



INSTITUTE FOR DEFENSE ANALYSES

**Technology and the Nature of War:
Four Vignettes**

Patrick J. Savage
Thomas C. Greenwood

September 2022

Approved for public release;
distribution is unlimited.

IDA Document NS D-33203
Log; H 22-000342



The Institute for Defense Analyses is a nonprofit corporation that operates three Federally Funded Research and Development Centers. Its mission is to answer the most challenging U.S. security and science policy questions with objective analysis, leveraging extraordinary scientific, technical, and analytic expertise.

About This Publication

This work was conducted by the Institute for Defense Analyses under Corporate Research Project C8307 "Technology and the Nature of War." The views, opinions, and findings should not be construed as representing the official position of either the Department of Defense or the sponsoring organization.

For More Information

Patrick Savage, lead author, Joint Advanced Warfighting Division
psavage@ida.org | 703-845-2514

Daniel Y. Chiu, director, Joint Advanced Warfighting Division
dchiu@ida.org | 703-845-2439

Copyright Notice

© 2022 Institute for Defense Analyses
730 East Glebe Road, Alexandria, Virginia 22305 • (703) 845-2000

This material may be reproduced by or for the U.S. Government pursuant to the copyright license under the clause at DFARS 252.227-7013 (Feb 2014).

Technology and the Nature of War: Four Vignettes

Military forces throughout history have pursued and embraced new technology for the combat edge it seems to portend. Superior surveillance platforms, weapons systems, communications equipment, and transportation methods can be decisive “combat multipliers.” The hope and promise that high technology will offer asymmetrical advantages is what imbues it with allure and appeal. It also helps explain why technology is heralded as a sterling example of American ingenuity, scientific research, and engineering prowess harnessed to serve national defense.

To claim that America’s affinity for military technology is baked into its DNA is no exaggeration. As Thomas Mahnken noted, “Reliance on advanced technology has been a central pillar of the American Way of War, at least since WWII. No nation in recent history has placed greater emphasis upon the role of technology in planning and waging war than the United States.”¹

Yet technology is no panacea: it must be tailored to plans, concepts, and a specific operating environment. Moreover, technical dominance over an enemy does not guarantee strategic success in achieving the political aims toward which nations fight. In World War II, U.S. materiel and technological dominance still required a grueling fight across the Pacific to the Japanese homeland before an exhausted and starving adversary ultimately capitulated.²

Robert Johnson emphasizes this point even more: “New technologies, from unmanned aerial vehicles to robotics, and new methods such as cyber denial of service or disruption, do no more to guarantee victory than did the faith in air and sea power in the early twentieth century. The novelty of a technology has never ensured success in its own right—it is the integration of innovation into effective methods and means that gives a strategic or tactical edge.”³

To Gray and Johnson’s points: while NATO coerced Serbian forces to withdraw from Kosovo in 1999, Operation ALLIED FORCE required an 11-week bombing campaign and the threat of ground invasion before Slobodan Milosevic capitulated.⁴ In the end, the air campaign failed to

¹ Thomas G. Mahnken, *Technology and The American Way of War Since 1945*, (New York: Columbia University Press, 2008), 5.

² Colin S. Gray, *Weapons Don’t Make War: Policy, Strategy and Military Technology*, (Lawrence, KS: University Press of Kansas, 1993), 176.

³ Robert A. Johnson, “Predicting Future War,” *Parameters* 44, 1 (Spring 2014): 69.

⁴ Ivo H. Daalder and Michael E. O’Hanlon, *Winning Ugly: NATO’s War to Save Kosovo*, (Washington: Brookings University Press, 2000), 117, 209.

destroy Serbia’s air defense network or prevent massive harm against Kosovo’s civilian population—a key NATO objective for going to war.⁵

In Iraq and Afghanistan, U.S. technological overmatch proved equally ineffectual against low-tech insurgents. The latter’s imaginative use of improvised explosive devices (IEDs) prompted a U.S. high-tech response that included employing synthetic-aperture radars mounted on drones to identify “tiny disturbances in the soil where insurgents might have buried IEDs or the command wires that triggered them.”⁶ Yet, insufficient forces and surveillance platforms in both countries prevented coalition units from inspecting thousands of such soil disturbances in search of casualty-producing explosives.

Today’s geostrategic challenge of trying to deter both China and Russia—nuclear armed states threatening U.S. global supremacy—coupled with the advent of the Fourth Industrial Revolution (4IR) and emerging technologies, has accelerated America’s quest to regain and maintain its previous high-tech military dominance. The growing confluence of a diverse array of technologies is unprecedented both in their scope and potential impact on society.⁷ Yet the synergy that may result from connecting so many technologies is likely to be more important than any one capability.⁸ This could significantly transform the *character* of war (i.e., the ways and means armies use to fight), but not the *nature* of war as Carl von Clausewitz defined years ago as the realm of uncertainty, chance, suffering, confusion, exhaustion, and fear—all factors that create friction.⁹ Echoing Clausewitz more recently, historian Margaret MacMillan contends that war will remain a violent, bloody, and destructive affair organized by humans who are fueled by “greed, fear and ideology.”¹⁰

New weapons and equipment require new tactical approaches, doctrinal changes, and most importantly, coherent overarching strategies before armies can reap their benefits. The 4IR is unlikely to alter this truism or necessarily make the world a more peaceful place. The diffusion of technology continues to erode the nation-state’s long-held monopoly over violence and enables hyper-empowered global citizens to expediently leverage commercially available technologies toward destructive ends. Thus, as technology marches inexorably forward, military

⁵ Martin Andrew, [“Revisiting the Lessons of Operation Allied Force,”](#) Airpower Australia Analysis, last modified 27 Jan 2014.

Daalder and O’Hanlon, *Winning Ugly...*, 195.

⁶ Technology Quarterly, “All the Targets, All the Time,” *The Economist* (27 Jan 2022): 6.

⁷ Peter Layton, “Prototype Warfare, Innovation and the Fourth Industrial Age,” (Canberra, Australia: Air Power Development Center, 2018), 1–10.

⁸ David Barno and Nora Bensahel, [“War in the Fourth Industrial Revolution,”](#) *War on the Rocks*, 19 June 2018.

⁹ Michael Howard, *Clausewitz*, (Oxford: Oxford University Press, 1983), 25.

¹⁰ Margaret MacMillan, *War: How Conflict Shaped Us*, (New York: Random House, 2020), 267.

organizations will continue trying to integrate the emerging capabilities into their forces' warfighting approach. As the following four vignettes highlight, this is no easy task.

Vignette 1: WWII Wonder Weapons and Technological Determinism

By 1943, the tide had turned against Adolf Hitler's Nazi Germany after earlier military successes. The advantages that Germany had enjoyed in marrying new military capabilities with innovative employment methods—such as *blitzkrieg* combined arms warfare in 1939—and superior maneuver and battlefield initiative had been steadily nullified and reversed. This reversal was due partially to the Allied powers superior materiel and manpower resources, but also to Germany's loss of its first-mover advantage with regard to adopting military technology. Moreover, Allied adaptation after their early defeats made them more proficient in combined arms tactics and operational art.¹¹

Among the means that Germany pursued to stave off defeat was the development of so-called *Wunderwaffen* (Wonder Weapons): novel and advanced military capabilities that were in their infancy. Germany invested considerable time, money, expertise, and critical resources into developing *Wunderwaffen* throughout the latter half of the war. Many of these inventions have become household names among military history enthusiasts: armored vehicles such as the Panther and Tiger tanks, advanced submarines like the Type XXI U-Boat, jet-powered aircraft such as the Me-262 Swallow fighter, and now-infamous "vengeance weapons" such as the supersonic V-2 rocket—the first long-range ballistic missile to be used in combat (for which the Allies had no countermeasure or warning mechanism).¹²

While some of these *Wunderwaffen* capabilities would be fielded in impressive numbers and contribute to localized tactical successes, they failed to turn the war back to Germany's favor. The select few *Wunderwaffen* that survived leaps from the design table to scale-model to production line yielded minimal strategic impact before Germany was defeated in May 1945.

The historical literature offers multiple reasons for the *Wunderwaffen* failure to manifest the potential that Hitler and his regime had envisioned: political and military interference in force development matters, industrial shortcomings, and effective Allied bombing raids on Germany's infrastructure, among others. However, Todd Schollars argues that the primary reason for the failures was Germany's lack of strategic vision—a failure not unique to *Wunderwaffen* programs but endemic throughout Nazi leadership and planning. This was nowhere more

¹¹ Williamson Murray and Allan R. Millett, *A War to Be Won*, (Cambridge, MA: Belknap Press of Harvard University Press, 2001), 298–303, 388–92.

¹² Marcus O. Jones, "Innovation for Its Own Sake: The Type XXI U-boat," *Naval War College Review* 67, 2 (2014): 117. T.D. Dungan, *V-2: A Combat History of the First Ballistic Missile*, (Yardley, PA: Westholme Publishing, 2005), 6–8.

manifest than with in Herman Goering’s short-sighted leadership of the *Luftwaffe*—especially as the war worsened for Germany and the search for miracle weapons intensified—Goering forsook pre-war, long-term plans for training, staffing, and industrial and technological development, in order to focus more on quick, short-term strategic goals.¹³

Underpinning all of this was the lack of a coherent and overarching Nazi plan for developing and employing *Wunderwaffen*. Thus, Germany’s dogged search for a technological breakthrough that could end the war on Berlin’s terms remained unattainable, unaffordable, and untimely.¹⁴ Like Goering, Nazi leadership eschewed developing new strategies, operational concepts, and doctrine for integrating *Wunderwaffen* capabilities into frontline forces. Instead, they focused on developing capabilities to solve their near-term military problems. Marcus O. Jones characterizes the Nazi approach as “a special, superficial kind of technological determinism, a confidence in the power of technology to prevail over the country’s strategic, operational, and doctrinal shortcomings.”¹⁵ To that end, Jones argues that Nazi leadership was ignorant of technology’s inability on its own to favorably decide battles and wars. Moreover, they misperceived how technology critically interacts with other human and cultural factors.¹⁶

Today, the United States develops operational concepts and doctrine to help deter potential adversaries and, if necessary, to fight as a Joint Force to achieve key national strategy and defense policy goals. The individual services strive to formulate, refine, and adopt their own warfighting concepts and doctrines that will enable them to most effectively contribute to a joint campaign. While this process is not without its shortcomings, the *Wunderwaffen* example illustrates what can happen when technological development for its own sake becomes the catalyst for military change, promoting a lopsided gamble against virtually impossible odds that a single breakthrough will become a “war winner.”

Vignette 2: The 1950s, the Pentomic Division, and Misjudging Future War

After World War II, the United States Army embarked on its own ill-fated attempt to harness burgeoning technology in the 1950s with the design of the Pentomic Division. Born out of President Dwight D. Eisenhower’s “New Look” defense policy that embraced the concept of Massive Retaliation—whereby the United States would respond to any attack on its interests

¹³ Todd J. Schollars, “German Wonder Weapons: Degraded Production and Effectiveness,” *Air Force Journal of Logistics* 34, 3/4 (2010): 30.

¹⁴ Schollars, “German Wonder Weapons:...,” 30.

¹⁵ Jones, “Innovation for Its Own Sake:...,” 120.

¹⁶ Jones, “Innovation for Its Own Sake:...,” 120–21.

with nuclear weapons—the Pentomic Division was an attempt to figure out how to most effectively design and organize U.S. ground forces to fight in a nuclear conflict.

The Pentomic Division’s primary operational goals were to be more survivable on the nuclear battlefield and to be able to effectively employ its own organic tactical nuclear weapons by focusing on dispersion, mobility, and flexibility. Units would disperse both laterally and in depth to avoid massing and presenting the enemy with lucrative targets. Mobility—by way of mechanization—would ensure that the division could disperse and re-mass quickly, even across an extended battlefield. Finally, a flexible command structure would ensure that even if the division’s leadership were destroyed, sub-units could continue fighting effectively.¹⁷

With these guiding principles in mind, the Army abandoned its World War II “triangular” structure that was based around “threes” of maneuver units: three regiments per division, three battalions per regiment, three companies per battalion, three platoons per company (not counting support units).¹⁸ In its place the Army adopted the new “pentomic” structure, dividing divisions into five “battle groups”—each bigger than a battalion but smaller than a regiment and comprising five maneuver companies each with five platoons.¹⁹ While smaller than a triangular division by more than 3,000 troops, the Pentomic Division was envisioned to be faster, more lethal, and more survivable on the nuclear battlefield, with most of the troop reductions asserted to be coming from training and staff positions rather than combat billets.²⁰

The Pentomic Division would never be tested in combat, let alone on a nuclear battlefield. By 1960, after less than a decade, the Army returned to a more traditional triangular structure.²¹ Multiple factors led to the Division’s failure as a warfighting concept. First, it was born in large part out of interservice politics. Under Eisenhower’s New Look, Army leadership faced considerable pressure to maintain the service’s relevance and prestige even though resources were prioritized to the Air Force that had been assigned the primary mission of nuclear defense. Thus, to help preserve its budget and end strength, the Army began to pivot in the 1950s to thinking about how ground forces could best employ tactical nuclear weapons, which further increased competition with the Air Force.²²

¹⁷ Richard W. Kedzior, *Evolution and Endurance: The U.S. Army Division in the Twentieth Century*, (Santa Monica, CA: RAND Corp., 2000), 25.

¹⁸ Combat Studies Institute, *Sixty Years of Reorganizing for Combat: A Historical Trend Analysis*, CSI Report No. 14, (Fort Leavenworth, KS: U.S. Army Command and General Staff College), 19.

¹⁹ Kedzior, *Evolution and Endurance:...*, 25.

²⁰ Combat Studies Institute, *Sixty Years of Reorganizing for Combat:...*, 19.

²¹ Kalev I. Sepp, “The Pentomic Puzzle: The Influence of Personality and Nuclear Weapons on U.S. Army Organization 1952–1958,” *Army History* 51 (Winter 2001): 1.

²² Kedzior, *Evolution and Endurance:...*, 23–24.

Second, the Pentomic Division depended heavily on technological developments that either fell short or did not materialize. The wide battlefield dispersion envisioned under the concept required communications technology that did not exist in the 1950s, nor would the Army invest the resources to develop such capabilities. The concept also required long-range artillery that the Army could not afford.²³ Army leadership also asserted that all Pentomic Divisions except the heaviest be air transportable; however, the Air Force refused to stop producing other aircraft—particularly strategic bombers—to provide the Army the air transport fleet it required.²⁴

Third, these miscalculations and misjudgments were exacerbated by the tactics designed for the Pentomic Division. It was assumed that flanking attacks would be unnecessary on a battlefield where nuclear weapons would blast massive gaps in enemy lines. This, in turn, would enable Army forces to penetrate enemy defenses with direct, frontal attacks that would no longer require such critical supporting actions as surprise and deception. Unfortunately, this made the Pentomic Division's tactics more closely resemble those of World War I rather than of World War II. In short, instead of using nuclear fires to enable decisive maneuver to destroy the enemy, the Pentomic Division became fixated on holding terrain in a static defense.²⁵

The concept's final and most significant shortcoming was the assumption that the next war would be nuclear. This limited the Division's flexibility to respond to other limited, conventional war scenarios. Emerging Cold War flashpoints in the late 1950s—the Suez Crisis, Hungarian Revolution, Algerian War, and Vietnam War—all demonstrated how ill-suited the Massive Retaliation concept was to meeting the security challenges of that era. History would subsequently show that the nuclear-centric New Look, Massive Retaliation, and Pentomic Division policies were ill-suited for the future.

Fortunately, U.S. and Soviet leaders grew to appreciate the destructive potential of nuclear weapons and worked to manage their geopolitical rivalry below the nuclear threshold. While the threat of nuclear conflict loomed over the Cold War, nuclear weapons were never employed in the various proxy conflicts that characterized great power competition during this time. Battlefield nuclear weapons did not disappear, but both superpowers began to conceive of the possibility of a large-scale war without nuclear weapons.²⁶

²³ Jack F. Smith, *Pentomic Doctrine: A Model for Future War*, (Fort Leavenworth, KS: U.S. Army Command and General Staff College, 1994), 22–24.

²⁴ Sepp, "The Pentomic Puzzle:...", 9–10.

²⁵ A.J. Bacevich, *The Pentomic Era: The U.S. Army Between Korea and Vietnam*, (Washington: National Defense University Press, 1986), 108–10.

²⁶ John S. Duffield, "The Evolution of NATO's Strategy of Flexible Response: A Reinterpretation," *Security Studies* 1, 1 (1991): 134–35.

While the Pentomic Division was a relatively short diversion for the Army, it still consumed precious time and resources during a strategically tumultuous time in U.S. history. Moreover, flawed assumptions about key technologies and the future operating environment were fueled by interservice politics that further incentivized the Army to squander almost a decade developing and implementing a concept that would have failed to serve the nation's interests in the emerging security environment of the 1960s.

Vignette 3: Vietnam War and Superior Technology in Search of a Winning Strategy

Wars of liberation against colonial powers across much of the developing world set the stage for the Second Indochina War during 1965–75. During the Vietnam War, the U.S. military embraced new technologies and pursued some operational adaptations in search of a war-winning approach. Ultimately, the military industrial complex and battlefield adaptations that occurred while fighting a limited war of attrition in Southeast Asia could not compensate for flawed U.S. policy and strategy.²⁷ U.S. technology could not win the Vietnam War, but neither did it lose it; rather, it was the failure to prevent North Vietnamese Army (NVA) forces from infiltrating the south along the Ho Chi Minh trail, and allowing them to use Laos and Cambodia as cross-border sanctuaries that led to America's defeat.²⁸

From 1966 to 1967, General William Westmoreland, Commander of the U.S. Military Assistance Command Vietnam, adopted a strategy that prioritized large unit sweeps (called “search and destroy operations”) over the fledgling counter-insurgency and pacification efforts on-going during the war's early years. Westmoreland's intent was to exploit America's advantage in aerial mobility and overwhelming firepower to try to locate, fix, and engage NVA regular units infiltrating the south.²⁹

While interdicting and containing NVA forces may have been necessary to help isolate the country's more heavily populated coastal regions, Westmoreland believed it was an insufficient theory of victory. In his judgment, winning required the NVA forces (and to a lesser degree, Vietcong [VC] guerrillas) to be decisively engaged and destroyed. A flawed assumption underpinning this approach was that the U.S. and South Vietnamese forces could dictate the time and

Director of Central Intelligence, “Soviet Nuclear Doctrine: Concepts of Intercontinental and Theater War,” SR RP 73-1, 1 June 1973, 8. Originally Top Secret; declassified 21 December 1993.

²⁷ Harry G. Summers, Jr., *On Strategy: The Vietnam War in Context*, (Carlisle Barracks, PA: Strategic Studies Institute–U.S. Army War College, 1981), 104–05.

²⁸ Summers, *On Strategy: The Vietnam War in Context*, 118.

²⁹ Summers, *On Strategy: The Vietnam War in Context*, 166–67.

place decisive battles would occur.³⁰ This happened episodically during 1966–67, but not on a scale that yielded decisive results.

Some major operations successfully drove the NVA’s 9th Division (and later the 5th and 7th Divisions) out of the Iron Triangle near Saigon, seriously disrupting the enemy’s regional command and control.³¹ However, the NVA retreated into Cambodia where it found sanctuary for the duration of the war. Rules of engagement prevented U.S. forces from pursuing and engaging the NVA in sustained cross-border operations outside of South Vietnam.³² Although the United States relied on airpower and CIA-directed guerrilla forces to try to stem the flow of NVA forces and supplies moving south along the Ho Chi Minh trail, these efforts were unsuccessful.³³

Over-estimating the effectiveness of technology and U.S. firepower throughout the war led to unwarranted optimism and unrealistic expectations regarding what soldiers and machines could deliver on the battlefield. This was not for want of trying. Under increasing pressure from Washington (most notably Secretary of Defense Robert McNamara) to quantify progress, the primary battlefield metric of success quickly became the enemy “body count.” Over-relying on this metric misled field commanders and Washington policymakers alike into believing that favorable “kill ratios” would eventually exceed Hanoi’s ability to replace its combat loses. Porous borders into South Vietnam prevented the United States from ever reaching a favorable “tipping point” and, as Lewis Sorley noted, America’s unwillingness to activate the reserves led Washington to run short of manpower before Hanoi.³⁴

Frustrated with the near-continuous flow of NVA forces and supplies into South Vietnam, leaders in Washington devised the “McNamara Line” (McNamara was an ardent supporter of the concept) in 1966 as a high-tech, anti-infiltration barrier system that would be built across South Vietnam from the South China Sea, along the southern edge of the Demilitarized Zone, through Laos, and to the border of Thailand. Technology in the form of hand-emplaced and air-delivered sensors and relay aircraft would augment more traditional engineering efforts that relied on trenches, counter-mobility obstacles, and concertina wire.³⁵ Construction began in 1967

³⁰ Summers, *On Strategy: The Vietnam War in Context*, 167.

³¹ Col A. R. Finlayson, USMC (Ret), letter to the authors, 2 May 2022. Colonel Finlayson spent 32 months in South Vietnam during the Vietnam War (1967–70) working entirely in combat billets that included long-range reconnaissance, infantry, and special operations in four provinces and two different geographic areas of that country (I Corps and III Corps).

³² Finlayson, letter.

³³ A. R. Finlayson, “A Winning Strategy: What Could Have Been,” unpublished paper prepared for the U.S. intelligence community, 2015, 3.

³⁴ Lewis Sorley, *A Better War: The Unexamined Victories and Final Tragedy of America’s Last Years in Vietnam*, (New York: Harcourt Brace & Company, 1999), 2.

³⁵ Mahnken, *Technology and The American Way of War Since 1945*, 108–09.

and required approximately five million fence posts and 50,000 miles of barbed wire at an estimated cost of between \$3–5 billion.³⁶

The design included a 400-person Infiltration Surveillance Center (ISC) in Thailand whose mission was to fuse information received from a vast array of sensors that detected enemy movement and then vector in strike aircraft from across the services to attack enemy units.³⁷ The ISC's mission was a complicated one given the number of false reports frequently generated by the sensor strings. Ultimately, enemy counter-measures reduced the operational effectiveness of completed portions of the McNamara Line.³⁸

The U.S. Navy also tried to adapt during the war in how it conducted riverine warfare. In addition to supporting the air war over North Vietnam and conducting maritime operations in the South China Sea, the Navy expanded its "brown water" riverine capabilities by fielding the Patrol Craft, Fast (also known as the Swift boat) and the follow-on more powerful and quiet Patrol Boat River.³⁹ Both enabled the Navy to conduct inshore operations along some of South Vietnam's key rivers, which included establishing a Mobile Riverine Force afloat in the Mekong Delta. This force employed a floating barracks large enough to billet the U.S. Army's 2nd Brigade, 9th Infantry Division, who then used helicopters, modified LCM-6 amphibious landing craft, and armored troop carriers to conduct maritime hit-and-run operations against VC strongholds in the Mekong and to secure the 45-mile Long Tau shipping canal to Saigon.⁴⁰

Arguably however, the most heralded adaptation of the Vietnam War were the heliborne or air mobile units.⁴¹ This innovation enabled General Westmoreland to meet the mobility requirements necessary to pursue his big war strategy in jungle and mountainous terrain by allowing air mobile forces to strike deep into enemy controlled territory.

During the Vietnam War, numerous other emerging technologies were employed across a diverse spectrum: night vision devices, ground sensors, early generation unmanned aerial vehicles, laser-guided munitions, airborne gunships, air-to-air missiles, jamming pods, and radar homing and warning equipment that alerted pilots when enemy surface-to-air missiles were launched. Collectively, the list of technological innovations was impressive.

One of the sad ironies of the war occurred during the 1968 Tet Offensive when U.S. and South Vietnamese forces tactically defeated the enemy. Both NVA forces and VC guerrillas suffered

³⁶ Mahnken, *Technology and The American Way of War Since 1945*, 111.

³⁷ Mahnken, *Technology and The American Way of War Since 1945*, 109–10.

³⁸ Mahnken, *Technology and The American Way of War Since 1945*, 110–112.

³⁹ Mahnken, *Technology and The American Way of War Since 1945*, 104.

⁴⁰ Mahnken, *Technology and The American Way of War Since 1945*, 106.

⁴¹ Mahnken, *Technology and The American Way of War Since 1945*, 103.

heavy losses. But as Harry Summers noted, “while they may have been tactical failures, they were strategic successes since, by eroding our will, they were able to capture the political initiative.”⁴²

Vignette 4: Future Combat Systems and Technological Overreach

Vietnam would not be the last time the U.S. military over relied on technology, though future misjudgments would not be just about machines triumphing over soldiers, but whether the technology was even feasible. The U.S. Army’s aborted Future Combat Systems (FCS) would encounter this problem.

Emerging at the dawn of the new millennium, FCS was the Army’s primary modernization program going into the 21st century. Described as “the Army’s most ambitious and far-reaching modernization since World War II,” FCS aimed to replace much of the Army’s Cold War-era arsenal of ground platforms to fundamentally change the way that it fought.⁴³ Unfortunately, FCS’ main legacy is as a case study in large-scale acquisition failure, spending around \$18 billion on research and development that produced few tangible results by the time it was officially cancelled in June 2009.⁴⁴

As with any failed acquisitions program, FCS did not materialize as intended for a number of reasons. Following the September 11 attacks and invasions of Afghanistan and Iraq, a two-decade-long focus on counter-insurgency and counter-terrorism shifted force development priorities and adversely impacted FCS. The ballooning of FCS’ already substantial budget did not help.⁴⁵ However, these factors were exacerbated by conceptual and technological challenges also at the heart of FCS’s shortcomings.

First, FCS was envisioned to be a “system of systems”: lightweight and linked into an extensive sensor network for greater situational awareness and fire support. The main goals for this system of systems were to enable the Army of the future to deploy more quickly and then to rapidly locate, outmaneuver, and destroy the enemy.⁴⁶ Toward those ends, FCS planned to employ a range of new and emerging advanced technologies. But by 2009—on the eve of FCS’

⁴² Summers, *On Strategy: The Vietnam War in Context*, 69.

⁴³ “Defense Secretary Gates Observes Army Future Combat Systems Progress,” *Federal News Service*, (9 May 2008).

⁴⁴ Robert N. Charette, “U.S. Army’s Future Combat Systems Program Formally Terminated, Transitions to Army Brigade Combat Team Modernization,” *IEEE Spectrum* (24 June 2009).

⁴⁵ Noah Shachtman, “Pentagon Chief Rips Heart Out of Army’s ‘Future’,” *Wired* (6 April 2009).

⁴⁶ Andrew Feickert, *The Army’s Future Combat System (FCS): Background and Issues for Congress*, CRS Report RL32888 (Washington: Congressional Research Service, Office of Congressional Information and Publishing, 3 August 2009), 1–4.

cancellation—critical program technologies had not yet matured, highlighting the program’s technological infeasibility, which had been glossed over from the beginning.⁴⁷

A key example of technological overreach and shifting requirements can be found in FCS’ Intelligence Fusion model—seen as key to its ability to find and destroy the enemy first, thus compensating for FCS vehicles’ lack of armor. This requirement to gain decision advantage over the enemy depended on the automated fusion of intelligence directly from FCS’ vast network of sensors. However, such automation required aggregation, deconfliction, and other data management tasks that were technically infeasible above an elementary level. This setback meant that FCS could not reach the level of situational awareness for its units upon which the entire concept depended for success.⁴⁸ Much like the Pentomic Division four decades earlier, the Army had again made unrealistic assumptions about technological feasibility and availability.

Second, according to a March 2008 Government Accountability Office (GAO) report on the challenges facing the program, the Army elected to develop FCS without defining the specific operational requirements or mature technologies that should have been in hand before the program officially started in 2003 (and still remained aspirational at the time of the GAO report’s publication).⁴⁹ Before the program’s cancellation in 2009, most of FCS’ key technologies were not mature enough to be tested as prototypes. By February 2009, it was estimated that the first FCS component prototypes would not be available for testing until 2013, and only after a final production decision had been reached. This would have put FCS into production without any comprehensive testing of its systems, raising additional risks.⁵⁰ Not surprisingly, FCS was cancelled several months later with only a handful of its constituent parts being spun off into new modernization programs, many of which were also cancelled without reaching final production.⁵¹

Unlike the case of Nazi Germany’s *Wunderwaffe*, one cannot say that FCS failed because the Army lacked a strategic vision. As with the Pentomic Division, the Army had a distinct vision—not only of the type of future war it anticipated fighting, but of the type of forces and combat systems it thought would deliver victory. Yet expectations vastly exceeded engineering and technical realities.

⁴⁷ Paul L. Francis, *Decisions Needed to Shape Army’s Combat Systems for the Future*, GAO Report GAO-09-288 (Washington: U.S. Government Accountability Office, March 2009), 7–11.

⁴⁸ Christopher G. Pernin, Elliot Axelband, Jeffrey A. Drezner, Brian B. Dille, John Gordon IV, Bruce J. Held, Scott McMahon, Walter L. Perry, Christopher Rizzi, Akhil R. Shah, Peter A. Wilson, Jerry M. Sollinger, *Lessons from the Army’s Future Combat Systems Program* (Santa Monica, CA: RAND Corp., 2012), 109–11.

⁴⁹ Paul L. Francis, *2009 Is a Critical Juncture for the Army’s Future Combat System*, GAO Report GAO-08-408 (Washington: U.S. Government Accountability Office, March 2008), 9.

⁵⁰ Hans Ulrich Kaeser, *The Future Combat System: What Future Can the Army Afford?* (Washington: Center for Strategic and International Studies, 2009), 21–22.

⁵¹ Pernin et al., *Lessons from the Army’s Future Combat Systems Program*, 47–49.

A RAND Corporation study on lessons learned from the project observed that the Army’s “propaganda” promoting the program outpaced what could be delivered and made it difficult for the Army to backtrack on grandiose public promises without understanding the impact on requirements and technologies.⁵² The Army’s plan failed to balance with technological realities that senior leadership had tacitly acknowledged would be a challenge at the outset. In 2004, then-Army Chief of Staff, General Peter Schoomaker, stated he gave FCS only a 28 percent chance of succeeding. As the program progressed, he raised his prediction to more than 70 percent; however, neither he nor the Army ever clearly defined what “success” would look like.⁵³

Conclusion

Today’s war in Ukraine is a sober reminder that while technology and the correlation of opposing forces may be important, the better-trained army endowed with the more effective logistics pipeline typically has the advantage. Yet, all of these attributes are secondary to the intangible and unquantifiable human factors—fear, self-sacrifice, courage—that influence soldierly performance on the battlefield. As historian John Keegan has observed, human factors are the ultimate arbiters in war: “What battles have in common is human: the behaviour of men struggling to reconcile their instinct for self-preservation, their sense of honour and the achievement of some aim over which other men are ready to kill them...above all, it is always a study of solidarity and usually also of disintegration—for it is towards the disintegration of human groups that battle is directed.”⁵⁴

Even when technophiles appropriately value human factors, there remain unmet challenges when leveraging new technology for military purposes. First, attempting to develop new miracle weapons during war is a high-risk proposition (*Wunderwaffen*). Second, a warfighting concept that hinges on a particular vision of future war and technology requires scrutinizing its key assumptions (Pentomic Division). Third, technological superiority in war cannot compensate for flawed strategy and poor operational design (Vietnam). Finally, a warfighting concept that centers on technology and depends on engineering cannot be fielded to the fighting forces until reliable hardware catches up with the big idea (FCS).

In his military analysis of the 2020 Second Nagorno-Karabakh War between Armenia and Azerbaijan, historian John Antal noted that while “drones set the conditions for Azerbaijan’s success, it took well-trained and aggressive ground forces to seize decisive terrain and secure

⁵² Pernin et al., *Lessons from the Army’s Future Combat Systems Program*, 92, 104–05.

⁵³ Feikert, *The Army’s Future Combat System (FCS):...*, 10

⁵⁴ John Keegan, *The Face of Battle*, (New York: Vintage Books, 1977), 297–98.

the center of gravity (town of Shusha). New precision weapons make the battlespace more lethal, but fires without maneuver are indecisive.”⁵⁵

As defense intellectuals debate what number of “off-sets” and “revolutions in military affairs” the United States has experienced since World War II, staff within the Department of Defense developing the future force and its capabilities should pay equal attention and energy to the difficult task of how best to integrate emerging technology with warfighting concepts if U.S. military forces are to enhance battlefield effectiveness.

Patrick Savage is a research associate in the Joint Advanced Warfighting Division at the Institute for Defense Analyses in Alexandria, VA. He holds a master’s degree in security studies from the Edmund A. Walsh School of Foreign Service at Georgetown University.

Tom Greenwood, U.S. Marine Corps (Ret.), is a research staff member in the Joint Advanced Warfighting Division at the Institute for Defense Analyses in Alexandria, VA. He was an infantryman with subsequent assignments in the Pentagon and the National Security Council staff.

⁵⁵ John Antal, *Seven Seconds to Die: A Military Analysis of the Second Nagorno-Karabakh War and the Future of Warfighting*, (Philadelphia, PA: Casemate, 2022), 143.