be able to fight and defeat an opposing army's mechanized forces in close combat because, despite often massive efforts, air forces performing interdiction were unable to prevent powerful opposing forces from coming into close proximity to army forces, especially if that movement took place at night or during bad weather. Prevailing in close combat made it necessary for the U.S. Army's armored units to become heavier and equipped with ever more powerful weapons, while also requiring that the U.S. Air Force devote significant assets to the close air support mission.

Serious limitations in the ability of airmen to detect, track, and precisely target an opposing army's vehicles explains why, historically, air forces have been limited to playing an important, but supporting, role in defeating an opposing army. These limitations explain why the reversal of roles between air and surface forces occurred first in naval warfare. In naval warfare, the relatively smooth surface of the sea made it somewhat easy for airmen in the 1940s to find an opponent's ships with their unaided vision well before these ships could move into close proximity of U.S. naval surface forces. For example, during the Battle of Midway, Lieutenant Commander C. Wade McClusky, Jr., flying at 20,000 feet and approximately 140 miles from his own carrier, visually spotted the wakes of the Japanese fleet, which included the 812-foot-long *Kaga* aircraft carrier, while he was still 35 miles away.³ Once they found the Japanese carriers, U.S. naval air forces were able to deliver the munitions needed to complete their destruction. Ultimately, the loss of their four carriers convinced the Japanese naval leaders that they could no longer risk engaging the U.S. fleet in close combat with their main force's battleships. The effectiveness of air forces against naval surface forces during World War II was also greatly enhanced by the development of airborne radar, which made it possible for airmen to find and sink ships even at night and in bad

weather.⁴ It is important to note that the ability of air forces to find and destroy an opponent's surface naval forces before they could move into close proximity to U.S. ships was made easier because of the relatively small number of ships in an opposing fleet and the large size of many of these ships.

Although airpower's role in defeating armies was far more limited in the past than it was in defeating naval surface forces, there are two key similarities that help explain why there is a need now to reverse U.S. Air Force and Army roles. One similarity is that, like navies with their dependence on ships, mechanized armies depend on their vehicles for the movement that creates the operational- and tactical-level advantages of surprise, mass, and favorable position, which enhance their ability to prevail in close combat. Mechanized armies are also similar to navies and their ships in their dependence on vehicles for armored protection, heavy firepower, engineering support, and, most importantly, for supplies, especially fuel.

Yet despite these similarities, there were major differences between naval and land warfare that explain why, until recently, a reversal of roles between the Air Force and Army was not appropriate. Compared to the relatively smooth surface of the sea, the land's surface is far more complex because of its roughness and the presence of vegetation and buildings.⁵ This complexity prevented airmen from using radar to find opposing vehicles because radar energy reflected from the land's surface created so much clutter that, until recently, it was impossible to see small objects like vehicles, especially when they were moving.

The complexity of the land's surface also made it much more difficult for airmen to see an opposing army's vehicles. The challenges of the visual search for opposing army vehicles were addressed by Royal Air Force Air Vice Marshal John Robert Walker. In addition to the problems posed by terrain roughness, vegetation, and buildings, he explained that there just is not much to see with a target like a 22-foot-long tank even at ranges of 3 kilometers. He stated that

holding the head of a pin at arm's length gives an idea of the difficulty aircrew faced in visually acquiring a target as small as a tank.⁶ Adding to this target acquisition problem was the near impossibility of determining visually from a fast-flying aircraft whether a vehicle had already been destroyed or was a decoy.

Airspeed and altitude also had an important impact on limiting the effectiveness of an airman's visual search for an army's vehicles. Although flying at slow airspeeds could provide more time to look, it also increased the amount of time air defenses had to hit the aircraft making the search. Similarly, while flying at low altitudes made it easier to see small objects such as vehicles, it greatly increased aircraft exposure to short-range surface-based air defenses.⁷ The impact slow airspeeds and low altitude had on increasing an aircraft's vulnerability to surface-based air defenses explains why, in the Southeast Asia conflict, fast movers, such as the F-100F "Misty" forward air controllers (FACs), replaced slower O-1 and O-2 FACs in high-threat areas.⁸

Given a pilot's limited field of view, it was necessary to fly a great many sorties to have a reasonable chance of finding an army's vehicles within a large search area, and this reliance on vision limited the search to good weather and often only to daylight hours. Opposing armies were quick to recognize that bad weather and darkness seriously degraded the ability of airmen to find and attack their vehicles. For example, by limiting their movement to the hours of darkness or to bad weather during Operation *Diadem* in Italy, the Germans were able to shift major units from one sector of the front to another despite harassment by a daily average of 2,000 Allied sorties.⁹

Recognition of the difficulties weather and darkness created for a visual search also does much to explain the timing of the German offensive known as the Battle of the Bulge. However, when the maneuver or threat of such maneuver by friendly army forces prevented an opposing army from limiting their movement to periods of bad weather or darkness, as was the case for the German army during the Allies' Normandy breakout, it became



U.S. Navy F-14A Tomcat, Fighter Squadron 211, Naval Air Station Oceana, Virginia Beach, Virginia, in flight over burning Kuwaiti oil wells during Operation *Desert Storm* (U.S. Air Force)

much easier for airmen to find and attack vehicles as they attempted to move. Still another challenge that severely limited the effectiveness of air interdiction in stopping the movement of an opposing army was the low probability of hitting and destroying or seriously damaging such small targets with cannon fire, dumb bombs, and unguided rockets, especially if the vehicles were moving.¹⁰

All these considerations help explain why airmen performing interdiction would often focus their attacks on fixed transportation infrastructure such as bridges and tunnels, the destruction or damage of which might stop or at least delay vehicular movement. But since the importance of such infrastructure was also

apparent to the opponent, these targets were often well defended, and opposing forces would prepare countermeasures such as bypasses or mass the resources needed to make rapid repairs. All these countermeasures help explain why the United States, despite thousands of sorties, had limited effectiveness in the interdiction of North Vietnamese forces moving on the Ho Chi Minh Trail.¹¹

But in Operation *Desert Storm* in 1991, and more recently in Operation *Iraqi Freedom*, the Air Force began fielding the capabilities that are needed to change the way we defeat an opposing mechanized army. The deployment of two prototype E-8A Joint Surveillance Target Attack Radar Systems (JSTARS)

during *Desert Storm* revealed that surface surveillance technology was now making it possible to detect and target vehicular movement deep in enemy territory, even when this movement was taking place during darkness. During a night attack on Khafji, Saudi Arabia, by two Iraqi divisions, JSTARS made it possible for coalition leaders to see that the developing attack was not a feint and to target powerful air attacks against the Iraqi divisions well before most of their units could move into close proximity to coalition ground forces. These attacks were so devastating that an Iraqi veteran of the Iran-Iraq war stated that his brigade suffered more losses in 15 minutes of air attacks north of Khafji than it had

endured in 10 years of the Iran-Iraq war.¹² JSTARS targeting was also proving to be a powerful force multiplier because, as JSTARS commander Colonel George K. Muellner put it, “With JSTARS, fighters went ‘bingo [empty] ammo,’ not ‘bingo fuel,’” which had not been the case when they had to search for their own targets.¹³

After their defeat at Khafji, in what the Iraqis had planned to be the “Mother of All Battles,” the Iraqis put increased emphasis on minimizing movement and dispersing their forces and digging in to reduce their vulnerability to air attack for the remainder of the war. These measures prevented training and limited resupply, causing Iraqi soldiers to see the growing futility of their situation.¹⁴ And when precision air attacks using laser-guided bombs began soon after the battle, the Iraqi soldiers’ sense of futility increased as they realized that even when their vehicles were dispersed and dug in, they were vulnerable to sudden, lethal precision attacks. Recognizing their increased vulnerability, many Iraqi soldiers moved away from their vehicles, which limited training and maintenance and made their forces extremely vulnerable to defeat when coalition land forces began their offensive.¹⁵ After the war, Colonel Aleksandr Tsalko, a Soviet army officer who also served as a deputy to the Supreme Soviet of the Union of Soviet Socialist Republics, recognized the growing capability of modern airpower against ground forces and called the idea of seeking victory in the future through the contact between large-scale ground forces as “sheer madness.”¹⁶

Operation *Iraqi Freedom* provided further evidence that advances in surveillance and precision air attack were making land forces far more vulnerable to detection and destruction by air attacks. In *Iraqi Freedom*, 9 of the 116th Air Control Wing’s 15 E-8C JSTARS aircraft were available and made a tremendous difference. With the *Desert Storm* model of protracted bombing before committing land forces to an offensive having been rejected, the U.S. Army’s 3rd Division had slowed its advance during a sandstorm to wait for its follow-on

unit, the 101st Airborne Division, as well as for supplies. Believing that this storm provided cover from air attack, the Iraqis moved their Medina Division south to attack the 3rd Division. But by breaking cover and moving, the Iraqis made it possible for JSTARS to detect the division’s vehicles and target them with air attacks, delivering hundreds of precision-guided weapons—predominantly satellite-guided—as well as “dumb” bombs, causing the Medina Division’s destruction before it could close with the 3rd Division. As Air Force Brigadier General Allen Peck put it, “Ground forces forced the enemy’s hand. If they massed, airpower could kill them, if they scattered they would get cut through by the ground forces.”¹⁷

Yet despite the abundant evidence from these recent conflicts of our growing capability to reverse the roles of air and land forces when fighting mechanized land forces, Service and joint doctrine remains stuck in the past. For example, joint doctrine’s guidance that air interdiction should be employed in support of land force maneuver reveals the U.S. military is failing to make the changes necessary to capitalize fully on our new capabilities.¹⁸ This failure stands in stark contrast to the dramatic changes that the Navy began making before and completed during World War II, reversing the roles of air and surface naval forces in defeating an opposing fleet.¹⁹

Reversing roles and making Air Force forces our primary means for attacking and defeating an opposing mechanized army would provide the United States with a number of extremely important advantages. These advantages are the result of unprecedented advances in the ability of Air Force surface surveillance systems to detect, track, target, and destroy an army’s moving vehicles well before they can reach a position in close proximity to friendly land forces. One important advantage from precisely targeting an opponent’s vehicles when they are moving is that it eliminates the possibility of wasting precious time and resources attacking previously destroyed vehicles or decoys. Of even greater importance, targeting moving vehicles

guarantees that these vehicles are occupied by an opponent’s soldiers. Killing or wounding these soldiers makes it possible to create such fear in other soldiers that they are likely to become unwilling to risk movement or even occupy their vehicles.²⁰ With careful planning, the prompt execution of attacks against moving vehicles is likely to create the degree of fear sufficient to cause paralysis while targeting and destroying a relatively small number of vehicles. This approach is in contrast to *Desert Storm*, where the Army emphasized the importance of air attacks, causing physical attrition while grossly underestimating the importance of the psychological impact air attacks had on Iraqi soldiers.²¹

Using fear to help create paralysis not only reduces the numbers of opposing army personnel killed, but it also allows the desired results to be achieved much faster and with far fewer sorties and munitions than could be achieved by relying solely on attrition. Yet another operational advantage provided by radar surface surveillance capabilities that can detect, track, and target vehicular movement is the ability to provide precise, real-time assessment of the degree to which attacks are achieving the desired paralysis. And when widespread paralysis of opposing mechanized forces has been achieved, U.S. Army forces will possess the immense operational advantage of dominant maneuver that makes it possible for them to quickly complete the defeat of the opposing forces with far less need for engaging powerful opposing mechanized units in high-risk close combat.²²

Despite the growing effectiveness of Air Force forces against mechanized forces, Army forces would still be needed to play a valuable supporting role in achieving the defeat of an opposing army. By exploiting the importance movement plays in land operations, Army maneuver could make an opposing army’s forces even more vulnerable to defeat by air attack.²³ In their supporting role, U.S. Army forces would use maneuver to put opposing land forces on the horns of a dilemma that has no satisfactory answer. The opposing army’s dilemma is this: If it attempts to counter the Army’s maneuver

by moving, it makes its vehicles far more vulnerable to detection and destruction by air attack, but if it attempts to reduce its risks from air attack by not moving, it will be unable to effectively counter Army maneuver while providing even more time for its vehicles to be located and destroyed by precision air attack.

Perfecting the ideas outlined here for exploiting the advantages made possible by reversing the roles of the Air Force and Army in the AirLand fight and turning these ideas into joint and Service doctrine will require applying lessons gained from intensive wargaming and exercises, just as was the case with the Navy's reversal of roles between its air and surface forces. And, as was the case with the Navy, reversing roles will depend on making major changes in the force structure of the two Services. Unfortunately, all the Services have a history of their senior leaders resisting major force structure changes brought about by advances in technology, despite these changes providing the promise of making our Armed Forces more effective. This resistance occurred even when the changes being made were confined to a single Service rather than requiring actions by two or more Services.²⁴ For example, the Navy's senior leaders' identification with their battleships made many of them slow to recognize the growing ability of aircraft carriers to change naval warfare.²⁵ Similarly, many of the Army's senior leaders were slow to recognize that advances in firepower were causing the horse cavalry to lose its effectiveness.²⁶ And some senior Airmen's attachment to manned bombers made it difficult for them to recognize the growing capabilities of ballistic missiles.²⁷

The changes the Air Force must make in order to assume the primary role in defeating an opposing mechanized army begin with its surface surveillance force structure. Changes in this force structure are necessary because detecting and destroying an opposing army's vehicles well before they can move into close proximity to U.S. Army forces depends on the employment of highly capable Ground Moving Target Indicator (GMTI) radar surveillance. Continuous and complete

coverage of all areas where opposing forces can move by wide-area, real-time, all-weather GMTI radar systems such as JSTARS is central to reversing roles. As a result, these systems cannot be fielded in the small numbers that currently make them such a high-demand but low-density capability. And recognizing that screening can limit what can be seen by JSTARS, their employment must be complemented by fielding sufficient numbers of other GMTI-capable systems such as Global Hawk, which can ensure all movement screened from JSTARS coverage will still be detected and tracked. In addition to significantly increasing its surface surveillance force structure, the Air Force must horizontally integrate its capabilities so that sensors, air and space operations centers, targeting systems, and shooters can seamlessly communicate with each other, eliminating time-consuming, error-prone manual translations by humans.²⁸ Since causing paralysis will require the prompt destruction of opposing vehicles whenever they attempt to move, it will be necessary to field sufficient numbers of shooters equipped with moving target-capable munitions in order to saturate their coverage of a large area. And given the importance of endurance for achieving the desired degree of shooter-target area saturation, it is likely that many of these aircraft should be unmanned aerial vehicles like the MQ-9 Reaper. But force structure alone will not be enough. It is also vital that the Air Force learn from Operation *Desert Storm* and focus far more attention on the operational level of war and conceptualize how to employ airpower in a campaign against ground forces.²⁹

Once the Air Force makes the necessary changes in its force structure and doctrine, changes in Army force structure could be made. In its supporting role, the Army would need fewer and lighter vehicles. Lighter vehicles would be more easily transportable by air, to include by vertical lift.³⁰ Not only would lighter vehicles make it possible for Army forces to reach a distant theater quickly, but enabling their vertical lift could also give Army forces a major operational and tactical advantage by allowing units to leap

over obstacles such as rivers and mountains, reducing their need for engineering support while making their maneuver much faster as well as far less predictable. As with the Air Force forces, Army forces will need to be horizontally integrated so their employment complements that of the Air Force while reducing the risk of fratricide. To make opposing army forces move so they could be more easily detected, targeted, and destroyed by Air Force forces while minimizing the risk of close combat with intact units, Army maneuver would need to be rapid and unpredictable. It is also quite likely that during a campaign's initial stages, this maneuver would be designed to tempt opposing forces to advance into areas where they could be more easily trapped and destroyed.

Despite the tremendous advantages possible with a reversal of roles, this change is very likely to be strongly resisted by the leaders of both the Army and Air Force. The Army's reluctance is easier to anticipate because of the great implications for its force structure and, perhaps most importantly, because of the dominant role the Army currently plays in planning and executing AirLand fight. Its unwillingness to accept the need for these changes is likely to be magnified by the failure of many Soldiers to appreciate fully the growing contribution modern airpower has made to the defeat of opposing armies.³¹ This lack of appreciation is evident in the way some Soldiers have criticized support provided by Airmen while simultaneously ignoring the favorable comments made by opposing soldiers regarding U.S. airpower's effectiveness.³² Perhaps part of the reason for the Army's attitude toward airpower can be found in the fact that it has been over 70 years since U.S. Soldiers have suffered significant losses from air attacks. Surprisingly, despite the criticism made by Soldiers, Airmen have been reluctant to criticize the Army even when the decisions made by Soldiers were responsible for seriously handicapping the Air Force's effectiveness.³³

Compared to the Army, the lack of interest Air Force leaders have exhibited in reversing roles in the AirLand fight is



Marines climb side of berm into attack positions during Operation *Desert Storm* (U.S. Marines/R.J. Engbrecht)

much more puzzling, especially when compared to naval airmen, who actively worked to reverse naval airpower's supporting role to the battleship in the years before World War II.³⁴ Perhaps RAND analyst Carl Builder's assessment of the Air Force was correct. He believed the Air Force could be said to worship at the altar of technology with pride of association with a machine, even before the institution. He noted an institutional resistance to the introduction of new weapons. Perhaps we see it today with JSTARS. The Air Force's focus on aircraft, especially the aerodynamic performance of aircraft, seemed to him to be its main priority along with its institutional independence.³⁵ If so, this would explain why the Air Force has paid so little attention to the importance of military theory, which shows why the new capabilities possessed by an "old" non-aerodynamically exciting platform such as E-8C JSTARS provides the

potential to transform the way the United States conducts the joint AirLand fight. The Air Force's slowness in recognizing the unprecedented advantages of the capabilities provided by JSTARS has been evident in how often the lessons from one operation on how to use JSTARS most effectively had to be relearned during the next operation.³⁶

Still another great obstacle to a reversal of AirLand roles can be found in the way jointness seems to work in today's U.S. military. Despite the major advances in airpower's ability to detect and destroy an opposing army's vehicles, which has been demonstrated in Libya and now against the Islamic State of Iraq and the Levant, all the Services have shown a lack of interest in exploring an operational concept that would require a reversal of roles. Part of the problem may be the tendency, especially in the Army, to focus on the tactical level of war and the close fight, rather than on the operational

level of war, where the role of wide-area surveillance-targeting air interdiction would be most evident.³⁷ It may also be because of an informal agreement among the Services to do nothing that would upset their current way of doing business, even at the cost of harming long-term military effectiveness and efficiency. Again, Builder faults all the Services when he notes that "when alternative concepts of war (or how to fight those wars) begin to affect the institution—its organization and aspirations—then its intellectual energies quickly become focused upon a competition for stature and survival."³⁸ If true, it would be a devastating indictment of our current military leadership, making it essential that the Nation's civilian leaders intervene, as they did with the Goldwater-Nichols Department of Defense Reorganization Act of 1986, to make the U.S. military much more unified and effective.³⁹



U.S. Air Force RQ-4 Global Hawk aircraft maintenance technicians perform preflight checks prior to mission, November 2010 (U.S. Air Force/Andy M. Kin)

The obstacle inter-Service politics poses to changing Service AirLand roles should be apparent to all concerned with national security. According to one expert, inter-Service politics undermines the popular theory that jointness has successfully integrated the four Services into an almost unified fighting force. He calls for the Services to “more openly acknowledge their parochial concerns and either argue that their parochial perspective better achieves U.S. national security objectives than others’ perspectives or abandon them.” The issue is so important that he believes “the Secretary of Defense should consider inter-Service politics the primary problem facing U.S. defense and look to weed out its clouding of policy choices. And the President and Congress should consider whether structural reform is needed to change the bargaining advantages that create today’s inter-Service politics.”⁴⁰

It is important to conclude on a note of optimism regarding the possibility of the Air Force at last advocating the need for a reversal of roles by calling attention

to what was stated by key leaders at a recent airpower symposium hosted by RAND and the Air Force Association’s Mitchell Institute for Aerospace Studies. Lieutenant General Steven Kwast, commander of Air University, stated that as the Air Force continues to shrink, it was urgent for Airmen to find new ways to solve old problems. As Retired Lieutenant General David A. Deptula, dean of the Mitchell Institute, put it, “The concepts of the last century will simply be eclipsed in the information age,” and all Airmen must be empowered to think critically on how to solve current and future challenges.⁴¹ JFQ

Notes

¹ A top priority for the Air Force is to recapitalize the E-8 JSTARS fleet, which possesses the ability to track moving targets through weather over a wide area, and proved to be invaluable in Iraq and Afghanistan, with a business-jet-size aircraft with equal or even greater capability than the E-8. See Amy Butler, “More for Less,” *Aviation Week & Space*

Technology, September 15, 2014, 42–46. The 250-pound Small Diameter Bomb successfully completed tests using its tri-mode seeker that proved its ability to achieve direct hits against both stationary and moving targets through weather or dust. See “SDB II Moves into Low-Rate Initial Production,” *Air Force Magazine*, November 2014, 25.

² The horse, chariot, railroad, and, most recently, the internal combustion engine have all caused revolutionary changes in land warfare by enhancing the ability of armies to move quickly. See John Keegan, *A History of Warfare* (New York: Alfred A. Knopf, 1993). Armies were most effective when their objective in moving was the mind and will of their opponents, using the speed of their movement to create disorder and paralysis. See Richard Simpkin, *Race to the Swift: Thoughts on Twenty-First Century Warfare* (London: Brassey’s Ltd., 1985); and Field Marshal Lord Carver, *The Apostles of Mobility: The Theory and Practice of Armoured Warfare* (New York: Holmes & Meier Publishers, Inc., 1979), 77. Even in Vietnam the mobility and firepower advantages provided by armor were evident in the fact that armor units were among the last units withdrawn. In December 1971, 54 percent of the U.S. maneuver battalions still in Vietnam were armored units. See Donn A. Starry, *Mounted Combat in Vietnam* (Washington, DC: Department of the Army, 1978), 164–165. After World War I, when reforming

the German army, General Hans von Seeckt's great contribution was thinking of a "war of movement." See Robert M. Citino, *Quest for Decisive Victory: From Stalemate to Blitzkrieg in Europe, 1899–1940* (Lawrence: University Press of Kansas, 2002), 195.

³ Jonathan B. Parshall and Anthony P. Tully, *Shattered Sword: The Untold Story of the Battle of Midway* (Washington, DC: Potomac Books, Inc., 2005), 217.

⁴ In July 1944, Admiral Towers decided to designate the light carrier USS *Independence* as a night carrier. Soon the Navy was equipped with night-capable aircraft such as the TBM Avenger, whose ASD-1 radar could see a flattop at 40 miles. See Clark G. Reynolds, *The Fast Carriers: The Forging of an Air Navy* (New York: McGraw-Hill Book Company, 1968), 229.

⁵ For an excellent discussion of the complexity of ground, see Simpkin, 57–77.

⁶ J.R. Walker, *Air-to-Ground Operations* (London: Brassey's Ltd., 1987), 109.

⁷ British Operational Research examining the armed reconnaissance mission, which required fighter-bomber pilots to fly low to look for German vehicles, found it to be more dangerous than close air support. See Ian Gooderson, *Air Power at the Battlefield: Allied Close Air Support in Europe 1943–45* (London: Frank Cass Publishers, 1998), 201–209.

⁸ William W. Momyer, *Airpower in Three Wars* (Washington, DC: Department of the Air Force, 1978), 326.

⁹ Eduard Mark, *Aerial Interdiction: Air Power and the Land Battle in Three American Wars* (Washington, DC: Center for Air Force History, 1994), 208.

¹⁰ The average Typhoon pilot in trials, firing all eight rockets in a salvo against a target the size of a tank, had roughly a 4 percent chance of a hit, and in combat the accuracy was further reduced. Average radial error for bombs was 158 yards. See Gooderson, 76–77.

¹¹ Trucks moving on the roads of Steel Tiger in southern Laos were considered the most lucrative and vulnerable targets because the road system was too redundant and easily repaired to be a good target. See Mark, 335. During Operation *Desert Storm* the Iraqis demonstrated similar skill in countering attacks on transportation infrastructure. After the conflict, General Chuck Horner cautioned, "Anybody that does a campaign against transportation systems [had] better beware! It looks deceptively easy. It is a tough nut to crack. [The Iraqis] were very ingenious and industrious in repairing them and bypassing them. . . . I have never seen so many pontoon bridges. [When] the canals near Basra [were bombed], they just filled them in with dirt and drove across the dirt." See Thomas A. Keaney and Eliot A. Cohen, *Revolution in Warfare? Air Power in the Persian Gulf* (Annapolis, MD: Naval Institute Press, 1995), 82–83.

¹² Williamson Murray, *Air War in the*

Persian Gulf (Baltimore, MD: The Nautical & Aviation Publishing Company of America, 1995), 253.

¹³ Richard P. Hallion, *Storm Over Iraq: Air Power and the Gulf War* (Washington, DC: Smithsonian Institution Press, 1992), 220, 245.

¹⁴ For in-depth treatment of this attack see Price T. Bingham, *The Battle of Al Khaffji and the Future of Surveillance Precision Strike* (Arlington, VA: Aerospace Education Foundation, 1997).

¹⁵ Keaney and Cohen, 18, 132.

¹⁶ Hallion, 261.

¹⁷ William M. Arkin, "Fliers Rose to Occasion—Speed Kills," *Los Angeles Times*, June 1, 2003.

¹⁸ Joint doctrine never mentions the need for or ability to achieve vehicular paralysis. While it states that interdiction and maneuver should normally be integrated to create dilemmas for the enemy and that interdiction attacks can produce a psychological impact that could significantly reduce enemy capabilities and morale, it does not provide any guidance for how this psychological impact could be achieved. See Joint Publication 3-03, *Joint Interdiction* (Washington, DC: The Joint Staff, October 14, 2011), vii, xi, I-3, and I-5.

¹⁹ While some commanders gave naval aviators more latitude in fleet exercises before the war, the battleship remained supreme with aviation playing a supporting role. In 1940 the General Board freed the aircraft carriers from the battleships, although the Battle Force—not carriers—remained the "core" of the fleet. The damage inflicted by the Japanese at Pearl Harbor shifted the burden of the Pacific War to aircraft carriers, and the superiority of the aircraft carrier became more clear as the war progressed. Even so, as late as 1943, Admiral Harry Yarnell's "Report on Aviation" noted the anger of aviators over the continued suppression of naval aviation by non-aviators. See William M. McBride, *Technological Change and the United States Navy, 1865–1945* (Baltimore: The Johns Hopkins University Press, 2000), 200–210.

²⁰ Examination of conflicts shows that the psychological effect of fear caused by air operations can be more important than the physical destruction inflicted. See Stephen T. Hosmer, *Psychological Effects of U.S. Air Operations in Four Wars 1941–1991: Lessons for U.S. Commanders* (Santa Monica, CA: RAND, 1996). During Operation *Desert Storm*, air interdiction succeeded in destroying the confidence of Iraqi soldiers in their equipment, which they saw as a magnet for air attacks. As a result, much of their equipment remaining intact when the ground offensive began was abandoned or at least unoccupied when reached by advancing Coalition ground forces. See Keaney and Cohen, 103–104. Operational Research ground surveys in World War II conducted by the British found that fighter-bomber attacks against the German armor did not destroy many tanks

because they could not be relied on to hit the target. However, these attacks were effective because of the disruption and morale effect. According to General Heinrich von Vietinghoff, the presence of Allied fighter-bombers paralyzed all German movement. See Gooderson, 212, 321.

²¹ Perry D. Jamieson, *Lucrative Targets: The U.S. Air Force in the Kuwaiti Theater of Operations* (Washington, DC: Air Force History and Museums Program, 2001), 118, 136.

²² Field Marshal Erwin Rommel commented on the impact Allied airpower had on his operations in Normandy, writing that "during the day, practically our entire traffic—on roads, tracks and open country—is pinned down by powerful fighter-bomber and bomber formations with the result that the movement of our troops on the battlefield is almost completely paralyzed, while the enemy can maneuver freely." See B.H. Liddell Hart, ed., *The Rommel Papers* (New York: Harcourt, Brace and Company, 1953), 476–477.

²³ As A-10 pilot First Lieutenant John Marks, who with Captain Eric Salomonson destroyed 23 Iraqi tanks with Maverick missiles, explained, regarding Phase IV of the Gulf War, "It was exactly what he had hoped, that the Army advance would do exactly what it did, that is, force the Republican Guard out of their prepared positions, out in the open and onto the roads." See Jamieson, 164.

²⁴ In the past the relationship between doctrine and force structure has caused the Services to neglect some important technological breakthroughs. This is because the formulation of doctrine is often used to justify a Service's attempt to obtain or maintain exclusive control over certain roles and missions. Since criticism of doctrine results in undermining the case the Service has made for certain roles and missions, such criticism is discouraged and breakthroughs in technology that might bring established doctrine into question are often ignored. See Perry M. 19 Smith, "The Role of Doctrine," *American Defense Policy*, vol. 3 (Baltimore: The Johns Hopkins University Press, 1973), 422–430.

²⁵ On the eve of World War II, many naval leaders and experts like naval analyst Bernard Brodie doubted the ability of the aircraft carrier to replace the battleship and revolutionize naval warfare. See Clark G. Reynolds, *The Fast Carriers: The Forging of an Air Navy* (New York: McGraw-Hill Book Company, 1968), 20–21.

²⁶ In October 1938, Major General John K. Herr, chief of the cavalry, stated that "he was unwilling to give up a single horse or man from the horse cavalry in order to organize any mechanized units." He asserted that "for a considerable period of time [mechanization was] . . . bound to play an important but minor role while the horse cavalry plays the major role so far as our country is concerned." See David E. Johnson, *Fast Tanks and Heavy Bombers: Innovation in the U.S. Army, 1917–1945* (Ithaca, NY: Cornell University Press, 1998), 136–137.

²⁷ Commenting on the Air Force's negative approach to long-range ballistic missiles in the early 1950s, Trevor Gardner, Secretary of the Air Force Harold Talbot's special assistant with responsibility for the Air Force missile program, thought that "the situation would continue unless some strong, external influence forced a change." See Edmund Beard, *Developing the ICBM: A Study in Bureaucratic Politics* (New York: Columbia University Press, 1976), 154–155.

²⁸ In April 2002, General John P. Jumper made an impassioned plea for this kind of integration. He compared what he wanted to how the Air Force performed air-to-air combat, saying, "The sum of all wisdom is a cursor over the target." See Raymond A. Shulstad, "Cursor on Target: Inspiring Innovation to Revolutionize Air Force Command and Control," *Air and Space Power Journal*, Winter 2011, 21.

²⁹ During Operation *Desert Storm*, air planners in the Black Hole focused on a strategic campaign against the Iraqi heartland, but there is no evidence of "an effort to conceptualize an operational-level air campaign against Iraqi ground forces . . . [the planners] responsible for the KTO [Kuwait theater of operations] simply threw air power up against an enemy sheltered in well-dug-in positions." See Murray, 320.

³⁰ A key performance requirement of the Sikorsky CH-53K heavy-lift helicopter, which was rolled out formally on May 5, 2014, is the ability to lift a 27,000-pound external payload 110 nautical miles in high/hot conditions (3,000 feet/91.5°F). See Graham Warwick, "Heavier Lifter," *Aviation Week & Space Technology*, May 5, 2014, 45.

³¹ The official Army account of the Gulf War gives the Army the main role in defeating the Iraqi army, stating that "as part of the Coalition, the American Army decisively defeated the fourth largest field army in the world. It did so at the lowest cost in human life ever recorded for a conflict of such magnitude." While it recognizes that air forces "so dominated the air that enemy ground units were largely prohibited from maneuvering and only dared to move at night or in bad weather," it also found airpower lacking. It notes that "despite 41 days of almost continuous aerial bombardment, the Republican Guard remained a cohesive and viable military force able to fight a vicious battle and survive to stop it from responding to the Great Wheel, or prevent it from retiring some of its elements to safety." See Robert H. Scales, Jr., *Certain Victory: The U.S. Army in the Gulf War* (Washington, DC: Brassey's, Inc., 1994), 5, 368.

³² See Jonathan M. House, *Combined Arms Warfare in the Twentieth Century* (Lawrence: University Press of Kansas, 2001), 171–172, 271. When discussing Allied AirLand operations in Europe in 1944, the author complains that General Elwood Quesada emphasized close air support only when ground commanders were launching a major ground offensive,

noting that Allied tactical air forces devoted more of their missions to interdiction. Yet he never notes that this interdiction contributed to success because it had (as German commanders noted) a devastating impact on the German army's mobility. He does mention that Allied air forces mistakenly attacked friendly ground forces throughout the war, but he does not comment on whether Army artillery might have also made the same mistake. When discussing the war against Iraqi in 1991, he writes that air planners assigned large numbers of U.S. aircraft to look for targets of opportunity with the purpose of preventing Iraqi movement in daylight because they "apparently preferred such potentially wasteful, independent operations to providing direct support to the ground forces."

³³ Even though it was the failure of the Army to coordinate with the Air Force that caused severe problems during Operation *Enduring Freedom's* Operation *Anaconda*, Army Major General Franklin Hagenbeck publicly criticized the Air Force's performance, noting its slow response in the crisis. See Rebecca Grant, "Stacked Up Over Anaconda," *Air Force Magazine* (March 2012), 58–62. The first year of the Korean conflict also provides a number of examples of decisions by Soldiers that severely limited the effectiveness of the Air Force. General Douglas MacArthur's staff, which consisted almost entirely of Army officers, often made critical decisions without first asking for Air Force input—for example, on August 13, 1950, directing that the entire B-29 force be diverted from interdiction to carpet bomb a suspected enemy "concentration" when the size of the target area was 26 square miles, not the 3 square miles the Air Force recommended. Post-attack reconnaissance revealed no evidence of enemy activity in the area bombed. See Robert Frank Futrell, *The United States Air Force in Korea, 1950–1953* (New York: Duell, Sloan, and Pearce, 1961), 130–131. After Inchon, the decision made by U.S. Soldiers to dedicate all airlift to the supply of advancing United Nations (UN) ground forces greatly delayed the deployment of Air Force fighters and Mosquito Forward Air Control aircraft to forward bases. When Chinese units ambushed UN forces, the distance between our air bases and the hard-pressed Army units seriously handicapped the Air Force's effectiveness because it significantly reduced the number of sorties that could be flown, lowered aircraft payloads, and increased the time it took these aircraft to reach the target. See HQ Fifth Air Force Memo for Record, "Meeting on Airlift to Pyongyang," HRA File K168.041-1, vol. 6 (part 4), October 22, 1950. Also see Futrell, 201–203.

³⁴ See Clark G. Reynolds, *Admiral John H. Towers: The Struggle for Naval Air Supremacy* (Annapolis, MD: Naval Institute Press, 1991).

³⁵ Carl H. Builder, *The Masks of War: American Military Styles in Strategy and Analysis* (Baltimore: The Johns Hopkins University Press, 1989), 19, 23, 71.

³⁶ See Price T. Bingham, "The Joint STARS Challenge," *Joint Force Quarterly* 49 (2nd Quarter 2008), 64–65.

³⁷ Discussing an Army corps acting as a joint task force headquarters, "The first priority must be to fight the joint fight—that is, to take advantage of the synergy available from synchronized, coordinated employment capabilities from all the Services. If they fight the joint fight well, they are unlikely to face the ground combat intensity that characterizes WFX [warfighter exercises]. . . . Joint training exercises create a Service training dilemma: Good joint level training does not necessarily provide a good component training experience." See Thomas E. Ward II, "A JTF Training Dilemma: Component Rigor Joint Realism," *Joint Force Quarterly* 46 (3rd Quarter 2007), 114.

³⁸ Builder, 129, 151.

³⁹ See James R. Locher III, *Victory on the Potomac: The Goldwater-Nichols Act Unifies the Pentagon* (College Station: Texas A&M University Press, 2002).

⁴⁰ R. Russell Rumbaugh, "The Best Man for the Job? Combatant Commanders and the Politics of Jointness," *Joint Force Quarterly* 75 (4th Quarter 2014), 97.

⁴¹ Autumn A. Arnett, "Innovating for Airpower," *Air Force Magazine* (January 2015), 18–21.