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The Airpower Edge:
Revolutionizing How the US Defeats Conventional Armies

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About the Forum

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Abstract

Through the history of warfare, advances in technology that provided significant new capabilities have played a key role in determining which military force had the best chance of prevailing in combat.

This paper, however, shows that in notable 20th century military breakthroughs by the Royal Air Force and the German Army that technology advances alone were not sufficient for military success. Success in both instances depended on leaders who understood how new technologies made key capabilities possible, and who could change assumptions about what was necessary to achieve victory. These examples also show the need for leaders with the ability to modify or even develop new doctrines to exploit new capabilities, as well as possess the power to implement these changes.

A quarter century ago, Operation Desert Storm revealed that the US possesses technologies which enable key capabilities for defeating opposing armies. These new capabilities have rendered assumptions about the "supporting role" of airpower obsolete; assumptions which current US doctrine for fighting conventional armies is still largely based upon. Since Operation Desert Storm, technological improvements have accelerated, sharpening a capability edge needed for US airpower to play a central role in defeating an opposing army. New doctrine that builds on existing operational war theories like those of Richard Simpkin and Mikhail Tukhachevskiy would help the US exploit these new capabilities. If not embraced by US military leaders who can foster and develop the necessary doctrine, the US will fail to exploit revolutionary capabilities despite their immense potential advantages.

Introduction: Technologies, Capabilities, and Victory

Throughout history, advances in technology that provided new or improved capabilities have played a key role in determining which military forces had the best chance of defeating an opposing force. The role technology plays in making military forces more successful can be seen in developments and inventions from the wheel, to the use of iron tools, to the compound composite bow, and gunpowder. Other key technologies that have changed warfare also include the breech-loading rifle, the machine gun, radio, aircraft, precision weapons, computers, and real-time, wide-area sensors.

But developments in technology alone are not sufficient to make militaries more successful. Success in warfare depends on leaders who understand how new technologies make new capabilities possible that could change assumptions about what is needed to achieve military success. It is also necessary these leaders have the ability to determine how best to exploit the advances in capability provided by developments in technology. Exploiting these advances require that leaders possess the ability to modify significantly, or even develop, new doctrines that determine how their forces are organized, trained, equipped, and employed.

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Yet recognizing the necessity of doctrinal change is not enough. It is essential for these leaders to possess the ability to implement these doctrinal changes. Military forces, especially successful ones, are well known for resisting change. This is particularly true for change that is likely to decrease an organization's bureaucratic power and prestige, the ability to implement change was often the explanation for why some militaries were much more successful than others who often were possessing the same technologies.[1]

World War II provides two examples of leaders who recognized how advances in technology could provide capabilities that made current assumptions obsolete, and who also had the ability to make and implement needed doctrinal changes. Both examples were unusual because their ability to achieve success depended on overcoming the many obstacles that normally prevent innovation.[2] These examples also show that successful innovation often depends on the assistance of people outside of military organizations.

The Royal Air Force (RAF) provides the first example of successful innovation. In the years before World War II, it was widely assumed that attacking aircraft would have the advantage because of the great difficulty defensive forces would have in finding attacking aircraft in time to intercept them. Fortunately for the RAF, the leader of its fighter command was Air Marshal Sir Hugh Dowding. Thanks to his background in air defense, his experience with the development and use of wireless communications in World War I, and his interwar service as the RAF's Air Member for Research and Development, he understood the implications of new efforts to use radio waves to detect aircraft.[3]

Dowding also had the help of key scientists within the RAF's research and development department, and outside members, especially Henry Tizard, chairman of the Aeronautical Research Committee, and the strong support of the Secretary of State for Air Sir Phillip Cunliffe-Lister. With their assistance, in only four years' time, Dowding was able to successfully develop the doctrine identifying the organization, equipment, and training needed to exploit the capability of detecting aircraft with radio waves—what would become known as radar. He then implemented this doctrine, allowing the RAF to defeat Germany's 1940 air offensive, known as the Battle of Britain.[4] Although Germany also possessed similar radar and radio technologies, its emphasis on using airpower offensively to support the army, along with fiscal considerations and bureaucratic rivalries between the army and navy explains why the Germans failed to pursue radar as effectively as the British. These same reasons also explain why the Germans were slow to understand how this capability could be exploited to defeat their air offensive.[5] In the end, it was the British and not the Germans who established command of the air.

During the same period of World War II, a similar development regarding the ability to

understand how to exploit advances in technology to make ground forces more effective was occurring within the German Army. Applying lessons it had learned from failure in World War I, the German Army General Staff under the leadership of Hans von Seeckt worked on doctrine that stressed mobility and the offensive. To achieve the mobility needed for the offensive employment of their army, the Germans put emphasis on the fullest possible use of motor transport and on using aviation to complement their combined arms mobile ground striking force. It is also important to note that Seeckt stressed teamwork, and paid special attention to communications to provide essential coordination of forces.[6]

It was in this doctrinal environment, using deep penetrations into an enemy's rear area to achieve the dislocation and disorientation of enemy command systems, that captain (and later general) Heinz Guderian played a key role. Guderian had come from a *jaeger* (light infantry) background, with its emphasis on maneuver, and had been a communications expert when, in 1922, he became chief of staff to the Inspectorate of the Motorized Transport Corps. With his background, and having studied British experiments with armor, he saw the possibilities of applying this technology to enhance needed capabilities to make the German Army's offensive doctrine more effective. Despite resistance from senior officers who favored the cavalry and infantry, as commander of a motorized battalion in 1929 Guderian began an effort that succeeded in advancing the cause of tanks and combined arms units that would result in the creation of *panzer* divisions.

Despite resistance from senior officers who favored the cavalry and infantry, as commander of a motorized battalion in 1929 Guderian began an effort that succeeded in advancing the cause of tanks and combined arms units that would result in the creation of *panzer* divisions.

After the success achieved with tanks in the Polish campaign of 1939, Hitler became a convert to the new doctrine, and took a personal interest in Guderian's career. This ensured continued emphasis on the role of the *panzer* division in the German Army's employment. Guderian and other officers such as Gen Erich von Manstein, recognized how panzer divisions composed of tanks accompanied by motorized infantry and artillery, and controlled by radio with the support of air attacks, could achieve rapid penetrations targeting key enemy nodes and the movement of reserves. They correctly believed that these penetrations could achieve the dislocation and disruption needed to exploit vulnerabilities in how other armies (like the French) planned to fight.

In contrast to the Germans, the French had assumed that defeating an enemy army depended on possessing large numbers of infantry supported by massive firepower and slow-moving tanks. The 1940 France campaign revealed that the key to success was not due just to technology—as French tanks were superior to those of the Germans, but were generally dispersed to support the infantry. The difference was that the Germans (like Guderian) had a better understanding of how to exploit the new capabilities tanks provided.[7]

Victory in the Gulf War: Airpower Upends Assumptions

As was the case with the defeat of the French in 1940, the Gulf War in 1990 revealed how new capabilities made possible by advances in technology were beginning to render key assumptions on the best way to defeat an opposing conventional army obsolete.

Before the Gulf War the leaders of the US Army and even some US Air Force leaders had assumed that airpower had limited effectiveness against opposing armies. Their assumption was based on the problems air forces had experienced in past conflicts, notably finding and then hitting small, dispersed, camouflaged targets like tanks and other vehicles, especially at night or during bad weather. Based on this assumption, airpower interdiction had focused on targeting enemy transportation infrastructure like railroads and bridges, but could only hope to slow enemy movement, not destroy large numbers of enemy vehicles. The perception of airpower's limited effectiveness against an enemy army caused the Army's leaders, and some leaders in the Air Force's Tactical Air Command (TAC) to emphasize the importance of subordinating American airpower to Army operations.[8]

During planning for the coalition ground offensive, US Central Command (CENTCOM)

under the leadership of US Army Gen H. Norman Schwarzkopf had assumed that the Iraqi Army's forces were numerically superior, and that for the offensive to be successful, airpower would have to achieve 50 percent attrition of those forces.[9] Making 50 percent attrition a requirement for a ground offensive was unprecedented, and indicated that, like Vietnam, the US military was measuring success in terms of attrition rather than by effects such as dislocation and disruption.

While coalition airpower intensely attacked Iraqi Army forces to meet the attrition requirements for a ground offensive, the Battle of Khafji in Saudi Arabia took place from January 29 to February 3, 1991. As had been possible in all previous wars, the Iraqi Army was attempting to use the cover of darkness to avoid detection and attack by coalition airpower at Khafji. The Iraqi objective was to force the start of a ground war with the coalition, but were unaware that the US and its allies possessed a new capability provided by the E-8 Joint Surveillance Target Attack Radar System (JSTARS), and its Ground Moving Target Indicator (GMTI) sensor capability. GMTI technology made it possible for the first time in the history of warfare to see and target ground vehicles moving throughout a large area, even at night or during bad weather.

While CENTCOM's Schwarzkopf did not seemingly appreciate the implications of the battle, the Iraqi commanders did. Their forces had dug in, attempting to survive coalition air attacks, but now the Iraqis realized how vulnerable they were even if they moved, whether to attack or withdraw.

The Iraqi attack initially achieved surprise because coalition commanders were unfamiliar with the JSTARS' capabilities, and had ignored the information the system was providing on Iraqi movements towards Khafji. However, once the Iraqi attack began the coalition's combined/joint force air component commander, US Air Force Lt Gen Charles Horner, quickly grasped the nature of the threat. Using the information provided by JSTARS, he ordered a series of devastating air attacks. The effect of these attacks was substantiated by an Iraqi brigade commander who said his unit suffered more damage in 30 minutes than it had in eight years fighting the Iranians.[10] When Iraqi III Corps Commander Maj Gen Salah Aboud Mahmoud requested permission to break off the attack because of heavy losses from allied air attacks, he was ordered to press on. After two more requests to break off the attack received the same order, Mahmoud radioed that "the mother is killing her children."[11]

While CENTCOM's Schwarzkopf did not seemingly appreciate the implications of the battle, the Iraqi commanders did. Their forces had dug in, attempting to survive coalition air attacks, but now the Iraqis realized how vulnerable they were even if they moved, whether to attack or withdraw. This put Iraqi forces on the horns of a dilemma, causing them to discard plans for future major operations.[12] Not grasping the significance of these new GMTI capabilities on display at Khafji, Schwarzkopf did not revise his war plan to take advantage of the battle's lessons. As a result, he was unprepared to take measures to use coalition airpower to prevent the subsequent escape of the Iraqi Republican Guard from Kuwait—an escape that resulted in an incomplete victory.[13]

Schwarzkopf was not the only Army officer who failed to recognize how new technologies provided airpower with unprecedented new capabilities for fighting an opposing army in the field. While the US Army's official history of the war stated that "coalition air forces had so dominated the air that enemy ground units were largely prohibited from maneuvering and only dared to reposition at night or in bad weather," the Army's record of the conflict then blamed airpower for its failure "to break the will of the Republican Guard" or to prevent it from retiring some of its elements to safety.[14] In making this statement, the history fails to mention that the US Army's XVIII Airborne Corps advanced the fire support coordination line (FSCL) well north of the Euphrates River so as to reserve the area for its attack helicopter operations. The impact of this move was to seriously handicap the US Air Force's ability to destroy retreating Iraqi units. The problem with the FSCL had built up since Schwarzkopf had prevented Army commanders from moving the FSCL beyond the Saudi border until the beginning of the ground offensive, preventing corps commanders from exerting the control over air attacks they were accustomed to having.[15]

Modern War: Updating Operational-Level Theories on Defeating Armies

Since the Gulf War, further developments in US military technology have accelerated, providing even more of the capabilities needed for airpower to play a more central role in defeating an opposing mechanized army. These capabilities include advances in GMTI, precision munitions capable of hitting moving targets in all weather conditions, communications, computing, remote piloted aircraft (RPA) capable of providing surveillance and delivering precision munitions, and more effective stealth technology. Thanks to these developments, a significant evolution in the theories for defeating an opposing army first developed by Soviet Army Marshal Mikhail Tukhachevskiy and British Army Brigadier Richard Simpkin is now feasible.

…Tukhachevskiy and later Simpkin developed operational-level theories that focused on the use of rapid, high tempo, deep operations supported by air attacks to achieve success through the disruption or dislocation of an opposing army's ability to fight effectively, instead of through costly envelopment and attrition operations.

Like Guderian and von Manstein in 1940, Tukhachevskiy and later Simpkin developed operational-level theories that focused on the use of rapid, high tempo, deep operations supported by air attacks to achieve success through the disruption or dislocation of an opposing army's ability to fight effectively, instead of through costly envelopment and attrition operations. Their theories were different from those of the Germans, in that they recognized the need for light mechanized air-landed army units that could move quickly, accompanied by essential logistical support. Both saw the advantages of air mobility for these light mechanized forces and the need for close cooperation between air and land forces.[16]

While both Tukhachevskiy and Simpkin recognized that airpower could play a valuable supporting role in the defeat of an enemy mechanized army, neither of these theorists could have dreamed of the degree to which advances in technology would give airpower the ability to do far more than support ground troops. The key to enabling airpower's more central role in defeating opposing armies is derived from advances in GMTI technology—which now provide the potential for US commanders to see and precisely target the movement of an opposing army's vehicles operating throughout a large area. Commanders can also more effectively maneuver their own ground forces, with the help of GMTI, to achieve and exploit advantages.

Unfortunately, there is far too little attention being given by many in the US armed forces, especially airmen, to the critical importance played by vehicular movement in ground warfare.[17] Few have recognized how this real-time information on an army's vehicular movement can help streamline intelligence assessments, especially given that the massive volume of data currently being collected by various sensors which (more often than not) acts to slow down operations rather than speed them up.[18] Moreover, the ability to see vehicular movement makes possible the near-real time assessment of the effectiveness of attacks designed to slow or even paralyze movement.

Given their attention to the role of human factors like fear and fatigue, both Tukhachevskiy and Simpkin would likely have recognized that the ability to quickly and precisely target vehicles attempting to move throughout a large area would have had a paralyzing effect on opposing soldiers. Enemy soldiers would soon realize that movement puts them at high risk of being targeted and killed. British operational research ground surveys in World War II, for example, found that while fighter-bomber attacks did not destroy many German tanks because of difficulties in weapons delivery accuracy, these attacks were effective because of their disruption and effect on morale. German Army Gen Heinrich von Vietinghoff even noted the presence of Allied fighter-bombers paralyzed all German movement.[19]

Modernizing Doctrine: Airpower, Land Maneuver, and Defeating Enemy Armies

While airpower's ability to cause widespread paralysis of an opposing army's units is vital to success, the rapid and complete defeat of an army would also depend on the employment of allied land forces, first by forcing the movement of enemy forces, which would expose them to precision air attacks. Once paralysis is achieved, these allied ground forces would rapidly penetrate deep into the enemy's rear area. However, success, especially

at the operational level with deep penetrations, would require much closer integration in the employment of air and land forces than has been witnessed in past conflicts.

Especially in the initial phases of combat, the maneuver of friendly land forces would be essential to putting the opposing army commander on the horns of a dilemma that has no satisfactory answer. If the opposing army attempts to counter friendly land maneuver by moving, it makes its vehicles more vulnerable to detection and destruction by precision air attack. But if the opposing army attempts to reduce its vulnerability to air attack by dispersing and not moving, it will be unable to effectively counter the maneuver of friendly land forces while providing even more time for enemy forces to be located and targeted by air attacks. This construct was proven true, as recently as the major combat phase of Operation Iraqi Freedom. Probes by coalition ground forces forced Iraqi forces to maneuver, significantly increasing their vulnerability to precision air attack.[20]

Since criticism of doctrine results in undermining the case a military 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.

In order for friendly land maneuver to have the greatest possible impact on the disruption and dislocation of an opposing army through rapid deep penetrations, it would need to exploit advances in technology to field light airmobile mechanized units. Given the vastly improved situational awareness provided by GMTI radar and other sensors, and the widespread use of RPAs, the need for friendly land forces to engage in close combat with opposing armor should be greatly reduced, making the use of lighter vehicles more feasible. By exploiting advances in heavy vertical lift capabilities, these light mechanized units would be able to quickly "leap" over natural obstacles like rivers and ridges, making fast, deep penetrations far more unpredictable. Moreover, by using vertical lift for relatively short distances, the amount of vertical lift capability required would be significantly reduced. Exploiting advances in unmanned vehicles for logistical support could also make it possible to significantly reduce the risks faced by light airmobile mechanized forces, while making their maneuver even more rapid.

Light airmobile mechanized forces would also have the important advantage of allowing more US Army forces to close quickly towards a distant theater. The increased capability of airpower to cause paralysis of the opposing army could further reduce the number of US Army units needed to achieve success. In many cases, the land forces of any US ally, augmented by key US Army capabilities such as surveillance and logistics and a backbone of a light airmobile mechanized units, could, in many cases, be sufficient to achieve US objectives. Possessing the ability to quickly reach a distant theater with powerful air forces and airmobile mechanized land forces should also serve as a powerful deterrent, making aggression even less likely.

Despite the many important potential advantages of fielding the air and land capabilities to make this theory a reality, the real challenge will be in its implementation. Unfortunately, if past experience is any guide this concept is likely to face immense resistance from the US military services. According to an analysis by military scholar Maj Gen Perry Smith, USAF (Ret.), the relationship between doctrine and force structure has caused the US military services to neglect important technological breakthroughs. Smith noted that 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 a military 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.[21]

Conclusion: Breaking Down the Barriers to New Theories

Resistance to the implementation of these new ideas by the US Army's leadership is also likely, since many soldiers have been reluctant to recognize the contributions US airpower has made to the defeat of opposing armies. This was certainly the case after the Gulf War. Part of the problem may be that many soldiers, not having been on the receiving end of the successful US air attacks in the Gulf War, do not fully appreciate or are unwilling to recognize how much these attacks

have contributed to their own success. But most of the resistance from the Army is likely to stem from the impact of this new theory on the makeup of its current force structure, especially its heavy armor units. Still another major factor could be that the implementation of this theory would mean the US Army would no longer play the dominant role in land warfare. The change for the Army would be as immense as that which occurred in the US Navy, when the aircraft carrier replaced the battleship in prominence.

There are service attitudes about the use of fixed wing airpower that are longstanding and will be hard to change. During an Operation Iraqi Freedom concept rehearsal drill carried out in December 2002, once the exercise began, the Army pushed the fire support coordination line out in their sector. At the same time, the US Marines pulled their FSCL in closer. This line movement was repeated after actual combat began in March 2003. In the beginning week of the war, the Marines were able to employ three times more fixed-wing airpower in their area of responsibility as compared to the Army, due to their FSCL location.[22]

Many in the US Air Force have not thought much about the theories and capabilities needed to fight and defeat an opposing army. Since September 11, 2001 a generation of airmen have only known the use of airpower in conjunction with land forces to conduct counterinsurgency and irregular warfare operations.

While resistance by the Air Force to implementation of this theory for revolutionizing how the US defeats armies not likely to be as pronounced as from the Army, it could still be significant. Many in the US Air Force have not thought much about the theories and capabilities needed to fight and defeat an opposing army. Since September 11, 2001 a generation of airmen have only known the use of airpower in conjunction with land forces to conduct counterinsurgency and irregular warfare operations. With the exception of the opening phase of Operation Iraqi Freedom in 2003—where the Iraqi Army was eliminated as an effective fighting force by airpower—these airmen have no recent experience in operations involving an organized, mechanized army.[23]

Additionally, airmen rightly emphasize the importance of controlling the air, but they tend to neglect the importance of knowing how to best exploit this control to defeat an opposing army. This tendency can be seen in the difference between how the Air Force trains with E-3 AWACS versus E-8 JSTARS aircraft. Not only has the Air Force fielded more E-3s than E-8s, the service exercises its AWACS forces more often. Both aircraft are limited in number, and are thus high demand, low density capabilities sought by combatant commanders around the world. But due to the E-8s GMTI capabilities, it has seen near continuous service supporting counterinsurgency operations in Iraq and Afghanistan.[24] To a large degree, this relative lack of attention to airpower capabilities needed to defeat an opposing army also results in part from US military doctrine and practice over the past 16 years, that largely views airpower as a supporting (and inferior) capability to ground power—a perspective emphasized to airmen and soldiers alike.

Besides the resistance from the Army and Air Force, resistance is also likely from the other services, and elements of the "joint community." While all the military services say jointness is vital to success, the proof is in their actions. Ultimately, "jointness" survives because it does not make serious demands on the services, but allows them to pursue their own agendas. Any implementation of this new theory for defeating an opposing army would require very close cooperation between the Army and Air Force, and no such cooperation between armies and air forces has been achieved in any other nation's armed forces yet, let alone in the US.

However, the possibility of realizing this concept would become more feasible if the services truly adopted a win-win paradigm. Instead of the current flawed paradigm of competition, the US armed forces should focus on personal and organizational excellence that develops information, and reward systems that reinforce the value of cooperation. This will require self-awareness, imagination, conscience, and independent will, along with mutual learning. It will also take great courage to create mutual benefit structures since it is likely to require interacting with others who are used to the current "win or lose" paradigm.[25] The US Air Force is working hard on multi domain command and control (MDC2) concepts that will be required to advance US combat capability into

the future. Such vision is needed to further joint, interdependent employment of military forces, and time will tell if the Air Force succeeds.

Implementing an operational-level theory that revolutionizes how the US defeats an enemy army will also depend on strong leaders both inside and outside of the military services. Inside both the Air Force and Army, leadership will need the courage to articulate and advocate for these capabilities. Key political leaders will be required to support this innovation through the promotion and assignment of officers who support, and know how to implement, such a revolutionary change. Aerospace industry and technical experts will also be needed who will support the research and development necessary to make this revolution a reality. The bottom line is that technology is no longer the challenge for this game-changing capability—the main challenge is institutional inertia, and the inherent conservatism of the US military services.

Implementing an operational-level theory that revolutionizes how the US defeats an enemy army will also depend on strong leaders both inside and outside of the military services.

Although he was discussing revolutions in science, Thomas Kuhn's observations also apply to military revolutions. He noted that a scientific theory "is declared invalid only if an alternative candidate is available to take its place." And the judgment to reject one theory involves comparison of both theories with each other.[26] Science continually works to bring theory and fact into closer agreement.[27] The key to needing a new theory is found in resolving anomalies in an existing theory with a new one that permits predictions different from its predecessor.[28]

Operation Desert Storm revealed the current military theory for defeating an opposing army was seriously flawed, in that models predicted the US would incur 30,000 casualties while actual losses came out to around 300 personnel—half of these not occurring in battle.[29] The problem with current theory is its failure to appreciate fully the effectiveness of airpower against opposing armies. In World War II the German Army had the same problem in that few of its senior officers anticipated the full impact of Allied airpower.[30] As illustrated in recent conflicts, airpower today is vastly more effective against armies than was the case in World War II, thanks to new capabilities that make it possible to see and target movement with precision weapons, in any weather conditions, day or night.

As Kuhn found, a new theory emerges first in the mind of one or a few individuals, as seen with Dowding and Guderian's operational theories. These individuals learned to see the world differently, and make a transition because of key circumstances. Their attention was intensely concentrated on a crisis-provoking problem, and they were committed less deeply than most of their contemporaries to the worldview and rules determined by an old paradigm.[31] In science, older and more experienced scientists may resist a new theory indefinitely, but most all can be reached one way or another.[32]

Americans and their allies can only hope that it will not take a crisis for the US military to adopt a new paradigm, and that most of the older, more experienced military officers will not resist this new theory of war indefinitely. ✪

Endnotes

1 Author's note: For an excellent discussion of how military innovation can be resisted see, Andrew Hill and Stephen Gerras, "Systems of Denial: Strategic Resistance to Military Innovation," *Naval War College Review, Winter 2016, Vol. 69, No. 1, 109-32.*

2 Author's note: Obstacles result from operational uncertainty, which is why militaries graft new technologies onto old doctrines. Militaries also have hard time learning from the wars of other military organizations, and can misperceive the implications of new technology unless the lessons are very clear. See Barry R. Posen, *The Sources of Military Doctrine: France, Britain, and Germany between the World Wars* (Ithaca, N. Y.: Cornell University Press, 1984), 54-5.

3 Richard Hough and Denis Richards, *The Battle of Britain: The Greatest Air Battle of World War II* (New York: W.W. Norton & Company, 1989), 28-9.

4 Ibid, 48-51.

5 Edward B. Westermann, *Flak: German Anti-Aircraft Defenses, 1914-1945* Lawrence, Kansas: University Press of Kansas, 2001. 96-7.

6 Larry H. Addington, *The Blitzkrieg Era and the German General Staff, 1865-1941 (*New Brunswick, New Jersey: Rutgers University Press, 1971), 28-31.

7 Posen, 210-9, Addington, 83-124.

8 Author's note: When looking at the Checkmate office's "Instant Thunder" plan, officers from Tactical Air Command (TAC) were concerned with its apparent lack of integration with the Army, and wondered how airpower would support the Army. Briefed on the TAC response, USAF Lt Gen Charles Boyd, then-commander of Air University, noted that many in the Air Force were suspicious of any view that made airpower anything more than support to the Army. In Boyd's opinion, this permanent subordination of airpower to the Army was crippling and dysfunctional. See: Col Richard T. Reynolds, USAF (Ret.), *Heart of the Storm: The Genesis of the Air Campaign Against Iraq (*Maxwell Air Force Base, Alabama: Air University Press, January 1995), 40, 48.

9 Thomas A. Keaney and Eliot A. Cohen, *Revolution in Warfare? Air Power in the Persian Gulf* (Annapolis, Maryland: Naval Institute Press, 1995), 40-1.

10 Ibid, 94-6.

11 Michael R. Gordon and General Bernard E. Trainor, *The Generals' War: The Inside Story of the Conflict in the Gulf* (Boston: Little, Brown and Company, 1995), 283.

12 Keaney and Cohen, 96.

13 Gordon and Trainor, 268-89.

14 Brig. Gen. Robert H. Scales, Jr., US Army, *Certain Victory: The US Army in the Gulf War* (Washington: Brassey's, 1994), 368.

15 Keaney and Cohen, 133-4.

16 Richard Simpkin and John Erickson, *Deep Battle: The Brainchild of Marshal Tukhachevskiy* (London: Brassey's, 1987) 32-77. Richard Simpkin, *Race to the Swift (*London: Brassey's, 1985).

17 Author's note: Modern armies depend on their vehicles for the movement that can create the operational and tactical advantages of surprise, mass, and favorable position. Besides movement, armies also depend on their vehicles for heavy firepower, armored protection, supply, and engineering support.

18 Author's note: Air Force Chief of Staff Gen David Goldfein, recently noted that "…the question becomes at what point is the volume of what you sense so large it actually starts slowing you down as opposed to speeding you up? The only answer, in my mind, is to get into the business of artificial intelligence and machine-to-machine learning. We need to neck down the terabytes of data we collect to the point of decision because the victor in future combat will be that person, that leader, who is able to command and control and move forces and deny the enemy the ability to do the same." See: An Interview with Gen David L. Goldfein, *Strategic Studies Quarterly,* Spring 2017, 8.

19 Ian Gooderson, *Air Power at the Battlefront: Allied Close Air Support in Europe 1943-45* (London: Frank Cast Publishers, 1998), 212, 321.

20 Author interview, USAF Col P. Mace Carpenter, chief of air & space strategy, US Central Command Air Forces (CENTAF), August 28, 2005.

21 Perry M. Smith, "The Role of Doctrine," *American Defense Policy,* Vol. 3 (Baltimore, Maryland: The Johns Hopkins University Press, 1973), 422-430.

22 Ibid, Col Carpenter interview.

23 Author's note: A Marine Corps platoon commander during the Operation Iraqi Freedom land offensive, Lt Nathaniel Fick wrote in his book *One Bullet Away*: "For the next hundred miles, all the way to the gates of Baghdad, every palm grove hid Iraqi armor, every field an artillery battery, and every alley an anti-aircraft gun or surface-to-air launcher. But we never fired a shot. We saw the full effect of American airpower. Every one of those fearsome weapons was a blackened hull."

24 Author's note: The Air Force produced 31 E-3 AWACS, but only 18 E-8 JSTARS aircraft. See: Aaron M.U. Church, "Gallery of Weapons: 2017 USAF Almanac," *Air Force Magazine,* June 2017, 103-4.

25 Author's note: See Habit 4: Think Win/Win in Stephen R. Covey, *The 7 Habits of Highly Effective People* (New York: Simon & Schuster, 2004) 215-46.

26 Thomas S. Kuhn, *The Structure of Scientific Revolutions* (Chicago: The University of Chicago Press, 1970), 67.

27 Ibid, 80.

28 Ibid, 97.

29 John T. Hanley, Jr., "Changing DOD's Analysis Paradigm," *Naval War College Review,* Winter 2017, Vol. 70, No. 1, 80.

30 See "A German Evaluation of Air Interdiction in World War II," Sabre Measures [Echo], United States Air Force Assistant Chief of Staff, Studies and Analysis, November 1970, 24. The lack of German awareness of the effectiveness of Allied airpower is also evident in Gen Omar Bradley's 12th Army Group report, *The Effect of Air Power on Military Operations in Western Europe*, based largely on POW interrogations.

31 Kuhn, 144.

32 Ibid, 152.

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