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RANDY A. GEORGE
General, United States Army
Chief of Staff

Official:

MARK F. AVERILL
Administrative Assistant
to the Secretary of the Army
2410903

Cover photo: Troops watch activity ashore on Omaha Beach as their landing craft approaches the shore on D-Day, 6 June 1944, during the Allied invasion of German-occupied France. (Photo courtesy of the Army Signal Corps Collection via the National Archives)

Army University Press

The Seventy-Fifth Anniversary of NATO and the Rules of Relevance

Col. Todd Schmidt, PhD, U.S. Army

In February 1944, Gen. Dwight Eisenhower, supreme commander of Allied Expeditionary Forces, began drafting an "Order of the Day" that would eventually initiate D-Day and the liberation of France. On 5 June 1944, he made some final edits and published it later that evening. The order was distributed to over 175,000 American and Allied troops preparing to launch the greatest armada in human history to commence the most expansive amphibious assault the world had ever seen on the beaches of Normandy on 6 June 1944. Following World War II, a new world conflict immediately enveloped the globe—the Cold War.

To withstand the power, influence, and international machinations of the Soviet Union, on 4 April 1949, the North Atlantic Treaty was signed. The NATO alliance and the U.S. mission to NATO existed then, as they do now, because they directly contribute to the security, prosperity, and liberty of Americans.[1] Article 5 of the treaty, the most renowned, stipulates that "an armed attack against one or more of them [the signatories] … shall be considered an attack against them all."[2] To be credible and of consequence to potential adversaries, Article 5 must be undergirded by the other less-renowned articles of the treaty and, most importantly, by the expressed support, national policy, and implementation of policy of the allied nations, especially the United States.

Caught in a paradoxical position of blessing and bane, the United States is the sine qua non element of the North Atlantic Treaty. It is a position and responsibility to which we ultimately expect and demand, yet ironically, one we may at times disdain. The legitimacy and credibility of the North Atlantic Treaty rests on the shoulders of the United States and the U.S. military.

Col. Todd Schmidt, PhD, U.S. Army
Director, Army University Press

Yet, legitimacy and credibility may be eroding as the U.S. political system becomes increasingly polarized, politicians undermine the importance and imperative of NATO, and our collective U.S. society forgets the sacrifices our forebearers made in world wars past.

As I have previously written in *ARMY* magazine, U.S. allies are not preordained and should not be presumed.[3] Our allies must be earned. As domestic political contests rage within our borders, are we also seeing a quiet erosion of America's reputation as a trusted ally and champion of the free world? There is a "narrative competition" being fought globally, one in which our adversaries paint the United States as fragile, temperamental, unreliable, weak in resolve, and societally sick. If or as this narrative gains traction, U.S. adversaries increasingly exploit the fissures and fault lines that are forming. Considering or endeavoring to isolate ourselves from this international contest is not an option.

For the U.S. Army, it is our responsibility to simultaneously remain apolitical while ensuring that we contribute to our national narrative "by being a lethal, competent, credible force and being recognized as such by key audiences among allies and partners, as well as adversaries."[4] This will be a tightrope upon which we must remain balanced as the national political environment becomes more brutal and public support for the military more brittle. To remain relevant and above a public, political fray fraught with fratricide, the Army must consider simple rules of relevance.

The first rule of relevance is that the United States must ensure that "would be" adversaries of NATO must be 100 percent certain that Article 5 is factually and determinedly backed by the full weight of the United States and its allies across all elements of national power. The second rule of relevance is that this fact must be credible and unassailable, backed by evidence of its invocation in the wake of the 9/11 attacks. The invoking or threat of invocation of Article 5 should be a determining element influencing adversarial action. The attack by Russia on Ukraine has been and will continue to be debated as a failure of strategic deterrence, but by strict definition, strategic deterrence remains intact and the NATO Alliance deserves credit.

The relevance of the United States and NATO must also be undergirded by deliberately structured national policy. Policies and official government statements, or the statements of politicians and political candidates, that weaken U.S. alliances or call their credibility into question must be rejected. National, institutional, and bureaucratic policies that prevent and needlessly burden allied cooperation, integration, and interoperability need to be revoked and rewritten. Policy, regulation, guidance, and instruction should empower and enable our alliances, not restrict and constrain.[5]

If you have not heard the idiom, "speed of relevance," you may have been living under a rock since 2018, when Secretary of Defense James Mattis is credited with its coinage.[6] Since then, it has been used countless times, particularly in our communities of national security, defense, and military professionals. Although the term cleverly communicates an imperative of information sharing and decision-making, its overuse has diluted its impact as a strategic message.

Regardless, the relevance of NATO remains certain and firm. On its borders and in the year ahead, NATO will continue to confront crisis, conflict, and collective self-questioning. For the U.S. Army, despite the domestic or international political debates and self-flagellation that may occur, military leaders must not forget the sacrifices marked in June 2024, the eightieth anniversary commemorating D-Day, or in May 2025, the commemoration of the eightieth anniversary of "Victory in Europe."

Just as importantly, we must not forget that our NATO allies are growing in number, from the original twelve members to the current thirty-two members, because they trust and depend on U.S. leadership, credibility, and willingness to remain the sine qua non of the greatest alliance in the world. We commemorate and celebrate the anniversary of D-Day with two articles in this edition and will publish several articles commemorating the seventy-fifth anniversary of NATO in future issues of *Military Review* through the remainder of 2024. ■

Notes

1. "About NATO," U.S. Mission to the North Atlantic Treaty Organization (NATO), accessed 29 March 2024, https://nato.usmission.gov/about-nato/.

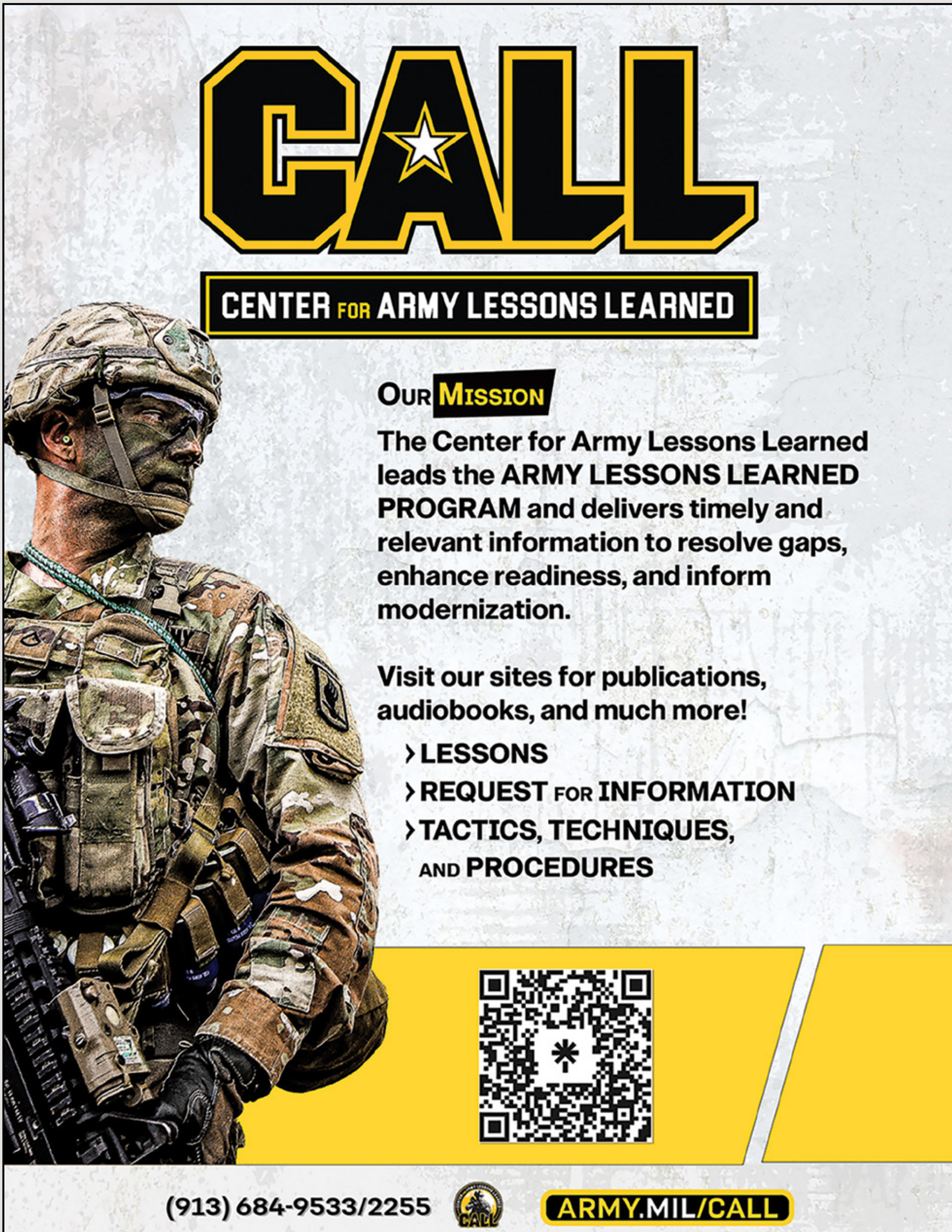
2. "Collective Defense and Article 5," NATO, last updated 4 July 2023, https://www.nato.int/cps/en/natohq/topics_110496.htm.

3. Todd Schmidt, "Army Must Strengthen Its Relationships with Allies," Association of the United States Army, 17 August 2021, https://www.ausa.org/articles/army-must-strengthen-its-relationships-allies.

4. James McConville, *The Army in Military Competition*, Chief of Staff Paper #2 (Washington, DC: Headquarters, Department of the Army, 1 March 2021), v.

5. Schmidt, "Army Must Strengthen Its Relationships."

6. James Mattis, *Summary of the 2018 National Defense Strategy of the United States of America* (Washington, DC: U.S. Department of Defense, 2018), 10.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Write for *Military Review*

Suggested Writing Themes and Topics—2024

- From the U.S. military perspective, what are the greatest external threats to the United States? Why, and how?
- Are there nations that consider themselves to be at war with the United States? If so, how are they conducting war, and what would increase the probabilities of their success?
- Is there a new "Cold War"? If so, who make up the new confederated blocs (i.e., the new "Axis" powers) aligned against the United States, and how do they cooperate with each other? What types of treaties or agreements do they have that outline relationships they share to reinforce each other?
- Who best synchronizes DIME (diplomacy, information, military, and economic) elements of power to achieve strategic goals? Contrast and compare employment of DIME by China, Russia, Iran, and the United States. How should the United States defend itself against foreign DIME?
- Does China have an "Achilles' heel"? What is its center of gravity? If it has one, how can it best be attacked/exploited?
- What does China view as the United States' "Achilles' heel" or center of gravity? (e.g., Trade relations? Resource shortages? Diminishing technological manufacturing base? Societal instability and factionalism?) How specifically is it exploiting these?
- How should the United States respond to Chinese aggression toward Taiwan?
- What lessons are we learning from Russia's war with Ukraine? What should be the next steps for the United States? What should be the desired end state from a U.S. perspective?
- What is the impact of irregular immigration on the security of the United States?
- What is the status of security force assistance brigades (SFAB)? What is the future for SFABs?
- What is the role now of the U.S. Armed Forces in Africa? Far East? Middle East?
- What logistical challenges will the U.S. military face in large-scale combat operations?
- What does the future hold for nanoweapons? Electromagnetic warfare? Artificial intelligence? Information warfare? How is the Army planning to mitigate effects?

Enter the U.S. Army's premier writing competition!

2024 General William E. DePuy Special Topics Writing Competition

This year's theme is "The Russia-Ukraine War"

Russia and Ukraine have been at war since Russia invaded its neighbor on 24 February 2022. The intent of this year's DePuy competition is to encourage close examination of this war and what lessons it has provided for the Army. A list of suggested topics for examination is provided below. However, the list is not exclusive, and manuscripts identifying and analyzing other salient topics are encouraged.

- What lessons have we learned from the Russia-Ukraine war so far?
- How do lessons from this war affect/influence how we approach Field Manual 3-0, *Operations*, and large-scale combat operations?
- Based on lessons learned from this conflict, what needs to change in U.S. Army doctrine?
- What have we learned about the evolution and the future of maneuver warfare (armor, fires, unmanned aircraft, etc.)
- Based on lessons learned from this conflict, what are the impacts of technology on modern warfare (e.g., cell phones, computers, artificial intelligence)?
- How do the Russian and Ukrainian approaches to information operations compare? Psychological operations? Civil-military operations? Who has been more effective? How have social and traditional media affected the war for each side?
- How does this conflict inform the Army of 2030–2040?
- How does this conflict influence U.S. adversaries? What are our adversaries learning?
- What are our allies learning from this conflict? How will it affect U.S. relationships with its allies? With NATO?
- How does this conflict affect/influence the U.S. approach in the Indo-Pacific?
- Based on what we have seen in this conflict, what is the role of the interagency at the operational level?

Competition opens 1 January 2024 and closes 19 July 2024

1st Place: $1,000 and publication in *Military Review*
2nd Place: $750 and consideration for publication in *Military Review*
3rd Place: $500 and consideration for publication in *Military Review*

Prize money contributed by the Association of the United States Army

For information on how to submit an entry, please visit https://www.armyupress.army.mil/DePuy-Writing-Competition/. Articles will be comparatively judged by a panel of senior Army leaders on how well authors have clearly identified discussion topics related to the Russia-Ukraine war relevant to the U.S. Army; how effectively detailed and feasible analysis of the issues identified is presented; and the level of expository skill the author demonstrates in developing a well-organized article using professional standards of grammar, usage, critical thinking, original insights, and evidence of thorough research in the sources provided.

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ARTIFICIAL INTELLIGENCE

REVIEW ESSAY

Soldiers from Company A, 16th Infantry, 1st Infantry Division (Big Red One) disembark from an LCVP (Landing Craft, Vehicle, Personnel) and wade onto the Fox Green section of Omaha Beach (Calvados, Basse-Normandie, France) on the morning of 6 June 1944. American soldiers encountered the newly formed German 352nd Infantry Division when landing. During the initial landing, two-thirds of Company E, 16th Infantry, became casualties. (Photo courtesy of National Archives)

Lessons from D-Day

The Importance of Combined and Joint Operations

Col. Gregory Fontenot, U.S. Army, Retired

The eightieth anniversary of the Allies' World War II invasion of France will be memorialized and celebrated in the United States and in Normandy. However, this article looks beyond D-Day to examine joint and combined operations in the context of a deliberate attack characterized both by time to prepare and good intelligence. All the means of intelligence gathering we have today existed then. We think of satellite imagery and cyber as new, but their predecessors were photo imagery from manned aircraft and signals intelligence. Technology has changed, but the basic intelligence means remain the same. The context also includes the estimates made by both Allies and the Germans. Future conflicts will be combined and joint and will assuredly include elements of irregular warfare. All these characteristics pervaded planning and operations for the invasion of France in 1944.

The material basis of war since 1945 in communications, intelligence gathering, air support, and fires has changed to the extent that an opposed landing on the scale and complexity of Normandy can no longer be conducted against a capable enemy. On the other hand, long-term strategic and operational planning and preparation—to include organization, intelligence gathering, force structure, and command and control—in the context of combined and joint warfare will continue to be required more or less as they were in June 1944. The scale of operations may be smaller, but the scope and complexity are arguably greater.

Coalition Strategic Planning

The broad coalition known as the United Nations began with discussions between the United Kingdom and the United States. In *Origins of the Grand Alliance: Anglo-American Military Collaboration from the Panay Incident to Pearl Harbor*, William T. Johnsen shows this collaboration began haltingly. Not until January 1941, after the introduction of President Franklin Delano Roosevelt's "lend lease" legislation, did staff talks begin that eventually cemented "the Grand Alliance." From the British point of view, this was as much as two years later than they would have preferred.[1]

At the end of World War II, Gen. George C. Marshall asserted that coordination with the British was "the most complete unification of military effort ever achieved by two allied nations."[2] Perhaps, but that "unification" did not come easily. These first discussions on military collaboration produced a commitment between the two sides to a Germany first strategy but also revealed differences based on national interests and the hard strategic facts. These discussions also revealed the essential cultural DNA of the Allied forces.

An early bone of contention stemmed from the American view that Russia could be kept in the war and final victory won only by invading western Europe. The British, with strong recollections not only of Dunkirk and the Dieppe Raid but their losses in World War I, sought to avoid the risks necessary to get ashore where the German defenses were strongest. The British were also not inclined to accept advice of the Americans who had come late to the party. Moreover, Stephen E. Ambrose argues in *The Supreme Commander: The War Years of General Dwight D. Eisenhower* that Gen. Alan Brooke, chief of the Imperial General Staff, "carried throughout the war the handicap of a prejudice against the Americans."[3] Of Gen. George C. Marshall, Brooke wrote, "I should not put him down as great man." Brooke was by no means the only British soldier who believed the Americans were not up to the task. Prejudice proved a common malady among both British and Americans.[4]

Coalition Command

When and whether to invade western Europe proved to be the chief difference between the two major allies. In any case, the number of ground troops necessary to invade France or anywhere in western Europe simply could not be found in 1942. Airpower was the only means to take the fighting to the Germans in the early days. Accordingly, Marshall assigned the priority of resources and manpower to the U.S. Army Air Force. American ground forces entered the war via North Africa in November 1942, while air operations against Germany began in early 1943.[5]

Gen. Dwight D. Eisenhower, destined for supreme command, arrived in the United Kingdom on 24

Col. Gregory Fontenot, U.S. Army, retired, is a consultant on threat emulation for Army experimentation and a working historian. He was lead author of *On Point: The US Army in Operation Iraqi Freedom* (CGSC Press, 2004) and is the author of *The 1st Infantry Division and the US Army Transformed: Road to Victory in Desert Storm, 1970–1991* (University of Missouri Press, 2017), winner of the 2017 Army Historical Foundation award for unit history, and *Loss and Redemption at St. Vith: The 7th Armored Division in the Battle of the Bulge* (University of Missouri Press, 2019). His most recent book is *No Sacrifice Too Great: The 1st Infantry Division in World War II* (University of Missouri Press, 2023).

June 1942 to take up responsibility as commander European Theater of Operations United States Army (ETOUSA). Eisenhower believed that among his several jobs, he had to assure "the British that we are here not as muddling amateurs but as earnest, competent soldiers who know what we are about."[6] Eisenhower spent a good part of the next three plus years managing and leading combined operations complicated by divergent national interests. He did that first as the supreme allied commander in the Mediterranean and then supreme command for Overlord and operations in Europe. He did not do so without the full cooperation of his British and American colleagues.

Despite their national concerns and biases, the British and Americans were committed to combined operations as a necessity. To that end, they formed the Combined Chiefs of Staff. On 23 April 1942, that august body established a combined staff to plan the cross-channel attack. The Combined Chiefs assigned British Lt. Gen. Frederick E. Morgan as chief of staff to the yet to be named supreme allied commander.[7] Morgan's staff became known by the acronym COSSAC (for chief of staff to supreme allied commander). Morgan, like Eisenhower, understood the need for cohesion in his combined staff. Morgan did, however, become frustrated when the chiefs did not select a supreme commander. He knew that planning the invasion required would not come easy. In his words, "The term 'planning staff' has come to have a most sinister meaning—it implies the production of paper. What we must contrive to do is to produce not only paper but action."[8] COSSAC laid out the outline plan and then the details once Eisenhower was appointed as supreme commander.

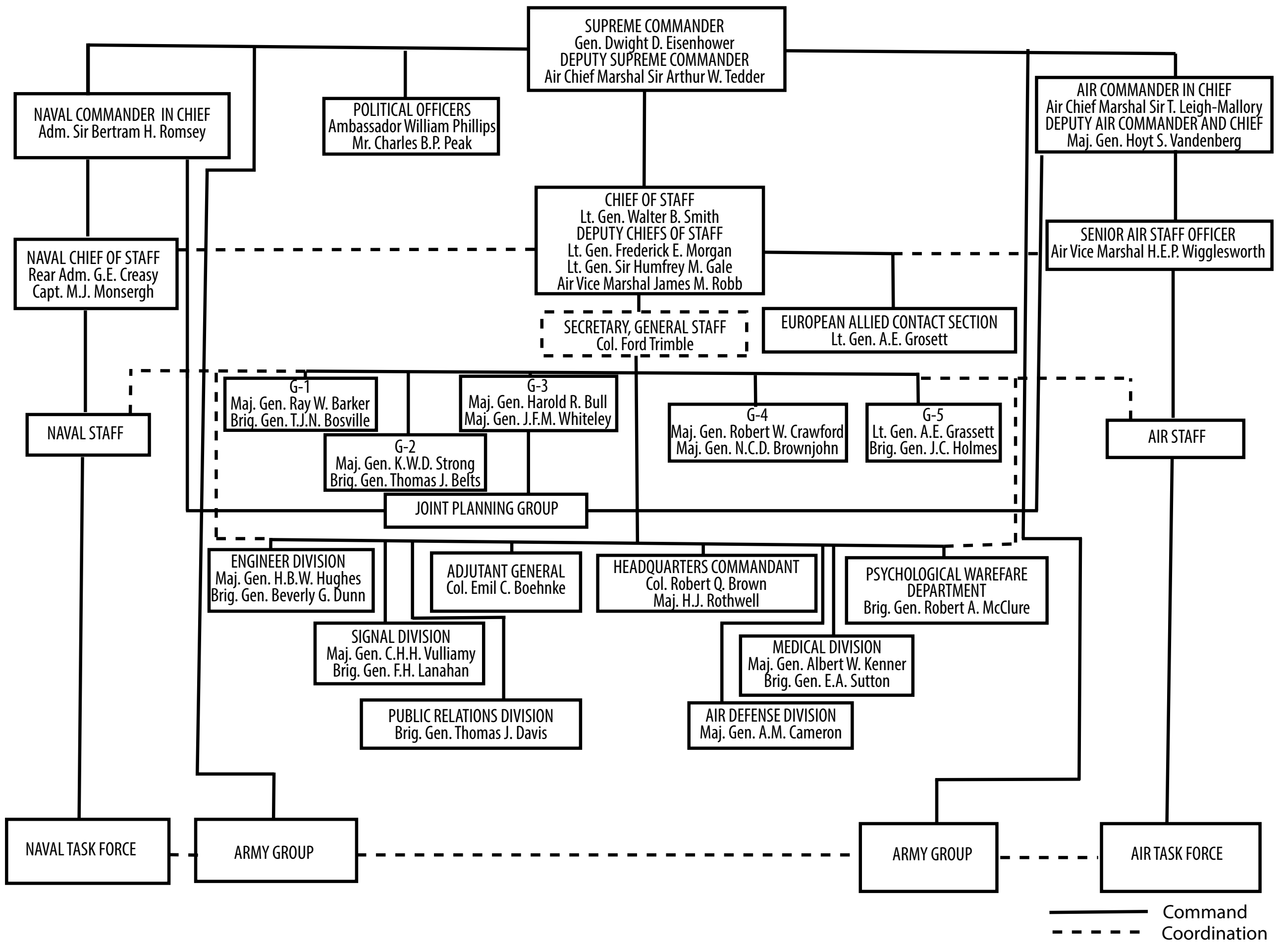
German Estimates and Command

In the summer of 1943, the Allies and the Germans reached critical strategic choices. In July, Germany's Operation Citadel to reduce the Kursk salient failed. That failure and the surrender of Italy in September led Adolf Hitler to revise his strategic appreciation. Gen. Walter Warlimont, deputy chief of staff for operations of the *Oberkommando der Wehrmacht* (High Command of the Wehrmacht, or OKW) described the German high command's condition in late summer 1943 as a "state of schizophrenia" based on running two theaters of war, one in the east and the other in the south around the Mediterranean.[9] In theory, the Germans enjoyed unity of command, but in practice, Hitler's interventions and the competition for resources led separate commands to work at cross purposes.

Germany also confronted problems with its remaining allies. Reports of the possible defection of Rumania and Hungary led to the OKW preparing for these possibilities. The situation in Bulgaria, a political ally only, proved worrisome as well. The various dilemmas confronting Germany led to the publication of *Führer Befehl* (Führer Order) 51; Warlimont noted that in doing so, OKW rose "to the level of real strategy once more."[10] The directive summarized the strategic situation, noting, "The danger in the east remains but a greater danger appears in the west: an Anglo-Saxon landing!" The directive continued by observing that Germany had strategic depth in the east but not in the west.[11]

In Hitler's voice, the order continued, "I have therefore decided to strengthen the defenses in the West, particularly at places from which we shall launch our long-range war against England. For those are the very points at which the enemy must and will attack; there—unless all indications are misleading—will be fought the decisive invasion battle."[12] Hitler honored his "own" guidance "more on paper than in reality."[13] He did however assign an energetic and determined officer to do what could be done. In November 1943, Field Marshal Erwin Rommel arrived in the low countries, where he inspected the defenses. In December, he took command of Army Group B, responsible for the defense of northwestern France, including Normandy.[14]

Rommel worked hard to bulk up the Atlantic Wall, which looked better in propaganda film than in reality. Rommel began his preparation for what Hitler described as the decisive battle by a personal reconnaissance of the defenses. He believed the battle had to be won on the beaches, and consequently, the armor reserves needed to be brought forward. However, Hitler retained the armor reserves in his personal control. Field Marshal Gerd von Rundstedt, who commanded (technically at least) the western theater, believed the battle could be won only by *bewegungskrieg*, or a war of movement. He wanted to keep the armor reserves inland and use them to mount a decisive counterattack. Rommel drove his troops hard laying millions of mines, developing the defenses on a heroic scale, and preparing his troops to fight with the limited means available.[15]



(Figure from Forrest Pogue, *The Supreme Command* [1989])

Figure 1. SHAEF Command and Staff Structure

Allied Assessment and Command

On 10 December 1943, just prior to the Casablanca Conference, Roosevelt told Eisenhower almost casually, "Well Ike, you are going to command Overlord."[16] In keeping with the Allied view and his own commitment to coalition operations, Eisenhower's deputy and three component commanders were British. Gen. (later Field Marshal) Bernard L. Montgomery went ashore in command of 21st Army Group with the British Second Army and the U.S. First Army reporting to him. In contemporary terms, Montgomery was the ground component commander (see figure 1). Eisenhower intended to take personal command of land operations once he could bring his Supreme Headquarters Allied Expeditionary Forces (SHAEF) ashore. That decision grated on the British for much of the rest of the war.[17]

Morgan's COSSAC had not been idle, but some of the key players for Overlord did not begin to arrive until the fall of 1943. Eisenhower and Montgomery did not arrive until January. Consequently, the plan evolved. Montgomery arrived on 2 January 1944 and Eisenhower on the 14th. Both joined headquarters that were still organizing. Lt. Gen. Omar N. Bradley, who had arrived in September 1943, stood up First U.S. Army in October. Maj. Gen. Lewis Brereton arrived that same month to organize 9th Air Force as a tactical air force to support ground operations in France. The arrival of Eisenhower and Montgomery represented commitment of the Allies to a cross-channel invasion in the spring or early summer. Their arrival enhanced the ongoing buildup of forces and the revision of the original COSSAC plan to reflect the availability of forces and the professional

Royal Marine commandos attached to the 3rd Division for the assault on Sword Beach move inland from the Normandy coast on 6 June 1944. A Churchill bridgelayer can be seen in the background. (Photo courtesy of the Imperial War Museums)

judgement of the supreme commander and his ground component commander.[18]

COSSAC settled on an attack on the Calvados Coast of Normandy, which the combined chiefs approved. What remained was planning the details. A lack of troops and assault craft of all kinds constrained planning until the final commitment and arrival of the last of the key players. Two days after he arrived, Montgomery and Lt. Gen. Walter Beedle Smith, SHAEF chief of staff, received a briefing on the plan. Montgomery objected to it as underresourced and attacking on a front that was too narrow. Smith was unhappy also with the planning and staffing of the air component. Smith wanted heavy bombers to support the landing, but they remained committed to Pointblank, the strategic bombing campaign. In fact, Gen. Carl "Tooey" Spaatz held the view that Overlord was unnecessary because strategic bombing alone could bring Germany down. Eventually, the airmen supported both bombarding the landing areas and the Transportation Plan that aimed to damage the French rail system and thus prevent the Germans from reaching the landing zone easily. The broad outline of what the allies executed in June emerged soon after. The evolution of the plan included a well-conceived deception plan designed to convince the Germans the assault would occur on the Pas-de-Calais.[19]

Other irritants arose quite apart from the differences in national interests. The British concept of the operation as reflected by Montgomery proved far more conservative than that of the Americans. Nigel Hamilton, Montgomery's chosen biographer, observed that the "Great War" battle of the Somme, during which Montgomery suffered life-threatening wounds, was the "seminal experience of his entire life" and shaped his view of warfare and how to conduct it.[20] The Somme cast a long shadow across the United Kingdom's people, its soldiers, and its leaders. The British were, to use a euphemism, risk averse. At war since 1939, they simply could not afford high casualties.

The difference in command culture was perhaps the hardest thing for the American and British to reconcile. Command culture of the United Kingdom featured top-down guidance, including high-level officials reaching far down the chain of command. In North Africa, Gen. K. A. N. Anderson, commanding the British First Army, parsed out regiments and even battalions of U.S. troops, sending them hither and yon subordinated to British formations. Not until after Kasserine Pass did Eisenhower put a stop to that habit.[21]

Winston Churchill articulated the essential difference clearly when he observed, "In practice it is found not sufficient for a government to give a General Directive and wait to see what happens." He continued, "A definite measure of guidance and control is required from the Staffs and high Government authorities."[22] At one point, Brooke complained to Marshall that Eisenhower seemed prone to taking advice from Bradley and Patton. Marshall riposted saying, "Well, Brooke, they [combined chiefs of staff] are not nearly as worried as the American chiefs of staff are worried about the immediate pressures and influence of Mr. Churchill on General Eisenhower."[23]

British and American views of planning horizons differed as well. The American system to this very day begins with the desired end state. From there one plans backward. In *Cross-Channel Attack*, Gordon A. Harrison illustrates the competing viewpoints. When the Americans offered long-range plans the British asked, "How can we tell what we should do six months or a year hence until we know how we come out of next month's action?" The Americans on the other hand asked, "How do we know whether next month's action is wise unless we know where we want to be a year from now?"[24]

Finding the right officers for the SHAEF staff required patience and even raised-voice discussions. Of the process, Air Marshal Sir Arthur Tedder observed "getting the right people and being ruthless … and you must be ruthless."[25] If a man could not be a team member he had to go. Beetle Smith did the hiring and firing, and he was ruthless. At one point, he and Brooke crossed swords due to Smith's raiding the Mediterranean theater for officers that Eisenhower wanted. As commander of the U.S. European Theater of Operations, Eisenhower had also to find "one army group commander, three army commanders, over a dozen corps commander and, eventually, nearly half a hundred division commanders."[26] Because he was human, Eisenhower wanted officers he knew. This of course led to squabbling with Lt. Gen. Jacob Devers, who had taken over in the Mediterranean theater. The dispute with Devers got nasty, with Eisenhower complaining to Marshall. In fact, Eisenhower knew it was wrong to cherry pick Devers' command but did so anyway, claiming that Overlord was more important than the fighting in Italy.

Logistics: Concentrating and Sustaining the Force

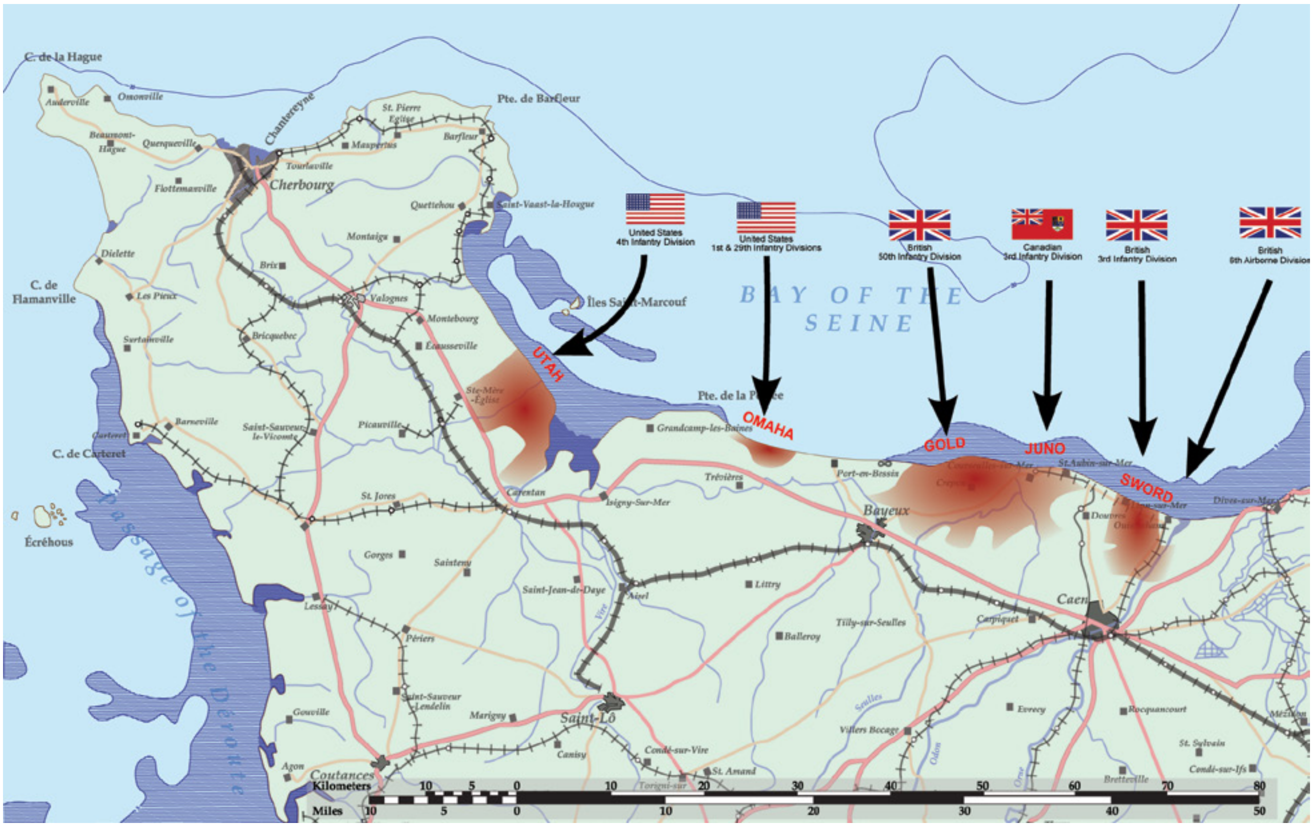
Logistics is far more than sustaining the force in the field. Finding the troops, forces, materiel, air support, and naval support are the logistics of concentrating the means to invade and then sustaining the fight ashore. The U.S. buildup of troops for the cross-channel invasion, known as Operation Bolero, began in 1942. Inevitably, troops were siphoned off first to invade North Africa, then to invade Sicily, and later the Italian mainland. Afterward, competition for resources continued with the Mediterranean theater and of course, the Pacific.

The build-up began when the 29th Infantry Division arrived in October 1942. Despite everything, the buildup reached 749,298 soldiers in 1944 on New Year's Day. Eleven divisions had arrived and were preparing for the invasion, including the 82nd and 101st Airborne Divisions, the 2nd and 3rd Armored Divisions, and the 1st, 2nd, 5th, 8th, 9th, 28th, and 29th Infantry Divisions. The build-up continued, reaching twenty divisions with some 1,525,965 troops by 1 June 1944. The troops in the UK included 620,504 ground troops, 426,819 airmen, and 459,511 services of supply soldiers.[27]

The United Kingdom could barely feed itself, so it could not feed the Americans. Food and nearly everything required to sustain the troops had to come from the United States protected by British and American naval forces. Not only did merchant shipping provide the means to support the troops training in the United Kingdom, but they also had to build up materiel to sustain the fight ashore. By June 1944, convoys had brought 5,297,306 long tons of everything from tanks to locomotives, ammunition, and fuel.[28]

The cross-channel attack required an enormous number of landing craft and heavy naval gunfire support. Assembling landing craft and adequate means of naval gunfire led to squabbling between the Americans and British as well as interservice debates on priority, particularly between SHAEF and the U.S. Navy, and even within the Navy. There simply were not enough of various landing craft, including Landing Ship, Tanks (LST). Of the problem, Churchill had this to say: "The destinies of two great empires … seemed to be tied up in some god-damned things called LSTs."[29]

The problem stemmed from a shortage in both the European and Mediterranean theaters, and the initial priority to the Pacific (see the table). At 11 knots maximum speed, moving LSTs from the Pacific to the European theater did not happen. Enough were produced for Overlord but not, as Eisenhower had hoped, to conduct a double



Map of the D-Day landings, 6 June 1944. (Map courtesy of Wikimedia Commons)

envelopment by invading southern France from two points simultaneously. In January 1944, he delayed the invasion from May to June to get another month's production of landing craft. In the end, with compromise on lift requirements for vehicles and other equipment, delaying the second landing and improving maintenance 3,601 amphibious craft were found.[30]

In February 1944, Adm. Ernest J. King sent his chief planner, Rear Adm. Charles M. Cooke, to the United Kingdom to settle both the complaints about amphibious craft and naval gunfire. At that conference, Rear Adm. John L. Hall, commander of Force O (responsible for executing the landing at Omaha Beach), "banged [his] fist on the table and said, 'It's a crime to send me on the biggest amphibious attack in history with such inadequate support.'"[31] Samuel Eliot Morison wrote of the incident only that SHAEF had a "legitimate complaint" on "Admiral King's tardiness in allocating battleships, cruisers and destroyers for gunfire support."[32] Cooke admonished Hall for his demonstration but found the ships.

D-Day, 6 June 1944

While the Allies haggled over the means and method to invade, the German army struggled to meet the needs of both the looming invasion and the immediate problems in the east. Rommel's tireless efforts to strengthen the German defenses fell short of what he wanted to achieve. Moreover, as noted previously, he lost the argument over control of the armor reserves. Finally, concentrating forces had not developed as Hitler promised.

By 1944, they were experiencing serious difficulty in manning and equipping units. Over the course of 1944, end strength for a German infantry division declined as the regiments were reduced from three to two battalions. End strength dropped from seventeen thousand to twelve thousand. Equipping these units proved equally difficult. Although German infantry divisions were organized with just over two thousand vehicles, 1,400 were horse-drawn. Many units and nearly all the fixed coastal defenses featured a menagerie of gear from any number of countries, which ensured nightmares at night and on the job for German logisticians.[33]

Table. U.S. and British Landing Ships and Craft from Different Theaters

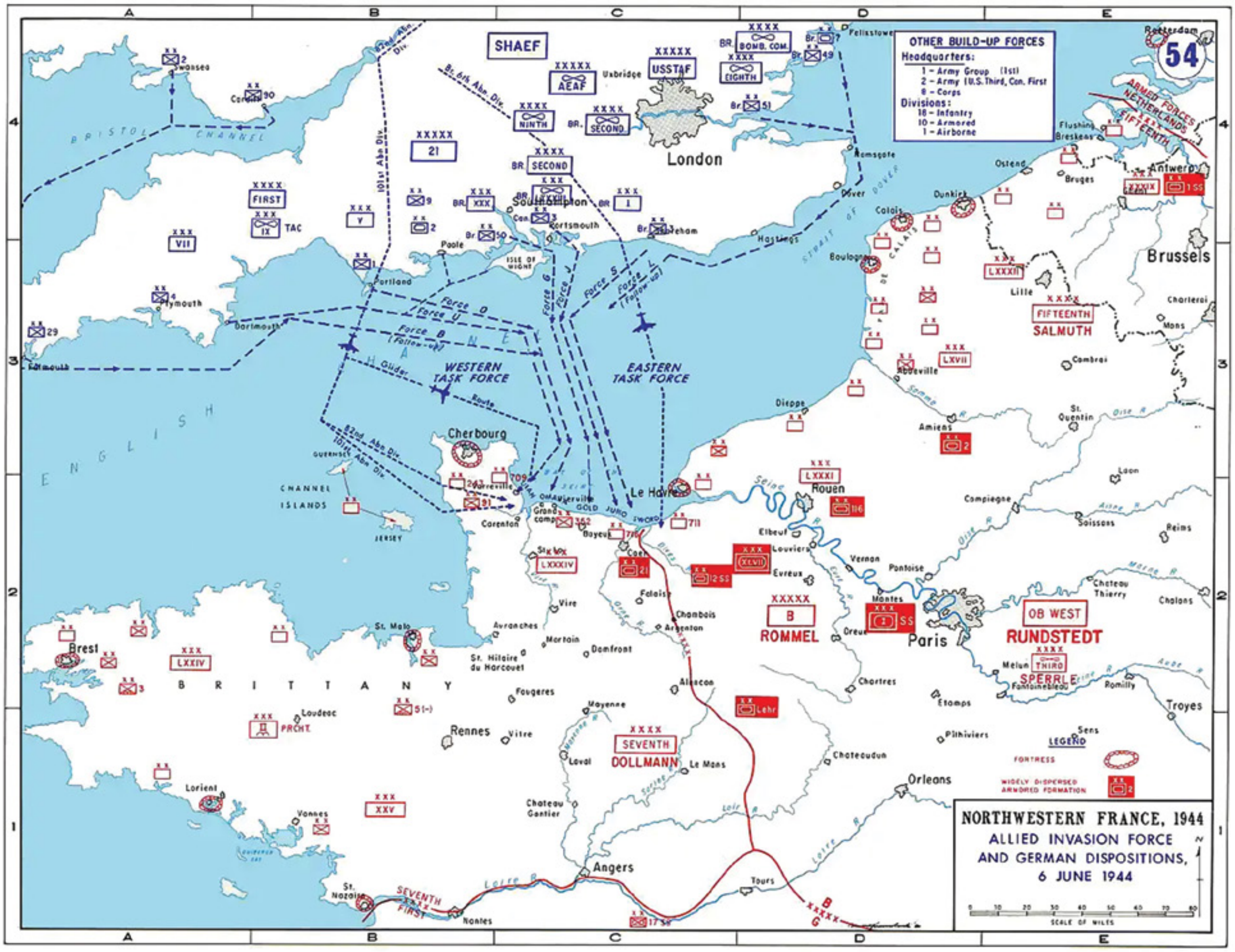
	Landing Ship, Tank	Landing Craft, Infantry (Large)	Landing Craft, Tank	Landing Craft, Mechanized	Landing Craft, Vehicle, Personnel	Landing Craft, Assault
U.S. in 12th Fleet (UK)	168	124	247	216	1,089	0
British in UK	61	121	664	265	0	646
U.S. in Mediterranean	23	59	44	185	395	0
British in Mediterranean	2	32	64	95	0	138
U.S. on East Coast, USA	95	89	58	57	341	0
U.S. on West Coast, USA	0	41	1	60	181	0
U.S. in all Pacific Areas	102	128	140	1,198	2,298	0
British on East Indies Station	0	4	2	67	0	46

(Table by Michael Lopez, data from "Combined Staff Planners Memo. for information No. 24," 19 June 1944)

Soldiers assigned to the infantry divisions were augmented by prisoners of war who volunteered to join "Ost" battalions as an alternative to the prisoner of war camps. They were not well motivated to defend the Reich. Overaged men provided much of the manpower for the German coastal defense divisions. These divisions lacked mobility; thus, they were static. One of them, the 716th Infantry Division, defended the Calvados coast where the Allies landed. Unfortunately for the soldiers who landed at Omaha Beach, a battalion from the credibly equipped and trained 352nd Infantry Division backed the 716th. With two battalions totaling about two thousand soldiers manning defenses, including fourteen well-armed strongpoints, what the Allies called Omaha Beach was well defended.[34]

The 1944 panzer divisions had also declined in strength. On 6 June 1944, the German army in the west fielded nine panzer divisions and one panzer grenadier division. Of these, the *Schutzstaffel* (SS) provided three panzer and one panzer grenadier divisions. No two of these ten divisions were organized in the same way. Together they had just over 1,700 tanks and more than two hundred self-propelled guns. The tanks included Mark IIIs, IVs, and Vs. Better known as Panther tanks, the Germans had 360 of the excellent Mark Vs. There were a handful of Mark VI Tiger tanks as well. Tank strength varied from a low of 86 in the 116th Panzer Division to 188 in Panzer Lehr. The 21st Panzer Division with 112 tanks was within twenty miles of the beaches. The 12th SS with another 164 tanks was less than fifty miles away. Finally, Panzer Lehr with 188 tanks and as many as eight tiger tanks was just under one hundred miles away.[35]

Arguably the best defended Omaha beach proved the most difficult for the Allies. The boundaries of the beach extended about ten miles from just east of Port-en-Bessin to just west of Pointe du Hoc. Controlled by the 1st Infantry Division, the 16th Infantry Regiment and the 29th Infantry Division's 116th Infantry Regiment made the main assault along five miles of elliptically shaped beach running from Port-en-Bessin to Vierville-sur-Mer. The beach bent southward, enabling devasting enveloping fires. Cliffs bounded the



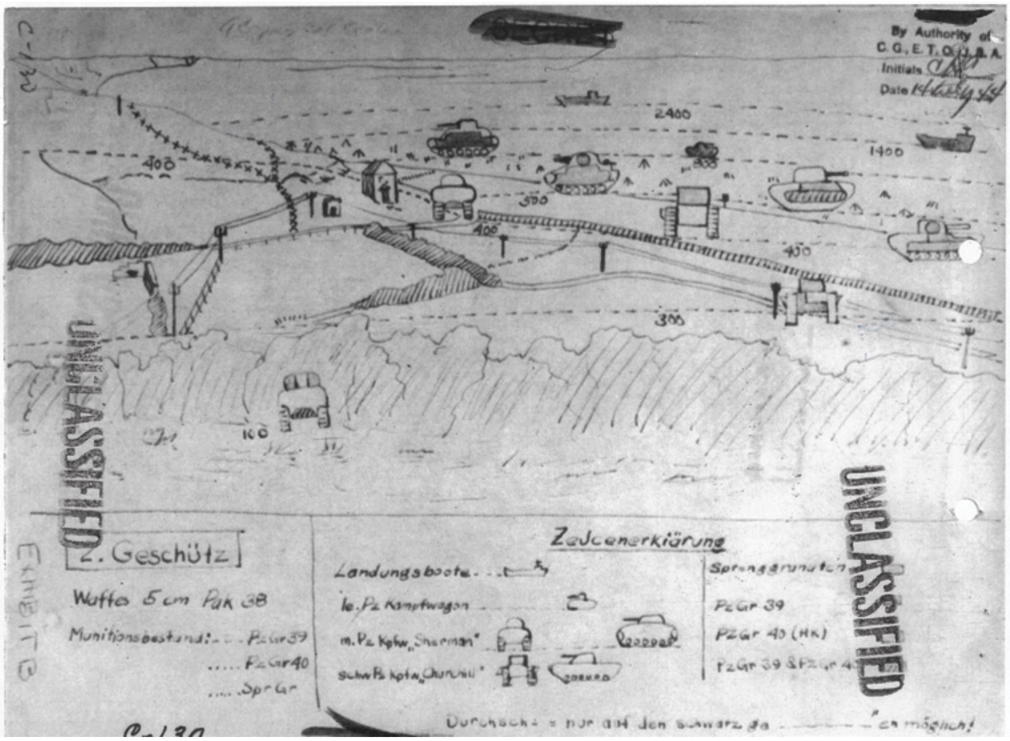
Allied invasion plans and German positions in Normandy. (Map courtesy of Wikimedia Commons)

beach both east and west. Once ashore, the Americans had to scramble up escarpment-like heights to control ravines the Overlord planners called exits. The German defenders' *widerstandsnesten* (strongpoints, or WN) each had sketch maps with ranges and sectors and were well supported by artillery (see figure 2). Overaged or not, the one thousand soldiers of the 716th Infantry Division supported by another one thousand from the better-equipped 352nd exacted an immense toll.[36]

Omaha's defenses came closest to Rommel's conception of how to defend the coast than any of the beaches assaulted on D-Day. The German defense included underwater wire and mine obstacles. To be able to see and avoid the underwater obstacles, the troops landed at low tide, necessitating that they cross several hundred yards of open terrain just to reach the seawall. The first assault wave consisted of eight rifle companies from the two regiments. Around 0300 hrs., the troops clambered into their landing crafts about thirteen miles offshore with the seas running three to five feet. The ensuing trip to the beach took nearly three hours, during which small crafts rolled, pitched, and yawed until all and sundry were cold, sodden, and desperately seasick.[37]

The Army Air Force bombed the beaches as part of the preparation fires to destroy coast defenses and to generate craters that could provide cover for ground troops. The official Air Force history opined that "too much was expected by the other services."[38] Although some air attacks took place in April, the main effort came on D-Day. The airmen made a prodigious effort; 1,083 of 1,361 heavy bombers struck that morning dropping 2,944 tons of bombs. However, because of low overcast conditions and bumping the aim points to assure safety, nearly all the bombs were dropped well past their intended targets. With understandable if misplaced bitterness, Lt. Col. Herbert Hicks, commander of the 2nd Battalion, 16th Infantry, observed, "The Air Corps might just as well have stayed home in bed for the all the good they did."[39]

Medium bombers and fighters flew as well. They too achieved less than hoped. The Allied air forces did achieve air supremacy. Not quite six miles offshore, the USS *Arkansas* and USS *Texas*, equipped with 12- and 14-inch guns, pummeled the beaches. The battleships were supported by cruisers and destroyers and even rocket-firing landing craft and a few howitzers, thumping away while inbound. Next came the duplex drive tanks that were to swim ashore buoyed by canvas "bloomers." Five made it ashore. Finally came the eight companies in the first wave (there were twenty-six waves in all). Some 1,600 bedraggled infantrymen, many of whom landed well away from their intended targets, began landing at 0630 hrs.[40]



(Graphic courtesy of the Robert R. McCormick Research Center)

Figure 2. German Sector Sketch Captured by the 16th Infantry

Many soldiers never reached the shore; still others died soon after. In *The Bedford Boys*, Alex Kershaw recounts the story of Capt. Taylor N. Fellers, and A Company, 1st Battalion, 116th Infantry. Fellers and perhaps all but one man in his boat section were killed shortly after landing. Within minutes, the Germans decimated the male population of Bedford, Virginia.[41] The struggle ashore succeeded because of bottom-up and top-down leadership—easy to say after the fact but difficult in execution. Young officers and NCOs made it off the beach out of sheer bloody-minded effort. Lt. John Spalding and his section sergeant Phillip Streczyk exemplified the courage and initiative required to get off the beach. By 1030 hrs. that morning, they and their boat section had reduced WN 64 and reached the top of the heights overlooking the beach. Both won the Distinguished Service Cross as did three of their soldiers.[42]

Young officers commanding destroyers assigned to Destroyer Squadron 18 played key roles as well. The destroyers came close in shore and reduced bunkers with direct fire. Writing soon after D-Day, Col. Stanhope B. Mason, chief of staff of 1st Infantry Division, asserted without naval gunfire, "we positively could not have crossed the beaches."[43] Maj. Gen. Leonard T. Gerow, commanding V Corps, said it succinctly: "Thank God for the United States Navy."[44]

Senior officers earned their pay that day as well. Brig. Gen. Norman D. "Dutch" Cota and Brig. Gen. Willard Wyman proved the wisdom of their promotions in action. Cota is frequently highlighted in accounts of D-Day, but Wyman has not received due credit. Wyman, the assistant division commander in 1st Infantry Division, brought his command post "danger forward" ashore shortly after 0800 hrs. Don Whitehead, a combat experienced journalist who came ashore with Wyman, looked around and concluded, "This time we have failed. God, we have failed!"[45] But Wyman stood erect and calmly sent lost units to where they were needed to push the lodgment inland.

Col. George A. Taylor exemplified a key role of senior officers that day. Taylor who had commanded in the 26th Infantry in North Africa and led the 16th ashore in Sicily, stood erect like Wyman and walked calmly along the beach exhorting and encouraging soldiers and junior leaders. At one point Taylor and his command group moved up near crest of a slope of shingle (softball-size gravel) and drew fire. His regimental surgeon, Maj. Charles E. Tegtmeyer, yelled at him, "For Christ's sake Colonel get down you're drawing fire," to which Taylor responded with a grin, "There are only two kinds of men on this beach, those who are dead and those who are about to die."[46]

In the eighty years since Taylor offered his justifiably famous observation, a great deal has changed. What has not changed is the importance of combined and joint operations. In 1944, combined operations required politically savvy officers who were conscious of the political nature of any operation let alone combined operations. Joint operations, despite doctrine intended to reduce friction and promote cross-domain success, will still depend personal relationships like those cultivated among the World War II Allies. Leadership and initiative from the bottom up and top down will not go out of style whatever we learn from the fighting in the Ukraine and the Gaza Strip; the same is true today. ■

Notes

1. William T. Johnsen, *Origins of the Grand Alliance: Anglo-American Military Collaboration from the Panay Incident to Pearl Harbor* (Lexington: University Press of Kentucky, 2016), 131; Chester Wilmot's *The Struggle for Europe* (Old Saybrook, CT: Konecky and Konecky, 1952), was one of the first histories of World War II published after the war. Wilmot's book makes it clear settling the competing interests of the two major allies proved fractious. The two volumes of the U.S. Army official history of that effort are Maurice Matloff and Edwin W. Snell, *Strategic Planning for Coalition Warfare: 1941–1942* (Washington, DC: Office of the Chief of Military History, 1963); and Maurice Matloff, *Strategic Planning for Coalition Warfare, 1943–1944* (Washington, DC: U.S. Army Center of Military History [CMH], 2003).

2. Gen. George C. Marshall, quoted in Wilmot, *The Struggle for Europe*, 99.

3. Stephen E. Ambrose, *The Supreme Commander: The War Years of General Dwight D. Eisenhower* (New York: Doubleday, 1969), 45–46.

4. Ibid. Most accounts of the war report that in the early years, at least, many if not most of the British high command held their American colleagues in low regard. It did not go unnoticed; Ralph Ingersoll, a New York newspaper man who served with Omar N. Bradley at II Corps, First Army, and 12th Army Group, fired an early shot in what became a cross-Atlantic war of words over American versus British leadership during the war. See Ralph Ingersoll, *Top Secret* (New York: Harcourt, Brace, 1946). Ingersoll's book is vitriolic, to say the least. See chapter 1, "The Johnnies Come Lately," and almost anywhere else in the book.

5. The Army Air Forces official histories are the best sources for the American air effort. Three volumes of interest are from editors Wesley Frank Craven and James Lea Gate: *The Army Air Forces in World War II: Volume I, Plans and Early Operations, January 1939 to August 1942* (1948; repr., Washington, DC: Office of Air Force History, 1983); *The Army Air Forces in World War II: Volume II, Europe: Torch to Pointblank, August 1942 to December 1943* (1949; repr., Washington, DC: Office of Air Force History, 1983); and *The Army Air Forces in World War II: Volume III, Europe: Argument to VE Day, January 1944 to May 1945* (1951; repr., Washington, DC: Office of Air Force History, 1983). The Office of Air Force history republished the entire seven volumes in 1983.

6. Ambrose, *The Supreme Commander*, 60.

7. The date of Lt. Gen. Frederick E. Morgan's appointment is from Mary H. Williams, *Chronology 1941–1945* (Washington, DC: U.S. Army CMH, 1958), 106.

8. Gordon A. Harrison, *Cross-Channel Attack* (Washington, DC: Office of the Chief of Military History, 1951), 51.

9. Walter Warlimont, *Inside Hitler's Headquarters* (New York: Frederick A. Praeger, 1964), 373. Warlimont served as deputy chief of staff–operations of the German High Command from 1938 until the end of the war in May 1945. Warlimont's memoir, like any memoir, needs to be read critically, but his accounts of the inner working of the High Command are essential to understand the German strategic estimates.

10. Ibid., 399–400; see "Führer Directive 51," Führer Headquarters, 3 November 1943, https://ww2db.com/doc.php?q=331; see also Matthew Cooper, "The Crisis of 1943," chap. 27 in *The German Army, 1933–1945* (New York: Stein and Day, 1978). Lucie-Marie Rommel, her son Manfred, and Gen. Fritz Bayerlein materially aided Liddell-Hart. Warlimont, *Inside Hitler's Headquarters*, 406.

11. "Führer Directive 51."

12. See B. H. Liddell-Hart, ed., *The Rommel Papers* (New York: Da Capo Press, 1982), 447.

13. Warlimont, *Inside Hitler's Headquarters*, 402.

14. Robert M. Citino, *The Wehrmacht's Last Stand: The German Campaigns of 1944–1945* (Lawrence: University Press of Kansas, 2017), 116; see also Hans Speidel, *We Defended Normandy* (London: Herbert Jenkins, 1951). Speidel, who served as Rommel's chief of staff, provides an insider's look at Army Group B and Field Marshal Rommel.

15. Citino is the best source on the debate within the German high command on whether to defend forward or attempt *Bewegungskrieg*. See chap. 3, "On the Beach: Normandy and Beyond," in

Citino, *The Wehrmacht's Last Stand*. The argument boiled down over the competing views of Rommel and his immediate superior, Von Rundstedt.

16. Ambrose, *The Supreme Commander*, 309; Harry C. Butcher, *My Three Years with Eisenhower: The Personal Diary of Captain Harry C. Butcher*, *USNR* (New York: Simon and Schuster, 1946), 454. Gen. Dwight Eisenhower had heard the news inadvertently from Marshall on 7 December. Williams, *Chronology 1941–1945*, 152.

17. Regarding the debate over broad versus narrow front and tension between Eisenhower and Montgomery, see G. E. Patrick Murray, *Eisenhower versus Montgomery: The Continuing Debate* (Westport, CT: Praeger, 1996); figure 1 from Forrest Pogue, *The Supreme Command* (Washington, DC: U.S. Army CMH, 1989), 67, https://history.army.mil/html/books/007/7-1/CMH_Pub_7-1.pdf.

18. Harrison, *Cross-Channel Attack*, 158; Omar N. Bradley, *A Soldier's Story* (New York: Henry Holt, 1951), 169–70. Bradley's chapters 11 and 12 discuss the development and evolution of Overlord. See also Bernard Law Montgomery, "The Battle of Normandy," chap. 14 in *The Memoirs of Field-Marshal the Viscount Montgomery of Alamein* (New York: World Publishing, 1958), 14; for Eisenhower's perspective on planning, see Dwight D. Eisenhower, "Planning Overlord," chap. 13 in *Crusade in Europe* (New York: Doubleday, 1948).

19. Harrison, *Cross-Channel Attack*, 164–65; see also D. K. R. Crosswell, *Beetle: The Life of General Walter Bedell Smith* (Lexington: University Press of Kentucky, 2010), 551–57. Beetle and Montgomery together pushed hard for the resources required. Regarding Operation Fortitude, see Roger Fleetwood Hesketh, *Fortitude the D-Day Deception Campaign* (London: St. Ermin's, 1999); see Craven and Cate, *The Army Air Forces in World War II*, 2:26; Butcher, *My Three Years with Eisenhower*, 447–44. The entry for November 1943 is seven pages long, including his observation on Gen. Carl Spaatz. Spaatz wanted the ground troops to grind their way up Italy to seize airfields that would shorten the range to bomb targets in Austria and Germany. In his memoir, Eisenhower noted the reluctance of the strategic air forces to be saddled with tactical targets. He believed he brought around Air Chief Marshal Sir Arthur Travis "Bomber" Harris. See Eisenhower, *Crusade in Europe*, 221, 271, 308. For the damage done to France, see Stephen A. Bourque, *Beyond the Beach: The Allied Air War against France* (Annapolis: MD: Naval Institute Press, 2018).

20. Quoted in Adrian Lewis, *Omaha Beach: A Flawed Victory* (Chapel Hill: University of North Carolina Press, 2001), 131; see also Nigel Hamilton, *Monty: The Battles of Field Marshal Bernard Montgomery* (New York: Random House, 1981), 5. This is the second of a brilliant three-volume biography of Montgomery.

21. Gregory Fontenot, *No Sacrifice Too Great: The 1st Infantry Division in World War II* (Columbia: University of Missouri Press, 2013), 78–90. Eisenhower admitted to attempting too much with too little. Nevertheless, Gen. K. A. N. Anderson used American units without regard to the integrity of their formations. See also Alan Moorehead, *The March to Tunis: The North African War* (New York: Harper and Row, 1965), 496.

22. Harrison, *Cross-Channel Attack*, 109.

23. Forrest C. Pogue, *Interviews and Reminiscences for Forrest C. Pogue* (Lexington, VA: G. C. Marshall Research Foundation, 1996), 541.

24. Harrison, *Cross-Channel Attack*, 95.

25. Ambrose, *The Supreme Commander*, 339.

26. Ibid., 340.

27. Harrison, *Cross-Channel Attack*, 158; Samuel Eliot Morison, *The Invasion of France and Germany*, *1944–1945* (Boston: Little, Brown, 1984), 51; Roland G. Ruppenthal, *Logistical Support of the Armies, I: May 1942–September 1944* (Washington, DC: U.S. Army CMH, 1995), 100, 232.

28. Ruppenthal, *Logistical Support*, 237.

29. Harrison, *Cross-Channel Attack*, 64.

30. Ibid., 167–68.

31. Lewis, *Omaha Beach*, 228.

32. Morison, *The Invasion of France and Germany*, 55. The USS *Arkansas* and USS *Texas* supported Omaha Beach as did three UK battleships and one French cruiser. Twelve British and U.S. destroyers completed the bombardment group. See Morison, appendix 1.

33. U.S. War Department, TM-E 30-451, *Handbook on German Military Forces* (March 1946; repr., Baton Rouge: Louisiana State University, 1990), 89, 297.

34. Mark J. Reardon, ed., *Defending Fortress Europe: The War Diary of the German 7th Army in Normandy*, *6 June to 26 July 1944* (Bedford, PA: Aberjona Press, 2012), 33–34; Fontenot, *No Sacrifice Too Great*, 248–50; see also John McManus, *The Dead and Those About to Die: D-Day the Big Red One at Omaha Beach* (New York: NAL Caliber, 2014), 52–53.

35. Reardon, *Defending Fortress Europe*, 31. There is no truly authoritative source for tank strength for 6 June. Reardon is, in the author's opinion as the best. Numbers vary by author. For example, Robert M. Citino, *The Wehrmacht's Last Stand: The German Campaigns of 1944-1945* (Lawrence: University Press of Kansas, 2017), shows eight Mark VI Tiger tanks assigned to Panzer Lehr. His source, like Reardon's, is German, but both cited sources are secondary sources. There were Tiger tanks in Normandy; the question is when did they arrive? Regarding the location of Panzers, see Harrison, *Cross-Channel Attack*, map XIV.

36. McManus, *The Dead and Those About to Die*, 55–62; see also Harrison, *Cross-Channel Attack*, 189–90, 319–20.

37. Fontenot, *No Sacrifice too Great*, 251; see also McManus, "H-Hour," chap. 3 in *The Dead and Those About to Die*.

38. Craven and Gate, *Army Air Forces in World War II*, 162, 19.

39. McManus, *The Dead and Those About to Die*, 16.

40. Fontenot, *No Sacrifice too Great*, 252–53; Morison, *The Invasion of France and Germany*, 134–36. The amphibious craft depended on guide boats and the skill of their young coxswains to land where intended. Morison described the result as "little better than the blind leading the blind" (131).

41. Alex Kershaw, *The Bedford Boys: One American Town's Ultimate D-Day Sacrifice* (Cambridge, MA: Da Capo Press, 2003), 139. Chapters 10–12 describe A Company's agony.

42. Ibid.; Fontenot, *No Sacrifice Too Great*, 260; see also John Spalding, "Interview with Master Sergeant Forrest C. Pogue and Staff Sergeant J. M. Potete, Belgium, February 9, 1945"; box 18952; Records of the Army Staff, Record Group 319; National Archives at College Park.

43. Fontenot, *No Sacrifice Too Great*, 264.

44. Ibid.

45. See Robert A. Miller, *Division Commander: Major General Norman D. Cota* (Spartanburg, SC: Reprint Company, 1989), chaps. 8 and 9. Maj. Gen. Norman D. Cota served previously in the 1st Infantry Division, first in the 16th Infantry Regiment, then as G-3, and finally as chief of staff. He made the Torch landing. Regarding his role on D-Day, see Fontenot, *No Sacrifice Too Great*, 261–62, 266.

46. Fontenot, *No Sacrifice Too Great*, 261. Maj. Charles E. Tegtmeyer's unpublished memoir from which this quotation comes is at the McCormick Research Center, Wheaton, Illinois.

"An Incredible Degree of Rugged and Realistic Training"

The 4th Infantry Division's Preparation for D-Day

Stephen A. Bourque, PhD

At 0640 hours, 6 June 1944, twenty LCVPs (Landing Craft, Vehicle, Personnel), generally called Higgins boats, stopped just short of the French coast at La Madeleine, near Sainte-Marie-du-Mont on the Cotentin Peninsula. On signal, the ramps lowered, and six hundred soldiers from the 1st and 2nd Battalions of Col. James Van Fleet's 8th Infantry Regiment jumped into chest-deep water and waded for one hundred yards past obstacles toward the smooth beach. The soldiers' movement in the icy water was slow as they approached the defenders from the 3rd Company, 919th (German) Infantry Regiment, who were attempting to recover from the Ninth Air Force's intense and accurate attack on their positions and the massive naval bombardment that had shifted fires only a few moments earlier. The attackers swept through the still-shocked defenders and began moving inland. Ten minutes later, the second wave landed and started expanding the bridgehead. Adjusting to landing about 1,200 yards south of the intended beach, the regiment continued forward toward the causeways and linked up with the 101st Airborne elements that had landed the previous night.

Col. Herve Tribolet's 22nd Infantry Regiment arrived on the shore at 0745 hours and, as rehearsed, turned north. It headed up the coast to destroy German defenders on the beach and artillery batteries still bombarding the landing area and the fleet. By noon, Col. Russell (Red) Reeder's 12th Infantry Regiment was ashore, pushing cross-country through the gap between the other two regiments. Throughout the day, tank, tank destroyer, artillery, air defense artillery, and engineer battalions moved in support of their respective regiments or began working on the innumerable tasks assigned by the 4th Infantry Division G-3. By the end of the day, Van Fleet's regiment had accomplished its primary task of joining with the 101st Airborne Division. The other two regiments had expanded the division's bridgehead, allowing other elements from the VII Corps to begin coming ashore. Through it all, the 4th Infantry Division commander, Maj. Gen. Raymond O. Barton, who had landed at 0934 hours, watched his soldiers in action. Besides occasionally directing traffic to clear the few roads in the marsh-infested area, he had almost nothing to do. When asked by subordinates for instructions, he told them to execute the plan as practiced.[1]

Belying Helmuth von Moltke's often quoted dictum that "no plan of operations extends beyond first encounter with the enemy's main strength," almost everything went according to schedule.[2] Although problems

U.S. soldiers of the 8th Infantry Regiment, 4th Infantry Division, move over a seawall on Utah Beach during the Allied invasion of Europe on 6 June 1944. (Photo courtesy of the U.S. Army Center of Military History)

in water navigation delayed the assault by about ten minutes and shifted the landing by 1,200 yards, almost no one but the first troops ashore even noticed. The German defenders on the beach offered only moderate resistance, and it was primarily their artillery batteries, positioned farther inland, that inflicted most of the division's 311 casualties—killed, wounded, and missing.[3] By the early evening, when Barton arrived at his command post at Audouville-la-Hubert to begin adjusting the plan for the following days, his command was in good shape and either on or close to all its initial objectives. His soldiers had accomplished thousands of individual tasks that day as well as driving the German 919th Grenadier Infantry Regiment away from the beach area. How did this happen?

Most Americans consider D-Day as a singular event: the physical landing of Allied forces, by air and sea, on the Normandy coast. But as soldiers know, many months, if not years, went by before a single Higgins boat touched down on Omaha or Utah beaches. For Americans, the preparation began in 1940 as the United States expanded its military forces. By 1941, the U.S. Army's Ground Forces, led by Lt. Gen. Leslie McNair, directed a series of large-scale maneuvers in Louisiana and the Carolinas, evaluating and training corps and armies. Specialized unit training for combat in mountains, deserts, and amphibious operations often followed these general maneuvers. One unit that participated in this extensive preinvasion training program was the 4th Infantry Division, one of the three infantry divisions to participate in the Normandy invasion on 6 June. Activated on 1 June 1940, the War Department directed its organization as a motorized division, and three years later, reorganized it as a standard infantry division. Starting in October 1943, it had a specific task: be the lead division in an assault against the German Atlantic Wall. Based on a focused training program developed that month, training began with general amphibious practice in the United States, a second phase with more sophisticated ship-to-shore exercises, and a third phase that rehearsed the invasion. The result was an efficient and productive assault on 6 June.[4]

Stephen A. Bourque, PhD, is professor emeritus at the U.S. Army Command and General Staff College. He left the U.S. Army in 1992 after twenty years of enlisted and commissioned service, with duty stations in the United States, Germany, and the Middle East. After earning a PhD in history at Georgia State University, he taught at several colleges and universities, including California State University-Northridge, and the Command and General Staff College's School of Advanced Military Studies. His books include *Jayhawk! The VII Corps in the 1991 Persian Gulf War* (U.S. Army Center of Military History, 2002), *The Road to Safwan* (University of North Texas Press, 2007), and *Beyond the Beach, the Allied War against France* (Naval Institute Press, 2018). His most recent book, *"Tubby," Raymond O. Barton and the US Army, 1889-1963*, is scheduled for publication in fall 2024. Portions of this article will appear in *Tubby*. Bourque is currently working on a book on the 4th Infantry Division's battle in the Hürtgen Forest.

Phase 1: Training on Fundamentals in the United States

The onset of war in Europe in 1939 interjected a sense of realism into the U.S. Army's organization and training. For most, it was not a surprise as many veterans of the First World War sensed that they would again return overseas to finish the job from the previous war.[5] Gen. George C. Marshall and other senior leaders began plotting a course to create a ground force capable of doing battle on the continent. The German offensive against France and the Low Countries that accelerated that effort included a significant expansion of the Regular Army and improved training for the National Guard. Between the German invasion of Poland (September 1939) and the Japanese attack on Pearl Harbor (December 1941), the War Department created two armored divisions and reactivated six infantry divisions.[6] Among these was the 4th Infantry Division, reactivated at Fort Benning, Georgia, on 1 June 1940.[7]

Almost immediately, replacements began flowing into Fort Benning and its three regiments: the 8th, 22nd, and 29th Infantry (later replaced by the 12th). Congress enacted the Selective Service Act in September 1940, increasing the influx of recruits heading to their new units.[8] Until June 1941, the Army had yet to expand its system of replacement centers, so the first time these inductees came face to face with the U.S. Army was when their noncommissioned officers met them getting off their bus. Over the next few months, sergeants instructed them in what has traditionally been called the school of the soldier.[9] In addition to the standard tasks of wearing the uniform, marching, military discipline, and marksmanship, the 4th Division's recruits also had to participate in a unique aspect of training: driving and motor vehicle maintenance. As a motorized division, it had many trucks, tracked vehicles, and jeeps. Many of the recruits, who had grown up during the Great Depression, had no experience with driving vehicles nor how to keep them moving. But it was not long before the division was rolling across the southeast.[10]

In August 1941, the 4th Motorized Division joined the remainder of the IV Corps during the Third Army Maneuvers in Louisiana. These lasted for ten days and were in preparation for the major exercises scheduled by the General Headquarters, U.S. Army (GHQ). At the end of the exercise, the division returned to Fort Benning for only a short period because, in November, the 4th Motorized participated with the rest of Maj. Gen. Oscar W. Griswold's IV Corps in the GHQ-directed Carolina Maneuvers. For ten days, it maneuvered as part of the largest concentration of motorized troops in America's history.[11] Returning to Fort Benning on 3 December, it had not yet unpacked when the Japanese navy attacked the Pacific Fleet.[12] The troopers remained alert for the next month, waiting to be dispatched to defeat an Axis incursion along the coast. Of course, it did not happen, and the command moved from Fort Benning to its new quarters at Camp Gordon, Georgia, later that month.[13] In July 1942, its former chief of staff, Maj. Gen. Raymond O. Barton, returned to command the 4th Motorized Division. Immediately, the division was back in the field.

4th Infantry Division commanders pose for a photograph at Brent Knoll Camp, England, on 30 May 1944. *Front row (left to right):* Brig. Gen. Harold W. Blakeley (4th Division Artillery), Maj. Gen. Raymond O. Barton, and Col. James Rodwell (Chief of Staff). *Back row (left to right):* Col. James Van Fleet (8th Infantry), Col. Hervey A. Tribolet (22nd Infantry), Col. Russell P. Reeder Jr. (12th Infantry), and Gen. James E. Wharton (1st Special Engineer Brigade). (Photo courtesy of the U.S. Army)

While Barton's soldiers were out training, Gen. Dwight D. Eisenhower's forces were in their last phase of destroying the German and Italian armies in Tunisia. At the Casablanca Conference in January 1943, the political and military leaders agreed that the Allied subsequent tasks were to clear Sicily, invade Italy, and knock the junior Axis power out of the war. As a result, the War Department sought to get its best-trained unit still in the United States into the next phase of combat. As the "Rolling Fourth" returned to Camp Gordon, Barton received orders to move the division to Fort Dix, New Jersey. By the second week of April, the division was on the move, this time by train-hauling all its equipment.[14] When they arrived, the troops continued to train with more weapons firing, small-unit attacks on fortified positions, and air-ground operations. Mortar crews received special training attention since they gave the infantry battalion commander his best fire support for close-in combat.[15]

This well-trained unit was not deploying to Italy due to its organization as a motorized division. In theory, there would be one of these for every two armored divisions, essentially replicating how the Germans had developed their panzer grenadiers to support their panzer divisions. However, because of the large amount of shipping required to get it overseas, as much as a standard armored division, it did not deploy. By the end of July 1943, the War Department decided to discard the motorized structure and redesignate these units as infantry divisions. On 24 August, GHQ ordered Barton to turn in his motorized equipment and prepare to move to the Amphibious Training Center, Camp Gordon Johnston, on the Florida Coast.[16]

Privately, a member of the GHQ staff let Barton know the 4th Division would be part of the assault on France, code name Overlord. In September, he flew to England for a general briefing on his role and to examine potential training and bivouac areas. When he arrived at Gordon Johnston in early October, he and his staff prepared a training memorandum (Number 73), published on 14 October, which spelled out the division's training plan for the next nine months. It identified three training phases: the first was an introduction to amphibious operations and honing small-unit skills in Florida between 18 October and 31 December. Phase 2 would commence after the division arrived in the United Kingdom in January and, although not stated in the memorandum for security reasons, would focus on more sophisticated ship-to-shore operations. Once the assault plan was firm, Barton's command would concentrate on practicing for the invasion.[17]

The War Department had established the Amphibious Training Center in October 1942 near the beach town of Carrabelle, Florida, about sixty miles

Map of the Slapton Sands Training Area, Devon, England, circa 1944. (Map courtesy of the National Archives of the UK, ADM 116/5082)

southwest of Tallahassee. The training area was large enough to accommodate an entire reinforced infantry division. While the instructional program was always in flux, depending on the unit, it generally consisted of several different phases:

- Embarkation operations
- Activities while afloat and en route to the landing location
- Movement from the ship to the shore
- Initial assault operations[18]

In addition, staff officers participated in a separate course emphasizing the role of the headquarters in planning for all phases of the assault. Finally, the center taught a series of special subjects, including swimming, physical conditioning, knife and bayonet fighting, and automatic weapons firing from landing craft. By the time the 4th Infantry Division arrived in September 1943, the center had been in operation for more than a year and was changing from a purely Army endeavor to a joint Army-Navy operation.[19]

For Phase 1, amphibious operations were the most crucial task, followed by other essential skills such as mine laying, sanitation, patrolling, and night operations. During assault training, the division used live ammunition when possible and emphasized the use of the bayonet. In addition to regular exercises, officers and noncommissioned officers attended schools on leadership and tactical subjects. Physical fitness was essential, and the division conducted long-distance cross-country runs at least once a week. They would practice marching, with full gear, from distances of fifteen to twenty-five miles.[20]

The details for much of the training was a 271-page syllabus titled "Shore to Shore Amphibious Training." It covered nearly everything a unit could expect to experience, from loading the vessels to landing on the far shore, communicating during the passage to the coast, and the beach organization after landing. It also had a series of tutorials for commanders and staff on how to write an amphibious order. This program ended with a series of exercises designed to put everything the soldiers and their leaders learned into practice.[21]

The training program was challenging and demanding. Soldiers working with the 4th Engineer Special Brigade got seasick for the first time as they spent hours offshore, bobbing in their landing craft. They landed at night on beaches on local islands and the Florida coast. They hiked at night to build physical fitness while avoiding the day's heat. They went swimming every afternoon to learn how to escape a sinking ship and

In this photograph released 12 June 1944, Army troops on board a Landing Craft, Tank prepare to ride across the English Channel to France. Some of these men wear the 101st Airborne Division insignia. (Photo courtesy of the U.S. Navy via the National Archives)

reach the shore. Combat teams practiced, for the first time, as units comprising infantry, engineers, medics, and artillery. While not on the prescribed training plan, the division ran a modified "Ranger" training plan for select members of each regiment. Capt. Oscar Joyner Jr., a former Amphibious Training Center staff member who was now with division G-3, ran this program. Its essence was on essential individual skills such as map reading, land navigation, use of explosives, detecting mines and booby traps, and scaling defensive walls. As the historian for the 22nd Infantry noted, "Probably no phase of the training of the regiment was more useful or more thoroughly detested than the time spent at Camp Gordon Johnston, Florida."[22] By the end of November, these young men were in the best physical condition of their lives, lean from the exercise and tan from hours in the sun. They were ready for the next training phase in England.[23]

Phase 2: General Amphibious Training in the UK

The 4th Infantry Division began its journey to Europe by leaving Camp Gordon Johnston on 1 December. Wheeled vehicles moved by convoy the 450 miles from the coast to Camp Jackson, South Carolina. There, it cleaned or replaced worn-out clothing and equipment. The division started moving again at the end of December, this time to Camp Kilmer, New Jersey, where they prepared for deployment. War Department inspectors and offices from various agencies moved soldiers through one last series of predeployment checks during the day. Soldiers received physical examinations and lectures on

The Collipriest House in Tiverton, England, served as headquarters of the 4th Infantry Division from February to May 1944. (Photo courtesy of Geograph)

security, and they removed all their unit patches and insignia. The men filled in the change of address cards and sent them home with any items they were not permitted to take with them. The War Department alerted the division for deployment at the end of December, and its advanced party, led by Col. James Rodwell, the chief of staff, departed New York Harbor on 27 December. Finally, Van Fleet's 8th Infantry was first, leaving on 10 January on the RMS *Franconia*, a Cunard liner. By 19 January, the entire division was at sea. It took thirteen days to cross the icy Atlantic Ocean. By the end of January, the whole division had arrived at Liverpool, and the debarkation process began.[24]

The Ivy Division's movement was part of Operation Bolero, the U.S. Army and Army Air Forces' deployment to England. The Bolero Combined Committee (London) supervised the "reception, accommodation, and maintenance of US forces in the United Kingdom."[25] This group coordinated with all British national and local government elements to ensure the process was as smooth as possible. It supervised the terrain and facilities for American troops and designated billeting areas. From Liverpool, the division's soldiers boarded trains and moved to their encampment areas in the large peninsula in southwest England called Devon (or sometimes Devonshire). One reason the committee selected this location is that it made amphibious training in English and Bristol Channels relatively easy. It was also close to the embarkation ports and the ultimate landing areas in western Normandy.[26] As soon as he arrived, Barton reported to Lt. Gen. Omar N. Bradley, the commander of the First U.S. Army, to get his briefing on what was to expect over the next few months.[27]

The headquarters was at a lovely early eighteenth-century mansion in Tiverton called Collipriest House. The division artillery headquarters was in the nearby village of Cullompton, with the battalions scattered near their supported regiments. Col. Harry Henderson's 12th Infantry Regiment moved into the area around Exeter. Van Fleet's 8th Infantry centered its command on Honiton, and Tribolet's 22nd Infantry moved into various villages in and around Newton Abbot. The distance from division headquarters to the various headquarters could be over forty-five miles, making it a challenge for Barton and his staff to interact with his commanders, who now were pretty much on their own when not on training exercises.[28]

As soon as the regiments were in place, they began small-unit training to prepare for the more extensive exercises. Training space in the British countryside was at a premium. Soon, the American theater command arranged for the division to practice at an area they called the U.S. Army Assault Training Center, located between Braunton and Barnstaple. Here, the division's troops could practice with infantry weapons, tanks, artillery, and air support, all using the same ammunition they would use in combat. At Braunton, soldiers learned or refreshed their memories on organizing boat teams, leading assault groups, and overcoming "hedgehogs" and other obstacles enemy defenders could use to stop the division's assault.[29] Since Barton had decided to lead the invasion with the 8th Infantry, he sent it immediately to Braunton. Its specialized training included assault amphibious techniques, reduction of beach defenses, and assault against fortified locations. As the division historian noted, "The training at Braunton was well organized, intensive, interesting, and of immense practical value to its recipients."[30] The remainder of the division spent February practicing with its new equipment at the company and battalion levels. This training included live-fire exercises and shooting direct and indirect fire over the assaulting troops.[31]

On 23 January, Eisenhower, now the supreme allied commander, notified the Combined Chiefs of Staff that he had approved a significant modification in the invasion concept. Because the Allies' posture for men and material had improved since the original invasion plan's development, they could now assault another beach, called Utah, on the Cotentin Peninsula. Bradley assigned this mission to the 4th Infantry as part of the VII Corps. The division had the task of seizing that beach, linking up with two divisions of airborne forces dropped inland, and turning north to lead the effort to capture the port at Cherbourg.[32] Since Eisenhower and Bradley's staffs had not yet worked out the invasion's details, Barton and the 4th Infantry Division continued execution of Phase 2 of his October training plan.[33]

Meanwhile, from February until 5 June, the division commander participated in an almost daily sequence of visits, meetings, and inspections. Barton's diary records each of these, consuming more than half of the time he had available to prepare his command. The U.S. secretary of war, the British prime minister, and almost every general officer and staff colonel in both armies made their way to his headquarters at Tiverton. Barton met with members of the corps headquarters almost daily. With more than thirty years of infantry service, "Tubby" Barton knew and had served with many of the American officers. Therefore, in this environment of constant activity, there was little time for reflection and contemplation by a division commander on the eve of one of America's most important battles.[34]

The division needed to hone its general amphibious skills as part of Phase 2 training. The 8th Infantry had begun this process at Brauton in late February. It started for the 12th Infantry with Operation Muskrat, on 12 March. At Plymouth, three assault transport ships awaited them: the USS *Dickman*, the USS *Barnett*, and the USS *Bayfield*, which would be the corps and division command post during the invasion. They headed north to the Firth of Clyde, southwest of Glasgow, Scotland. There, they dropped anchor, and for the first week, the battalions practiced various drills such as reaching boat stations under blackout conditions, debarking over the sides of the ships, and wearing full gear with ladders, nets, and ropes. Throughout the week, soldiers experienced cold rain and the expected seasickness caused by bouncing around in the late winter coastal waters. For the following week's exercise, a detachment from the 1st Engineer Special Brigade boarded the three ships. Now, the soldiers put their training to use as they organized into boat teams, scurrying down the transports' sides and into their assigned Higgins boats. They formed up into assault waves and approached the hostile shore. Then they jumped into the icy water, often up to their armpits, and waded to shore. It was a harrowing experience with the constant danger of injury or drowning, and everyone was always wet and cold.[35]

> Then they jumped into the icy water, often up to their armpits, and waded to shore. It was a harrowing experience with the constant danger of injury or drowning, and everyone was always wet and cold.

Barton had watched the final exercise from a high point overlooking the beach until thirty minutes after the troops landed. He then went down to the beach. He was displeased by what he found. The soldiers seemed listless and unmotivated. In most cases, they were going through the motions, not using the terrain for cover and hiding from direct enemy fire. More importantly, leaders were not taking charge and making corrections from his perspective. He found Henderson and took him up and down the beach, pointing out what he saw. The regimental commander had not been with the division very long, and Barton was not impressed with what he discovered.[36]

The 22nd and 8th Infantry went through similar exercises. Tribolet called his training series Mink, which occurred at Slapton Sands. Unlike the 12th Infantry, he only had to qualify two battalions since the 3rd Battalion would train with Van Fleet's regiment. He practiced the same drills as the Muskrat exercise. Meanwhile, the

Maj. Gen. Raymond O. Barton, commanding general of 4th Infantry Division, transmits instructions over a radio on 27 April 1944 while on the USS *Bayfield* off the coast of England during Exercise Tiger. (Photo courtesy of the U.S. Army via the National Archives)

8th Regiment, including the 3rd Battalion of the 22nd Infantry, moved to Dartmouth and continued its assault training in another exercise called Otter during the same period. Since Van Fleet would be first on the shore, he demanded that its practice be more in-depth with an increased sense of urgency.[37]

Phase 3: Preparing for Neptune

By mid-March, the First Army and VII Corps commanders and staffs had made most of the central planning decisions. Although the VII Corps would not publish Field Order #1, Neptune, until 28 May, Barton knew that Maj. Gen. J. Lawton Collins, the corps commander, had assigned the 4th Infantry Division the task of landing on the Cotentin Peninsula, linking up with the 82nd and 101st Airborne Divisions, and driving north toward Cherbourg. It was time for him to move to Phase 3 of his training plan, preparing for the invasion.[38]

The first significant invasion rehearsal was Exercise Beaver; running from 27 to 30 March, this would be a full rehearsal of the anticipated assault, with the 8th and 22nd Infantry leading the way. Now, the regiments were combined arms organizations called regimental combat teams. In addition to the infantry, the division assigned them tank platoons, engineers, medics, signal troops, and a direct support artillery battalion. In many cases, these attachments would continue for the war's duration. For this exercise and the invasion, the 1st Engineer Special Brigade and the 1106th Engineer Group joined the 4th Division. Since this was a VII Corps-directed activity, Collins and his headquarters also controlled the 101st Airborne Division's 502nd Parachute Infantry Regiment and received support from the Ninth Air Force.[39]

The exercise would take place at the Assault Training Center at Slapton Sands on the south Devon coast, west of Dartmouth. It was a seven-mile-long beach, and possessed terrain similar to that which the Americans would encounter in June. Of special note was the Slapton Ley, a salt marsh just behind the beach that mirrored almost exactly the situation at Utah Beach.[40]

American troops land on a beach in England 25 April 1944 during Exercise Tiger, the final dress rehearsal for the invasion of Nazi-occupied France. (Photo courtesy of the U.S. Signal Corps via the Library of Congress)

Using the draft 4th Infantry Division field order as a guide, the 8th Regimental Combat Team led the way, followed by the 22nd and 12th Regimental Combat Teams. It was the first significant rehearsal of the division's assault plan. Disembarkation and the beach assault went generally according to schedule. The assault units secured a bridgehead and moved inland. But Barton was not happy with the performance of some of his companies and battalions.[41]

The following day, the exercise continued. It was time for the logistics units to begin supporting the combat teams on the shore. The European Theater Service of Supply landed about 1,800 tons of food, fuel, and ammunition, allowing everyone to practice resupply operations. That evening, the combat units began returning to their Devon camps. At the same time, the division commander and his operations group went to Plymouth and met the naval task force commander, Adm. Don P. Moon, Collins, and the VII Corps staff. As a training exercise of this scale, it exposed many flaws in unit training and Army-Navy cooperation. Many participants remembered it as a too confusing event. Based on his performance over the last month, Barton replaced one of his regimental commanders, Col. Harry Henderson, from the 12th Infantry. Bradley sent him Col. Russell P. "Red" Reeder Jr., one of Marshall's young protégées who had just arrived in the theater to replace him.[42]

Early discussions about Exercise Tiger began almost as soon as Eisenhower and British Gen. Bernard L.

Montgomery, the ground force commander, arrived in England in February, and they agreed to add another invasion beach. Bradley, therefore, ordered Collins to start planning for the exercise on 1 April, with the execution date during the last week of the month. As this was a dress rehearsal, the task organization was the same as the corps would employ on Utah Beach in June. The 4th Infantry Division would land as scheduled by sea, supported by the 1st Engineer Special Brigade to clear the beaches of mines and obstacles. It was not practical to use large amounts of aircraft to ferry the airborne troops from the 82nd and 101st Airborne Divisions; these troops arrived by truck to simulate the link-up with the forces landing by sea on D (execution day) +1. That same day, the logistics train of quartermaster, medical, and other sustaining units would also rehearse its landing and establishment of the supporting element on the invasion beach.[43]

Using the draft VII Corps Field Order #1, Neptune, as the guide, Barton and his staff prepared Field Order #1, Exercise Tiger, on 18 April.[44] The division would employ its three regiments, now configured as combat teams with all supporting engineers and tanks, precisely as planned for the invasion. Van Fleet's Combat Team 8, reinforced by the 3rd Battalion, 22nd Infantry, led the way and would move to Lower Ley to secure the causeway location. Tribolet's Combat Team 22, minus the battalion under Van Fleet's control, would be the next wave. Its mission was to land on the beach, secure a causeway, and take command of its 3rd Battalion. Then, it was to continue the attack along its assigned avenue of advance. Reeder's Combat Team 12 landed next with the task to secure a river crossing location. The 1st Engineer Special Brigade was mixed among the division, supporting the landing and improving the beach for follow-on forces and supplies. Finally, following the assault troops would be divisional, corps, and army supply units, practicing the movement of needed ammunition and food from ship to shore. This training event was as close to the invasion as the VII Corps staff could plan and execute.[45]

Over thirty thousand soldiers headed to the embarkation ports on 22 April, arriving at assembly areas off Devon's south coast a few days later. Thursday, 27 April was a beautiful day for a practice invasion, and the live-fire bombardment was ready to go. However, for various reasons, Moon postponed the assault from 0730 to 0830 hours, never something to try at the last minute. The element of friction, described by Carl von Clausewitz, took charge.[46] Not all the ships got the word. Companies E and F, 8th Infantry, received the change of orders and held back. However, Company G, the reserve unit, never got the message and continued ashore as scheduled. They were alone on shore as the Navy began its rescheduled bombardment. Fortunately, the heavy guns hit no one, but some explosions got a little too close to some of the troops on the beach.[47]

The division had other problems; Barton and senior commanders sensed a lack of energy across the command. Soldiers failed to employ the fundamental aspects of cover and concealment as if it were an invasion. Part of the problem was the absence of the regimental commanders with the initial landings. Van Fleet and Tribolet were stranded on a "free boat." Theoretically, they had the option to land anywhere, thus placing the regimental commanders where needed. However, the British skipper had other ideas and did not get them onto the beach until much later. When Barton landed, he received a profane-laced narrative from Van Fleet, who had been denied the chance to correct the problems in his team. Not long after, around 1045, Barton encountered Montgomery; Adm. Bertram H. Ramsay, commanding the Allied Naval Force; and Lt. Gen. Courtney Hodges, Bradley's deputy commander, on the beach. Not knowing the landing problem's background, Montgomery confronted the division commander. "Where the devil are regimental commanders, now General, they must be with the troops during the landing." Quite offended, Barton replied, "Now listen to me, General, you better tell that to your British skipper, my commanders would be in here but for his inefficiency." Montgomery pulled back and discussed the issue with Ramsay.[48]

Although this was the most critical training event for the 4th Infantry Division, Exercise Tiger has also gone down in history as one of the U.S. and British Navy's most significant failures in the European Theater of Operations. Early in the evening on 27 April, a convoy of eight LSTs (Landing Ship, Tank) departed Plymouth and headed for an assembly area in Lyme Bay, east of the exercise landing area. These large vessels, each four hundred feet long and capable of carrying twenty tanks and more than two hundred soldiers, were the backbone of the Allied invasion force. Onboard this convoy was the follow-up force for the landing, including soldiers and equipment providing engineer, logistics, medical, and communications support. Many of these were from the 1st Engineer Brigade. Shortly after midnight on 28 April, nine German torpedo boats left Cherbourg harbor to investigate the reported activities near Plymouth. Making contact with the Allied vessels around 0200, they encountered the LSTs and began their attack. When it was over, and British patrol ships arrived to chase them away, the German vessels had sunk two landing craft (LST 507 and LST 531), damaged two more, and killed approximately eight hundred Allied soldiers and sailors. Fearful that news of their success could tip off the Germans to the impending invasion, Allied headquarters slapped a security quarantine around the area. They warned medics and those aware of the disaster to say nothing. Senior officers of both nations and services pointed fingers at each other, assigning blame for the tragedy. Like most military actions, the event's details remained classified until the war's end.[49] Like many such instances, however, most considered it the price of preparing for the invasion and moved on. Moon had the grace to send a note to Collins to "express my deepest sympathy for their (1st Engineer Special Brigade) losses suffered on our first joint contact with the enemy."[50]

Conclusion

The U.S. Army's assault on the Normandy coast did not just happen. It took many months of training and practice to ensure that all the complex aspects of the invasion would come together to produce tactical success. The 1st and 29th Infantry Divisions had training programs similar to the 4th Infantry Division in preparation for their assault on Omaha Beach. It was the same for the 82nd and 101st Airborne Divisions that practiced for their night drops before the naval assault. The British and Canadian soldiers, who would land on Gold, Juno, and Sword beaches, also participated in extensive amphibious training programs. As historian Peter Caddick-Adams pointed out in his introduction to *Sand & Steel*, "When compared with the Germans, most servicemen who assaulted northern France had experienced an incredible degree of rugged and realistic training that put them at the peak of physical fitness, acclimatized them to battle, and equipped them mentally and physically well enough to win."[51] For Raymond O. Barton's Ivy Division, this rugged and realist training began on the warm shores of the Gulf of Mexico and ended on the frigid shore of Slapton Sands eight months later. ■

Notes

1. George L. Mabry, "The Operations of the 2nd Battalion 8th Infantry (4th Inf. Div.) in the Landing at Utah Beach, 5-7 June 1944 (Normandy Campaign) (Personal Experience of a Battalion S-3)" (student paper, Infantry Officer Advanced Course, Donovan Research Library, Fort Moore, GA, 1947); Raymond O. Barton, "War Diary: March 1944 to January 1945," Barton Personal Papers, private Barton family collection (Barton Papers); Roland G. Ruppenthal, *Utah Beach to Cherbourg* (1948; repr., Washington, DC: U.S. Army Center of Military History [CMH], 1984), 43–47.

2. Daniel J. Hughes, ed., *Moltke on the Art of War: Selected Writings* (Novato, CA: Presidio, 1993), 45.

3. Joseph Balkoski, *Utah Beach: The Amphibious Landing and Airborne Operations on D-Day* (Mechanicsburg, PA: Stackpole Books, 2005), 330.

4. G-3, 4th Infantry Division, "Training Memorandum 73: Training Directive, 18 October 1943-16 March 1944," 14 October 1943, entry 37042, box 3320, 4th Infantry Division Memos, Training, Record Group (RG) 338 (Army Organizations), National Archives at College Park, College Park, MD (NACP).

5. Raymond O. Barton, "Letter to Clare Conway Barton, May 10, 1940," Barton Papers; Peter J. Schifferle, *America's School for War: Fort Leavenworth, Officer Education, and Victory in World War II* (Lawrence: University Press of Kansas, 2010), 14–15.

6. Kent Roberts Greenfield, Robert R. Palmer, and Bell I. Wiley, *The Army Ground Forces: The Organization of Ground Combat Troops* (1947; repr., Washington, DC: U.S. Army CMH, 1987), 9–10.

7. John B. Wilson, *Armies, Corps, Divisions and Separate Brigade* (Washington, DC: U.S. Army CMH, 1987), 187; Raymond O. Barton, *The 4th Motorized Division, Camp Gordon, GA* (Augusta, GA: Walton Printing, 1942), 12. Fort Benning was renamed Fort Moore in 2023.

8. John B. Wilson, *Armies, Corps, Divisions and Separate Brigade* (U.S. Army CMH, 1987), 187; Raymond O. Barton, *The 4th Motorized Division*, Camp Gordon, GA (Augusta, GA: Walton Printing, 1942), 12. The Army renamed this post Fort Moore in 2023.

9. 4th Infantry Division Headquarters, "Narrative History, 4th Infantry Division, June 1940-March 1946," 2, entry 427, box 5663, RG 407 (World War II Operational Reports), NACP; Leonard L. Lerwill, *The Personnel Replacement System in the United States Army*, Department of the Army Pamphlet No. 20-211 (Washington, DC: Department of the Army, 1954), 247–49. Note: Most VII Corps and 4th Infantry Division records may also be found in the War Department Microfilm Collection at the Combined Arms Research Library, Fort Leavenworth, Kansas.

10. Christopher R. Gabel, *The U.S. Army GHQ Maneuvers of 1941* (Washington, DC: U.S. Army CMH, 1991), 27–29.

11. Kent Roberts Greenfield and Robert R. Palmer, *Origins of the Army Ground Forces General Headquarters, United States Army, 1940-1942, Study No. 1* (Washington, DC: Headquarters, Army

Ground Forces, 1946), 24, https://cgsc.contentdm.oclc.org/digital/collection/p4013coll8/id/4437/rec/1; Gabel, *The U.S. Army GHQ Maneuvers*, 133–35, 155–57.

12. Gerden F. Johnson, *History of the Twelfth Infantry Regiment in World War II* (Boston: National Fourth [Ivy] Division Association, 1947), 35.

13. Ibid., 36. Fort Gordon was renamed Fort Eisenhower in 2023.

14. Information Office, U.S. Army Training Center, *History of Fort Dix, New Jersey, 1917-1967* (Fort Dix, NJ: U.S. Army Training Center, 1967), chap. 9.

15. Johnson, *History of the Twelfth Infantry Regiment*, 39.

16. General Staff War Department, "Memorandum for Commanding General, Army Ground Forces: Amphibious Training, 18 August, 1943," RG 337 (Records of Headquarters Army Ground Forces), NACP; Greenfield, Palmer, and Wiley, *Organization of Ground Combat Troops*, 338–39; Wilson, *Armies, Corps, Divisions and Separate Brigades*, 197.

17. "Army Retirement Board Proceedings: Raymond O. Barton, September 29, 1945," RG 319 (Records of the Army Staff), National Archives at Saint Louis. Barton reveals he went to England in September 1943. Training Memorandum 73, RG 338, NACP.

18. Marshall O. Becker, *The Amphibious Training Center: Study No. 22* (Washington, DC: Historical Section, Army Ground Forces, 1946), 4, 57–70; Peter T. Wolfe, Training Memorandum Number 2, RG 337, NACP.

19. Ibid.

20. Training Memorandum 73, RG 338, NACP.

21. "Syllabus," Headquarters, Amphibious Training School, 1 October 1943, RG 337, NACP.

22. Johnson, *History of the Twelfth Infantry Regiment*, 40.

23. Bill Boice, *History of the Twenty-Second United States Infantry Regiment in World War II* (self-pub., 1959), 2; Andrew Haggerty, "Three Generals, Staff Officers, Swim Their Fifty Yards," *The Ivy Leaf: Weekly Newspaper of the 4th Infantry Division*, 11 November 1943.

24. Boice, *History of the Twenty-Second United States Infantry Regiment*, 2–3; Paul F. Braim, *The Will to Win: The Life of General James A. Van Fleet* (Annapolis, MD: Naval Institute Press, 2008), 66–67; Johnson, *History of the Twelfth Infantry Regiment*, 41–44.

25. Findlater Stewart, "Subject: American Forces in the United Kingdom: Reception and Liaison Arrangements Bolero Combined Committee," letter to John Maude, Minister of Health, MH79/571, The National Archives of the UK.

26. Roland G. Ruppenthal, *Logistical Support of the Armies, Volume I: May 1941-September 1944* (1953; repr., Washington, DC: U.S. Army CMH, 1995), 54, 61–65.

27. Headquarters, 4th Infantry Division, "Narrative History, 4th Infantry Division, June 1940-March 1946," 7, RG 407, NACP.

28. Ibid.; Boice, *History of the Twenty-Second United States Infantry Regiment*, 4; Johnson, *History of the Twelfth Infantry Regiment*, 45; H. W. Blakeley, *4th Infantry Division (Yearbook), 1941–48* (Baton Rouge, LA: Army and Navy Publishing, 1946), 78.

29. Johnson, *History of the Twelfth Infantry Regiment*, 46; "Welcome to Braunton," Braunton Countryside Centre, accessed 15 March 2024, https://www.brauntoncountrysidecentre.org/explore-braunton/.

30. Narrative History, RG 407, NACP.

31. Ibid.

32. Stephen C. Kepher, *COSSAC: Lt. Gen. Sir Frederick Morgan and the Genesis of Operation Overlord* (Annapolis, MD: Naval Institute Press, 2020), 214; Alfred D. Chandler Jr. and Stephen E. Ambrose, eds., "Cable, Eisenhower to Combined Chiefs of Staff, January 23, 1944," *The Papers of Dwight David Eisenhower: The War Years*, vol. III (Baltimore: Johns Hopkins University Press, 1970), 673–74.

33. Training Memorandum 73, RG 338, NACP.

34. Barton, "War Diary," Barton Papers.

35. Johnson, *History of the Twelfth Infantry Regiment*, 47–49; Clifford L. Jones, "Part VI, Neptune: Training, Mounting, The Artificial Ports," in *The Administrative and Logistical History of the ETO* (Washington, DC: U.S. Army CMH, 1946), 240, https://www.ibiblio.org/hyperwar/ETO/Admin/ETO-AdmLog-6/index.html.

36. Barton, "War Diary," Barton Papers.

37. Boice, *History of the Twenty-Second United States Infantry Regiment*, 4–5; Jones, *Administrative and Logistical History*, 240.

38. VII Corps G-3, "Field Order #1 (Neptune)," 28 May 1944, RG 407, NACP.

39. Jones, *Administrative and Logistical History*, 241.

40. Ibid., 240; Peter Caddick-Adams, *Sand & Steel: The D-Day Invasion and the Liberation of France* (Oxford: Oxford University Press, 2019), 198–99.

41. Jones, *Administrative and Logistical History*, 242; 4th Infantry Division G3, "Field Order #1, May 12, 1944, Neptune," 1944, entry 427, box 5763, RG 407, NACP; 4th Infantry Division Headquarters, "History of the 4th Infantry Division (SHAFE Background)," 8, RG 407, NACP; Barton, "War Diary," Barton Papers.

42. Barton, "War Diary," Barton Papers; "COL (R) Russell P. Reeder, Jr. '26," West Point Association of Graduates, accessed 6 March 2024, https://www.westpointaog.org/DGARussellReeder-Jr1926; Christopher D. Yung, *Gators of Neptune: Naval Amphibious Planning for the Normandy Invasion* (Annapolis, MD: Naval Institute Press, 2006), 159–60.

43. Jones, *Administrative and Logistical History*, 253; VII Corps G-3, "Field Order #1(Neptune)," 28 May 1944, RG 407, NACP.

44. 4th Infantry Division G3, "Field Order #1, Exercise TIGER," 18 April 1944, RG 407, NACP; Jones, *Administrative and Logistical History*, 255–56.

45. Ibid.

46. Carl von Clausewitz, *On War*, ed and trans. Michael Howard and Peter Paret, indexed ed. (Princeton, NJ: Princeton University Press, 1984), 119–21.

47. Jones, *Administrative and Logistical History*, 254–55; Yung, *Gators of Neptune*,161; Stephen P. Cano, ed., *The Last Witness: The Memoirs of George L. Mabry, Jr. from D-Day to the Battle of the Bulge* (Fresno, CA: Linden Publishing, 2021).

48. Raymond O. Barton, interview by Cornelius Ryan, box 013, folder 07, Cornelius Ryan Collection of World War II Papers, Ohio University Libraries Digital Archival Collections, https://media.library.ohio.edu/digital/collection/p15808coll15/id/17349/rec/1.

49. Jones, "Administrative and Logistical History," 257–63; Charles B. MacDonald, "Slapton Sands: The Cover-up That Never Was," *Army* 38, no. 6 (1988): 64–67; Caddick-Adams, *Sand & Steel*, 238–39; Yung, *Gators of Neptune*, 165–67.

50. "Letter Moon to Collins," 29 April 1944, J. Lawton Collins Papers, 1914–1975, Dwight David Eisenhower Presidential Library, Abilene, Kansas.

51. Caddick-Adams, *Sand & Steel*, xxxviii.

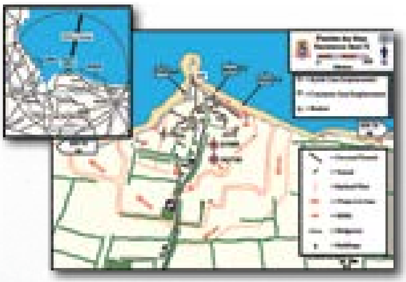
Normandy
Virtual Staff Ride

Normandy virtual staff ride products are available for download from the Army University Press website. This study focuses on the American side of the invasion to include the airborne assault, Omaha and Utah Beaches, Pointe du Hoc, and a study on sustainment and the artificial harbors. Materials include instructor notes, participant read aheads, and the virtual terrain. These products will enable organizations with access to Virtual Battlespace 3 to conduct their own virtual staff ride or to conduct their own professional development sessions without the terrain.

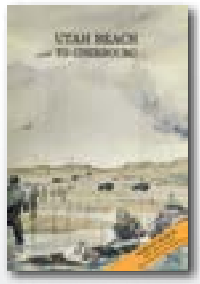

Omaha Beach


German Defenses


Brecourt Manor


Instructor Material


Virtual Staff Ride



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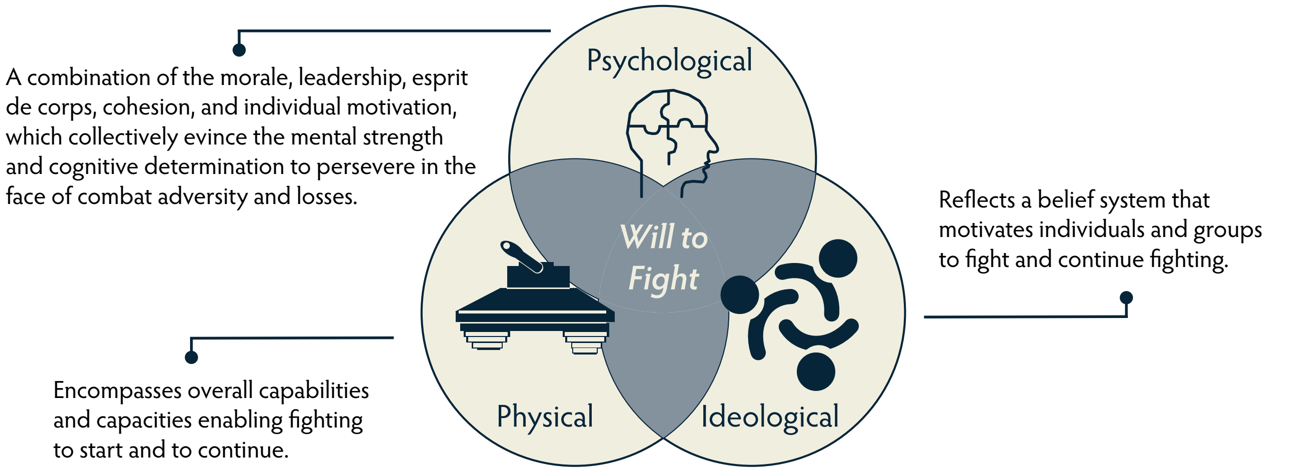
Omaha Beach, 6 June 1944 (Photo courtesy of the National Archives)

A member of a Ukrainian special police unit falls after firing a D-30 howitzer toward Russian positions near Kreminna, Ukraine, on 7 July 2023. (Photo by Libkos via Associated Press)

"Will to Fight"

Twenty-First-Century Insights from the Russo-Ukrainian War

Benjamin A. Okonofua, PhD
Nicole Laster-Loucks, PhD
Lt. Col. Andrew Johnson, U.S. Army, Retired



(Figure from Global Cultural Knowledge Network)

Figure 1. Analytic Elements of Will to Fight

We are waging a war against the country whose size is 28 times larger than ours, whose population is 4 times larger than ours, and whose military capabilities are many times greater than ours. We are waging a war by land, air, sea, cyberspace, etc. We have been at war not for 8 months, but for 8 years and 8 months. All this testifies to our resilience, courage to defend our own, and the will to win. Would other countries withstand such pressure? … I don't know about others, but we are holding on, regrouping, building up reserves, strengthening the defence, and gradually liberating our homeland. The victory is given to us very hard. But it will definitely be secured.

—Valerii Zuluzhnyi, Former Commander in Chief, Armed Forces of Ukraine, 31 October 2022

The 2022 Russo-Ukrainian War is a complex and enduring confrontation that warrants a nuanced exploration of the forces driving the determination, capacity, and narrative of the warring parties. These forces coalesce to produce a "will to fight," an often underestimated component in the annals of warfare and strategic defense. It develops at the individual level, extends to the national level, and is necessary to win.[1]

At its core, the will to fight in this conflict can be understood as a composite of psychological resilience, physical capability and capacity, and ideological conviction (see figure 1). These dimensions continually evolve or change because of the interplay between unique opposing forces. Each of these dimensions plays a pivotal role in shaping the dynamics of the conflict, influencing both the strategies employed and the tenacity displayed by the involved nations.

The historical significance of a resolute will to fight is vividly illustrated by the United States' strategic evolution during World War II. Upon entering the conflict, the United States lacked a clear vision of victory. A crucial shift occurred in 1942 when U.S. leadership, considering military strengths, the global strategic context, and a moral imperative to overcome fascism, committed to the ambitious goal of the complete and unconditional surrender of the Axis powers. This resolve was publicly affirmed at the 1943 Casablanca Conference, where President Franklin D. Roosevelt and Prime Minister Winston Churchill announced there would be no peace negotiations, only the pursuit of unconditional surrender. This stance, reinforcing the national will to fight alongside superior military resources, was instrumental in securing victory.[2] Conversely, the conflicts in Vietnam and Iraq highlight the critical role of assessing the will to fight within both allies and adversaries. In Vietnam, the United States encountered tenacious resistance from the North Vietnamese and the Viet Cong, who were deeply committed to defending their country and opposing foreign forces. This determination significantly contributed to the protraction of the conflict, despite the United States' superior military resources.[3] Similarly, in Iraq, the resilience and dedication to the cause of insurgent groups, combined with unclear strategic goals by the United States and its allies, led to extended engagements and mixed results.[4]

These cases emphasize the complexity of military engagements, where the psychological and ideological components of warfare are as crucial as the physical aspects. They underscore the crucial role of the will to fight alongside military capabilities in determining conflict outcomes. This concept, embodying determination, resilience, and resolve, often decisively influences engagement results beyond mere military strength.[5] Recognizing the multifaceted nature of the will to fight—spanning psychological, physical, and ideological aspects—is essential for leaders, policymakers, planners, and scholars. The subsequent analysis of these dimensions within the Russo-Ukrainian War context aims to dissect the complex interplay of factors driving this protracted conflict, illustrating how these elements of resolve, which are not static, evolve over time and dynamically interact to impact the ongoing military engagements. Understanding these dynamics is vital for comprehending the motivations and actions of involved parties, highlighting the significance of the will to fight in shaping conflict trajectories.

Psychological Will to Fight

The psychological will to fight or the determination to persist in combat plays a crucial role in maintaining resolve beyond the limits of territorial divisions. It encompasses a range of interactive factors, including morale, leadership, cohesion, and motivation, which collectively drive militaries and civilians to persevere amid adversity.

In any conflict, the strength of a nation's resolve is often propelled by psychological factors. Morale, the sense of purpose, and individual determination play critical roles in enabling forces to transcend physical limitations. Leadership and cohesion further enhance the mental fortitude and cognitive determination of soldiers and civilians, fostering resilience in the face of combat adversity. For example, facing difficult odds at the Battle of Stalingrad, Soviet soldiers displayed unyielding determination, fortified by leaders like Gen. Georgy Zhukov, which increased their resilience and eventually shifted the battle in their favor.[6]

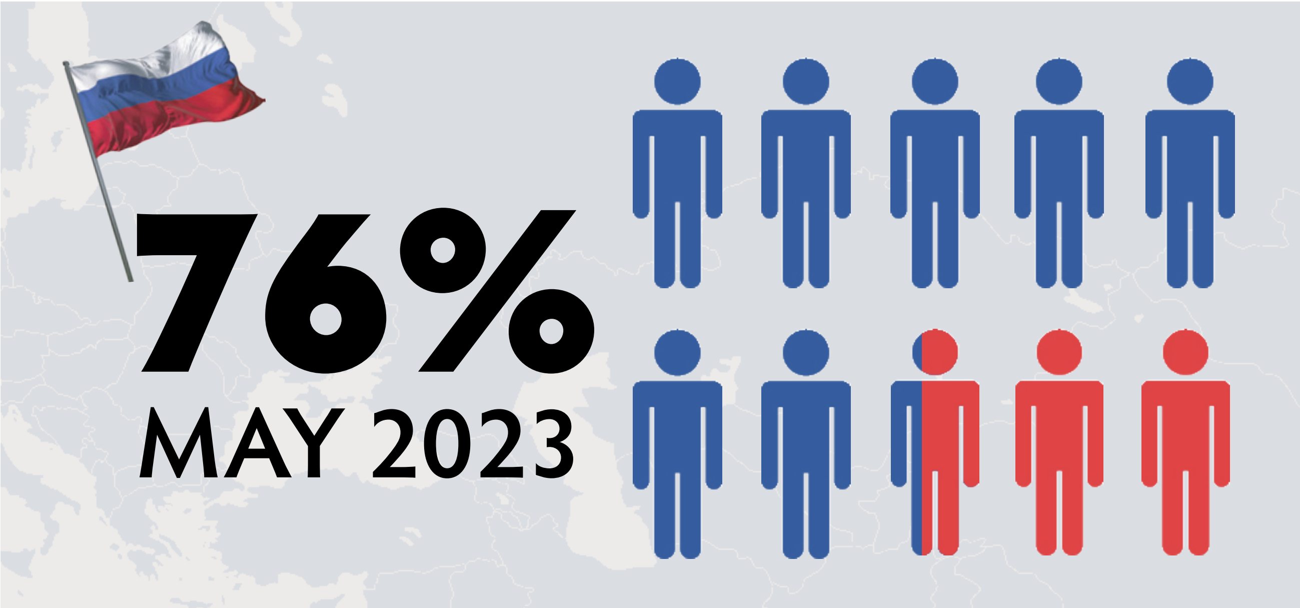
Various internal and external factors continually influence the psychological will to fight. Understanding this dimension provides essential insights into the dynamics that determine the endurance and success of military engagements, making it a pivotal aspect of resolve and occasionally the tipping point in any conflict.

Russia's psychological will to fight. Understanding the psychological dimension of Russia's will to fight in the ongoing conflict is crucial for comprehending the dynamics of the war. Initially, Moscow framed the war as a "special military operation" (SMO) to propagate Kremlin narratives of denazification and demilitarization, downplay the risks to Russian forces and Ukrainian society, and bolster confidence in Russian military superiority. However, battlefield realities shattered these expectations. Russian troops faced significant casualties and equipment losses, particularly among elite units like *Spetznaz* (special operations) and airborne troops. Some

Benjamin A. Okonofua, PhD, is the project manager for the strategic-level security cooperation assessment, monitoring, and evaluation program at U.S. Africa Command J-5. He is a Global Cultural Knowledge Network subject-matter expert on Africa and an adjunct professor at National Intelligence University. He received his PhD from Georgia State University and is a member of the editorial board of Sage Open.

Nicole Laster-Loucks, PhD, is the lead social scientist for U.S. Army Training and Doctrine Command G-2's Global Cultural Knowledge Network. She deployed to Afghanistan as a social scientist from 2011 to 2012 with the Human Terrain System in support of Operation Enduring Freedom. She earned her PhD from the University of Texas at Austin and is the chief architect of the Exploitable Conditions Framework.

Lt. Col. Andrew Johnson, U.S. Army, retired, is a senior research analyst for the U.S. Army Global Cultural Knowledge Network. Johnson is the author of multiple studies and training courses focused on analysis of sociocultural aspects of the operational environment. He is a retired Special Forces officer and earned a BA from the University of Washington and an MA from Kansas State University.



(Figure from the ANO Levada Center)

Figure 2. Percentage of Russians Who Support the So-Called "Special Military Operation" in Ukraine

soldiers were misled; believing they were deploying for exercises, they found themselves in combat in Ukraine. Additionally, SMO objectives such as the demilitarization and denazification of Ukraine were revealed as Kremlin disinformation. These factors likely contributed to a diminishing psychological will to fight among Russian troops.

Moreover, Russia's informational asymmetry (overestimating its strength and underestimating Ukrainian capabilities) created a significant expectancy violation (see breakout box on page 39).[7] The Kremlin's narratives of military power, backed by visible displays of forces and equipment, initially boosted confidence but were challenged by the realities of combat in Ukraine.[8] Over time, many Russians began questioning the war's rationale and their belief in Russian military prowess.[9] Information discrepancies between the official narratives and soldiers' experiences on the battlefield further eroded the will to fight, leading to a desire to surrender or escape combat.[10]

The Kremlin's efforts to mobilize citizen support by framing the conflict as defending the motherland against an "evil" foreign threat faced challenges in maintaining control over the information space.[11] Reports of Russian "barrier troops" to stop unauthorized withdrawals underscored command anxiety over the will to fight.[12] While domestic Russian support has eroded gradually from its high in the mid-80 percent of people polled, a majority still backs the war (see figure 2).[13] However, growing awareness of the war's realities has dampened public confidence, increased disenchantment, and caused troops' will to fight to decline.[14] Despite ongoing efforts by President Vladimir Putin, heavy-casualty-producing attacks continue to impact troop morale, hindering their effectiveness.[15]

Ukraine's psychological will to fight. The psychological dimension of Ukraine's will to fight in the ongoing conflict showcases a remarkable resilience and determination among Ukrainian forces and civilians. The war, which began with Russia's annexation of Crimea in 2014 and the conflict in the Donbas region, profoundly influenced Ukrainian national identity and resolve. Ukrainians confronted Russian aggression and aspirations to reestablish regional dominance, galvanizing a collective war mentality against an existential threat to Ukrainian statehood.[16]

Numerous polls indicate that nearly all Ukrainians believe in victory over Russia. This support is particularly robust in regions farther from the front lines, the west and center, and slightly weaker in areas closer to the conflict in the south and east. Opposition to Russian aggression existed long before the 2022

As Russia's military operation in Ukraine continues, Russian radiation, chemical, and biological defense troops of the Southern Military District watch an online broadcast of President Vladimir Putin's annual address to the Federal Assembly on a laptop at an unknown location. (Photo by RIA Novosti/Sputnik via Associated Press)

invasion, as a majority consistently demanded the liberation of all Russia-occupied territories.[17]

However, it is essential to acknowledge that the initial enthusiasm for volunteering to fight Russia has waned as the war has entered has entered its third year with escalating casualities and no clear end in sight. This shift led the Ukrainian Armed Forces (UAF) to depend more on conscription and to relax certain nonqualifying conditions for enlistment.[18] While these changes reflect the evolving nature of the conflict, they do not diminish the overall psychological will to fight.

Physical Will to Fight

The physical will to fight is critical to a country's determination to persist during conflict, transcending national boundaries. It encompasses the capability and capacity to initiate and sustain engagements underpinned by factors such as training, leadership, equipment, personnel, and logistics. In any armed confrontation, effectively employing military resources is a crucial and decisive component for victory.

Capability includes training and leadership, while capacity includes personnel and materiel. Both are pivotal in shaping the physical will to fight by enhancing combat effectiveness, bolstering resources, and increasing the resolve of military personnel. Militaries are capable when resourced with a proper level of competence to compete. Additionally, adequate personnel, equipment, logistics, and support contribute to a nation's physical capacity to engage in protracted conflicts. The Battle of Thermopylae in 480 BC exemplifies this, wherein a vastly outnumbered Spartan army led by King Leonidas demonstrated exceptional physical resilience and combat acumen against a vastly superior Persian foe.[19] Yet, as shown by the Islamic State's triumph over a better-resourced Iraqi Army in 2015, physical capacity—in isolation—will not ensure victory.[20]

Thus, understanding the physical will to fight offers invaluable insights into a nation's ability to persevere in the face of adversity. It underscores the intricate dynamics that determine the success or failure of military

GLOBAL FIREPOWER INDEX MILITARY STRENGTH RANKING	2021	2022	2023
Russian Federation	2nd	2nd	2nd
Ukraine	25th	22nd	15th

(Figure from Global Firepower)

Figure 3. Global Firepower Military Strength Ranking of Russia and Ukraine, 2021–2023

endeavors, making it an essential dimension of resolve in any conflict scenario.

Russia's physical will to fight. Russia's excessive confidence in its military superiority in terms of forces, firepower, and information control, relative to its smaller but well-led, trained, and motivated Ukrainian adversary, led to the failure of its initial objectives and necessitated a reassessment of strategy and tactics. The SMO exposed significant deficiencies in Russian military capabilities spanning tactics, training, logistics, and leadership. These shortcomings resulted in substantial casualties and equipment losses, ultimately eroding the Russian military's will to fight.

Since the February 2022 invasion, Russian forces have consistently underperformed against their Ukrainian counterparts despite having superior resources and firepower (see figure 3).[21] Russia's military had engaged in a decade-long modernization program, allocating a substantial portion of its military budget to arms procurement and a significant share of its GDP to defense.[22] However, persistent deficiencies, including inadequate war planning, resourcing, and execution, have resulted in battlefield failures.[23] Russia reverted to Soviet-style tactics after its initial failure to rapidly force Kyiv's capitulation through environment

Russian versus Ukrainian Military Strength

Prior to the February 2022 invasion, the Ukrainian Armed Forces were significantly weaker in terms of materiel and troop strength than Russia. Since the invasion, Ukraine has steadily moved up in the Global Firepower Index Military Strength Ranking, while Russia's position has remained firm. Ukraine underwent a military modernization program after Russia's seizure of Crimea and the Donbas region of eastern Ukraine in 2014–2015. By January 2023, Ukraine improved its global ranking by ten spots because of its whole-of-nation response to Russia's invasion and the corresponding massive military and economic support from the West. Russia held steady in the rankings because of its massive manpower and materiel resources, even despite its limitations related to preparedness, leadership, training, and supply issues.

Source: "2023 Russia Military Strength," Global Firepower, 19 January 2023, https://www.globalfirepower.com/country-military-strength-detail.php?country_id=russia.

Russian Command and Control versus Mission Command

Russia does not employ the U.S. concept of "mission command" in its version of the military decision-making process (MDMP) and has no equivalent to "commander's intent." In practice, the Russian system of decision-making requires a somewhat rigid system of tactics. Russian tactics at battalion level and below can best be described as battle drills that are standardized for ground forces, naval infantry, and airborne units. According to U.S. and Western officers who have interacted with their Russian counterparts, there appear to be several main distinctions in the Russian approach to MDMP. First, Russian military leaders appear to use a shortened and largely informal MDMP. Second, Russian commanders intentionally wait until the last possible moment before making decisions, when they are confident they have gathered as much information as needed. Third, the Russian system is designed to support a highly capable commander and relatively small staff. Thus, Russian MDMP is much more commander-centric than in Western militaries, and the personality of an individual commander plays a major role.

Source: Roger N. McDermott and Charles K. Bartles, *The Russian Military Decision-Making Process & Automated Command and Control* (Hamburg, DE: German Institute for Defence and Strategic Studies, 29 October 2020), https://gids-hamburg.de/the-russian-military-decision-making-process-automated-command-and-control/#.

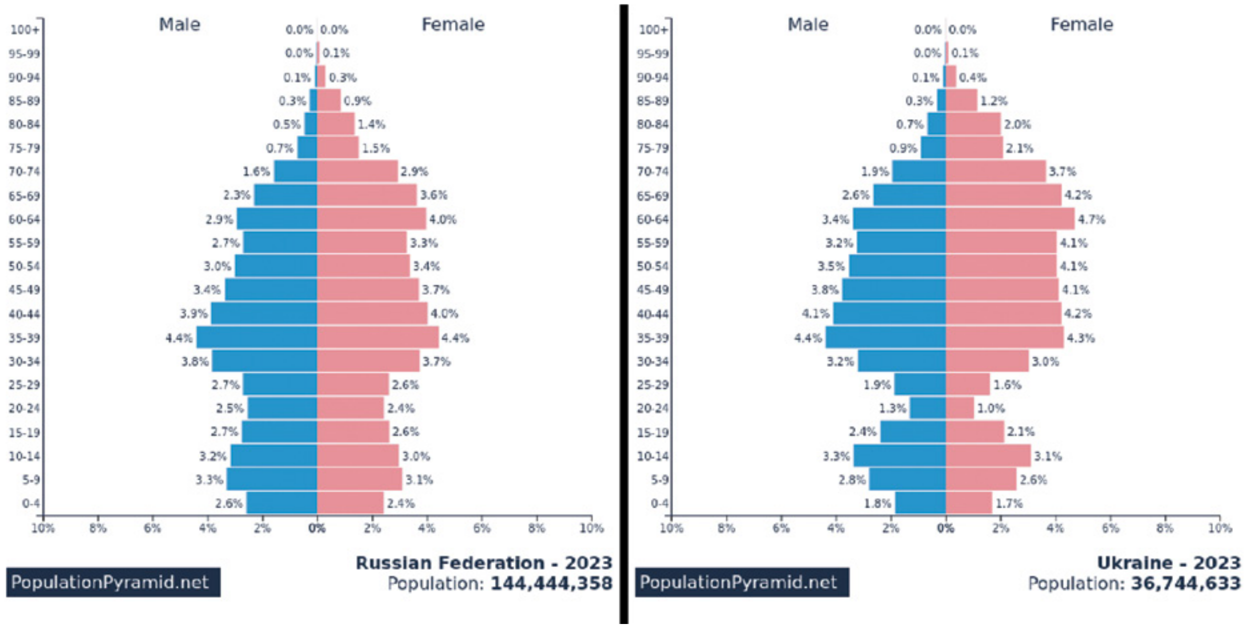
preparation followed by swift military actions.[24] Russian tactics have since shifted toward identifying weak points in Ukrainian lines and exploiting them, with some success. However, Russian reliance on brute-force tactics combined with the determined resistance of Ukrainian forces, lack of initiative by low-level leadership, and insufficient training contributed to significant Russian casualties and equipment losses. Additionally, the combination of poor logistics and limited medical support has kept the Russian military's will to fight in a weakened state, predominantly bolstered by military leadership from the top-down rather than at the troop level.[25]

The absorption of substantial personnel and equipment losses, even among elite units like Spetznaz and airborne troops, sends the message that the Russian command is willing to accept these costs, potentially undermining the will to fight among both troops and the broader public.[26] A recent reorganization of Russian infantry forces aimed at conserving more elite troops has bolstered the will to fight in higher-tier formations but undermined the lower-tier infantry's resolve, as they perceive themselves as expendable.[27] Despite heavy casualties, Russia's significant population advantage over Ukraine has provided a larger pool of replacements for battlefield losses. However, increasing casualty figures have placed political pressure on Putin and impacted soldier morale.[28]

Inadequately trained new troops, particularly conscripts and hastily mobilized *mobiki* (Russian reservists), have contributed to the high casualty figures. Both Russian and Ukrainian soldiers have reported that Russian replacements arrive on the battlefield with as little as two weeks of training and often with outdated weapons and equipment. Intercepted communications record Russian soldiers and leaders complaining about ammunition shortages, lack of spare parts, inadequate food, and insufficient battlefield medical support.[29] In peacetime, the absence of adequate training, equipment, and support already negatively affects morale, which is further amplified in combat situations, occasionally resulting in Russian troops refusing to fight.[30]

Ukraine's physical will to fight. Over the years, the UAF's transformation has been a remarkable evolution from a Soviet-style, command-heavy force with antiquated equipment into a modern, adaptable Western-style force. While still militarily weaker than Russia in measurable capacity, Ukraine's commitment to rebuilding its armed forces, with support from the United States and NATO, has significantly boosted its physical will to fight.[31]

Since the annexation of Crimea in 2014, Ukraine has received substantial foreign support in terms of training, weaponry, and institution building, especially from the United States and other NATO countries.



(Figure from PopulationPyramid.net)

Figure 4. Comparison of the Populations of Russia and Ukraine

This assistance has enabled Ukraine to develop a professional military with enhanced institutional capacity, leadership, and access to modern equipment.[32] However, external support before the invasion did not immediately result in battlefield success. Initially, heavy casualties, logistical issues, delays in weapon deliveries, poor communication, and reliance on outdated Soviet-style leadership and tactics by senior leaders dampened morale.[33]

Nonetheless, continued support from the West has augmented and improved UAF capacity and capability. Training programs encompassing advanced weapon systems (e.g., Patriot, HIMARS, M-1 Abrams tanks, and Leopard tanks), combined arms tactics, and mission command principles provided Ukrainian soldiers with a diverse skill set for modern warfare.[34] Notably, transitioning from a rigid top-down command structure to a more flexible mission command approach has empowered field- and company-grade leaders to show initiative and make quicker decisions on the battlefield.[35]

Another critical factor contributing to the UAF's success and elevated morale is the development of a competent Ukrainian noncommissioned officer (NCO) corps. This transformation aligns with Western military practices, promoting independence and initiative among smaller units. The newfound agency of individual Ukrainian soldiers, fostered by NCO-led units employing mission command principles, has notably boosted morale when compared to the rigid, centralized approach favored by the Russian military.[36]

Nevertheless, Ukraine still faces physical challenges. Heavy casualties continue to attrit its experienced soldiers and leaders. As time passes and casualties rise, addressing troop shortages becomes increasingly difficult as Ukraine's population is a quarter that of Russia's (see figure 4).[37] The conflict's protracted nature has led to a shortage of seasoned troops, with replacements often lacking experience and adequate training due to the exigencies of the conflict.[38] Estimates reveal staggering figures of casualties, both killed and wounded, underscoring the toll war has taken on Ukraine.[39]

Supply shortages remain a concern. Despite becoming the third-largest global arms importer in 2022, Ukraine still grapples with Soviet-era equipment, ammunition shortages, and the challenge of integrating modern weaponry effectively.[40] These factors, when combined with the lack of combat experience among new troops, can impact their will to fight and overall effectiveness.[41]

The Russian Orthodox Church

For generations, the Russian Orthodox Church (ROC) has played a significant role in Moscow's ability to project influence domestically and internationally. The Kremlin spends considerable resources using the ROC to promote Moscow's concept of a global "Russian world" comprised not only of ethnic Russians but also Russian speakers, their families, and others whose cultural, familial, or business connections to Russia make them Russia's "compatriots" (*Sootechestvenniki*). Russia is the largest Orthodox majority country, with ninety million church members, and its Moscow Patriarchate oversees the world's largest community of Orthodox Christians: 150 million, which is half of the total number of Orthodox Christians worldwide.

Sources: Robert Kurz, Foreign Military Studies Office, as part of Ukrainian Senior National Defense Personnel Studies Group Consultation conducted in Kyiv, Ukraine, in May 2016 and from within the United States in November 2017; Vera Zakem, Paul Saunders, and Daniel Antoun, *Mobilizing Compatriots: "Russia's Strategy, Tactics, and Influence in the Former Soviet Union"* (Arlington, VA: CNA, November 2015), https://www.cna.org/CNA_files/PDF/DOP-2015-U-011689-1Rev.pdf; J. Eugene Clay, "Invasion of Ukraine Has Split 200 Million Orthodox Christians," Greek Reporter, 29 March 2022, https://greekreporter.com/2022/03/29/ukraine-split-300-million-orthodox-christians/; Laurence Peter, "Orthodox Church Split: Five Reasons Why It Matters," BBC, 17 October 2018, https://bbc.com/news/world-europe-45877584; "Orthodox Church," WorldData.info, accessed 21 March 2024, https://www.worlddata.info/religions/orthodoxes.php.

Ideological Will to Fight

The ideological will to fight is a distinct and vital factor in perseverance during conflicts, surpassing the limits imposed by national identity. It is the combatant's science of ideas from a particular political or religious belief system from which narratives are constructed to justify and motivate engagement in armed conflicts.[42] These narratives often portray combatants as defenders against perceived threats, invoking historical sentiments and reinforcing beliefs that underpin the cause and emanate from social conditions that are vulnerable to protest. In this sense, religious institutions often play a pivotal role in providing ideological justifications for conflicts, framing them as sacred struggles. Thus, whether religious, as seen in some of the Crusades of the Middle Ages or the Islamic State's pursuit of an Islamic caliphate, or politically driven such as the Russian Revolution or Nazi Fascism, this element can be the primary motivator in conflict.[43]

However, the extent to which an ideological narrative resonates with the population as a belief system can vary widely, with the depth of religious or political commitment influencing individual and collective resolve. Understanding the ideological will to fight offers valuable insights into the complexities of resolve, shedding light on the delicate interplay between narratives, historical sentiments, and religious influences in the context of armed conflicts.

Russia's ideological will to fight. The ideological dimension of the Russian will to fight is closely intertwined with the narrative of the conflict and

(Figure courtesy of the Ukraine Ministry of Defense)

Figure 5. UAF Video from #FreedomIsOurReligion Social Media Campaign

Russian Influence through the Church

Ukraine has been a direct target of Russian influence through the Russian Orthodox Church (ROC). Next to Russia, Ukraine has the largest Orthodox population in the northern hemisphere, with approximately 65 percent of its 27.8 million people identifying as members of the Orthodox Church. Until the 2018 formation and official recognition of the Orthodox Church of Ukraine (OCU), the majority of the country's Orthodox communities fell under the Moscow Patriarchate, the Kyiv Patriarchate (which split from the former in 1992),[1] and the Ukrainian Autocephalous Orthodox Church.[2] Until recently, the Ukrainian Orthodox Church (UOC), under the Moscow Patriarchate, formed the largest Orthodox community in the country and was the most highly integrated with Moscow's politically influenced church leadership. Today, the OCU has grown to significantly erode and eclipse the size and influence of the Moscow Patriarchate in Ukraine, a development that has only gained momentum as the Russia-Ukraine war continues.

1. The Kyiv Patriarchate was not officially recognized by the greater Orthodox community until 2018, when Ecumenical Patriarch Bartholomew in Istanbul, of the Constantinople Patriarchate—whose overarching position in the Orthodox Church community authorizes him to recognize and endorse Orthodox churches—revoked a seventeenth-century ruling that places Ukraine's Orthodox Church under the Moscow patriarch. The Kyiv Patriarchate then combined nearly all non-Moscow Patriarchate churches in Ukraine into a new "Orthodox Church of Ukraine," which Bartholomew subsequently recognized. For most Ukrainians, this symbolized a final step in their country's independence from Moscow. Valery Kalinosvsky, "Russian Orthodox Church Cuts Ties with Constantinople," MSN, 15 October 2018, https://www.msn.com/enus/news/world/russianorthodoxchurchcytstieswithconstantinople/arBBOqBy2; Carlotta Gall, "Ukrainian Orthodox Christians Formally Break from Russia," *New York Times* (website), 6 January 2019, https://www.nytimes.com/2019/19/01/06/world/europe/orthodoxchurchukrainerussia.html.
2. "Autocephalous" means that the church has its own head.

Source: Vera Zakem, Paul Saunders, and Daniel Antoun, *Mobilizing Compatriots: "Russia's Strategy, Tactics, and Influence in the Former Soviet Union"* (Arlington, VA: CNA, November 2015), https://www.cna.org/CNA_files/PDF/DOP-2015-U-011689-1Rev.pdf.

the role of the Russian Orthodox Church (ROC). The Kremlin's justification for the SMO portrays Russian soldiers as defenders of their motherland against an evil enemy, framed within the context of preserving Russian identity and Orthodox Christian civilization. This narrative effectively stirs historical Russian hatred of Nazism and reinforces perceptions of the threat to Russian citizens in Ukraine and Russia from the West. The ROC plays a pivotal role in this narrative, providing religious legitimization for the conflict and framing it as a holy struggle akin to the Great Patriotic War (World War II). The narratives from the Kremlin and the ROC likely have bolstered domestic support for the SMO.[44]

Despite the Kremlin's efforts to cultivate ideological support for the war, there exists a significant gap between identification with these narratives and religious practice within Russia, particularly within the Russian military. While the ROC endorses the government's narrative and encourages the faithful to endorse the "holy" war, the skepticism toward religion within the Russian military remains relevant. This skepticism is rooted in the historical association of the ROC leadership with the Kremlin, which often leads soldiers to view religious promises as hollow and insincere.[45]

Ukraine's ideological will to fight. The Ukrainian will to fight is less ideological than it is psychological. The ideological element is rather small comparatively. Ukrainians are primarily motivated to fight Russian forces for political, social, and rational reasons instead of religious reasons (see figure 5). The Kremlin's attempts to use the ROC to sway Ukrainian sentiment and gather intelligence on the Ukrainian military have yielded an unexpected outcome. It has led to a rejection of the Moscow Patriarchate's control of Orthodox Christianity in Ukraine by the Ukrainian government and a significant portion of the population.

The Kremlin's strategy of advancing the concept of a greater ethnocultural Russian state, *Russkiy Mir* (Russian World), to unite Russians and their

"Expectancy Violation Theory" Explains Russia's and Ukraine's Disparate Wills to Fight

The difference in Russian and Ukrainian will to fight can be explained with the concept of expectancy violation. This refers to situations in which an individual's thoughts or beliefs about a particular event or outcome are not what they expected and are instead violated or challenged. An expectancy violation can be both positive and negative. In the context of military conflicts, expectancy violations can have both positive and negative effects on the psychological will to fight.

Russia. Repeated failures, setbacks, or unmet expectations eroded morale and weakened Russian soldiers' psychological will to fight. Sustained disappointments led to a loss of confidence, demoralization, and a diminished belief in the likelihood of success. Further, expectancy violation introduced doubt and uncertainty regarding the feasibility of achieving the objectives of the special military operation. As Russia repeatedly encountered unexpected challenges from Ukrainian forces, its strategic plans began to fail, which undermined Russian forces' confidence and created skepticism about the likelihood of victory, weakening the psychological will to fight.

Ukraine. Ukrainian soldiers experienced an expectancy violation in terms of unexpected success or achievement on the battlefield against Russian forces. Surpassing initial expectations created a sense of empowerment and reinforced their belief that victory is possible. Further, expectancy violation fostered greater cohesion and trust within Ukrainian forces. As soldiers witnessed their comrades' surpassing expectations or displaying exceptional bravery, it enhanced their belief in the collective strength and capabilities of their units. This shared experience strengthened bonds, boosted morale, and increased their psychological will to fight as a cohesive force.

Source: Judee K. Burgoon and Jerold L. Hale, "Nonverbal Expectancy Violations: Model Elaboration and Application to Immediacy Behaviors," *Communication Monographs* 55, no. 1 (1988): 58–79, https://doi.org/10.1080/03637758809376158.

compatriots has faced staunch resistance in Ukraine.[46] The Ukrainian Security Service has conducted investigations into pro-Russian Ukrainian Orthodox Church (UOC) entities, accusing them of spreading Russian propaganda and disinformation, potentially collecting intelligence on the Ukrainian military. This scrutiny has led the Ukrainian government to limit UOC influence and bolstered popular anti-Russian sentiment.[47]

In response to Russia's aggression, Orthodox Ukrainians have distanced themselves from the Moscow Patriarchate, transferring their allegiance to churches not under its authority, including the growing UOC. Markedly, Kyiv's decision to shift the celebration of Christmas from the traditional Orthodox date of 7 January to 25 December further underscores the resistance to Moscow Patriarchate tradition. This shift represents a direct response by Ukrainians to Russia's attack on their territory, ethnic identity, and values.[48]

Conclusion

The Russo-Ukrainian War offers a vivid lesson on the dynamics of the will to fight. While material capabilities are crucial in modern warfare, the spirit, resilience, and commitment of a people to defend their homeland, as Ukraine has demonstrated, can profoundly shape the course of a conflict. Policymaking and planning must go beyond mere assessments of Russian and Ukrainian military capacity and capability and incorporate a deeper understanding of the psychological and social factors that drive their will to fight, especially as both nations exhibit significant, albeit diverse, motivations in their desire to prevail.

Russia's will to fight originates mainly from the top down, influenced by a Kremlin-controlled information milieu and bolstered by its vast resources. Although the Kremlin exploits the Russian Orthodox Church, ideological motivations are not the primary driving force for either side in this war.

Ukraine's will to fight emanates from a profound psychological and nationalistic source, supported by both its military and populace. The existential threat posed by Russia fuels Ukraine's determination, amplified by the reality of defending its homeland. Ukraine holds the psychological upper hand, but it grapples with tangible challenges to its will to fight, particularly in materiel and troop reinforcement, whereas Russia's larger economy and population provide it an advantage. Ukraine's ability to continue to fight hinges on the West's continued materiel support and its dwindling pool of recruitable citizens. The unfolding Russo-Ukrainian War suggests several lessons that can guide U.S. and allied military decision-makers in planning for future large-scale combat operations and other types of conflict:

Underestimating resilience. One of the significant lessons from the conflict is the danger of underestimating a nation's resilience and will to fight based on material assessments. Russia, with its superior military might, faced stiffer resistance than anticipated due to the strong will of the Ukrainian defense forces and citizens.

Moral high ground. A nation or group that believes it holds the moral high ground can demonstrate an outsized will to fight. For many Ukrainians, the defense of their homeland is seen in moralistic terms, which further fuels their resolve.

International solidarity. The will to fight is not just a domestic phenomenon. International support, both moral and material, can bolster the spirit of a nation under threat. Ukraine's ability to garner international sympathy and support plays a role in sustaining its will to fight.

Limitations of soft power. While "soft power" strategies like information warfare, propaganda, and economic pressure are essential in modern conflicts, the Russo-Ukrainian War underscores that these cannot easily erode a determined will to fight.

Implications for the U.S. Army

The psychological element of the will to fight is a tipping point. The psychological will to fight, intrinsically tied to physical capacity, is paramount. When external support is held constant, internal resolve becomes the game-changer. Even for the U.S. Army, material support alone is not sufficient; fostering psychological resilience is an intrinsic and vital factor in achieving objectives during large-scale combat operations (LSCO). Partnering with allies like Ukraine potentially offers valuable insights for the U.S. Army to bolster its training and morale-building strategies.

Ukraine's staunch resistance, even when outmatched, underscores that facing an existential threat sparks a deep-seated will to fight. The U.S. Army can address such fervent resistance in future exercises and engagements and consider approaches to recalibrate strategies when facing or supporting forces motivated by this variable.

While numerically disadvantaged forces like Ukraine may struggle in a prolonged personnel attrition war, they can potentially succeed in eroding an adversary's resolve. It is important for the U.S. Army to understand the benefits of targeting an opponent's will, especially by factoring in aspects of foreign material support and psychological operations, as well as anticipating how adversaries may use similar tactics against them.

The Russo-Ukrainian War reinforces the efficacy of mission command against a more centralized, top-driven command structure in LSCO. Initiative and innovation at all levels of command breed success and contribute to the will to fight. While still learning to take fuller advantage of combined arms tactics, the UAF has effectively employed mission command, especially in its counteroffensives. The U.S. Army can capitalize and generate gains by reinforcing its mission command principles, especially as they might be employed in LSCO.

The conflict illustrates that superior training, leadership, and equipment can counterbalance numerical advantages. By investing strategically in enhancing the quality of its training and equipment, the U.S. Army may benefit from the ability to offset numerical deficits in future LSCO scenarios. Moreover, observing the contrast between the UAF's successes and Russian setbacks, the U.S. Army can further refine its focus on producing well-trained, well-equipped forces, ensuring readiness and adaptability. ■

Contributors to this article include Robert Kurz (FMSO/GCKN); Susan Littleton (FMSO/GCKN); Charles Raymond (TRADOC G-2); Marcus Griffin, PhD (GCKN); Ray Finch (FMSO); Peter Wood (FMSO); Charles Bartles (FMSO); Cindy Hurst (FMSO); and Neil Sleevi (CAC).

Notes

Epigraph. Valerii Zaluzhnyi (CinCAFofUkraine), "We are waging a war against the country whose size is 28 times larger than ours, whose population is 4 times larger than ours, and whose military capabilities are many times greater than ours. …," Facebook, 31 October 2022, https://www.facebook.com/CinCAFofUkraine/posts/pfbid02Zk9Qo8oe4xJnUeXL3w8U8V54n91TMdAZsqp89M7JSAPuQJTSHwFJaTShMorSKSWxl.

1. Ben Connable et al., *Will to Fight: Returning to the Human Fundamentals of War* (Santa Monica, CA: RAND Corporation, 2019), https://www.rand.org/pubs/research_briefs/RB10040.html.

2. Office of the Historian, "The Casablanca Conference, 1943," U.S. Department of State, accessed 13 March 2024, https://history.state.gov/milestones/1937-1945/casablanca; John Keegan, *The Second World War* (London: Penguin Books, 1998), 297–426.

3. Lewis Sorley, *A Better War: The Unexamined Victories and Final Tragedy of America's Last Years in Vietnam* (San Diego: Harcourt Brace, 1999), 2–9.

4. Thomas E. Ricks, *Fiasco: The American Military Adventure in Iraq* (London: Penguin Books, 2006), 3–12.

5. Colin S. Gray, *Modern Strategy* (Oxford, UK: Oxford University Press, 1999), 1–44; Mary Kaldor, *New and Old Wars: Organized Violence in a Global Era* (New York: Polity Press, 2012), 1–14.

6. David M. Glantz, *Zhukov's Greatest Defeat: The Red Army's Epic Disaster in Operation Mars, 1942* (Lawrence: University Press of Kansas, 1999), 1–30.

7. Keith Gessen, "How the War in Ukraine Might End," *New Yorker* (website), 29 September 2022, https://www.newyorker.com/culture/annals-of-inquiry/how-the-war-in-ukraine-might-end.

8. Phillips Payson O'Brien and Edward Stringer, "The Overlooked Reason Russia's Invasion Is Floundering," *The Atlantic* (website), 9 May 2022, https://www.theatlantic.com/ideas/archive/2022/05/russian-military-air-force-failure-ukraine/629803/.

9. Sarah Oates, "Putin's Control over Ukraine War News Is Not Total – It's Challenged by Online News and Risk-Taking Journalists," The Conversation, 23 March 2022, https://theconversation.com/putins-control-over-ukraine-war-news-is-not-total-its-challenged-by-online-news-and-risk-taking-journalists-179540.

10. "Entire Divisions of Russian Army Are Surrendering and Over a Million People Have Used Ukrainian Website 'I Want To Live,'" Ukrainska Pravda, 17 December 2022, https://www.yahoo.com/now/whole-divisions-russian-army-surrender-154958448.html.

11. Rebekah Koffler, *Putin's Playbook: Russia's Secret Plan to Defeat America* (Washington, DC: Regnery Publishing, 2021), 135.

12. Tom Watling, Tim McNulty, and Sean Meleady, "Russian Mercenary Claims Deserters Are Shot and Thrown into Graves," *Express* (website), 1 February 2023, https://www.express.co.uk/news/world/1728446/Russia-war-Commonwealth-forces-Australia-UK-military-live; Allison Quinn, "Russia Now Has a Second Frontline Set Up Just to Kill Its Deserters: Intel," Daily Beast, 27 October 2022, https://www.thedailybeast.com/russia-now-has-a-second-frontline-set-up-just-to-kill-its-deserters-intel; Isabel van Brugen, "Russian Army Threatening to Shoot Deserters amid Low Morale: U.K.," *Newsweek* (website), 4 November 2022, https://www.newsweek.com/russian-army-threatening-shoot-deserters-low-morale-uk-1756880; Pjotr Sauer, "Russian Soldiers Say Commanders Used 'Barrier Troops' to Stop Them Retreating," *Guardian* (website), 27 March 2023, https://www.theguardian.com/world/2023/mar/27/russian-soldiers-commanders-used-barrier-troops-stop-retreating.

13. "Conflict with Ukraine: Assessments for March 2023," ANO Levada Center, 7 April 2023, https://www.levada.ru/en/2023/04/07/conflict-with-ukraine-assessments-for-march-2023/; "Conflict with Ukraine: Assessments for February 2023," ANO Levada Center, 13 March 2023, https://www.levada.ru/en/2023/03/13/conflict-with-ukraine-assessments-for-february-2023/; "Approval of Institution, Ratings of Parties and Politicians: March 2023," ANO Levada Center, 7 April 2023, https://www.levada.ru/en/2023/04/07/approval-of-institutions-ratings-of-parties-and-politicians-march-2023/; "Conflict with Ukraine: Assessments for April 2023," ANO Levada Center, 27 April 2023, https://www.levada.ru/en/2023/04/27/konflikt-s-ukrainoj-ostenki-aprelya-2023-goad/.

14. Ibid.

15. "Putin's Gamble for Resurrection and Coups in Russia," Odysee, posted by "Geo Perspective," 30 September 2022, https://odysee.com/@GeoPerspective:b/putin%27s-gamble-for-resurrection-and:a; Jack Watling and Nick Reynolds, *Meatgrinder: Russian Tactics in the Second Year of Its Invasion of Ukraine* (London: Royal United Services Institute for Defence and Security Studies, 19 May 2023), https://rusi.org/explore-our-research/publications/special-resources/meatgrinder-russian-tactics-second-year-its-invasion-ukraine.

16. Katri Pynnöniemi, "The Kremlin Rhetoric and the Framing of the War in Ukraine," *Russian Military and Security Research Group* (blog), 25 May 2022, https://rusmilsec.blog/2022/05/25/the-kremlin-rhetoric-and-the-framing-of-the-war-in-ukraine/; Steve Taylor, "Why Do Human Beings Keep Fighting Wars?," *Guardian* (website), 5 August 2014, https://www.theguardian.com/commentisfree/2014/aug/05/why-human-beings-keep-fighting-wars-warfare.

17. To compare Ukrainian polling, see the following: "Ukrainians Still Committed to Victory, Staying in Ukraine—New Survey," New Voice of Ukraine, 23 April 2023, https://english.nv.ua/life/new-survey-reveals-most-ukrainians-desire-for-victory-and-to-remain-in-ukraine-news-50319726.html; "Public Opinion on the War, Victory, and Security Guarantees," Razumkov Centre, 24 April 2023, https://razumkov.org.ua/en/sociology/press-releases/public-opinion-on-the-war-victory-and-security-guarantees; "Symbols, Events, and Personalities Shaping Ukrainians' National Memory of Russia's War against Ukraine," Ilko Kucheriv Democratic Initiatives Foundation, 16 May 2023, https://dif.org.ua/en/article/symbols-events-and-personalities-shaping-ukrainians-national-memory-of-russias-war-against-ukraine#_Toc134379502; "What Ukrainians Think about Future of Crimea," Ilko Kucheriv Democratic Initiatives Foundation, 23 August 2021, https://dif.org.ua/en/article/what-ukrainians-think-about-future-of-crimea; Tobias Bunde, Sophie Eisentraut, and Leonard Schutte, "Auch bei Russischem nuklearschlag 89 prozent der Ukrainer wollen weiterkampfen" [Even in the event of a Russian nuclear

strike, 89 percent of Ukrainians want to continue fighting], *Tagesspiegel* [Daily Mirror] (website), 2 July 2023, https://www.tagesspiegel.de/internationales/auch-bei-russischem-nuklearschlag-89-prozent-der-ukrainer-wollen-weiterkampfen--bis-zur-ruckeroberung-der-krim-9299993.html; Anton Hrushetskyi, "Dynamics of Readiness for Territorial Concessions for the Earliest Possible End of the War: Results of a Telephone Survey Conducted on September 7-13, 2022," Kyiv International Institute of Sociology press release, https://www.kiis.com.ua/?lang=eng&cat=reports&id=1133&page=1; Anton Hrushetskyi, "Dynamics of Readiness for Territorial Concessions for the Earliest Possible End to the War: Results of a Telephone Survey Conducted on February 14-22, 2023," Kyiv International Institute of Sociology press release, https://www.kiis.com.ua/?lang=eng&cat=reports&id=1192&page=1; "Понад 90% українців вірять у перемогу Понад 90% українців вірять у перемогу" [More than 90% of Ukrainians believe in victory], Ukrinform, 25 August 2023, https://www.ukrinform.ua/rubric-society/3689814-ponad-90-ukrainciv-virat-u-peremogu.html; "Reconstruction of Ukraine and International Aid (November 2022)," Rating Group, 13 December 2022, https://ratinggroup.ua/en/research/ukraine/v_dbudova_ukra_ni_ta_m_zhnarodna_dopomoga_20-21_listopada_2022.html; R. J. Reinhart, "Ukrainians Support Fighting until Victory," Gallup, 18 October 2022, https://news.gallup.com/poll/403133/ukrainians-support-fighting-until-victory.aspx; Peter Dickinson, "Poll: 86% of Ukrainians Want to Fight on despite Russian Terror Bombing," *UkraineAlert* (blog), Atlantic Council, 25 October 2022, https://www.atlanticcouncil.org/blogs/ukrainealert/ukraine-defiant-as-putins-terror-bombing-plunges-cities-into-darkness/.

18. Tom Mutch, "A Terrifying Secret in Putin's War Is Now Impossible to Hide," Daily Beast, 7 June 2023, https://www.thedailybeast.com/ukraine-fears-military-recruitment-crisis-in-the-war-against-russias-army.

19. Rupert Matthews, *The Battle of Thermopylae: A Campaign in Context* (Gloucestershire, UK: The History Press, 2008).

20. Ibrahim Al-Marashi and Daniel P. Bolger, "ISIS's Projection of Landpower in Iraq," in *Landpower in the Long War: Projecting Force After 9/11*, ed. Jason W. Warren (Lexington: University Press of Kentucky, 2019), 202–16, https://doi.org/10.2307/j.ctvg5bst0.17.

21. Steven Pifer, "The Russia-Ukraine War and Its Ramifications for Russia," Brookings Institution, 8 December 2022, https://www.brookings.edu/articles/the-russia-ukraine-war-and-its-ramifications-for-russia/; "Comparison of United States and Russia Military Strengths (2024)," Global Firepower, https://www.globalfirepower.com/countries-comparison-detail.php?country1=ukraine&country2=russia; "GlobalFirepower.com Ranks (2005-Present): Military Powers Ranked since 2005 According to Global Firepower," Global Firepower, accessed 20 February 2024, https://www.globalfirepower.com/global-ranks-previous.php; figure 3 from "2023 Ukraine Military Strength," Global Firepower, 31 May 2023, https://www.globalfirepower.com/country-military-strength-detail.php?country_id=ukraine.

22. "Russia," Heritage Foundation, 24 January 2024, https://www.heritage.org/military-strength/assessing-threats-us-vital-interests/russia.

23. Fred Kaplan, "No You're Not Imagining It: Russia's Army Is Inept," Slate, 28 February 2022, https://slate.com/news-and-politics/2022/02/no-youre-not-imagining-it-russias-army-is-inept.html.

24. David Brennan, "How Russian Forces in Ukraine Are Learning to Fight: U.S. Veteran Trainer," *Newsweek* (website), 13 March 2023, https://www.newsweek.com/how-russian-forces-ukraine-learning-fight-american-veteran-trainer-1787239; Quentin Sommerville, "Bakhmut: Russian Casualties Mount but Tactics Evolve," BBC, 16 March 2023, https://www.bbc.com/news/world-europe-64955537; Matthew Loh, "A Ukrainian Drone Commander Said Russian Troops Would Sit around and Get Shot at the Start of the War, but Have Learned from Their Mistakes," Business Insider, 19 April 2023, https://www.businessinsider.com/ukrainian-soldier-says-russians-sat-around-get-shot-war-start-2023-4.

25. Jake Epstein, "Russia and Ukraine Have a Lot of the Same Tanks and Jets, but Kyiv Has a Decisive 'Flesh and Bone' Advantage, Top US Enlisted Leader Says," Business Insider, 1 March 2023, https://www.businessinsider.com/ukraine-decisive-flesh-bone-edge-over-russia-top-us-leader-2023-3; Seth G. Jones, Riley McCabe, and Alexander Palmer, "Ukrainian Innovation in a War of Attrition," Center for Strategic and International Studies (CSIS), 27 February 2023, https://www.csis.org/analysis/ukrainian-innovation-war-attrition.

26. Sommerville, "Bakhmut"; Natalia Yurchenko, "РФ способна полностью обеспечить свою армию людьми для продолжительной войны: как заманивают" [The Russian Federation is able to fully provide its army with people for a long war: How to lure], RBC-Ukraine, 13 April 2023, https://www.rbc.ua/ukr/news/rf-zdatna-povnistyu-zabezpechiti-svoyu-armiyu-1681377036.html; "Russia's Population Nightmare Is Going to Get Even Worse," *Economist* (website), 4 March 2023, https://www.economist.com/europe/2023/03/04/russias-population-nightmare-is-going-to-get-even-worse.

Jones, McCabe, and Palmer, "Ukrainian Innovation"; Julius Lasin, "'Unprecedented' Casualties for Russian Troops," *USA Today* (website), 28 February 2023, https://www.usatoday.com/story/nletter/ukraine-russia-crisis/2023/02/28/ukraine-russia-crisis-unprecedented-casualties-russian-troops/11365763002/. Regarding personnel losses, after one full year of battling (February 2022–February 2023), CSIS estimates that Russia has suffered roughly 200,000 to 250,000 casualties—personnel killed, wounded, or missing—since the Kremlin invaded Ukraine in February 2022, with 60,000 to 70,000 of those reportedly dead.

Jakob Janovsky et al., "Attack on Europe: Documenting Russian Equipment Losses during the Russian Invasion of Ukraine," *Oryx* (blog), 24 February 2022, https://www.oryxspioenkop.com/2022/02/attack-on-europe-documenting-equipment.html; Jakob Janovsky et al., "List of Aircraft Losses during the Russian Invasion of Ukraine," *Oryx* (blog), 20 March 2022, https://www.oryxspioenkop.com/2022/03/list-of-aircraft-losses-during-2022.html. Regarding equipment losses, as of mid-July 2023, the widely cited open-source intelligence blogger team Oryx lists a total of 11,033 Russian vehicles and 444 aircraft destroyed, damaged, abandoned, and captured as confirmed by photo or videographic evidence.

27. Brennan, "How Russian Forces in Ukraine Are Learning to Fight"; Sommerville, "Bakhmut"; Watling and Reynolds, *Meatgrinder*. The Royal United Services Institute (see Watling and Reynolds) has labeled these categories by function: line infantry holds ground in defense; assault infantry attacks weak points; disposable infantry are skirmishers and probe for weak points; and specialized troops, including airborne and Spetznaz, are used for raiding and special operations.

28. Sommerville, "Bakhmut"; Yurchenko, "The Russian Federation"; *Economist*, "Russia's Population Nightmare."

29. Jessica Warren, "Russian Conscripts Are Resorting to 'Playing Dead on the Battlefield' as They Are Sent in to Fight with Poor Equipment and Insufficient Training," *Daily Mail* (website), 2 November 2022, https://www.dailymail.co.uk/news/article-11383061/Russian-conscripts-resorting-playing-dead-battlefield.html; Sinéad Baker, "Russia Is Sending Troops to 'Less Experienced' Belarus for Training because Most of Its Own Instructors Have Been Deployed to Ukraine, Says UK Intel," Business Insider, 24 March 2023, https://www.businessinsider.com/russia-troops-trained-belarus-own-instructors-deployed-ukraine-uk-intel-2023-3; Isabel van Brugen, "Russia Admits It's Running Out of Equipment for Mobilized Soldiers," *Newsweek* (website), 27 October 2022, https://www.newsweek.com/russia-equipment-weapons-shortage-peskov-soldiers-ukraine-1755057; Associated Press, "'How Long Can This Go On?': Russia's Chaotic Draft Leaves Soldiers Cold and Unequipped," *Los Angeles Times* (website), 26 October 2022, https://www.latimes.com/world-nation/story/2022-10-26/russia-chaotic-draft-leaves-soldiers-cold-unequipped.

30. Warren, "Russian Conscripts Are 'Playing Dead'"; Allison Quinn, "Taped Call Captures Putin's Troops in Self-Loathing Spiral," Daily Beast, 23 March 2023, https://www.thedailybeast.com/leaked-tape-captures-russian-troops-mocking-vladimir-putins-war-in-ukraine; Connor Surmonte, "Vladimir Putin's Soldiers Starving in Ukraine, Surviving on Only 'Instant Noodles' & Potatoes Cooked on 'Rockets,'" Radar Online, 6 February 2023, https://radaronline.com/p/vladimir-putin-soldiers-starving-ukraine-surviving-instant-noodles-potatoes-cooked-rockets/.

31. Cory Welt, "U.S. Security Assistance to Ukraine," Congressional Research Service (CRS) In Focus IF12040 (Washington, DC: CRS, 15 February 2024), https://crsreports.congress.gov/product/pdf/IF/IF12040; "Relations with Ukraine," NATO, last updated 28 July 2023, https://www.nato.int/cps/en/natolive/topics_37750.htm; Sophia Ankel, "The Rise of Ukraine's 'Iron General' Who Reformed Its Army and Became Putin's Worst Nightmare," Business Insider, 16 February 2023, https://www.businessinsider.com/valerii-zaluzhnyi-iron-general-putin-ukraine-war-russia-2023-1.

32. Welt, "U.S. Security Assistance to Ukraine"; NATO, "Relations with Ukraine."

33. Emily Feng and Kateryna Malofieieva, "As Ukraine's War Grinds On, Soldiers Are Outgunned and Injuries Are Rising," NPR, 18 July 2022, https://www.npr.org/2022/07/18/1112113033/ukraine-russia-war-injuries-morale; Phil McCausland, "Foreign Soldiers Flocked to Ukraine after Russia Invaded. Five Months On, the Fighting Is Taking a Heavy Toll," NBC News, 21 July 2022, https://www.nbcnews.com/news/world/ukraine-russia-foreign-soldiers-invasion-morale-us-veterans-rcna39268.

34. Daniel Kochis, "Assessing the Global Operating Environment: Europe," Heritage Foundation, 24 January 2024, https://www.heritage.org/military-strength/assessing-the-global-operating-environment/europe; Isabelle Khurshudyan, Paul Sonne, and Karen DeYoung, "Ukraine Short of Skilled Troops and Munitions as Losses, Pessimism Grow," *Washington Post* (website), 13 March 2023, https://www.washingtonpost.com/world/2023/03/13/ukraine-casualties-pessimism-ammunition-shortage/; Tara Copp, "1st Class of Ukrainian Fighters Finishes Advanced US Training," Associated Press, 17 February 2023, https://apnews.com/article/russia-ukraine-politics-lloyd-austin-ap-top-news-afcffd86e422d6a848087cc5160af554; "Ukrainian Military Completing Training on Patriot System – Top Defense Official," Ukrinform, 28 February 2023, https://www.ukrinform.net/rubric-ato/3676510-ukrainian-military-completing-training-on-patriot-system-top-defense-official.html; Marco Trujillo and Juan Medina, "Ukrainian Soldiers Wrap Up Leopard 2A4 Tank Training in Spain," Reuters, 13 March 2023, https://www.reuters.com/world/europe/ukrainian-soldiers-wrap-up-leopard-2a4-tank-training-spain-2023-03-13/.

35. Brian Mann, "A Young Officer Hopes to Turn the Tide of War as Ukraine Fights to Retake a Key City," NPR, 3 August 2022, https://www.npr.org/2022/08/03/1114755089/a-young-officer-hopes-to-turn-the-tide-of-war-as-ukraine-fights-to-retake-a-key.

36. Christoher Woody, "Ukraine's Battlefield Success Surprised Russia, but US Troops Who Trained Ukrainians Saw It Coming, National Guard Chief Says," Business Insider, 27 January 2023, https://www.businessinsider.com/ukrainian-ncos-helped-fend-off-russian-attack-national-guard-chief-2023-1; Epstein, "Russia and Ukraine Have a Lot of the Same Tanks and Jets"; Jake Epstein, "Ukrainian Troops Say Western Military Officers Have Been FaceTiming with Them to Teach Them How to Use Weapons Coming without Instructions," Business Insider, 17 April 2023, https://www.businessinsider.com/western-officers-facetime-ukrainian-troops-help-teach-using-weapons-2023-4; Christopher Woody, "Russian Forces 'Can't Cope' with the 'Unpredictability' of Ukrainian Troops, Top Enlisted Leader Says," Business Insider, 2 August 2022, https://www.businessinsider.com/russian-forces-cant-cope-with-ukrainian-ncos-enlisted-leader-says-2022-8.

37. Liam Collins, "In 2014, the 'Decrepit' Ukrainian Army Hit the Refresh Button. Eight Years Later, It's Paying Off," The Conversation, 8 March 2022, https://theconversation.com/in-2014-the-decrepit-ukrainian-army-hit-the-refresh-button-eight-years-later-its-paying-off-177881; Ankel, "The Rise of Ukraine's 'Iron General'"; Khurshudyan, Sonne, and DeYoung, "Ukraine Short on Skilled Troops and Munitions"; Jake Epstein, "After the Next Round of Major Fighting with Russia, Ukraine May Be Living 'Paycheck to Paycheck' with Western Gear, Expert Says," Business Insider, 7 April 2023, https://www.businessinsider.com/ukraine-may-live-paycheck-to-paycheck-western-gear-expert-russia-2023-4.

Figure 4 from "Population Pyramids of the World from 1950 to 2100: Ukraine," PopulationPyramid.net, 19 July 2023, https://www.populationpyramid.net/ukraine/2023/; "Population Pyramids of the World from 1950 to 2100: Russia," PopulationPyramid.net, 19 July 2023, https://www.populationpyramid.net/russian-federation/2023/.

38. David Brennan, "Russian Spring Offensive May Already Be Stalling: U.S. Trainer in Ukraine," *Newsweek* (website), 9 March 2023, https://www.newsweek.com/russian-spring-offensive-already-stalling-american-trainer-ukraine-1786587; Jones, McCabe, and Palmer, "Ukrainian Innovation"; John Leicester and David Keyton, "Low Morale Takes Hold of Ukrainian, Russian Troops," PBS NewsHour, 19 June 2022, https://www.pbs.org/newshour/world/low-morale-takes-hold-of-ukrainian-russian-troops; *Economist*, "Russia's Population Nightmare."

39. Khurshudyan, Sonne, and DeYoung, "Ukraine Short on Skilled Troops and Munitions"; David Lawler, "Ukraine Suffering up to 1,000 Casualties per Day in Donbas, Official Says," Axios, 15 June 2022, https://www.axios.com/2022/06/15/ukraine-1000-casualties-day-donbas-arakhamia; "Подоляк о ежедневных потерях ВСУ: цифры уменьшились в три раза"

[Podolyak on the daily losses of the Armed Forces of Ukraine: the numbers have decreased three times], RBC-Ukraine, 9 August 2022, https://www.rbc.ua/rus/news/podolyak-ezh-ednevnyh-poteryah-vsu-tsifry-1660032459.html; Andrew S. Bowen, "Ukrainian Military Performance and Outlook," CRS In Focus IF12150 (Washington, DC: CRS, updated 1 December 2023), https://crsreports.congress.gov/product/pdf/IF/IF12150; Tom Mutch, "A Terrifying Secret in Putin's War Is Now Impossible to Hide," Daily Beast, 7 June 2023, https://www.thedailybeast.com/ukraine-fears-military-recruitment-crisis-in-the-war-against-russias-army.

40. "Surge in Arms Imports to Europe, while US Dominance of the Global Arms Trade Increases," Stockholm International Peace Research Institute, 13 March 2023, https://sipri.org/media/press-release/2023/surge-arms-imports-europe-while-us-dominance-global-arms-trade-increases; Associated Press, "Ukraine Was the 3rd Largest Importer of Arms in2022, Thanks to Aid from US, Europe," Fox News, 13 March 2023, https://www.foxnews.com/world/ukraine-3rd-largest-importer-arms-2022-thanks-aid-us-europe; Epstein, "After the Next Round of Major Fighting."

41. Chris Panella, "Front-Line Ukrainian Soldiers Say It Seems Like Russia Has 'Unlimited' Artillery Shells to Throw at Them While They're Worried about Running Out," Business Insider, 24 March 2023, https://www.businessinsider.com/front-line-ukrainian-soldiers-describe-russian-artillery-shells-bbc-video-2023-3; Khurshudyan, Sonne, and DeYoung, "Ukraine Short of Skilled Troops and Munitions."

42. H. M Drucker, "Marx's Concept of Ideology," *Philosophy* 47, no. 180 (April 1972): 152–61, https://doi.org/10.1017/S0031819100040882.

43. Jonathan Leader Maynard, "Identity and Ideology in Political Violence and Conflict," *St. Antony's International Review* 10, no. 2 (February 2015): 18–52.

44. "Рождественское интервью Святейшего Патриарха Кирилла телеканалу Россия 1" [Christmas interview of His Holiness Patriarch Kirill to the TV channel Russia 1], Patriarch.ru, 7 January 2023, http://www.patriarchia.ru/db/text/5992951.html; Olesya Pavlenko, "Патриарх Кирилл считает, что желание уничтожить Россию приведет к концу мира" [Patriarch Kirill believes that the desire to destroy Russia will lead to the end of the world], *Kommersant* (website), 19 January 2023, https://www.kommersant.ru/doc/5774586; Anastasia Koskello, "Церковь не очень-то нужна армии" [The church is not really needed by the army], *Nezavisimaya Gazeta* (website), 15 November 2022, https://www.ng.ru/ng_religii/2022-11-15/9_540_army.html; Andrei Melnikov, "О великодержавном богословии патриарха Кирилла" [On the great power theology of Patriarch Kirill], *Nezavisimaya Gazeta* (website), 6 November 2022, https://www.ng.ru/kartblansh/2022-11-06/3_8582_kartblansh.html; NATO Strategic Communication Centre of Excellence (STRATCOM COE), *Analysis of Russia's Information Campaign against Ukraine* (Riga, LV: NATO STRATCOM COE, 2015), https://stratcomcoe.org/cuploads/pfiles/russian_information_campaign_public_12012016fin.pdf; "Disinformation and Russia's War of Aggression against Ukraine: Threats and Governance Responses," Organisation for Economic Co-operation and Development (OECD), 3 November 2022, https://www.oecd.org/ukraine-hub/policy-responses/disinformation-and-russia-s-war-of-aggression-against-ukraine-37186bde/.

45. Koskello, "The Church Is Not Really Needed by the Army."

46. Patriarch.ru, "Christmas Interview of His Holiness Patriarch Kirill"; Pavlenko, "Patriarch Kirill Believes"; Koskello, "The Church Is Not Really Needed by the Army"; Melnikov, "On the Great Power Theology of Patriarch Kirill"; NATO STRATCOM COE, *Analysis of Russia's Information Campaign*; OECD, "Disinformation and Russia's War of Aggression"; Alexandra Markovich, "As More Ukrainians Choose Kyiv Patriarchate, Push Intensifies for Unified National Orthodox Church," *Kyiv Post* (website), 23 June 2016, https://www.kyivpost.com/post/10788.

47. МИХАЙЛО ТКАЧ, "Московська церква має 'скласти зброю' в Україні" [The Moscow Church must lay down its arms in Ukraine], Ukrainska Pravda, 11 April 2023, https://www.pravda.com.ua/columns/2023/04/11/7397428/; Robert Kurz, Foreign Military Studies Office, in conversation with author Andrew Johnson as part of Ukrainian Senior National Defense Personnel Studies Group Consultation conducted in Kyiv, Ukraine, in May 2016 and email correspondence in November 2017; Valentyna Romanenko, "СБУ оглянула 350 споруд УПЦ МП: знайшли підозрілих росіян, гроші і літературу для промивання мізків" [Security Service of Ukraine searches 350 buildings of Ukrainian Orthodox Church or Moscow Patriarchate], Ukrainska Pravda, 23 November 2023, https://www.pravda.com.ua/news/2022/11/23/7377563/; Valentyna Romanenko, "Крім Лаври СБУ завітала до церковників УПЦ МП на Рівненщині: шукають ДРГ і зброю" [In addition to Kyiv-Pechersk Lavra, Ukraine's Security Service visits monastery in Rivne Oblast: Looking for sabotage and reconnaissance groups and weapons], Ukrainska Pravda, 22 November 2023, https://www.pravda.com.ua/news/2022/11/22/7377416/; Valentyna Romanenko, "До Києво-Печерської Лаври прийшли СБУ, поліція і Нацгвардія" [Ukraine's security forces, police and National Guards conduct counterintelligence operations in Kyiv monastery], Ukrainska Pravda, 22 November 2023, https://www.pravda.com.ua/news/2022/11/22/7377385/; "SBU Finds Propaganda Materials Denying Existence of Ukraine in Moscow Patriarchate Churches in Western Ukraine," Interfax-Ukraine, 28 November 2023, https://en.interfax.com.ua/news/general/875101.html.

48. "З початку року 63 церкви перейшли до ПЦУ, ще 8,5 тисяч залишаються в УПЦ МП" [63 religious organisations have joined Orthodox Church of Ukraine since beginning of 2023], Ukrainska Pravda, 10 April 2023, https://www.pravda.com.ua/news/2023/04/10/7397195/; "Yet Another Orthodox Parish in Ukraine Snubs Moscow-Run Church," Ukrinform, 11 April 2023, https://www.ukrinform.net/rubric-society/3694255-yet-an-other-orthodox-parish-in-ukraine-snubs-moscowrun-church.html; Asami Terajima, "Ukrainians Celebrate 'Double Christmas' in the Shadow of Russia's Brutal War," Kyiv Independent, 7 January 2023, https://kyivindependent.com/national/ukrainians-celebrate-double-christmas-in-the-shadow-of-russias-brutal-war; Karina Levitska, "Вже цього року. Українська греко-католицька церква переходить на новий календар" [Already this year. The Ukrainian Greek Catholic Church is switching to a new calendar], RBC-Ukraine, 6 February 2023, https://www.rbc.ua/rus/news/vzhe-tsogo-roku-ukrayinska-greko-katolitska-1675698015.html.

Figure 5 from Ukraine Ministry of Defense (@DefenceU), "There is no force in the world that can stop this nation from achieving its sacred goal of living in freedom on its God-given land. #FreedomIsOurReligion," X (formerly Twitter), 27 May 2023, 5:05 a.m., https://twitter.com/DefenceU/status/1662399743514005505.

Soldiers with the 1st Multi-Domain Effects Battalion (1st MDEB) train 13 February 2023 at Fort Huachuca, Arizona. 1st MDEB demonstrated a wide array of capabilities during the training event, highlighting the 1st Multi-Domain Task Force's progress toward becoming fully operationally capable and contributing to the Army's goal of achieving information advantages. (Photo by Sgt. 1st Class Henrique De Holleben, U.S. Army)

Information Advantage

A Combined Arms Approach

Col. Richard Creed, U.S. Army, Retired

Lt. Col. Michael Flynn, U.S. Army, Retired

Information is central to everything we do—it is the basis of intelligence, a fundamental element of command and control, and the foundation for communicating thoughts, opinions, and ideas.

—Lt. Gen. Milford H. Beagle Jr., foreword to ADP 3-13, *Information*

Army doctrine on information changed with the November 2023 publication of Army Doctrine Publication (ADP) 3-13, *Information*. This new doctrine represents an informed consensus about the role information plays during the range of operations Army forces conduct across the competition continuum. It addresses the informational aspects of multidomain operations found in Field Manual (FM) 3-0, *Operations*, by describing a framework for creating and exploiting information advantages to achieve objectives. It provides fundamental considerations for how Army forces use, protect, and attack data and information while affecting the threat's (adversary or enemy) ability to do the same.[1] Most importantly, it makes clear that everyone in the Army plays some role in achieving information advantages relative to our adversaries worldwide.

As a keystone publication, ADP 3-13 links the Army's application of information to all warfighting functions and methods of warfare in ways previous doctrine did not. It represents an evolution in how Army forces think about the military uses of data and information, emphasizing that everything Army forces do, including the information and images it creates, generates effects that contribute to or hinder the achievement of objectives. ADP 3-13 addresses information as a dynamic of combat power and stresses a combined arms approach to creating and exploiting information advantages.

Background

The more you employ stratagems and ruses, the more advantages you will enjoy over the enemy. You must deceive him and induce him to make mistakes in order to take advantage of his faults.

—Frederick the Great[2]

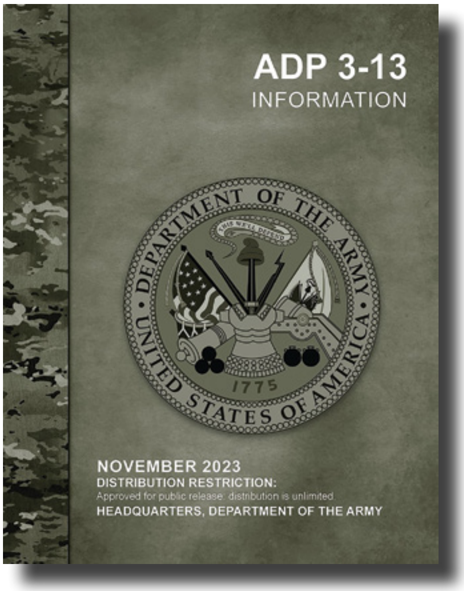
Historically, successful military leaders understood the importance of using information to create and exploit an advantage—a condition that puts a force in a favorable geographical, psychological, or moral position. They understood that knowing more than the enemy and acting effectively on that knowledge faster than their opponent provides an advantage. They understood denying the enemy information or affecting the enemy's ability to communicate enhances friendly chances of success. Successful commanders also understood that using information combined with action or inaction to mislead the enemy creates favorable conditions for the friendly force.

Some of the Army's earliest doctrine finds references of the importance of information to achieve objectives. The Army's first combined arms doctrine, the 1905 *Field Service Regulations*, dedicated a chapter to the "Service of Information," which focused on reconnaissance and communications.[3] Army doctrine throughout World War II, Korea, and Vietnam emphasized security, deception, psychological operations, and electromagnetic warfare to protect friendly intentions, deceive enemy forces, and disrupt enemy command and control (C2). The 1991 Gulf War demonstrated the benefit of employing these elements together in a synchronized fashion to disrupt enemy C2 and to deceive Iraqi leaders about the coalition's plan of attack. Successes in the Gulf War and accelerated growth of information technologies (military and civilian) led to the Army's first comprehensive field manual on information operations, FM 100-6, in 1996.[4]

A lot has changed since the publication of the Army's first information operations manual. Today, military operations are influenced by the exponential growth of information technologies that accelerate and expand the ability of the joint force to collect, process, analyze, store, and communicate data and information at a scale previously unimaginable. A proliferation of satellites, advanced computing and automated

Col. Richard Creed, U.S. Army, retired, is the director of the Combined Arms Doctrine Directorate at Fort Leavenworth, Kansas, and one of the authors and editors of Army Doctrine Publication 3-13, *Information*. He holds a BS from the U.S. Military Academy, an MS from the School of Advanced Military Studies, and an MS from the Army War College. His previous assignments include G-3 of the 2nd Infantry Division, and he has completed tours in Germany, Korea, Bosnia, Iraq, and Afghanistan. He commanded at company, battalion, and brigade levels.

Lt. Col. Michael Flynn, U.S. Army, retired, is a doctrine author and analyst in the Combined Arms Doctrine Directorate and one of the authors of Army Doctrine Publication 3-13, *Information*. As a veteran doctrine writer, he has helped shape Army operations, command and control, and planning doctrine for over twenty years. He served in multiple infantry and staff assignments to include service in Germany, Kuwait, and Afghanistan. He has a master's degree from the School of Advanced Military Studies.



Army Doctrine Publication 3-13, *Information*, can be found online via the Army Publishing Directorate at https://www.armypubs.army.mil/.

systems, mobile networks, and social media are some of the technologies affecting how forces use and employ data and information to achieve objectives. Our primary adversaries now have the same capabilities as the United States. These adversaries can degrade joint force information advantages we may have held in the past, so it is time to start thinking differently.

Multidomain Operations and Information Advantage

The 2022 revision of FM 3-0 is driving change to how Army forces train and fight. The most significant update is the introduction of multidomain operations as the Army's operational concept. Multidomain operations, as defined in FM 3-0, are "the combined arms employment of joint and Army capabilities to create and exploit relative advantages to achieve objectives, defeat enemy forces, and consolidate gains on behalf of joint force commanders."[5] Multidomain operations are the way Army forces employ ground-based Army capabilities with capabilities from air, sea, space, and cyberspace in mutually supporting ways to create and exploit relative advantages. Information is central to the idea of relative advantage.

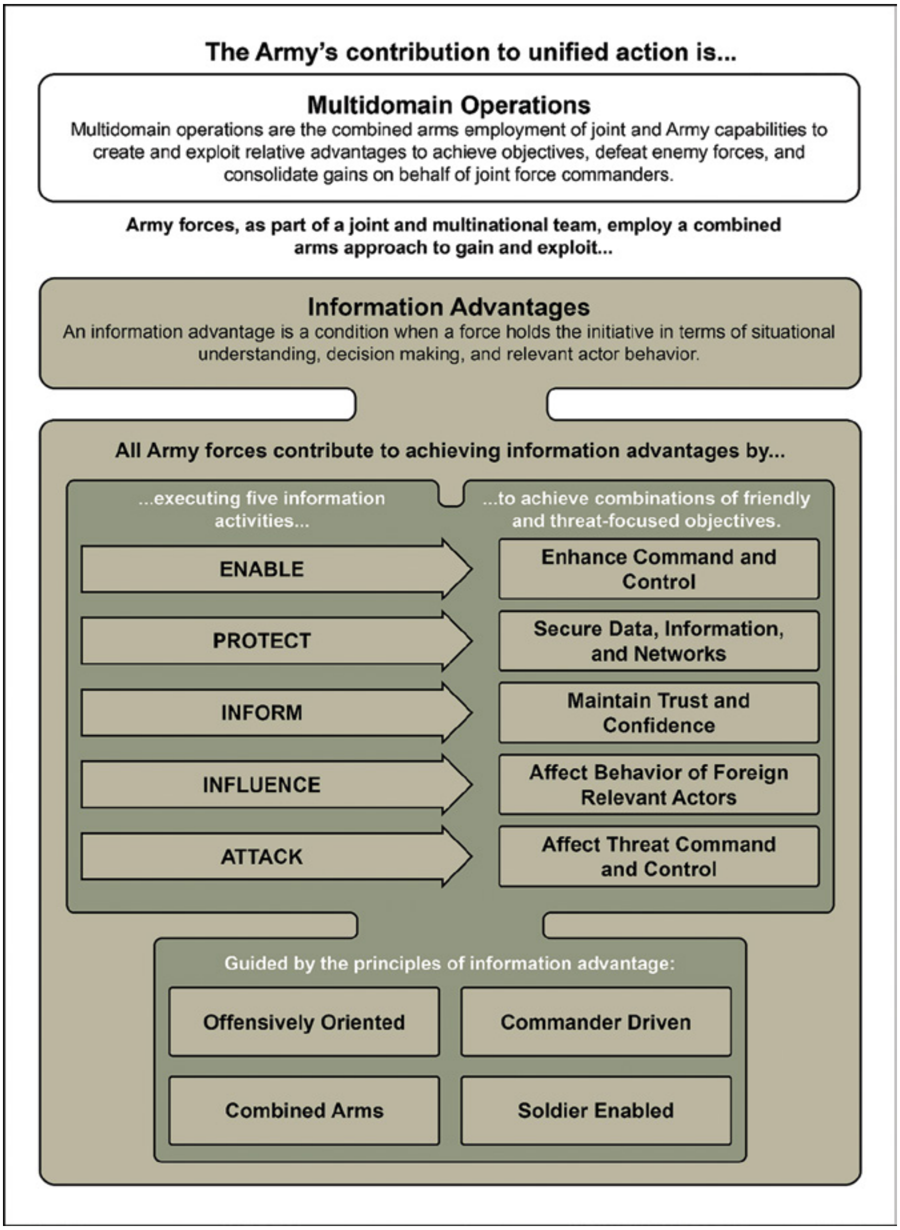
FM 3-0 defines a *relative advantage* as "a location or condition, in any domain, relative to an adversary or enemy that provides an opportunity to progress towards or achieve an objective."[6] Relative advantages are characterized as human, information, or physical. They complement each other. Physical actions, particularly involving the use of force, create information and generate psychological effects. When exploited, these effects can lead to information advantages as friendly forces use information to influence enemy behavior. When combined over time, these physical and information advantages can lead to a collapse of the enemy's morale and will—a human advantage.

This phenomenon was once well understood by military professionals across our Army, but we increasingly made information considerations the purview of specialists and specific staff sections over time. The unintended consequence was intellectual atrophy among many noninformation specialists who planned and led the operations Army forces conducted. ADP 3-13 supports FM 3-0 by ensuring we all adequately consider the desirable cognitive effects we want our operations to achieve. Linking interrelated advantages in the physical, information, and human dimensions addresses that shortcoming since they apply to every echelon, warfighting function, branch, and occupational specialty.

Expanding on relative advantages, ADP 3-13 defines information advantage and describes how creating and exploiting information advantages contribute to achieving objectives.[7] When describing information advantage, ADP 3-13 emphasizes three points. The first is the importance of understanding informational considerations of an operational environment as a precursor to developing effective ways to create and exploit advantages. Informational considerations are those aspects of the human, information, and physical dimensions that affect how humans and automated systems derive meaning from, use, act upon, and are impacted by information.[8] ADP 3-13 describes how leaders analyze informational considerations from friendly, threat, and neutral perspectives to aid them in developing ways to use, protect, and attack data, information, and capabilities. This analysis enhances several aspects of planning, including the selection of targets and objectives, approaches to influence threats and other foreign relevant actors, and identification of force protection measures.

The second point is the recognition that there are many forms of information advantage—not just a single overarching condition relating to all things information.[9] For example, a force that collects, processes, analyzes, and uses information to understand, decide, and act more effectively than an opponent has an advantage. However, that same force may be at an information disadvantage because the opposing force effectively uses information to influence relevant actor behavior in opposition to friendly-force objectives.

A third point of emphasis is the temporary and relative nature of an information advantage.[10] Like physical and human advantages, information advantages are often temporary and vary over time relative to an adaptive opponent and changes in an operational environment. While friendly forces seek information advantages, threat forces are doing the same. An information advantage is something to gain, protect, and exploit below and above the threshold of armed conflict.



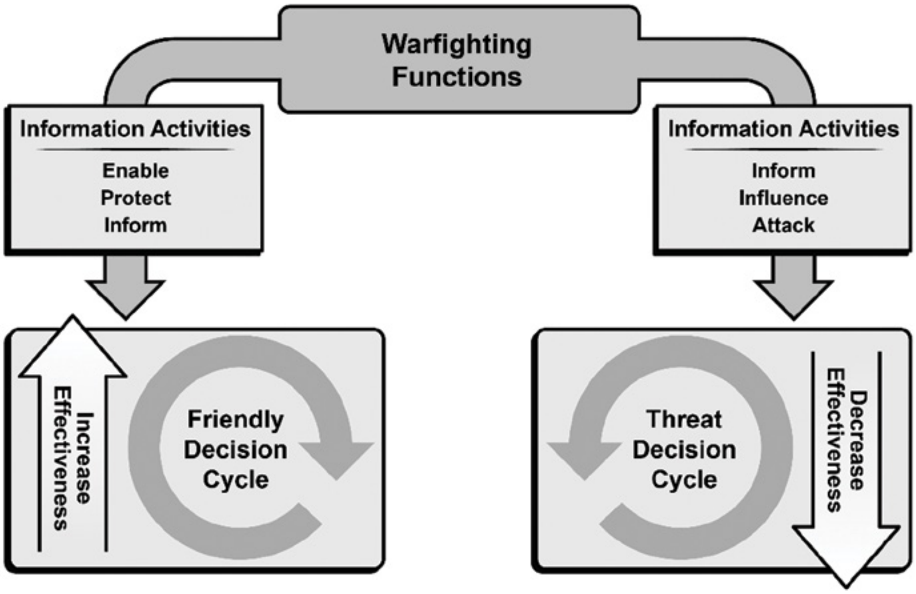
(Figure from Army Doctrine Publication 3-13, *Information*)

Figure 1. Information Advantage Logic Chart

Information Advantage Framework

ADP 3-13 provides an organizational framework to assist commanders and staffs with integrating capabilities and synchronizing actions to create and exploit information advantages. As shown in figure 1, the framework describes how Army forces integrate all relevant military capabilities by executing five information activities (enable, protect, inform, influence, attack).[11] Each information activity incorporates several tasks and subtasks from the warfighting functions to achieve various friendly and threat-based objectives. Guided by the principles of information advantage, Army leaders plan, prepare, execute, and assess information activities as part of the operations process.

The *enable* information activity includes tasks to enhance situational understanding, decision-making, and communications. The *protect* information activity includes tasks that deny threat access to friendly data and information while preserving friendly communications capabilities. The *inform* information activity includes tasks that foster informed perceptions of military operations and activities among various audiences. This activity focuses on maintaining the trust and confidence of internal (members of U.S. Army, Department of the



(Figure from Army Doctrine Publication 3-13, *Information*)

Figure 2. Information Activities Contributions to Agility

Army civilians, contractors, and family members) and external audiences (U.S. domestic and international audiences). The *influence* information activity includes tasks that affect the thinking and, ultimately, the behavior of threats and other foreign audiences. This activity focuses on reinforcing or changing how individuals and groups think, feel, and act in support of objectives. The attack information activity includes tasks that affect the threat's ability to exercise C2. This activity focuses on affecting threat data and their physical capabilities used to communicate and conduct information warfare. This includes the data and communications between automated systems, such as the communications among radars, fire control systems, and firing systems.

Information activities are interdependent. For example, the protect and inform information activities help defend the force against malign influence. The influence and attack information activities affect the threat's ability to C2 but employ different means. Synchronizing military information support operations (an influence means) to enhance the effects of a cyberspace attack (an attack means) represents a combined arms approach to degrading threat C2.

ADP 3-13 illustrates how combining and executing all the information activities to achieve both friendly and threat-focus objectives contributes to agility and the ability to understand, decide, and act more effectively than the threat. As shown in figure 2, the enable and protect information activities increase the effectiveness of the friendly decision cycle.[12] The influence and attack information activities decrease the effectiveness of the threat's decision cycle. The inform information activity is used to both enhance friendly C2 and to degrade the threats decision cycle. The combined effects of enhancing the friendly decision cycle while degrading the threats create a significant information advantage for Army forces.

Principles of Information Advantage

To help guide the thinking about the use of information and the employment of capabilities to create information advantages, ADP 3-13 introduces four principles (see figure 3).[13] The first principle—offensively oriented—is focused on initiative. Any information advantage not sought or actively defended is potentially ceded to the threat. Army leaders maintain an offensive mindset and anticipate events in pursuit of various information advantages. The combined arms principle is tied to the idea that all military activities have inherent informational effects and that all military capabilities can be employed for information advantage. Army leaders combine available organic, joint, interagency, and multinational capabilities in complementary and reinforcing ways to enable C2, protect information and networks, inform audiences, influence threats and other relevant actors, and attack threat C2.

The third principle—commander driven—is related to the idea that information is central to all activity Army forces undertake. Therefore, commanders must understand information and thoughtfully integrate it into operations through the command and control, fires, maneuver, protection, and sustainment warfighting functions during planning. Commanders think of information as a resource to achieve situational understanding, a tool to induce ambiguity and uncertainty in the threat, and the primary means to direct Army forces. Commanders direct the use of information and capabilities to penetrate threat decision-making processes, exploit information dependencies, achieve surprise, and disrupt the threat from within.

Finally, all soldiers have a role in gaining and exploiting information advantages, which is the focus of the fourth principle. All soldiers must protect information. Considerations such as operations security, physical security, noise and light discipline, and electromagnetic emissions control apply to everyone in a formation. Every soldier consumes, communicates, and relies on information to accomplish the mission. Soldiers must retain their digital literacy and readiness as they operate various information systems essential to communications. As representatives of the U.S. Army and the United States, soldiers understand that their presence, posture, and actions always communicate a message open to interpretation. High visibility offers great opportunity as well as potential risk. Effective soldiers at all levels understand the impact that their actions and messages communicate—and that all their activities communicate a message to some audience. This requires all soldiers to understand the broader purpose of operations. It also requires practicing operations security and disciplined communication through all forms of media—including personal media accounts—both in operations and while at home station.

Offensively oriented—seize and exploit the initiative to create, protect, and exploit information advantages in all domains.

Combined arms— integrate all available Army, joint, interagency, and multinational capabilities in pursuit of information advantages.

Commander driven—visualize and describe the deliberate integration of information to create maximum effects.

Soldier enabled—all soldiers have a role in collecting, assessing, processing, communicating, and protecting information.

(Figure by authors; information from Army Doctrine Publication 3-13, *Information*)

Figure 3. Principles of Information Advantage

Warfighting Function Contributions

A significant difference from past doctrine is the idea that all military capabilities can be employed for an information advantage—not just a select list of information-related capabilities synchronized with each other as part of information operations.[14] The information advantage framework is based on the idea that information is essential to all warfighting functions, and all warfighting functions can contribute to friendly or threat-focused information advantages. Based on this understanding, the Army did not establish an information warfighting function.[15] Additionally, because of the disparate nature of capabilities and multiple tasks used to create information advantages, ADP 3-13 does not assign a single staff section overall responsible for information advantage; rather, it assigns a staff lead for each activity and identifies staff leads for each task within each information activity.[16]

Information activities organize various tasks and capabilities from the six warfighting functions (C2, intelligence, movement and maneuver, fires, protection, and sustainment). The C2 *warfighting function* directly contributes to the enable information activity. The entire C2 system (people, processes, networks, and command posts) is designed to support commanders in their abilities to understand, visualize, describe, direct, lead, and assess faster and more effectively than their opponents.

The *intelligence warfighting* function contributes to the integration of all the information activities by providing relevant information and intelligence. It directly contributes to the enable information activity by providing information and intelligence for situational understanding that informs decision-making concerning all aspects of operations. The *movement and maneuver warfighting function* contributes to the enable, protect, influence, and attack information activities. Through reconnaissance, forces gain information on the enemy and terrain facilitating friendly decision-making. Security operations protect friendly information and

C2 nodes. The positioning and maneuver of forces signals intent, demonstrate capability, and drive tempo that influence threats and assure partners. Raids and other attacks contribute to the capture or destruction of enemy C2 systems and infrastructure. The *fires warfighting function* contributes to the protect, influence, and attack information activities. The delivery of fires ranging from surface to surface to cyberspace and electromatic attacks can protect friendly data and information, influence threats, and affect threat C2. Several tasks within the *protection warfighting function* directly contribute to the protect information activity to include survivability, air and missile defense support, electromagnetic protection, operations security, and cybersecurity and defense. The *sustainment warfighting function* contributes to all information activities by ensuring the friendly force is healthy, manned, equipped, maintained, and supplied. Sustainment activities also contribute to the influence information activity. Providing sustainment to relevant actors can reinforce or change their behavior. The position of sustainment forces and their activities can contribute to both deception and the communication of a will to fight.

Way Ahead

In his foreword, Lt. Gen. Milford H. Beagle Jr. writes, "ADP 3-13 provides the intellectual underpinnings that describe how Army forces will gain, protect, and exploit information advantages. But doctrine is only the beginning. The hard work begins when we incorporate these ideas into leader development, education, and training. As leaders, it is our obligation to study, understand, and implement the doctrine in ADP 3-13."[17] The publication of ADP 3-13 is just the start of a sustained education campaign from the Combined Arms Center.

As with FM 3-0, the Combined Arms Doctrine Directorate is developing a series of products to help soldiers understand the new doctrine. Articles, videos, and podcasts devoted to ADP 3-13 are in the works and will be announced via the Combined Arms Doctrine Directorate's social media channels. The team will also work closely with the centers of excellence, Army University, and the combat training centers to ensure this information is incorporated into professional military education and training. Mobile training teams will also visit select installations and organizations to further integrate the ideas outlined in the manual. ■

Notes

Epigraph. Army Doctrine Publication (ADP) 3-13, foreword to *Information* (Washington, DC: U.S. Government Publishing Office [GPO], 2023).

1. Ibid., 1-1. Data and information are related but are not the same. ADP 3-13 defines data as "any signal or observation from the environment." Information is defined as "data in context that a receiver (human or automated) assigns meaning."

2. Jay Luvaas, ed. and trans., *Frederick the Great on the Art of War* (Boston: Da Capo Press, 1999), 334.

3. General Staff, Chief of Staff of the U.S. Army, *Field Service Regulations* (Washington, DC: U.S. Government Printing Office, 1905), 38–48.

4. Field Manual (FM) 100-6, *Information Operations* (Washington, DC: U.S. Government Printing Office, 1996), iii–vi.

5. FM 3-0, *Operations* (Washington, DC: U.S. GPO, 2022), 3-1. The 2022 edition of FM 3-0 formally established multidomain operations as the Army's operational concept. It describes the tenets and imperatives that guide Army forces in competition below armed conflict, crisis, and armed conflict.

6. Ibid., 1-3.

7. ADP 3-13, *Information*, 2-3.

8. Ibid., 1-8.

9. Ibid., 2-3.

10. Ibid.

11. Ibid., viii.

12. Ibid., 2-12.

13. Ibid., 2-14–2-15.

14. Based on changes to joint information doctrine, Army doctrine no longer use the terms information operations, information-related capabilities, or information superiority.

15. Change 1 to Joint Publication (JP) 1, *Doctrine for the Armed Forces of the United States* (Washington, DC: U.S. GPO, 2017), added information to the joint functions (command and control, intelligence, fires, movement and maneuver, protection, and sustainment) in 2017. JP 3-04, *Information in Joint Operations* (Washington, DC: U.S. GPO, 2022), expands doctrine on the joint information function. JP 3-04 describes the joint information function as the management and application of information to change or maintain perceptions, attitudes, and other drivers of behavior, and to support human and automated decision-making. Combined with the other joint functions the information joint function helps joint force commanders and staffs effectively use information to create information advantages and achieve objectives.

16. ADP 3-13 highlights both the chief of staff (executive officer) and G-3 (S-3) as having responsibilities for overall integration and synchronization of information activities. The chief of staff ensures staff integration where the G-3, as operations officer, ensures information activities are integrated and synchronized into the concept of operations in accordance with the commander's intent and guidance.

17. ADP 3-13, *Information*, foreword.

Integrated Battle Command System, shown here on 1 December 2023 at Redstone Arsenal, Alabama, is the foundation of the Army's broader modernization efforts and provides transformational air and missile defense capabilities to the battlefield. (Photo by Nathaniel Pierce, Program Executive Office Missiles and Space)

Goldilocks Kill Chains and the Just Right Data

Maj. Michael G. Dunn, U.S. Air Force

The Department of Defense (DOD) faces a crucial challenge in achieving its goal of joint all-domain operations due to the inability to achieve foundational, fast-paced evolution of data storage, management, and analytics exemplified in the commercial sector. A shift began around 2000, when the commercial industry began outpacing defense in technological advancement, primarily because of its adaptable data strategies and computing capacity.

This analysis emphasizes the significance of data processing in achieving cost-effective kill chain development for joint all-domain operations, given its requirement for complex operations across multiple domains. It differentiates between big data, which necessitates complex machines for comprehension, and small data, which humans can understand naturally. Furthermore, it draws parallels between commercial and military operations, using the data-information-knowledge-wisdom (DIKW) pyramid as a decision model.

The analysis proposes the adoption of object-based storage to address the challenges of cross-domain data integration and presents a framework based on the DIKW pyramid, illustrated by an analogy of rivers, streams, reservoirs, waterfalls, and lakes. This framework demonstrates how adopting commercial data strategies, particularly object-based storage, can enable the DOD to leverage data from various sources, enhancing knowledge for tactical and operational decision-makers. In essence, this research underscores the urgency for the U.S. government and DOD to embrace commercial data practices to facilitate advanced cross-domain algorithms, empowering decision-makers with a deeper understanding of complex situations and more effective decision-making capabilities.

Garbage In, Garbage Out

Information is the oil of the 21st century, and analytics is the combustion engine.

—Peter Sondergaard[1]

In 1640, John Graunt recorded the first use of the English word "data" while trying to provide the first description of data analytics.[2] The first calculations to create facts or types of data occurred as early as 19,000 BCE.[3] Since the seventeenth century, data has continuously expanded in complexity and application from agriculture to medicine to defense. The defense industry remains on the forefront of novel ways of applying data and decision-making formulas including the speed of data transmission; for example, pathways changing from a scouting party to a telegram to radio to computer speeds. Gordon Moore predicted in 1965 that the number of components per integrated function will increase at a logarithmic rate as technologies advance and the cost per component decreases in what is commonly referred to as "Moore's law."[4] The relationship of computing availability and complexity between the commercial and defense sectors has inverted since the 1960s.[5] In the 1960s, the military had the clear advantage of access to higher performance computing, leading the way in application of computer technologies to problem-solving. Today, the commercial-to-defense computer power application has inversed, leading to the amount of computing that occurs in the commercial world far outweighing that of a single system in the military.

Maj. Michael Dunn, U.S. Air Force, is a member of the deputy chief of staff's studies group at Headquarters Air Force. He holds a BS in systems engineering-computer systems from the U.S. Air Force Academy. During his career, Dunn served with the 15th Reconnaissance Squadron, the 432nd Operational Support Squadron, the 26th Weapons School Squadron, the 17th Attack Squadron, and the 30th Reconnaissance Squadron. He also attended an Air University yearlong fellowship at the Defense Advanced Research Projects Agency.

As a prime example, a Tesla vehicle with full self-driving capability has roughly 180 times the computing power of an F-35 fighter.[6] While tactical edge-based computing, such as in an aircraft, a vehicle, or a handheld radio, must continually strive to increase safe and reliable computing in order to disaggregate computational locality and complicate enemy targeting, things the commercial world worries little about, the military can find advantage in the inverse relationship by focusing on commercial applications of data analytics. More data generation does not necessarily equal better decisions, and in the cost curve of acquiring new computing technology, the military can drastically increase its use of current data sets to enable decision space.

Defining commercial data, strategies, and dichotomies is necessary to determine what commercial advances in data analytics should find applicability in the defense sector. Moreover, this section presents a commercial viewpoint of so-called data layers to include transitioning from data to usable products or decisions. The etymology of the word "data" gives an insight into its formation. Data is the "plural form of the Latin word 'datum,' which means the 'thing given.'"[7] Classically used, datum is "a fact given as the basis for calculation in mathematical problems."[8] A data set, singular, expresses a block of data and allows for classification in generalities, such as big or small data. Generalizing things into data sets does not allow for proper data understanding, classification, curation, and management without acknowledging the individual datum types inside the larger data set. Thus, to keep things simple, data sets allow for the application of data strategies, but big or small data, when classified, constrains to the operational or tactical use of said data strategies.

Big versus Small Data—FIGHT!

All data are blocks of facts in whatever size, shape, storage location, etc., and further attempts to separate the fact that big and small data are more than just

A Tesla vehicle with full self-driving capabilities has roughly 180 times the computing power of an F-35 fighter. (Photo courtesy of Tesla)

classifications creates unevenness in arguments about data management. However, regardless of data purism or an etymology faux pas, keeping the separation between seemingly big or small data allows for targeted application of strategies, concepts of operations, and concepts of employment. The primary differentiation between big or small data derives from the measurement of four characteristics called the four Vs of data: (1) volume, (2) velocity, (3) variety, and (4) veracity.[9] Each "V," in and of itself, could drag a data set from small to big classification. Simply defined: (1) volume is "the amount of data," (2) variety is "the diversity of sources and types of data," (3) velocity is "the speed of data transmission and generation," and (4) veracity is "the accuracy and trustworthiness of the data."[10] A fifth "V," value, creates additional utility by providing an answer to the "why" question for businesses to apply information management techniques.[11] Unfortunately, value for a business model vice value for a military application creates an argument between subjective and objective value (value of decisions made versus dollar value); thus, this analysis abstains from applying the value classification.

From a simpler perspective, the business world simply classifies small data as "small enough for the human to comprehend both in terms of volume and format" and big data as "chunks of data that are too large and complex to be analyzed and processed by traditional data-processing techniques."[12] In order to classify what a human can process, one must assume that the human received training and a competency level in processing said data. In a reductionist example, an electrically optimized (EO) sensor, such as a daytime television camera, produces video imagery that a trained human can process and make decisions from. In contrast, a farm of EO daytime television and infrared cameras would create such a complex picture across multiple modalities (infrared and EO), including multiple sources, that a single human would struggle to process the raw imagery in a near instantaneous timeline.

Enter the New Model: DIKW

Why are data important? While data in and of itself are interesting, data generation for the sake of data generation should never be the end goal. Data

Two F-35 Lightning IIs bank after receiving fuel over the Midwest 19 September 2019. While tactical edge-based computing must strive to increase safe and reliable computing to disaggregate computational locality and complicate enemy targeting, things the commercial world worries little about, the military can find advantage in the inverse relationship by focusing on commercial applications of data analytics. (Photo by Master Sgt. Ben Mota, U.S. Air Force)

must have a downstream effect, and the effect it provides is wisdom to make a correct action. Therein lies the question, how does one get from data to action? Data analysts in the commercial world use an action pyramid model called the data-information-knowledge-wisdom (DIKW) pyramid (as depicted in figure 1), which starts with the foundational data layer, builds to an information layer, again onto a knowledge layer, and finally, ends with wisdom.[13] Action produced from the layers of knowledge and wisdom implies that the person or entity that consumes the wisdom generated from data brings predefined or pretrained institutional decision matrices that when married with wisdom produces the proper output. While the DIKW pyramid was introduced in the early 2000s in the information technology sector, the true beauty of it derives from its simplicity.[14] Because it is simple, the DIKW is data categorization agnostic, meaning it could apply to both big and small data. In a small data example, a person or computationally small computer—in this case, think tactical systems—could organically derive the information from the gathered data either by preprogrammed filters, algorithms, or human intuition, bring its own knowledge of the situation, and finally, make an action. Simplicity in data, system, and algorithms equals a reduction in timeline for processing and decision-making.

The "data" layer is the foundation of the DIKW pyramid, the beating heart pumping raw facts into the action model. Assume that for the generic action, without data, the action model collapses. In 1989, Russell L. Ackoff, an organizational theorist, defined data and information:

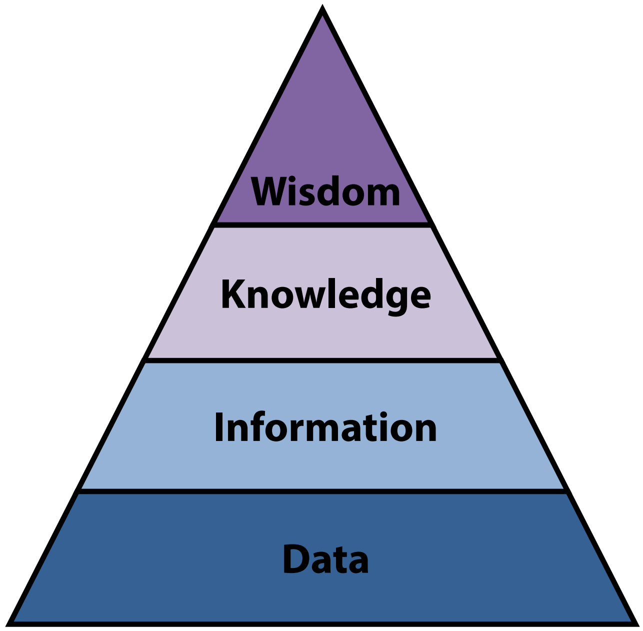
> Data are symbols that represent properties of objects, events, and their environments. They are products of observation. To observe is to sense. The technology of sensing, instrumentation, is, of course, highly developed. Information, as noted, is extracted from data by analysis in many aspects.[15]

Suffice to say, the raw facts of a situation, environment, or other observations form the data layer.

Information builds the next layer of the DIKW pyramid. Think of information as the answer to questions one might have about the data. The questions could drive specific answers or inferred answers that combine multiple pieces of data to hypothesize and answer the question. The question could also drive additional functions accomplished on the data to derive an answer. Consider the following examples and explanations of precise and derived data. If a data analyst queries for a specific person's birthdate or social security number from a list of attendees to an event, the analyst extracts precise information. If, instead, the data analyst wants to know the average age of everyone who attended, the analyst would have to first make sure everyone on the list attended, maybe by querying an attendance binary, and then execute an averaging function across the complete list of ages. This simple example expresses a few critical relationships between data and information. To derive information requested, the data set queried must contain the exact or derivable data requested; conversely, information could also reveal what is not contained within the data, including correlations of datums. Data not contained within the set queried helps find relationships between different data sets helping to derive answers or reveals a data structure problem.

Any data analysts trying to optimize information extraction must first analyze the relationship of information requests to data structure. According to the *Encyclopedia of Big Data*, "Data can be classified as structured, semi-structured, and unstructured based on how it is stored and analyzed."[16] Structured data is organized data, typically "in a strict format of rows and columns."[17] Semistructured data is a separate form of structured data, but because of its nature, whether raw or strict, it does not have an "underlying data model, hence cannot be associated with any relational database."[18] Finally, unstructured data, the most common type, has "no conceptual data-type definition," and the content is typically stored in some unique to the generating system type file, for example, a smartphone picture, a webpage, or a multispectral image.[19]

As described within the DIKW section of the *Encyclopedia of Big Data*, "As data sets increase in both structured and unstructured forms, analysis and management get more diverse."[20] In the commercial sector, multiple diverse types of networked storage and other wide-ranging technologies or techniques exist to



(Figure by author)

Figure 1. DIKW Pyramid

"analyze, manipulate, aggregate, and visualize big data," but one that keenly aligns with the defense sector is object-based storage.[21]

Object-based storage allows for managing, storing, and calling large swaths of unstructured data or semistructured data. It is a form of data curation, which is the "process of creating, organizing, and maintaining data sets so they can be accessed and used by people looking for information."[22] MySQL, one of the most "widely used open-source relational database management systems in the world," was created in 1995 using a codebase created in 1981.[23] Since 1981, the commercial and defense sectors alike have creatively matured and evolved the use of MySQL, among other tools, to leverage efficient and effective database management. However, to unlock the use of those creative, legacy techniques, the data must exist in some form of a structured database. Therefore, the key is to curate unstructured or semistructured data in such a way as to enable a multiplicity of data strategies while simultaneously preventing acquisition vendor lock.

Object-based techniques can allow for data structuring by storing data based on their content and other attributes, using variable lengths and applying unique identification parameters for calling the data.[24]

By creatively applying simple algorithms to separate unstructured or semistructured data into objects with specific attributes and proper identification, data analysts can, with some requisite changes, apply legacy data mining algorithms to extract information swiftly and accurately. Coincidently, object-based management can allocate new object space for unforeseen or never-before-seen observations, and while it may not allow for immediate use, it can guide future use to adjust for any data class imbalances. (Note: Class imbalance is important for machine learning to prevent biased information output.) While object-based storage is not the panacea of unstructured or semistructured data management or inclusion into structured data sets, it does offer an avenue of organization that enables contemporary and evolutionary information generation strategies.

Data begets information leading to both knowledge and wisdom in the DIKW pyramid. Since each dataset will not have all the required data to answer an information call, optimizing storage and management systems enables increases in information returns. Object-based storage is an example of large dataset management, unstructured or semistructured, that would enable rapid data flexibility and information answerability. The next section breaks down how to apply the concept of the DIKW pyramid and object-based storage to both tactical and operational military constructs.

Break It Down—Build It Up

You can have data without information, but you cannot have information without data.

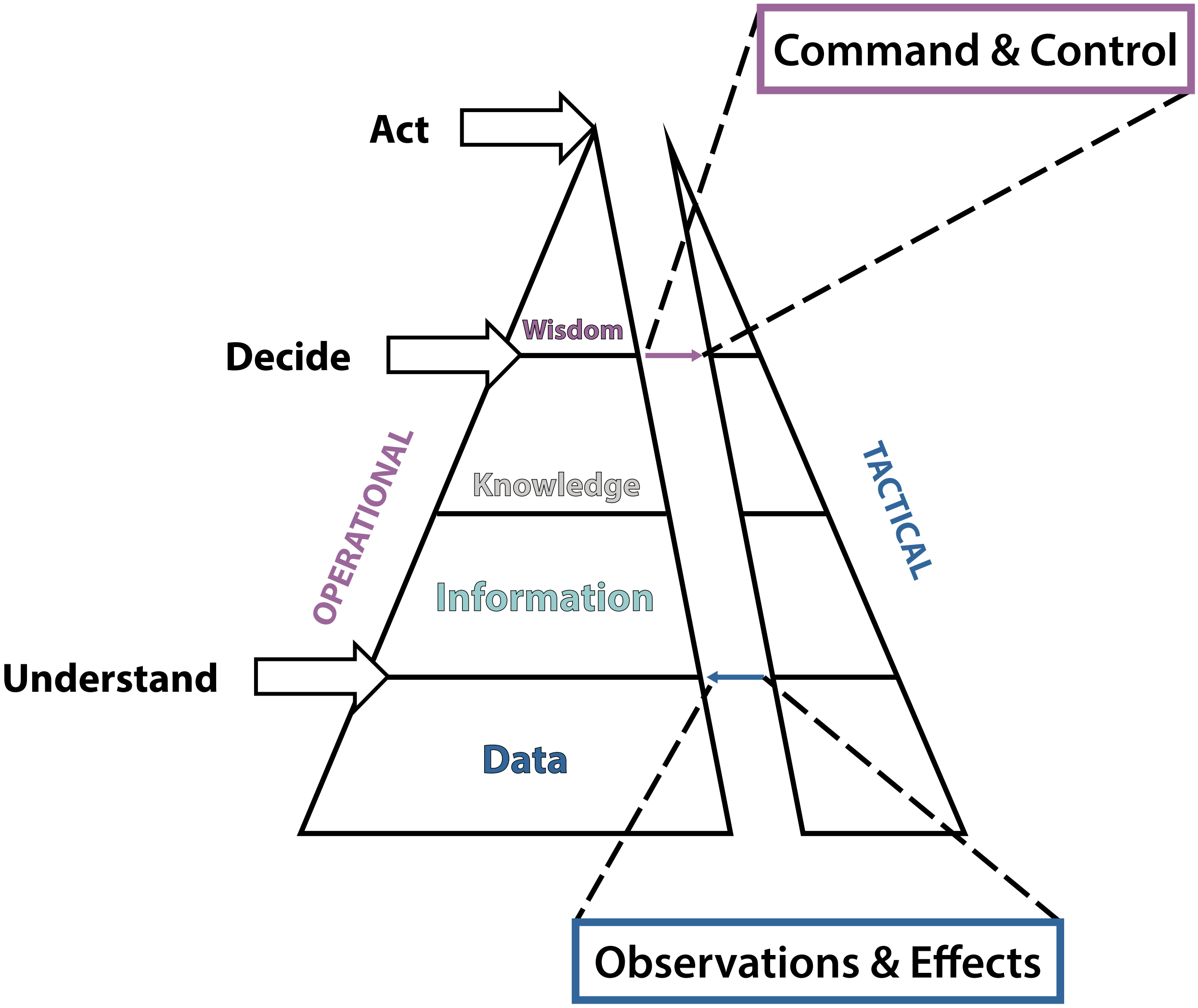
—Daniel Keys Moran[25]

Data management and information calling strategies have differing effects when applied to various levels of decision-making. Tactical and operational decision-making definitions have similar characteristics when compared between the commercial and defense sectors. The difference between the two resides on the tactical level, which is exemplified by immediate decisions needed to provide an in-situation effect against a specific goal. The operational level holds the grander scale decisions to provide long-term goal completion. This analysis focuses on one primary differentiator between operational and tactical levels, which is the timeline with which each follows.

Longer, operational timelines provide advantage in the opportunity for more data assembly and usage, but as a double-edged sword, the word "operational" implies larger force schemes of maneuver and thus, requires continuous, decisive, and contemporaneous action to affect the battlespace. Tactical timelines, while much more granular, offer simpler decisions and therefore, more precise data required to make the decision. If one imagines the DIKW pyramid as the total sum of all parts in or related to the battlespace, then operational actions should strive to account for the greatest chunk of the pyramid. Meanwhile, tactical actions should strive to optimize decision space by accounting for only that information, which relates to the next set of actions. As illustrated in figure 2, the DIKW pyramid could break down into varying shapes that exemplify different types of actions. The figure shows an example operational kill chain of understanding the environment, deciding on preferred commands, and acting within relative control to enable passing command-and-control actions along the seams of wisdom and knowledge. Those actions enter the segment of the pyramid wherein a tactical user enables their understanding of the intent or authority contained therein, decides on the correct effects and timeliness and acts, all the while relaying back to the operational segment both observations and effects.

When the Levee Breaks

Operational and tactical relationships, on a grander scale, necessitate that information and knowledge flow freely and bidirectionally across the inherent divide. Operational actions inherently encompass a series of tactical actions. Since the flow of data, information, knowledge, and wisdom is critical to operational and tactical success, analogize each layer of the DIKW pyramid as a body of water. Each body of water fills or flows at different rates. Consider a constantly streamed intelligence collector as a river of data and the information assertation results as streams filling a section of a knowledge reservoir. The knowledge from each individual collector coalesces to form the overarching situational awareness or knowledge reservoir. Similarly, knowledge produces pockets of battlespace awareness and understanding in the form of waterfalls. These waterfalls, in turn, help fill the situationally dependent wisdom lake that is already partially filled and sourced

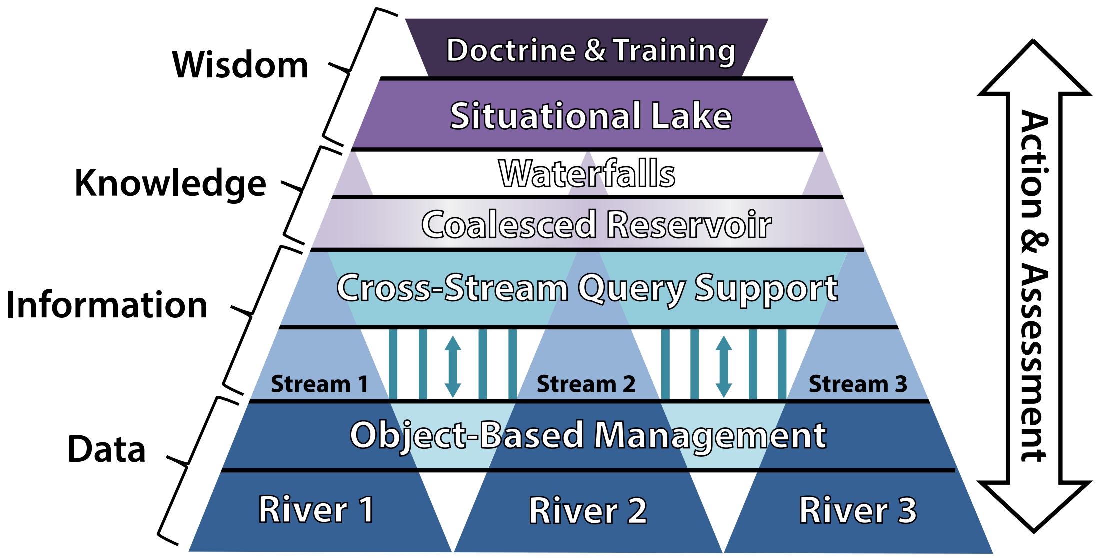


(Figure by author)

Figure 2. Example DIKW Breakdown

from pretraining, doctrine, and recent events. This lake ebbs and flows as knowledge of a situation changes, but as it ebbs, it will reach decisive fill points that necessitate action. Once an action occurs, it inherently reduces the lake's waterline while waiting on the results of said action in the form of assessment. This water analogy appears in figure 3 as a DIKW water table.

The DIKW water pyramid is agnostic of operational or tactical systems. It exemplifies how multiple different collectors from a single tactical system might create tactical understanding, decisions, and actions, or applied operationally, how multiple different tactical systems might feed operational understanding, decisions, and actions. The critical factor is how objected-based management of data fills the gaps of informational streams by allowing informative queries to transcend any individual data river. Furthermore, this factor highlights that a cohesion of multiple streams and cross-stream information fills a coalesced reservoir of knowledge in which individual pieces of knowledge can enable situational awareness that activates doctrine and training. Where doctrine and training lack, however, it also creates decision space for atypical actions that, when properly informed, might create the optimal solution to the current situation. Removing data cohesion eliminates the ability



(Figure by author)

Figure 3. DIKW Water Table

for pulling information from multivarietal sources, reducing the knowledge gained in any one situation, and creating ill-informed actions. Thus, data management enables data processing and subsequent information garnering, the cheapest and most cost-effective way to improve kill chain dynamics.

Conclusions

Without big data analytics, companies are blind and deaf, wandering out onto the web like deer on a freeway.

—Geoffrey Moore[26]

The defense sector lies at an inflection point for applying leap ahead technologies to exploit data in all forms. The commercial world has exploded with data applications from personalized advertisements to machine learning language models such as ChatGPT to market research to data storage and calling. The DIKW pyramid provides a simple data growth framework that, when applied correctly, could take future kill chain concepts and make them tenable. The critical key in making webs of sensors that feed webs of shooters is data management. In a world where communication, especially high-bandwidth, low-latency versions, cannot be guaranteed, data management can provide a continuum of successful decisions in a more future-proof, forecastable way. The best way to achieve data management at an infinite scalability with reliability and resilience in mind is object-based storage and management. Use any search engine, and find solution after solution advocating for object-based storage, from Google to Amazon Web Services to RedHat and more. "Developed in the late 1990s by researchers at Carnegie Mellon University and the University of California–Berkeley, object storage software today can store and manage terabytes (TBs) or petabytes (PBs) of data in a single namespace with the trifecta of scale, speed, and cost-effectiveness."[27]

The DOD should lead the next generation of kill chain dynamics in Joint All-Domain Operations by adopting object-based storage solutions within its intelligence apparatuses. First, it should accomplish an analysis of all its sources of data, specifically looking for where and how the source stores data. Then, it should look for where object-based storage solutions could, when inserted correctly, adapt current data streams into objects. They must accomplish this step both at tactical edge nodes and big data facilities, an underdeveloped operation. Finally, it should experiment with different information calling algorithms to ensure data usability. At completion, the DOD will have created a framework for all portions of the U.S. government to adopt, and it will have laid the groundwork for joint all-domain command and control and future design methodologies. Again, object-based storage is not the panacea, but it is one example of how the government could take advantage of the commercial sector's efforts to find, extract, and implement the most cost efficient and useful elements. Understanding the way data feeds the overarching machine is critical to the government as it would enable better decisions now, using legacy investments, optimizing data workflows, and ultimately, provide tools and knowledge when and where required. ■

Notes

1. Peter Sondergaard, "Keynote Address" (conference presentation at Gartner IT Symposium/Xpo, Orlando, FL, 2011).
2. Sarah E. Shatby, "The History of Data: From Ancient Times to Modern Day," 365 DataScience, 1 June 2022, https://365datascience.com/trending/history-of-data/.
3. Ibid.
4. Gordon E. Moore, "Cramming More Components onto Integrated Circuits," *Electronics* 38, no 8 (April 1965): 114–17.
5. Ibid.
6. Charles Morris, "Is Tesla's Onboard AI Chip Smarter than USAF's F-35 Fighter Jet?," InsideEVs, 21 May 2021, https://insideevs.com/features/508879/tesla-ai-chip-crazy-powerful/.
7. *Online Etymology Dictionary*, s.v., "data (*n.*)," accessed 29 January 2024, https://www.etymonline.com/word/data.
8. Daniel Barker, "How We Use the Word 'Data' Has Changed—and It's Dangerous," Towards Data Science, 23 February 2018, https://towardsdatascience.com/how-we-use-the-word-data-has-changed-and-it-s-dangerous-b7b6278a8e09.
9. Maddalena Favaretto et al., "What Is Your Definition of Big Data? Researchers' Understanding of the Phenomenon of the Decade," *PLoS ONE* 15, no. 2 (25 February 2020): Article e0228987, https://doi.org/10.1371/journal.pone.0228987.
10. Hui Luan et al., "Challenges and Future Directions of Big Data and Artificial Intelligence in Education," *Frontiers in Psychology* 11 (October 2020): Article 580820, https://doi.org/10.3389/fpsyg.2020.580820.
11. Ibid.
12. Sagar Khillar, "Difference between Big Data and Small Data," DifferenceBetween.net, 14 July 2020, http://www.differencebetween.net/technology/difference-between-big-data-and-small-data/.
13. Martin Frické, "The Knowledge Pyramid: A Critique of the DIKW Hierarchy," *Journal of Information Science* 35, no. 2 (April 2009): 1–13, https://doi.org/10.1177/0165551508094050.
14. Ibid.
15. Russell Ackoff, "From Data to Wisdom," *Journal of Applied Systems Analysis* 16 (1989): 3–9.
16. Laurie A. Schintler and Connie L. McNeely, eds., "Big Data Workforce," in *Encyclopedia of Big Data* (Cham, CH: Springer, 2022), 110, https://doi.org/10.1007/978-3-319-32010-6_208.
17. Ibid.
18. Ibid.
19. Ibid.
20. Ibid.
21. Ibid.
22. Mary K. Pratt, "Data Curation," TechTarget, 20 January 2022, https://www.techtarget.com/searchbusinessanalytics/definition/data-curation.
23. Emmanuelle Rieuf, "History of MySQL," Data Science Central: A Community for Big Data Practitioners, 16 December 2016, https://www.datasciencecentral.com/history-of-mysql/.
24. Schintler and McNeely, "Big Data Workforce," 110.
25. Corinne Lenherr, "'Patch Everything, All the Time' Is Out – Today Is Threat Intelligence," *Security Awareness* (blog), InfoGuard, 11 April 2019, https://www.infoguard.ch/en/blog/patch-everything-all-the-time-is-out-today-is-threat-intelligence.
26. Geoffrey Moore (@geoffreyamoore), "Thoughts from the week #1: Without big data analytics, companies are blind and deaf, wandering out onto the Web like deer on a freeway," Twitter, 12 August 2012, 10:29 p.m., https://twitter.com/geoffreyamoore/status/234839087566163968?lang=en.
27. Sudipto Paul, "What Is Object Storage? It's Crucial for Managing Cloud Data," G2, 5 November 2021, https://www.g2.com/articles/object-storage.

(Map courtesy of Wikimedia Commons)

International Force East Timor

A Case Study in Multinational Mission Command

Commandant Gavin Egerton, Irish Army

Derived from its original Prussian foundations in *Auftragstaktik*, mission command has become the contemporary command template of many Western land forces.[1] The philosophy promotes decentralized decision-making and the empowerment of subordinates to show disciplined initiative within the sphere of their commander's intent.

The practice of mission command has been espoused by senior U.S. Army leaders for more than twenty years. Army Doctrine Publication 6-0, *Mission Command*, published in 2019, clearly states that this is the U.S. Army's approach to command and control.[2] Yet, despite being enshrined in doctrine and enjoying strong advocacy, the universal adoption and practice of mission command remains elusive. As former Army Chief of Staff Gen. Mark Milley noted, the U.S. Army is "over-centralized … overly specify[ing] everything a subordinate has to do all the time."[3] Milley also recognized that while the U.S. Army preaches mission command, it doesn't necessarily practice it daily in everything it does.[4] In many instances, formations fail to achieve shared understanding, foster sufficient trust, or reward subordinates who show initiative.[5]

The factors that stifle mission command in organic U.S. Army formations are further exacerbated in the multinational environment. Additional barriers posed by linguistic, cultural, and doctrinal divergence, in addition to competing political objectives, create friction. This friction can serve to impede the application of mission command, particularly where commanders' intents are not successfully communicated to lower levels. Since Operation Desert Storm, the trend for the U.S. Army has been to conduct military operations as part of multinational forces. The twenty-first century has seen multinationalism proliferate and become the norm, and U.S. Army commanders should expect to operate as part of a multinational force.[6] Looking at future potential conflict, Field Manual 3-0, *Operations*, recognizes that large-scale combat operations typically include joint and multinational partners.[7] Therefore, the challenge facing current and future commanders of multinational forces is how to apply mission command in a heterogenous, ad hoc force with myriad contributing allies and partners.

This article provides an instance of an Indo-Pacific region stabilization operation in which mission command was successfully employed across a hastily assembled and diversely multinational force. What follows is an examination of the integration of an Irish platoon into a New Zealand battalion, which was part of an Australian brigade in the Australian-led International Force East Timor (INTERFET), 1999–2000. It serves as a useful case study for leaders who may contribute to or command a multinational force in the future.

Background to INTERFET

Originally a Portuguese colony, East Timor had a long struggle for independence. In 1949, the western half of the island of Timor became part of the newly established Republic of Indonesia, while the eastern half remained a Portuguese colony in which Portugal showed little interest.[8] The 1974 military coup in Portugal and resultant democratically elected government led to efforts to shed colonial baggage.[9] As Portuguese forces departed in December 1975, Indonesia invaded East Timor, ultimately incorporating the territory into the Republic of Indonesia.[10]

In 1998, Indonesia agreed to facilitate a United Nations-supervised referendum process in order to establish what status the people of East Timor wanted: semiautonomy as part of Indonesia, or full independence.[11] The result of the 30 August 1999 ballot was that the people of East Timor overwhelmingly favored full independence.[12] Immediately following the result, details began to emerge of how pro-Indonesia militia "were reducing East Timor's infrastructure to ruins," with instances of "intimidation, physical harassment, sniping, murder, and massacres."[13] The ensuing international media backlash made a military intervention all but inevitable. Such an intervention would likely

Commandant Gavin Egerton, Irish Army, is an infantry officer with twenty-one years of service. He has held command, staff, and training appointments at home and deployed overseas on operations on four occasions; once each to Chad and Mali, and twice to Lebanon. He holds an MA in political communication from Dublin City University and is completing a PhD in history from University College Cork, where his thesis title is "The Application of Mission Command in Multinational Forces." He is currently a student on the Command and General Staff Officer Course at Fort Leavenworth, Kansas.

Capt. Jim Deery talks with locals in the village of Fatululic, East Timor. Following the 1999 deployment of International Force East Timor, internally displaced persons could return to their homes. (Photo by Padraig O'Reilly)

be led by Indonesia's nearest and most militarily capable neighbor, Australia. However, any intervention needed to be a multinational effort, for as is the case in many regional crises, it was politically and militarily impossible for Australia to intervene unilaterally.[14]

Australian Command

At this time, Peter Cosgrove, then a major general, was simultaneously commander of the Australian Army's 1st Division and the Deployable Joint Force Headquarters, meaning that he would command the multinational joint force should an intervention occur. Cosgrove, a veteran of both Malaya and Vietnam, had been exposed to mission command as a young platoon commander—a significant factor is his adoption of the command philosophy throughout his career.[15] As Australian preparation for an increasingly likely intervention intensified, a coincidental but convenient preplanned Australian-U.S. combined joint exercise, Crocodile '99, served as a useful rehearsal.[16] As former Australian Prime Minister John Howard puts it, "If, as it finally eventuated, we were invited to contribute military personnel we would not be doing so from a standing start."[17]

On 15 September 1999, United Nations Security Council Resolution 1264 was adopted, invoking Chapter VII of the UN Charter and establishing an Australian-led multinational force.[18] Australia formed the nucleus of INTERFET's multinational joint headquarters and provided the largest number of troops. On 20 September 1999, INTERFET deployed to Dili by sea and air.[19] This diversely multinational force eventually included contributions from twenty-two nations with a strength of 11,500.[20]

New Zealand and Irish Contributions

The initial contribution from New Zealand was an infantry company group formed around Victor Company, 1st Battalion, Royal New Zealand Infantry Regiment (1 RNZIR), later joined by the remainder of the battalion plus elements of supporting arms. Due to other nations including Ireland, Fiji, and Canada contributing smaller contingents to 1 RNZIR, the battalion group (task force) eventually peaked at almost one thousand personnel.[21]

On 12 October 1999, answering the call for international military support, Ireland committed to the deployment of forty military personnel. This included a platoon of thirty Irish soldiers drawn from the Army Ranger Wing (ARW)—Ireland's special operations force—operating within the New Zealand battalion group.[22] The Irish platoon initially helped constitute a hastily formed "Reconnaissance Company," operating from the main battalion base at Suai and led by then Maj. John Rogers. The Irish platoon later moved to Victor Company—a typical rifle company—led by then Maj. John Howard, where they were assigned their own discrete platoon area of operations and patrol base close to the border with West Timor.

Perceptions of Mission Command Prior to Deployment

Interestingly, some Irish soldiers deploying to East Timor had little or no familiarity with the theory of mission command. As Bravo Team leader who served with the 1st Irish contingent (IRCON 1) explains, "It's new to me even now—Mission Command—but when we talk about it I know what it is, and [in the ARW] we've been doing that since the '80s."[23] Some other interviewees had encountered the command philosophy in practice and could recount positive experiences. The commander of the first Irish platoon to deploy to INTERFET with IRCON 1 was then Capt. Benny McEvoy. Early in his career, McEvoy was exposed to mission command when engaged on an internal security operation to secure Dublin Airport during a European summit:

> My company commander gave me Mission Command to patrol my area without interfering … he gave me a section of the area; he didn't specify how I was to secure it. And he gave me the resources to interact with the other companies and also an Air Corps [helicopter] … He never interfered with my mission, and I adopted the same approach with my NCOs.[24]

Furthermore, McEvoy encountered mission command on his first overseas deployment to the United Nations Interim Force in Lebanon (UNIFIL), prior to INTERFET. He recalls, "[the company commander] had drilled-in his intent, how he wanted us to be high-profile, to make decisions and be confident, and to trust our NCOs … he had entrusted us and gave us confidence to carry out his intent."[25]

In contrast to McEvoy's positive experiences with mission command, Capt. (Ret.) Jim Deery, who commanded the second Irish platoon to deploy to East Timor, was not as fortunate. His experiences prior to joining the ARW and deploying to INTERFET was of an army with little scope for initiative. Deery explains,

> It was very hierarchical: you do what you're told and you swing up your arms. … As a junior officer—a second lieutenant—there would have been no latitude for [initiative]; I probably really didn't encounter it until I went to the Ranger Wing.[26]

This lack of freedom to show initiative is echoed by one of the most junior members of Deery's platoon in East Timor, Ray Goggins, then a corporal. Reflecting on the early years of his career, Goggins outlines a very similar lack of mission command prior to joining the ARW:

> Prior to East Timor … I had been an infantry corporal and I was used to being tasked very specifically; and your next commander up is never too far away from you so there's always a very short leash on you. You get a small bit of leeway; probably not that much really. So my view of Mission Command was extremely narrow.[27]

The impression one gets from these contributions is that the practice of mission command in the Irish Army of the 1990s was inconsistent, largely contingent on the personalities of the commanders involved. Mission command was not yet enshrined in Irish doctrine and it was still an emergent command philosophy in most Western militaries. However, Col. Ray Murphy sheds some light on the prevailing command culture in the Irish Army in the late 1990s. Then a captain and serving as second-in-command (2IC) of the ARW, Murphy was selected as the officer in charge of the ARW detachment deployed to

An Army Ranger Wing team from 2nd Irish Contingent patrols the village of Fatululic, East Timor. (Photo by Padraig O'Reilly)

Irish infantry soldiers serving with the follow-on UN peacekeeping force board a New Zealand Army helicopter. This was often the only viable means of insertion for patrolling the mountainous terrain. (Photo courtesy of Ireland Military Archives)

INTERFET with IRCON 1. He explains why mission command was difficult to implement in the Irish Army during this period:

> Firstly, there was an element of stagnation taking place in the organization … the only operations that were being conducted, in general, were those in Aid to the Civil Power and our only operational focus overseas was UNIFIL … Secondly, there was a disparity between what young officers were being taught and what their superiors had been taught in the past. However, I did notice that even without my superiors' understanding of Mission Command, if they had trust in me to complete a task in the manner they expected, I was given freedom of action.[28]

Murphy's explanation provides a very useful snapshot of the Irish Army of that era. It was emerging from an internal security role and becoming increasingly professionalized, with concepts such as mission command only just beginning to take hold. However, the ARW was slightly different. Akin to other special operations units, soldiers serving in the ARW were expected to show initiative in line with their commander's intent and were given freedom of action to do so.[29] Murphy explains that "while the operators in the unit at the time may not have known about the concept of Mission Command they certainly understood what was the best way to maximize their particular skill sets to get the job done in the most efficient and effective fashion."[30] Thus, the ARW was at that time ahead of the developmental curve of the rest of the Irish Army in terms of empowerment, freedom of action, decentralized authority, etc. Consequently, many of the ingredients of mission command were present in practice, if not by name or underpinned by doctrine.

The New Zealand Army of the same era was more advanced in this regard. Maj. Gen. John Howard points out that mission command was already the command and control philosophy of the New Zealand Army,

Patrol commanders were empowered to conduct their operations as they saw fit, once those operations aligned with their platoon and company commanders' intents. (Photo courtesy of Ireland Military Archives)

having been adopted in the early 1990s and embedded in all career courses.[31] As Howard explains, "The tenets were well explained and endorsed … [and] it was very much imbued into our training prior to going to Timor."[32] The Irish platoon was consequently entering an already established mission command culture, though also bringing their own ethos of freedom of action and comfort with working independently whilst aligned with the commander's intent.

The Presence of Mission Command in INTERFET

Many Western armies have devised their own principles of mission command, with the U.S. Army adopting competence, mutual trust, shared understanding, commander's intent, mission orders, disciplined initiative, and risk acceptance.[33] However, the contributions from the commanders interviewed justify a further rationalization to three essential components: communication, empowerment, and trust.

Communicating and understanding commanders' intents. To create unity of effort and purpose, commanders must carefully construct and transmit their intent to those under their command. Without a clear understanding of the commander's intent, it is impossible to generate decentralized decision-making or disciplined initiative. In the case of INTERFET, Cosgrove summed up his strategic intent as "first, to restore and maintain peace and security for East Timor; second, to assist the United Nations to return and perform its functions in East Timor (this included establishing a follow-on UN military force); and, third and emphatically, to improve our relationships with Indonesia."[34] A concise intent such as this is easily transmitted and remembered—it is short and covers just three key goals. It also provides a clear end state.

Significantly, Cosgrove recognized how vital it was for his intent to be understood at the lowest levels: "I thought it was extraordinarily important for my subordinates to know enough of the strategic intent, and the political-military factors, so that they would react with that in mind and always react in a way appropriate to the circumstances."[35] This demonstrates an appreciation of the ability of the most junior commander to influence the overall outcome of the entire mission, congruent with Krulak's infamous "strategic corporal."[36] As Rogers points out, "[Cosgrove] would talk about the strategic section commander" concept, indicative of his attitude toward empowering junior leaders.[37] Col. (Ret.) Kevin Burnett commanded 1 RNZIR during the duration of INTERFET and its transition to United Nations Transitional Administration East Timor. He remembers,

> I was very clear on commander's intent from a strategic perspective from Major General Cosgrove, because he was very articulate, and that's very helpful … so the strategic intent was clear. And so was the brigade-level operational objectives; very clear at all phases of the operation, I didn't have any doubt about what was being asked for us.[38]

Rogers, as company commander, remembers his superiors' intents being communicated regularly:

> We all understood them very clearly, and they were communicated formally in orders … We would have a nightly conversation and Kevin [Burnett] would reinforce his intent as it evolved. And of course, he'd be out visiting and we'd be back in [battalion headquarters] and so there would be the informal reinforcing or texturing of that intent as well.[39]

Commandant (Ret.) Eamonn Kenneally, then a sergeant, served as 2IC of Alpha Team in IRCON 1. He remembers an early visit from Cosgrove where he outlined his intent:

> I think the words he gave us (not verbatim) was that our primary purpose there was to restore peace to East Timor so that the East Timorese people—who were the center of gravity—could return to a safe and secure environment and live their normal lives … He also mentioned about the people who were going to come after us.[40]

Furthermore, Kenneally recalls that his company commander visited each platoon regularly and offered further context. As Kenneally explains, "I was left in no doubt what our job was and what the commander's intent was."[41]

Empowerment and freedom of action. If subordinates are not given sufficient freedom to decide and act with minimal supervision, they are unlikely to exercise disciplined initiative and mission command will fail. Burnett recalls,

> We provided our sub-units with clear direction as to what we wanted them to achieve [and] we gave them the resources to do it. And we didn't dictate their approach, we didn't bound the way they went about their business.[42]

Furthermore, when tasking his company commanders, Burnett used a "mission orders" approach congruent with mission command theory. He remembers emphasizing "real clarity over the objectives two-up, real clarity about what I wanted us to achieve and then tasks that I thought the subunits needed to undertake, and then as much freedom to operate as we could reasonably give."[43]

From the perspectives of the company commanders, Rogers notes that he felt "very, very much empowered." As he recalls, "We had a high level of autonomy, a high level of trust … and our freedoms and constraints were very clear."[44] Howard concurs but admits, "I've never been an officer who waits for orders. Our officer cadet training is very clear about understanding intent and getting on and doing something."[45]

From the Irish perspective at team/section level, Kenneally remembers, "It was very obvious from day one that Captain Benny McEvoy had created a culture that was one of trust and belief in us … We were empowered by him and by his commander to use Mission Command where applicable."[46]

Such empowerment and freedom of action is a product of sufficient trust present within the chain of command.

Fostering trust. One of the key ingredients in mission command is trust, but trust is more difficult to build in a hastily formed heterogenous multinational force than in a homogenous national formation. Cosgrove, when reflecting on the importance of trust, points out that "part of learning to trust is to be careful with Mission Command; that you fundamentally understand and have confidence in the person in whom you are entrusting the mission."[47] Australia and New Zealand were already partner nations with a deep, shared military history so for them, trust built quickly and Cosgrove as force commander could readily employ

Heavily laden soldiers of 5th Irish Contingent, drawn from the Irish Army's 4th Infantry Battalion, return from a long-range patrol. (Photo courtesy of Ireland Military Archives)

mission command with those contingents. However, prior to INTERFET, neither country was familiar with the ARW specifically, or even with the Irish Army in general. As Alpha Team leader puts it, "We were a completely unknown entity before we arrived."[48] And Burnett admits, "We didn't know what we were getting. We hadn't worked with the Irish before to any degree."[49] Therefore, commanders at all levels had to work hard to build relationships and foster trust, and this began during combined predeployment training in Townsville, Australia. Alpha Team leader believes a number of early demonstrations of competence served as quick wins, contributing to the initial generation of trust: "We went to an electronic gallery range in Townsville and had a shooting competition as a unit, and we won. … They also saw us out training and they saw what we could do."[50]

Murphy recalls during predeployment training in Townsville, the battalion 2IC of 1 RNZIR appointed a warrant officer with a special forces background as liaison between the Irish contingent and his own headquarters. Murphy points out, "It was clear that an additional reason for the attachment of the support NCO was to assess our standards and settle any doubts that the 1 RNZIR command element may have had."[51] Part of Murphy's role was that of liaison officer. This early exchange of liaison officers between the Irish platoon and the New Zealand battalion seems also to have been decisive in the initial generation of trust. As Murphy explains,

> When this NCO met us, and started to talk with [our platoon HQ and team leaders] it became very clear, very quickly that all were talking the exact same operational language. … After a few hours with us it was noticeable how relaxed he was in our company and how all of the Irish soldiers treated him as one of their own. I'm sure that this got back to the battalion commander and 2IC and went some way to assuaging any fears they had that we wouldn't fit in.[52]

Burnett remembers receiving initial reports of the Irish platoon: "I heard great stories of the arrival of the Irish platoon into the battalion main body in Townsville … there was real capability in that platoon, their training levels were high … and that gave us a lot of confidence."[53]

Rogers notes that, "the trust built very quickly, just based on seeing their capability and confidence."[54] As the deployment progressed, and as IRCON 1 demonstrated increasing competence and reliability, the level of trust steadily increased. As Bravo Team leader recalls, "We always worked at nighttime when we patrolled … (we had good night vision) … we preferred to work at night. And that's where I believe the trust was from: we were given missions, and we were never compromised."[55]

Competence is a principle of mission command and a key ingredient in the generation of trust and a move toward a mission command-friendly environment. This appears to have been decisive in the integration of the Irish platoon.

What Made Mission Command Work in INTERFET?

The evidence above demonstrates how mission command manifested and developed in INTERFET, but there were a number of significant factors that were decisive in its successful application. The strong advocacy from leaders, the physical environment, and the existing habitual association all contributed to mission command's effectiveness.

Advocacy for mission command doctrine and practice. INTERFET benefitted from the presence of strong advocates for mission command, commanders who not just practiced but championed the philosophy. The force commander himself was a strong advocate for mission command. As Cosgrove puts it, "There are some occasions where if you try to apply something other than Mission Command, you're setting people up to fail."[56] The commander of 3rd Brigade—the Australian formation that 1 RNZIR was part of in INTERFET—was Brig. Mark Evans, who was also a strong advocate for mission command and had already adopted that command philosophy with his brigade. Evans recalls that 3rd Brigade deployed on preplanned brigade exercise earlier in 1999, a period that he considers key to the operational success seen later in East Timor.[57] As he explains,

> It was at [this exercise] that the foundations were put in place for us to operate using mission command as our command and control philosophy: mutual trust, a clear and universal understanding of our standard operating procedures and encouragement of initiative at all levels, and this became the hallmark of the brigade.[58]

Burnett notes that "Mark Evans was a great commander. He gave us a lot of leeway, a lot of opportunity to operate in the way that we wanted to operate. So I didn't feel in the least bit constrained by the brigade headquarters."[59]

As stated, New Zealanders were already practitioners of mission command, and Burnett recalls that they were "fully embracing Mission Command long before East Timor," and for the New Zealand Army, it was "just the normal way people commanded."[60] The commanders of the two companies that the Irish platoons came under were particularly strong advocates of mission command. From Rogers's perspective, "Mission Command was absolutely organic to how we worked—fundamental—and I'm a very strong advocate for Mission Command."[61] Howard observes, "In my experience, if you look at any military operation that has been planned, conducted, and executed under Mission Command, it produces better outcomes."[62] With such strong advocacy for mission command at all levels from force commander, through brigade, battalion, and company commanders, it was certainly a very positive environment for McEvoy to enter with his IRCON 1 platoon.

Impact of the environment on command. East Timor's interior is a physically harsh mountainous environment that slowed internal communications.[63] Alpha Team leader remembers one patrol: "It took us eight hours to travel something like four kilometers. It was just outrageous terrain."[64] This physical environment and the nature of the patrolling, which was conducted primarily by sections or platoons, meant the empowerment of junior leaders was critical.

Col. Colm Ó Luasa served as the officer in charge of IRCON 2's ARW detachment, but also as Howard's company 2IC.[65] Ó Luasa explains how the restrictive nature of the terrain, particularly in terms of accessibility to the platoons operating from remote patrol bases, necessitated a mission command approach: "There was quite a large amount of Mission Command [which] was almost enforced simply by distance and accessibility … [The battalion was] spread over a large area and you couldn't even drive by vehicle to all those areas."[66]

For the New Zealand battalion, and for INTERFET more broadly, a hands-on, detailed command style simply could not be employed. Ó Luasa explains how Burnett overcame this challenge:

> [The battalion commander] dealt with his command and control by having 'prayers' every evening on the radio. It was all verbal, over the radio, and each company would come up, give a SITREP, then he would ask a number of questions and then move on to the next company … He could give his intent and direction but he didn't have the facility or the time to get into levels of detail required. So he gave his general direction and he let the company commanders deal with the detail.[67]

Therefore, mission command was the only real option for command and control in INTERFET. To attempt to impose himself on his subordinate commanders, a battalion or company commander would have a difficult journey over rough terrain, covering a lot of distance, thus necessitating a decentralized approach to command.

Habitual association and predeployment training. Australia and New Zealand enjoyed a shared military history and culture that includes the two nations routinely conducting combined joint training together. Burnett recalls an exercise where his unit familiarized themselves with 3rd Brigade:

> I took over command of the battalion in 1997, and the first thing I did was I took the battalion to Australia to work with 3 Brigade on exercise. So we knew 3 Brigade—different commander, different key staff officers, but the same formation."[68]

This familiarity was very beneficial upon arriving in East Timor, with some familiar faces and existing relationships to help 1 RNZIR integrate into the brigade. While the Irish platoon did not have the same access to such experiences, they did get the opportunity to conduct combined predeployment training in Townsville.

Conclusion

INTERFET can be regarded as an exemplar in terms of the practical application of mission command in a multinational force. A relatively unknown entity prior to INTERFET, the Irish platoon integrated successfully into the New Zealand battalion, which itself smoothly merged into the Australian brigade with which they were already familiar. Leaders from force commander to platoon commander espoused and practiced mission command, and the ARW team leaders were more than sufficiently experienced and competent to thrive in such a command-and-control environment. The physically harsh terrain slowed communication, and the distributed nature of 1 RNZIR necessitated a mission command approach. During combined predeployment training, demonstrations of competence and building of relationships at the lowest levels contributed to the rapid building of trust.

Notwithstanding the obvious benefits of shared military history and training, an outsider element can integrate successfully in a relatively short period of time, as long as enough commonality and competence exists in terms of culture, training, doctrine, tactics, etc.

For senior officers soon to take command of a multinational force, formation, or unit, the lessons learned from this case study are worthy of consideration. Of particular note is the importance of constantly communicating and contextualizing commanders' intents, empowering subordinates with freedom to decide and act, and making a conscious effort to foster an environment of mutual trust. With these elements present mission command will not just succeed, it will flourish. ■

Notes

1. Russell W. Glenn, "Mission Command in the Australian Army: A Contrast in Detail," *Parameters* 47, no. 1 (Spring 2017): 21, https://press.armywarcollege.edu/cgi/viewcontent.cgi?article=2833&context=parameters; Anthony C. King, "Mission Command 2.0: From an Individualist to a Collectivist Model," *Parameters* 47, no. 1 (Spring 2017): 7, https://press.armywarcollege.edu/cgi/viewcontent.cgi?article=2832&context=parameters.

2. Army Doctrine Publication (ADP) 6-0, *Mission Command: Command and Control of Army Forces* (Washington, DC: U.S. Government Publishing Office [GPO], 2019), 1-16.

3. Mark Milley, as quoted in David Barno and Nora Bensahel, "Three Things the Army Chief of Staff Wants You to Know," War on the Rocks, 23 May 2017, https://warontherocks.com/2017/05/three-things-the-army-chief-of-staff-wants-you-to-know/.

4. Ibid.

5. David J. Devine, "The Trouble with Mission Command: Army Culture and Leader Assumptions," *Military Review* 101, no. 5 (September-October 2021): 42, https://www.armyupress.army.mil/Journals/Military-Review/English-Edition-Archives/September-October-2021/Devine-Mission-Command/.

6. Joint Publication 3-16, *Multinational Operations* (Washington, DC: U.S. GPO, 2019), I-1.

7. Field Manual 3-0, *Operations* (Washington, DC: U.S. GPO, 2022), 1-16.

8. Tom Frame, ed., introduction to *INTERFET: Lessons and Legacies from East Timor 20 Years On* (Redland Bay, AU: Connor Court Publishing, 2020), 2; John Crawford and Glyn Harper, *Operation East Timor: The New Zealand Defence Force in East Timor 1999-2001* (Auckland, NZ: Reed, 2001), 11.

9. Crawford and Harper, *Operation East Timor*, 11; Kevin Riordan, "Peacekeeping Operations in East Timor: A New Zealand Legal Perspective," *New Zealand Armed Forces Law Review* (October 2001): 20, https://heinonline-org.ucc.idm.oclc.org/HOL/Page?handle=hein.journals/nzaflr1&id=19&collection=journals&index=journals/nzaflr.

10. Frame, *INTERFET*, 3.

11. David Dickens, "The United Nations in East Timor: Intervention at the Military Operational Level," *Contemporary Southeast Asia* 23, no. 2 (August 2001): 215, https://www.jstor.org/stable/25798543.

12. Marianne Jago, "InterFET: An Account of Intervention with Consent in East Timor," *International Peacekeeping* 17, no. 3 (2010): 378, https://doi.org/10.1080/13533312.2010.500149.

13. Dickens, "The United Nations in East Timor," 216.

14. Peter Cosgrove, *My Story* (Sydney: HarperCollins, 2006), 166, 167.

15. Peter Cosgrove (retired general), in communication with the author, 28 September 2021.

16. Cosgrove, *My Story*, 152.

17. John Howard, "A Political Perspective," in Frame, *INTERFET*, 3.

18. UN Security Council, Resolution 1264, Establishment of Multinational Peace Force in East Timor, S/RES/1264 (1999).

19. John Blaxland, "Information Era Manoeuvre: The Australian-Led Mission to East Timor," *Journal of Information Warfare* 1, no. 3 (2002): 94, https://www.jstor.org/stable/26504107.

20. Crawford and Harper, *Operation East Timor*, 150.

21. Kevin Burnett (retired colonel), in communication with the author, 7 October 2022.

22. "International Agreements: Motion," 509 Dáil Deb. 1 (12 October 1999) (Ir.), https://www.oireachtas.ie/en/debates/debate/dail/1999-10-12/13/.

23. A pseudonym for the sergeant in charge of one of the four teams in the Army Ranger Wing platoon with the first Irish contingent; Bravo Team leader, in communication with the author, 23 August 2022.

24. Benny McEvoy (retired lieutenant colonel), in communication with the author, 13 July 2022.

25. Ibid.

26. Jim Deery (retired captain), in communication with the author, 24 June 2022.

27. Ray Goggins (retired sergeant), in communication with the author, 11 July 2022.

28. Ray Murphy (colonel), email message to author, 2 September 2022.

29. Ibid.; Alpha Team leader, in communication with the author, 23 August 2022; Bravo Team leader, communication.

30. Murphy, email.

31. John Howard (major general), in communication with the author, 18 July 2022.

32. Ibid.

33. ADP 6-0, *Mission Command*, 1-7.

34. Peter Cosgrove, "The Commander's Perspective," in Frame, *INTERFET*, 79.

35. Serge Desilva-Ranasinghe, "The Australian Army Has Certainly Evolved a Very Strong COIN Doctrine: Exclusive Interview with General Peter Cosgrove," *Asia Pacific Defence Reporter (2002)* 36, no. 7 (September 2010): 33, https://search.informit.org/doi/10.3316/ielapa.664521582376331.

36. Charles C. Krulak, "The Strategic Corporal: Leadership in the Three Block War," *Marine Corps Gazette* 83, no. 1 (January 1999): 21, https://www.mca-marines.org/wp-content/uploads/1999-Jan-The-strategic-corporal-Leadership-in-the-three-block-war.pdf.

37. John Rogers (retired lieutenant colonel), in communication with the author, 2 September 2022.

38. Burnett, communication.

39. Rogers, communication.

40. Eamonn Kenneally (retired commandant), in communication with the author, 13 July 2022.

41. Ibid.

42. Burnett, communication.

43. Ibid.

44. Rogers, communication.

45. Howard, communication,

46. Kenneally, communication.

47. Cosgrove, communication.

48. Alpha Team leader, communication.

49. Burnett, communication.

50. Alpha Team leader, communication.

51. Murphy, email message.

52. Ibid.

53. Burnett, communication.

54. Rogers, communication.

55. Bravo Team leader, communication.

56. Cosgrove, communication.

57. Mark Evans, "A Tactical Commander's Perspective," in *East Timor Intervention: A Retrospective on INTERFET*, ed. John Blaxland (Melbourne, AU: Melbourne University Publishing, 2015): 99.

58. Ibid., 100.

59. Burnett, communication.

60. Ibid.

61. Rogers, communication.

62. Howard, communication.

63. A. Ryan, "The Strong Lead-Nation Model in an Ad-Hoc Coalition of the Willing: Operation Stabilize in East Timor," *International Peacekeeping* 9, no. 1 (Spring 2002): 30, https://doi.org/10.1080/714002694.

64. Alpha Team leader, communication.

65. The very fact that an Irish officer was filling the role of second in command of a New Zealand company is testament to the high levels of professional trust that had developed between the two militaries by the time the second Irish contingent deployed.

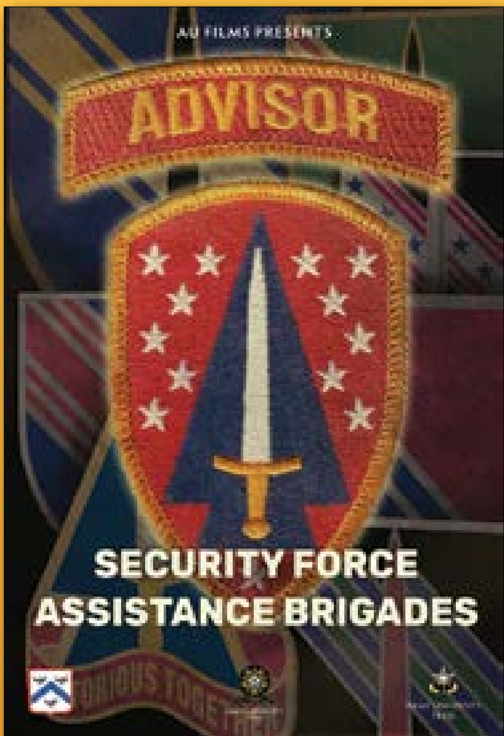
66. Colm Ó Luasa (colonel), in communication with the author, 28 June 2022.

67. Ibid.

68. Burnett, communication.

Army University Films Presents

Security Force Assistance Brigades



Working in collaboration with Security Force Assistance Command (SFAC), AU Films recently released a documentary on Security Force Assistance Brigade (SFAB). Since their creation in 2017, SFABs have provided the U.S. Army with dedicated advisor units that allow brigade combat teams to focus on their primary mission, large-scale combat operations. In the interview-driven documentary, AU Films examines the SFAB mission, what life is like as an advisor, and the challenges SFABs face in the future. The film features Maj. Gen. Donn H. Hill, Lt. Gen. (Ret.) Michael Lundy, and other SFAC/SFAB leaders who discuss how SFABs strengthen our allies and partner forces while supporting U.S. security objectives.

Scan the QR Code or visit the link below to watch *Security Force Assistance Brigades*

https://youtu.be/ohQxtys7FQU?si=hVb6hxpzK96o2HpF

For more about the origin and role of SFABs, view past articles online from *Military Review*

"Enabling Division Operations across the Conflict Continuum: What an SFAB Can Do for You" by Lt. Col. Eric B. Alexander, U.S. Army, https://www.armyupress.army.mil/Journals/Military-Review/English-Edition-Archives/March-April-2024/Conflict-Continuum/

"The Lesson of the Security Force Assistance Brigade in Africa: Find the Authority to Compete and Win" by Maj. Spencer D. Propst, U.S. Army, https://www.armyupress.army.mil/Journals/Military-Review/English-Edition-Archives/March-April-2022/Propst/

"Thinking Outside of the Sandbox: Succeeding at Security Force Assistance beyond the Middle East" by Lt. Col. Jahara "Franky" Matisek, PhD, U.S. Air Force; and Maj. Austin G. Commons, U.S. Army, https://www.armyupress.army.mil/Journals/Military-Review/English-Edition-Archives/March-April-2021/Matisek-SFAB-Beyond/

"Concepts for Security Force Assistance Brigade Company Task Forces in Large-Scale Combat Operations" by Maj. Zachary L. Morris, U.S. Army, https://www.armyupress.army.mil/Journals/Military-Review/English-Edition-Archives/November-December-2023/Maj-Morris/

"Preparing SFABs for the Complexity of Human Interaction" by Lt. Col. Brent A. Kauffman, U.S. Army, https://www.armyupress.army.mil/Journals/Military-Review/English-Edition-Archives/July-August-2018/Kauffman-SFA/

"Lewis and Stokes: What Lawrence of Arabia and His Sergeants Teach Us about the Modern Combat Advisor" by Lt. Col. Garrett M. Searle, U.S. Army, https://www.armyupress.army.mil/Journals/Military-Review/English-Edition-Archives/March-April-2024/Lewis-and-Stokes/

3D Printing Solutions for Contested Medical Logistics

Lt. Col. Michael Browning, DMD, MS, U.S. Army
Lt. Col. Michael Hoffman, DDS, MS, U.S. Army
Lt. Col. Michael Kroll, DMD, MS, U.S. Army
Lt. Col. Andres Mendoza, DDS, MS, U.S. Army*
Maj. Ross Cook, DMD, MS, U.S. Army
Maj. Martin Smallidge, DMD, MPH, MS, U.S. Army

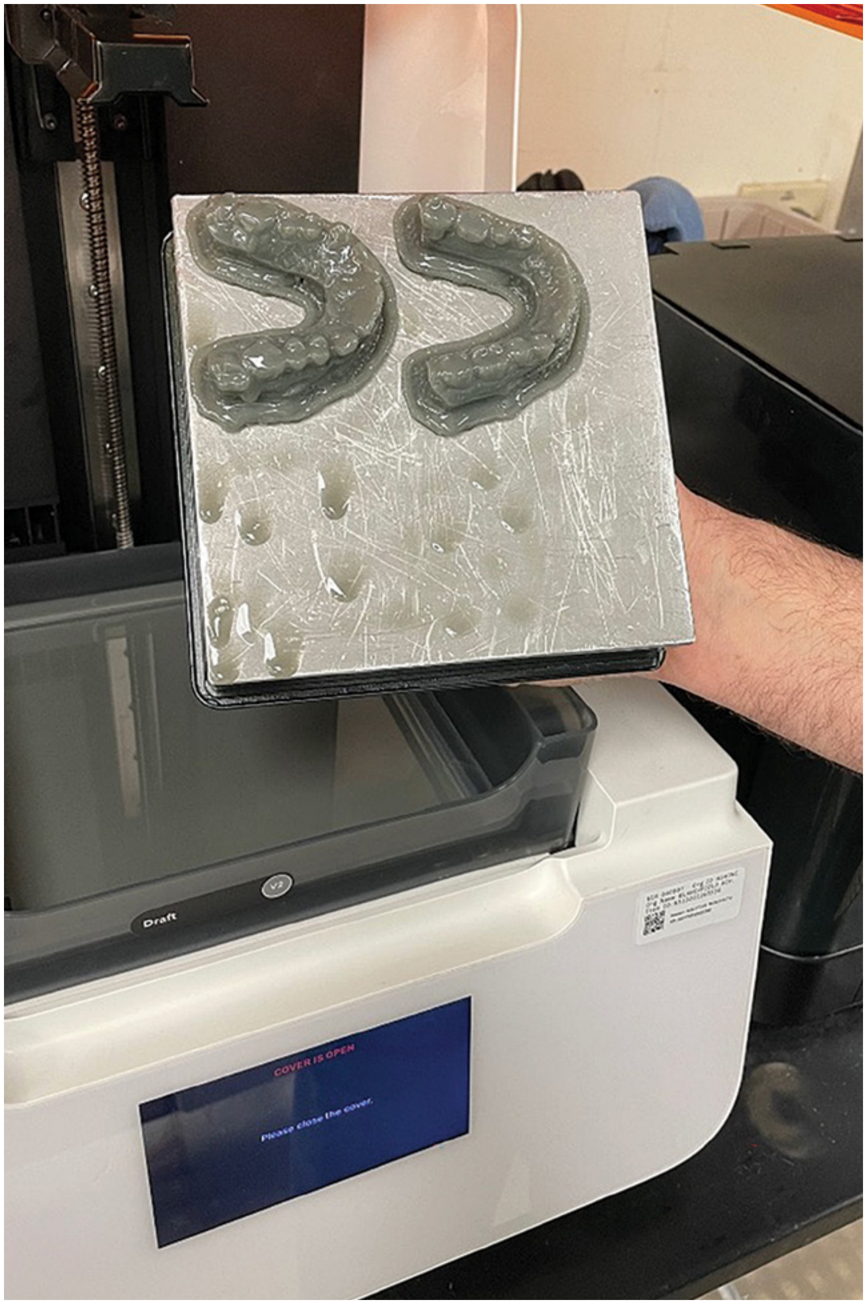
The Army Health System must reduce the size and weight of contemporary equipment to keep pace with the kinetic, dispersed nature of future conflicts. The *Army Medical Modernization Strategy* introduces the role of additive manufacturing, or 3D printing, in pharmacy and medications.[1] However, a growing body of literature suggests a wider range of uses in health care. Additive manufacturing can fabricate products such as bioactive bandages, orthopedic screws, surgical instruments, and medical simulation models.[2] The U.S. Navy 3D-printed teeth in 2021 to restore a young marine's ability to eat, smile, and speak after reconstructive jaw surgery.[3] The clinical and operational implications of this emerging technology are vast. Integrating additive manufacturing technology from Role of Care I to Role of Care III can reduce size and weight while improving mobility for forward medical units supporting maneuver elements. The Army Health System can employ 3D printing technology to enhance materiel sustainment by leveraging the U.S. Army Dental Corps' training, knowledge, and experience.

Medical Mobility Is a Timeless Problem

Cumbersome medical equipment challenges mobile support. During World War II, the Mediterranean and North African campaigns revealed the recurring experience of dental, medical, and surgical units struggling to transport materiel. Medical containers were often mislabeled during landing operations and sometimes only partially filled with equipment. These units arrived either without any equipment or with a significant shortage of equipment, which reduced their capabilities. Patient litters, a basic item, were one of the most cited shortages.[4] "Standard dental chests," analogous to modern dental equipment sets, were often deemed too heavy and left behind.

During Operation Desert Storm, mobile Army surgical hospitals were significantly hindered by the weight of their medical and nonmedical equipment, such as surgical equipment, tentage, and portable generators. One mobile Army surgical hospital weighed 1,450 tons, equivalent to twenty-one M1A1 tanks.[5] Exacerbating this problem, these medical units lacked adequate vehicles and competed with combat units for corps-level transportation assets. To maintain supporting distance with frontline movement, these hospitals advanced with only 40 percent bed capacity and 50 percent surgical capability.[6] Medical units had to sacrifice their effectiveness to keep pace.

The materiel challenges of World War II and Desert Storm remain relevant. A brigade support medical company (BSMC) provides Role II care to an entire brigade combat team. In 2021, a BSMC commander for the 101st Airborne Division (Air Assault) determined their forty medical equipment sets and dental equipment sets take four hours to set up.[7] This footprint impeded responsive support to air assault operations. The BSMC commander coordinated with the brigade support battalion's distribution company to develop scalable, mobile support for a dynamic forward line. However, moving the equipment sets required an M1120 Load Handling System, a ten-ton vehicle; an M1077 flat-rack; and three Tricon shipping containers.[8] Modernization demands reduced footprints of this size and weight to effectively support highly mobile units.



These recently printed dental models are still covered with liquid resin residue. These models require post-processing wash and polish prior to clinical use. The printer bed filled with a pool of gray liquid resin can be seen in the foreground. (Photo by Maj. Ross Cook, Advanced Education in General Dentistry Residency Program)

Conflict with near-peer adversaries demands agile support. The nature of large-scale conflict with a near-peer adversary will restrict evacuation, overwhelm treatment facilities, and exhaust medical logistics. Warfighter exercises estimate three thousand to four thousand casualties per day of large-scale combat.[9] A U.S. Army corps-level wargame projected twenty-one thousand casualties in seven days, a loss of half the corps' strength.[10] Accurate reports from the Russian-Ukrainian conflict are unavailable since Moscow and Kyiv do not publish official figures. However, multiple sources estimate the Ukrainian military suffered 120,000 casualties, with killed in action ranging from seventeen thousand to seventy thousand.[11] Daily averages amount to fifty-four civilian casualties, 314 Ukrainian military casualties, and 502 Russian military casualties.[12] To offer perspective, the U.S. Army incurred 354 wounded in action and ninety-six killed in action over the entire duration of

Operation Desert Storm.[13] These numbers have overwhelmed Ukraine's battered medical infrastructure.

Russian military tactics in Ukraine restrict movement and forward treatment. Long-range precision weapons and area-denial munitions, such as antitank and antipersonnel mines, along with trench warfare resemble World War I. Medics struggle to reach patients, and evacuation to hospitals can take up to ten hours.[14] Civilian centers and medical infrastructure were targeted and attacked, with some medical facilities hit up to 400 km west of the Russian border.[15] Since November 2022, Russia damaged or destroyed 1,100 health-care facilities, and at this point in the conflict, only ninety-five hospitals are fully restored.[16] These conditions create a scarcity of medical equipment and medications. Implications for the U.S. Army are that medical evacuation platforms and larger hospitals may need to be positioned rearward to prevent being targeted, and forward medical teams may need to be positioned within hardened structures or even underground.[17] Forward medical units must have the agility to relocate as quickly as one hour despite these constraints.[18] Units with additive manufacturing capabilities could produce lightweight medical and surgical equipment in resource-scare environments like those observed in Ukraine. These same units can utilize this technology to produce repair and replacement parts to improve field-level maintenance.

Vulnerability of Medical Supply Chains

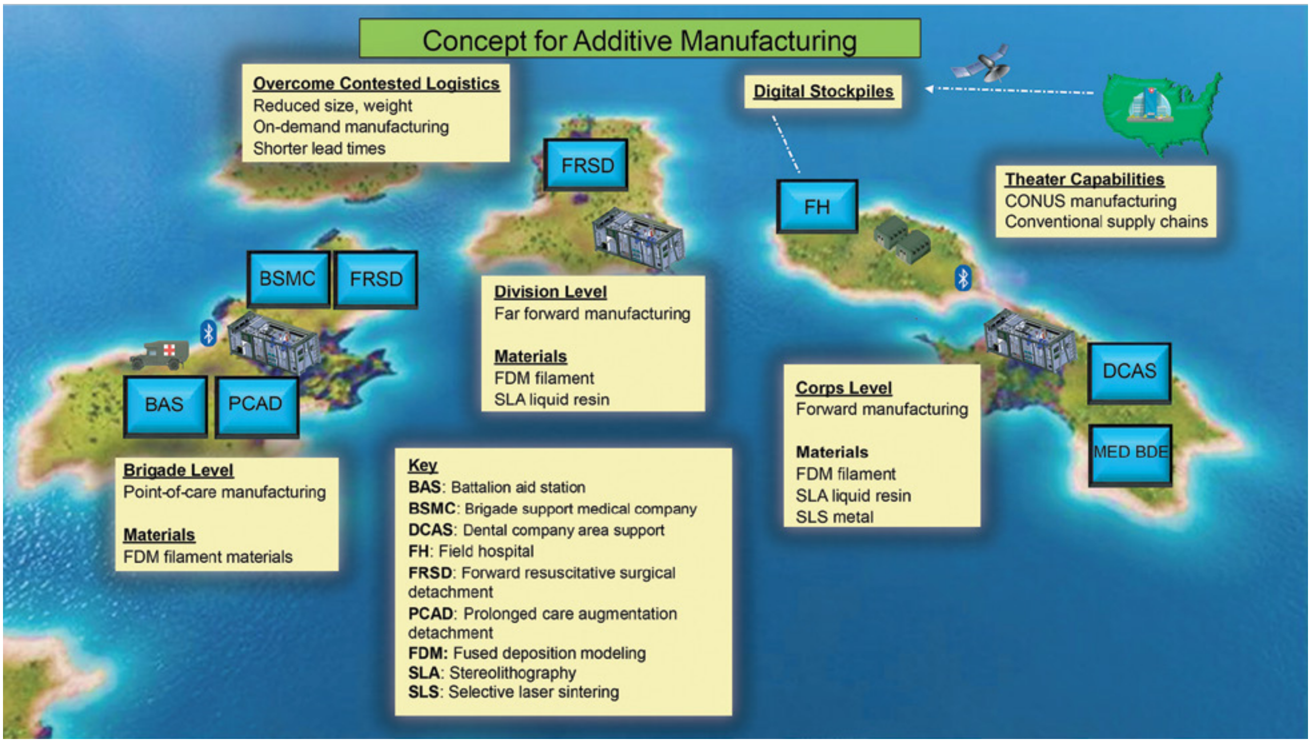
The globalization of medical supply chains represents another vulnerability in the American medical infrastructure. The United States relies on Asia, Europe, and India for its medical devices and medications. In 2019, the United States imported $20.7 billion in pharmaceuticals from China, accounting for 9.2 percent of all imports that year.[19] Chinese companies provide America with more than 90 percent of its antibiotics, ibuprofen, and hydrocortisone.[20] During the COVID-19 pandemic, 85 percent of America's personal protective equipment, such as the N-95 mask, came from China.[21] The Hubei Province was ground zero for the pandemic, and when this production hub declined, it reduced China's export of personal protective equipment by 75 percent.[22]

A scarcity of medical equipment creates a market for low-quality, alternative products. Ukrainian military medical units are critically short of tactical medical kits, especially tourniquets. To distribute products at scale, Ukraine purchased Chinese-made tourniquets for approximately US$3 each, a cost-effective necessity since American-made tourniquets cost approximately US$40 each.[23] But this is a matter of quantity over quality. The cheaper tourniquets are failing, which is alarming given prolonged care and delayed evacuation.[24] A civilian medical company designed an open-source 3D-printable tourniquet, but the quality control is unclear, and they strongly caution its

Lt. Col. Michael Browning, U.S. Army, is a comprehensive dentist and the commander of the 131st Field Hospital at Fort Bliss, Texas. He holds a BS from the U.S. Military Academy at West Point, an MS from the Uniformed Services University of the Health Sciences, and a DMD from the University of Alabama at Birmingham School of Dentistry. During his career, Browning has served with the 2nd Infantry Division, 3rd Infantry Division, 82nd Airborne Division, 44th Medical Brigade, and 1st Medical Brigade.

Lt. Col. Michael Hoffman, U.S. Army, is a comprehensive dentist assigned to U.S. Army Special Operations Command at Fort Liberty, North Carolina. He holds a DDS from the University of Michigan and an MS from the Uniformed Services University of the Health Sciences. During his career, Hoffman has served with the 10th Mountain Division, 3rd Special Forces Group (Airborne), and as commander, Dental Health Activity at Fort Campbell, Kentucky.

Lt. Col. Michael Kroll, U.S. Army, is the digital dentistry consultant to the Army Dental Corps chief and dental clinic commander at the Defense Language Institute Army Garrison Presidio of Monterey. He is a comprehensive dentist and holds a DMD from Case Western Reserve and an MS from the Uniformed Services University of the Health Sciences. During his career, Kroll has served as forward commander with the 673rd Dental Company Area Support and program director at the Advanced Education in General Dentistry–12-Month Program, Fort Sill, Oklahoma.



3D printing capabilities aligned to medical roles of care against the backdrop of an island chain. This demonstrates geographic isolation for medical units and increasing capability with higher roles of care. (Graphic by Maj. Martin Smallidge, Medical Capability Development and Integration Directorate)

use and assembly.[25] Yet these products are used across multiple conflict zones, which speaks to the dire shortage of medical supplies. Employing additive manufacturing at echelon can enhance the capabilities of medical units by producing Class VIII armamentarium and replacement parts on demand, thereby decreasing supply chain dependence.

Fundamentals of 3D printing. Additive manufacturing technology converts digital data into physical objects from various base materials. Standard Tessellation Language is a printable file that represents a 3D physical object. Two common 3D printing techniques are stereolithography (SLA) and fused deposition modeling (FDM). Each technique has unique materials, processing, and post-processing requirements. SLA incrementally prints objects from a liquid resin.[26] The Formlabs Form3BL resin

Lt. Col. Andres Mendoza, U.S. Army, is a comprehensive dentist and research scientist at the U.S. Army Institute of Surgical Research, Fort Sam Houston, Texas. He holds a DDS from the University of Texas Health Science Center San Antonio and an MS from the Uniformed Services University of the Health Sciences. During his career, Mendoza has served with the 82nd Airborne Division; 5th Special Forces Group (Airborne); and the Captains Career Course, Medical Center of Excellence. **He is the primary author of this article.*

Maj. Ross Cook, U.S. Army, is a comprehensive dentist and the assistant program director at the Advanced Education in General Dentistry–12-Month Program, Fort Campbell, Kentucky. He holds a DMD from the University of Kentucky and an MS from the Uniformed Services University of the Health Sciences. Cook previously served with 10th Special Forces Group (Airborne).

Maj. Martin Smallidge, U.S. Army, is the capability manager for dental services at the Medical Capability Development and Integration Directorate, Fort Sam Houston, Texas. He is a prosthodontist and holds a DMD and an MPH from the University of Pittsburg, and an MS from the Uniformed Services University of the Health Sciences.

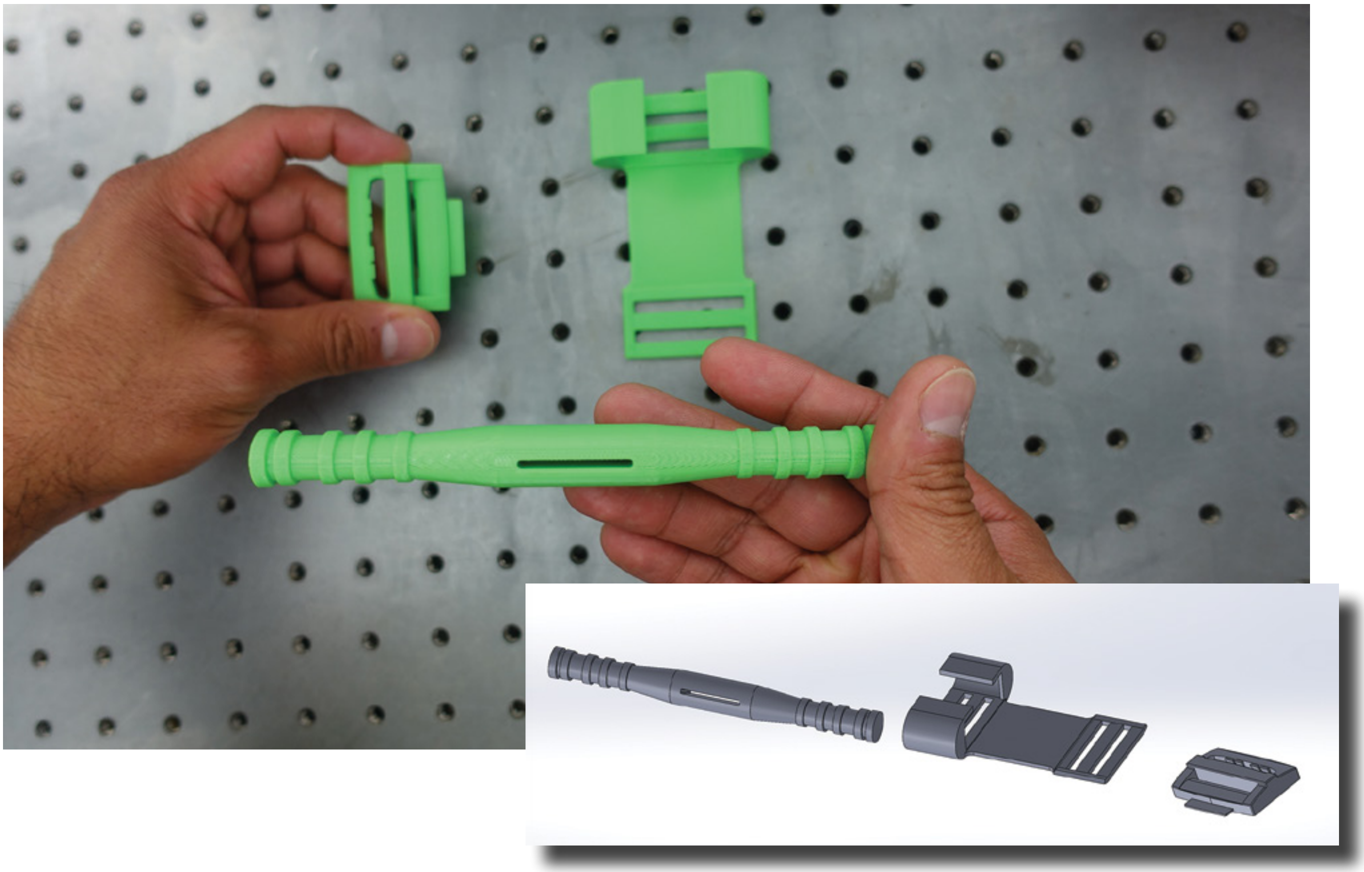
printer offers medical-grade resins for various uses, such as single-use instruments, anatomical models, and personal protective equipment.[27] The Formlabs BioMed Durable is an FDA-approved resin that offers accuracy and biocompatibility.[28] This material seems ideal for printing surgical equipment; however, this printing technique is demanding. It requires meticulous post-processing, including an isopropyl alcohol wash, post-curing, and polishing. The mechanical properties of a liquid resin may also degrade with the temperature and environmental extremes of field deployments; however, there is limited literature on this topic.

FDM printers extrude a spooled filament material through a heated nozzle.[29] Raise3D's Pro2 Plus is a commercial FDM printer compatible with various filaments like polylactic acid (PLA).[30] These materials are more commonly used for prototyping, industrial models, and vehicle parts. The bulk of scientific literature discusses using PLA filaments to print surgical instruments. In terms of base materials, filament offers a significant advantage because the spools are lightweight and dimensionally stable, suggesting less transportability challenges. Additionally, the extrusion process reaches such a high temperature that the production can be considered a sterilization technique.[31] Challenges may arise in humid climates. Filament materials can be hygroscopic, meaning they absorb moisture from air, which would reduce print quality. These are all vital considerations when selecting the appropriate material for surgical instruments or medical equipment in an austere environment.

A benchtop fused deposition printer. The spools of black, green, and white filament are visible in the top storage compartment. This printer melts, or fuses, the spools together to produce items. (Photo by Lt. Col. Andres Mendoza, U.S. Army Institute of Surgical Research)

Selective laser sintering is another manufacturing process that incrementally melts or "sinters" powder layers together. Selective laser sintering introduces the option of fabricating parts from metals like stainless steel and aluminum; however, these products have a grainy surface and require air blasters for post-processing and finishing.[32] Historically, this printing technique was cost-prohibitive and limited to industrial use, but smaller, more affordable benchtop printers are now available.[33]

Advantages of 3D printing. These 3D-printed instruments offer multiple advantages over traditional stainless-steel instruments, such as reduced weight and cost. PLA surgical retractors weigh twenty-five grams and cost only 5 percent of the online retail price.[34] A reduction in the volume and weight of this scale is significant for medical units when compared to traditional medical equipment sets. Basic surgical sets, such as hemostats, needle drivers, and forceps, can be printed on demand and customized as needed to serve the end user.[35] Printing can be conducted in hours as a surgical team establishes operations and prepares to receive patients.[36] Multiple instrument sets could be printed to expand surgical capacity to match the need, and 3D



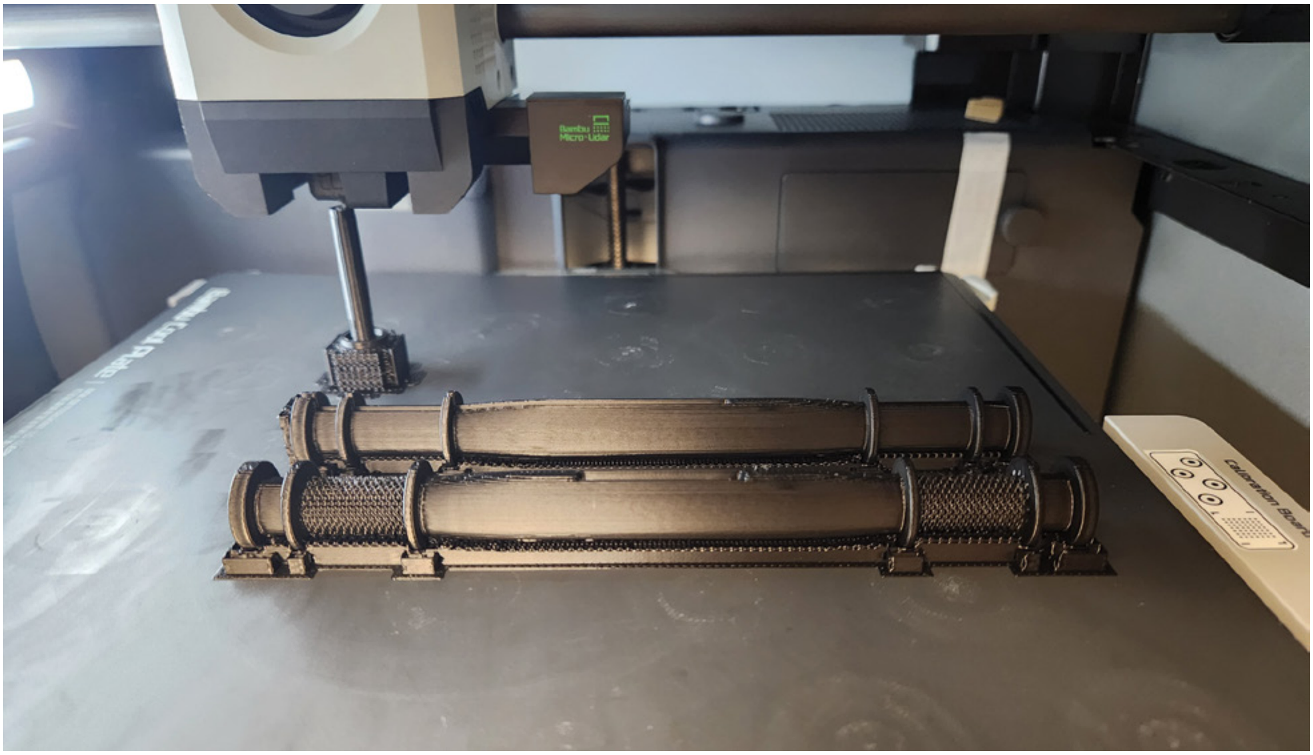
Computer-aided design models like those in the inset and Standard Tessellation Language files were used to print prototypes of tourniquet components in green filament during the manufacturing phase. This served as a proof of concept that tourniquet components can be reliably produced using 3D printing. (*Inset*) These computer-aided design models represent 3D renderings of traditional injection-molded components from a commercially available tourniquet, created during the design phase. (Photos by Capt. Joseph Wolf, U.S. Army Institute of Surgical Research)

printing allows for scalable mission sets. When weight is critical, a small medical team could print instruments on demand in lieu of packing and bringing every equipment set they may need on deployment.

Single-use disposable items can now become a production option. These items could be safely discarded after use, reducing the risk of infection transmission between patients. Single-use items introduce flexibility for medical teams to rapidly relocate without the burdensome task of packing and transporting medical equipment sets. This would also significantly reduce the need for field sterilization, which often requires generators and imposes logistical challenges on small teams in remote settings.[37] The tabletop sterilizer used by a field hospital consumes 1400W and 12A of power and current, which can interfere with forward resuscitative surgical detachment split-team operations.[38] In comparison, the Formlabs 3L liquid-resin printer requires 650W and 8.5A, and the Raise3D Pro2 filament printer requires 600W and 3.3A.[39] Reduced power consumption would improve overall mission effectiveness.

Limitations of 3D printing. One known challenge is that high temperatures reached during traditional steam sterilization would weaken 3D-printed surgical equipment, especially the filament-based PLA.[40] Cold sterilization may be an effective alternative to achieve rapid disinfection in austere environments using commonly available materials.[41] Another limitation is that 3D-printed surgical instruments often have reduced mechanical strength compared to traditional stainless-steel instruments. Policy and procedures would need to be developed to establish a standard for using surgical instruments and equipment printed in the expeditionary environment.

Additionally, 3D printing requires a stable, level, and clean workspace to fabricate products. The liquid



A black handle with detailed knurling is printing in layers from a benchtop fused deposition printer. This printer melts, or fuses, the spools together to produce items. (Photo by Lt. Col. Andres Mendoza, U.S. Army Institute of Surgical Research)

resin is most susceptible to misprints or failures if the printer is not balanced and level. Filament printers can fail if the nozzle gets clogged during the printing process. Additionally, any high-quality manufacturing must avoid contaminants like dust from entering the machine. Solutions to minimize these limitations must be considered prior to fielding at scale. These printers must also be field tested in hot and cold climates to determine how weather affects performance.

Integrating 3D Printing across the Medical Roles of Care

The Army of 2040 must integrate additive manufacturing throughout the entire Army Health System, beginning at the Role I battalion aid station.[42] A framework to meet this end state is achievable through commercially available printers and materials. Role I and Role II medical and surgical units should be fielded portable, ruggedized 3D printers along with a library of printable files. These units, such as the Role I battalion aid station and the Role II brigade support medical company and forward resuscitative surgical detachment, require agility to operate in austere, dispersed environments. Their additive manufacturing capability should include an FDM printer compatible with various filaments like nylon or carbon fiber. These materials are more dimensionally stable and lightweight. The lighter weight introduces the possibility for resupply with drones, as tested by special operations forces to deliver small packages of medical equipment and supplies.[43] Containers filled with liquid resin are heavier and could break during transportation, potentially leaking their contents. Additionally, a printer compatible with various materials could rapidly print replacement parts for biomedical equipment, bypassing supply chain constraints. To that end, these units should also be issued optical scanners to generate printable files in the field, effectively reverse engineering equipment as needed. For example, if a plastic attachment breaks on a surgical suction device, then a digital technician could scan and print a replacement part overnight.

Role III medical and surgical units such as field hospitals and hospital centers should field both SLA-liquid resin and FDM-filament-type printers. The more fixed nature of these units introduces the potential for robust utilization of this technology. The 673rd Dental

Company Area Support (DCAS), a Role III dental unit, successfully employed liquid crystal display printers while deployed to the U.S Central Command area of operations in 2022.[44] Supply chain shortages and mobility limitations motivated the DCAS to innovate and improve processes within their forward treatment sections. These sections can be forward deployed to support both Role I and Role II units; however, the forward-treatment section only has 50 percent mobility based on its vehicles and equipment.[45]

The DCAS forward treatment section adopted intraoral optical scanning and 3D printing to reduce the reliance on heavy dental equipment sets. Optical scanning and photography also allowed for asynchronous telemedicine consultations to support dispersed providers and units. The forward-deployed DCAS team practiced reaching back and leveraged continental U.S. support teams to design novel products and email those printable files to the end user. These efforts improved access to dental services while simultaneously reducing the weight of equipment for any forward missions. For example, the traditional prosthodontic equipment set weighs 1,200 lb. and contains over 350 line items, which makes its employment impractical forward of the corps support area. In comparison, the equipment required for a digital workflow weighed less than 100 lb. and could be transported on foot, nontactical vehicles, and vertical air lift.[46] This 92 percent reduction in overall weight offers promise to making the DCAS 100 percent mobile. The timely pivot to innovate dental services generated US$350,000 worth of expeditionary treatment and represents a proof of concept for integrating additive manufacturing.[47] This weight reduction, paired with increased capability, can make dental and medical support a more rapidly deployable asset to the warfighter. Lessons learned from this vignette could also be applied to medical companies across the Army Health System.

Dental officers assigned to the dental company or field hospital could serve as 3D printing subject-matter experts. Dental officers, especially comprehensive dentists and prosthodontists, receive extensive computer-aided design/computer-aided manufacturing (CAD/CAM) training during their residency programs, which includes printing and optical scanning. Dentists could serve in an adjunctive role as additive manufacturing officers for Role II and Role III units. This would enhance materiel sustainment without creating the need for additional training requirements or course development. This has precedent as additive manufacturing curriculum was added to the 91E (allied trade specialist) and 914A (allied trades warrant officer) advanced individual training courses. Dental officers' skills and expertise can be leveraged to enhance capabilities across the Army Health System.

Developing a Digital Stockpile for Strategic Independence

A digital library of medical equipment and replacement parts must be developed to maximize the potential of additive manufacturing. The U.S. Department of Health and Human Services and the National Institutes of Health offer examples of medical stockpiles. The Health and Human Services Strategic National Stockpile stores supplies in the case of emergencies or natural disasters, but this is labor intensive and requires maintenance, inventory, and testing to extend the shelf-life of equipment and medications.[48] The National Institutes of Health 3D Print Exchange has a small library of digital products, mostly limited to masks and personal protective equipment.[49] A digital stockpile of printable files would provide greater strategic independence and operational flexibility in the case of escalating global competition. A digital stockpile (or library) could also tailor medical support to the demand signal. For example, a hospital unit could download and print more personal protective equipment if activated to support a pandemic or chemical incident. Ideally, medical and surgical units would download these printable files prior to deployment based on their operational demands. Forward medical units could also reach back to this digital stockpile to print products in theater. This stockpile could include commonly needed replacement parts for medical equipment.

Developing a library of printable digital files requires close collaboration among multidisciplinary working groups of clinicians, engineers, and industry. Successful reverse engineering, or digitizing, physical equipment requires communication and feedback from the end user, along with materials testing and analysis. Partnerships with industry could reduce the need for extensive reverse engineering. A systematic product development would eliminate a trial-and-error approach. These materials and printers should also be field tested in cold, hot, and humid climates to simulate environments found in the U.S. European Command and the U.S. Indo-Pacific Command.

In the future, a forward surgical team could deploy with one physical set of equipment and a 3D printer to then expand capacity as needed. As this technology becomes more robust, medical and surgical teams would only require a printer and a copy of digital files for deployment. A medical unit deploying with a stored library of printable files would eliminate concerns over network connectivity or generating digital signatures in theater. This reduction in size and weight would create space for expendable items or reduce the load entirely. It could also allow time for predeployment training and skills refresher versus the laborious task of equipment load.

Conclusion

Additive manufacturing imparts flexibility to expeditionary medical support. Robust 3D printing capabilities would provide a secondary logistics chain and allow rapid replacement of broken or nonserviceable items. Medical units would only need to maintain essential medical equipment and could print items on demand once in theater. Field-level maintenance can be expanded by enabling units to print items that traditionally require sustainment-level maintenance.

During conflict with a near-peer adversary, it will be critical that medical and surgical units reduce their size and weight without compromising capability and agility. These units must maximize mobility to maintain proximity to the maneuver forces. Additive manufacturing can provide capabilities to overcome contested logistics in large-scale conflict with a near peer. Army dental officers represent a preexisting cohort of 3D printing subject-matter experts with an established training and education pipeline. The *Army Medical Modernization Strategy* must open its aperture to also pursue solutions that streamline well-established challenges to medical logistics and equipment. ■

Notes

1. Army Futures Command, *Army Medical Modernization Strategy* (Austin, TX: Army Futures Command, May 2022), https://www.army.mil/e2/downloads/rv7/about/2022_Army_Medical_Modernization_Strategy.pdf.

2. Jason Barnhill et al., "Additive Manufacturing for Fabrication of Point-of-Care Therapies in Austere Environments," *Military Medicine* 188, no. 7-8 (July-August 2023): e1847–53, https://doi.org/10.1093/milmed/usad007; Shayne Kondor et al., "On Demand Additive Manufacturing of a Basic Surgical Kit," *Journal of Medical Devices* 7, no. 3 (September 2013): Article 030916, https://doi.org/10.1115/1.4024490; Shayne Kondor et al., "Personalized Surgical Instruments," *Journal of Medical Devices* 7, no. 3 (September 2013): Article 030934, https://doi.org/10.1115/1.4024487; Mitchell George et al., "3D Printed Surgical Instruments: The Design and Fabrication Process," *World Journal of Surgery* 41, no. 1 (January 2017): 314–19, https://doi.org/10.1007/s00268-016-3814-5; Larry V. Duggan et al., "Front-of-Neck Airway Meets Front-of-Neck Simulation: Improving Cricothyroidotomy Skills Using a Novel Open-Access Three-Dimensional Model and the Airway App," *Canadian Journal of Anesthesia* 64, no. 10 (October 2017): 1079–81, https://doi.org/10.1007/s12630-017-0926-9; Jeffrey Huang et al., "A Novel Approach to Emergency Airway Simulation Using a 3D-Printed Cricothyrotomy Task Trainer," *Journal of Education in Perioperative Medicine* 23, no. 3 (July-September 2021): e670, https://doi.org/10.46374/volxxiii_issue3_sims; Matteo Parotto et al., "Evaluation of a Low-Cost, 3D-Printed Model for Bronchoscopy Training," *Anaesthesiology Intensive Therapy* 49, no. 3 (2017): 189–97, https://doi.org/10.5603/ait.a2017.0035.

3. Jacob L. Greenberg, "Marine Receives DOD's First Jaw Reconstruction Using 3D-Printed Teeth," U.S. Department of Defense, 9 July 2021, https://www.defense.gov/News/Feature-Stories/Story/Article/2683418/marine-receives-dods-first-jaw-reconstruction-using-3d-printed-teeth/.

4. Charlie M. Wiltse, *The Medical Department: Medical Service in the Mediterranean and Minor Theaters* (Washington, DC: U.S. Government Printing Office, 1965; repr., Washington, DC: U.S. Army Center of Military History, 1987), xxvi, https://history.army.mil/html/books/010/10-8/CMH_Pub_10-8.pdf.

5. U.S. General Accounting Office (GAO), *Operation Desert Storm: Full Army Medical Capability Not Achieved*, GAO/NSIAD-92-175 (Washington, DC: U.S. GAO, August 1992), https://www.gao.gov/products/nsiad-92-175.

6. Ibid.

7. Robert G. Cockerham, "Improving Mobility, Survivability, and Modularity in a Brigade Support Medical Company," Center for Army Lessons Learned, 1 June 2021, https://api.army.mil/e2/c/downloads/2023/01/31/e3ba64bd/improving-mobility-survivability-and-modularity-in-a-brigade-support-medical-company-jun-21-public.pdf.

8. Ibid.

9. Matthew Fandre, "Medical Changes Needed for Large-Scale Combat Operations: Observations from Mission Command Training Program Warfighter Exercises," *Military Review* 100, no. 3 (May-June 2020): 36–45, https://www.armyupress.army.mil/Portals/7/military-review/Archives/English/MJ-20/Fandre-Medical-Changes.pdf; Mason H. Remondelli et al., "Casualty Care Implications of Large-Scale Combat Operations," *Journal of Trauma and Acute Care Surgery* 95, no. 2S (August 2023): S180–84, https://doi.org/10.1097/ta.0000000000004063.

10. Todd South, "21,000 Casualties in Seven Days: The Push to Update Medic Training," *Army Times* (website), 6 October 2023, https://www.armytimes.com/news/

your-army/2023/10/06/21000-casualties-in-seven-days-the-push-to-update-medic-training/.

11. Remondelli et al., "Casualty Care Implications"; Svitlana Morenets, "Ukraine's Real Killing Fields: An Investigation into the War's First Aid Crisis," *The Spectator*, 26 August 2023, https://www.spectator.co.uk/article/ukraines-real-killing-fields-an-investigation-into-the-wars-first-aid-crisis/; Helene Cooper et al., "Troop Deaths and Injuries in Ukraine War Near 500,000, U.S. Officials Say," *New York Times* (website), 18 August 2023, https://www.nytimes.com/2023/08/18/us/politics/ukraine-russia-war-casualties.html.

12. Remondelli et al., "Casualty Care Implications."

13. "U.S. Military Casualties: Persian Gulf War Casualty Summary, Desert Storm," Defense Casualty Analysis System, last updated 9 February 2024, https://dcas.dmdc.osd.mil/dcas/app/conflictCasualties/gulf/stormsum.

14. Morenets, "Ukraine's Real Killing Fields."

15. "Russia Warns Kyiv Residents to Leave as Armored Convoy Nears Ukraine's Capital," Vanguard News Nigeria, 1 March 2022, https://www.vanguardngr.com/2022/03/russia-warns-kyiv-residents-to-leave-as-armored-convoy-nears-ukraines-capital/; Diane Cole, "Russia's 226 Attacks on Health-Care Targets in Ukraine Are Part of a Larger Problem," NPR, last updated 24 May 2022, https://www.npr.org/sections/goatsandsoda/2022/03/16/1086982186/russias-strike-on-ukraine-maternity-hospital-is-part-of-a-terrible-wartime-tradi; Aaron Epstein et al., "Putting Medical Boots on the Ground: Lessons from the War in Ukraine and Applications for Future Conflict with Near-Peer Adversaries," *Journal of the American College of Surgeons* 237, no. 2 (August 2023): 364–73, https://doi.org/10.1097/xcs.0000000000000707.

16. "Russians Damaged 1,100 Medical Facilities in Ukraine," Ukraine Crisis Media Center, 8 November 2022, https://uacrisis.org/en/rosiyany-poshkodyly-v-ukrayini-1100-medzakladiv.

17. Epstein et al., "Putting Medical Boots on the Ground."

18. Ibid.

19. Committee on Security of America's Medicial Supply Change, *Building Resilience into the Nation's Medical Product Supply Chains* (Washington, DC: National Academies Press, 2022).

20. Tony Paquin and David Sanders, "To Protect the Medical Supply Chain, 'Made in America' Will Be Key," STAT News, 14 December 2022, https://www.statnews.com/2022/12/14/made-in-america-protect-medical-supply-chain/.

21. Ibid.

22. Chad P. Bown, "How COVID-19 Medical Supply Shortages Led to Extraordinary Trade and Industrial Policy," *Asian Economic Policy Review* 17, no. 1 (January 2022): 114–35, https://doi.org/10.1111/aepr.12359.

23. Morenets, "Ukraine's Real Killing Fields."

24. Ibid.

25. "The Glia Tourniquet Project," Glia, accessed 9 February 2024, https://glia.org/pages/the-glia-tourniquet-project; "GliaX/tourniquet," GitHub, accessed 12 February 2024, https://github.com/GliaX/tourniquet.

26. George et al., "3D Printed Surgical Instruments."

27. "3D Printing Materials for Healthcare," Formlabs, accessed 9 February 2024, https://formlabs.com/materials/medical/.

28. "BioMed Durable Resin Manufacturing Guide" (Somerville, MA: Formlabs, 2023), https://media.formlabs.com/m/14cff42db244f816/original/-ENUS-BioMed-Durable-Manufacturing-Guide.pdf; "Technical Data Sheet: BioMed Durable Resin" (Somerville, MA: Formlabs, 2023), https://formlabs-media.formlabs.com/datasheets/2310772-TDS-ENUS-0.pdf.

29. George et al., "3D Printed Surgical Instruments."

30. "Wide Range of Engineering Material Solutions," Raise3D, accessed 9 February 2024, https://www.raise3d.com/filaments/.

31. Russell Y. Neches et al., "On the Intrinsic Sterility of 3D Printing," *PeerJ* 4 (2016): e2661, https://doi.org/10.7717/peerj.2661.

32. George et al., "3D Printed Surgical Instruments."

33. "Guide to Selective Laser Sintering (SLS) 3D Printing," Formlabs, accessed 9 February 2024, https://formlabs.com/blog/what-is-selective-laser-sintering/.

34. Joshua V. Chen et al., "3D Printed PLA Army-Navy Retractors When Used as Linear Retractors Yield Clinically Acceptable Tolerances," *3D Printing in Medicine* 5, no. 16 (November 2019): 1–9, https://doi.org/10.1186/s41205-019-0053-z.

35. Kondor et al., "On Demand Additive Manufacturing of a Basic Surgical Kit"; Kondor et al., "Personalized Surgical Instruments."

36. George et al., "3D Printed Surgical Instruments."

37. Ross K. Cook et al., "Use of a Pressure Cooker to Achieve Sterilization for an Expeditionary Environment," *Journal of Special Operations Medicine* 21, no, 1 (Spring 2021): 37–39, https://doi.org/10.55460/wpgc-a599.

38. "2540M Technical Specs," Tuttnauer, accessed 12 February 2024, https://tuttnauer.com/us/medical-clinics/tabletop-sterilizers/manual/2540m#pane-technical-specs.

39. "Formlabs Stereolithography 3D Printer Tech Specs," Formlabs, accessed 12 February 2024, https://formlabs.com/3d-printers/form-3/tech-specs/; "Raise3D Pro2 Series Technical Specifications," Raise3D, accessed 12 February 2024, https://www.raise3d.com/pro2-series/.

40. Joshua V. Chen et al., "Identifying a Commercially-Available 3D Printing Process That Minimizes Model Distortion after Annealing and Autoclaving and the Effect of Steam Sterilization on Mechanical Strength," *3D Printing in Medicine* 6, no. 1 (2020): 9, https://doi.org/10.1186/s41205-020-00062-9.

41. Andrew Francis et al., "Rapid Cold Sterilization of 3D Printed Surgical Instruments for the Austere Environment," *American Journal of Surgery* 225, no. 5 (May 2023): 909–14, https://doi.org/10.1016/j.amjsurg.2023.03.010.

42. Role I Tabletop Exercise, U.S. Army Medical Capability Development Integration Directorate, Fort Sam Houston–Joint Base San Antonio, Texas, 28 August 2023.

43. Tomaz Mesar, Aaron Lessig, and David R. King, "Use of Drone Technology for Delivery of Medical Supplies during Prolonged Field Care," *Journal of Special Operations Medicine* 18, no. 4 (Winter 2018): 34–35, https://doi.org/10.55460/m63p-h7dm.

44. Michael Kroll, *Digital Dentistry and Additive Manufacturing in CENTCOM, Executive Summary* (Joint Base Lewis-McChord, WA: 673rd Dental Company Area Support, December 2022).

45. Army Techniques Publication 4-02.19, *Dental Services* (Washington, DC: U.S. Government Publishing Office, August 2020).

46. Kroll, *Digital Dentistry and Additive Manufacturing in CENTCOM*.

47. Ibid.

48. "Sustaining the Stockpile," Administration for Strategic Preparedness and Response, accessed 12 February 2024, https://aspr.hhs.gov/SNS/Pages/Sustaining-the-Stockpile.aspx.

49. "NIH 3D," National Istitutes of Health, accessed 12 February 2024, https://3d.nih.gov.

The Coming Military AI Revolution

Col. Joshua Glonek, U.S. Army

The simple fact is that we see everything the enemy is doing and they see everything we are doing. In order for us to break this deadlock we need something new, like the gunpowder which the Chinese invented and which we are still using to kill each other.

—Gen. Valery Zaluzhny, Former Ukrainian Armed Forces Commander in Chief

The U.S. military's long-held technological overmatch is quickly eroding.[1] Over the past twenty-five years, China has invested heavily in its military—the People's Liberation Army (PLA)—putting it on a path to "complete national defense and military modernization by 2035" and to transform the PLA into a "world-class military

A video screen plays footage of Chinese People's Liberation Army soldiers on a robot from Chinese robot maker Jiangsu Eastern Gold Jade Intelligent Robot Company at the World Robot Conference in Beijing on 15 August 2018. (Photo by Mark Schiefelbein, Associated Press) by the middle of the century."[2] China's increased military strength now presents a formidable challenge to the U.S.-led international order, and to the security of U.S. allies and partners.[3]

One technology in particular will determine the preeminence of military forces in the coming decades: artificial intelligence (AI). With the advent of self-driving cars and ChatGPT, AI has moved beyond the realm of science fiction and is now beginning to proliferate throughout society. This disruptive technology is also creating new opportunities for military forces. Dual-use applications of AI provide tools to quickly analyze large amounts of data, enhance links between sensors and shooters, and increase decision-making speed. The U.S. military must embrace this transformative technology and accelerate the development of innovative applications of AI to preserve its technological edge, deter adversary aggression, and, if necessary, prevail in armed conflict.

Soldiers employ AI to analyze collected data and prepare for a tactical-level operation. (AI image by Col. Joshua Glonek, U.S. Army)

A soldier considers employment of a variety of weapons and support systems either individually or in a coordinated action. The battlefield of the future will be characterized by a range of AI-driven weapons platforms and support systems, including unmanned aircraft and tactical vehicles. (Illustration by Jamie Lear, U.S. Army)

Alan Turing (1912–1954) at Princeton University in 1936. Turing was an English mathematician, computer scientist, cryptanalyst, and theoretical biologist. He is widely considered to be the father of theoretical computer science and one of the founding fathers of artificial intelligence. (Photo courtesy of Wikimedia Commons)

The coming military AI revolution is situated squarely within the wider geopolitical competition between the United States and China. The stakes of this competition are high and the outcome uncertain. China believes the United States is a superpower in decline. As the PLA grows in strength, its actions are becoming more aggressive. Over the last two years, the United States has documented over 180 instances of dangerous PLA air intercepts against U.S. allies and partners.[4] The South China Sea remains a contentious flashpoint, with China asserting illegitimate territorial claims and continuing to signal its willingness to use military force against Taiwan.[5] Tensions are high, and the risk of conflict is real.

Succeeding in this great power competition—and deterring war—will require the U.S. military to preserve its technological advantages. Achieving this, however, demands a groundbreaking innovation effort as China is quickly closing the gap. Determined to "intelligentize" warfare, the PLA is rapidly pursuing an entirely new generation of AI-enabled military systems.[6] In support, the Chinese Communist Party is marshalling a significant amount of state and private resources toward this effort. Progress is continuing to accelerate.

In response, the U.S. Department of Defense (DOD) has embarked on its own path of military modernization. Accelerating the adoption of AI is now a major priority for the DOD, as it seeks to harness the innovation power of the American private sector, home to the world's leading AI companies. By fielding AI-enabled systems at scale and employing them on the battlefield in new ways, the U.S. military intends to offset the PLA's progress and remain the world's unmatched superpower.

The consequences of the coming military AI revolution are enormous. If developed effectively, AI will permeate across all military systems and processes. Enormous efficiency gains will be realized as AI reduces the demands on humans to process data, preventing cognitive overload and enabling more thorough analysis. Situational awareness will grow, operations will become more precise, and decisions will be better informed. The speed of warfare will increase. Those with the best AI tools will be constantly exploiting the initiative, while those without will struggle to make sense of what is happening.

As the military AI revolution proceeds, it's incumbent on all members of the profession to prepare. From general to private, we will all have a role to play in the transformation of the force that will occur over the coming years. We must embrace what is new and adapt to the changing environment. As Italian airpower theorist Giulio Douhet once stated, "Victory smiles upon those who anticipate the change in the character of war, not upon those who wait to adapt themselves after the changes occur."[7] Douhet's words, written over a century ago, still resonate powerfully today.

A Brief History of AI

Although AI may seem like a relatively new phenomenon, British mathematician Alan Turing first devised the theory in 1950. Having played a key role in the development of computers, Turing believed AI would be achieved once machines became capable of generating answers to questions that were indistinguishable from human responses.[8] For the next two decades, AI researched flourished as the Defense Advanced Research Projects Agency funded the creation of AI labs at several major universities.[9] Despite this initial flurry of AI research, the lack of computational power and data storage found in primitive computers led many to believe continued advancements were no longer feasible. As a result, funding was significantly reduced for most AI research.

AI development experienced a resurgence in the 1980s as advanced microprocessors enabled greater computing power. Consistent with a concept called "Moore's law," the capacity of computer chips continued to grow exponentially, doubling approximately every two years.[10] These more powerful semiconductors allowed computer scientists to access larger databases, enabling more sophisticated algorithms. A new series of programs known as "expert systems" were developed, which, for the first time, were able to replicate the decision-making of humans.[11] Expert systems contained an extensive collection of knowledge and facts about a specific topic. These programs could solve narrowly defined problems that would otherwise require human subject-matter experts. For example, the DOD employed expert systems to develop maintenance software that enabled users to input diagnostic data and receive a report on the underlying cause of the malfunction, as well as recommended solutions.[12] Although expert systems excelled at bespoke applications, they were incapable of engaging in problem-solving beyond their preprogrammed knowledge.[13]

IBM engineer Arthur Samuel with an early machine-learning computer he developed circa 1962 that improved at the game of checkers the more games it played. Samuel laid the groundwork for a series of breakthroughs in artificial intelligence at IBM during the 1990s. (Photo courtesy of IBM)

The next wave of AI progress came in the 1990s with the creation of machine learning. Unlike expert systems that had to be manually programmed, machine learning algorithms used training data to "learn" how to perform tasks and solve problems.[14] This allowed developers to fine-tune the models' parameters to achieve desired outcomes, resulting in highly flexible AI programs that could perform well in new environments. Further progress was made with the development of "deep learning" algorithms that used neural networks loosely modeled on those of the human brain. Combining deep learning with massive datasets has enabled "computer vision," which is the basis for a variety of applications from self-driving vehicles to facial recognition programs.[15]

The most recent breakthrough in AI was introduced to the world in November 2022 when OpenAI released its ChatGPT Large Language Model program. The Large Language Model capitalizes on the fact that natural language is arranged in a sequential order, creating logical connections between the words in a sentence. By reading a very large number

Col. Josh Glonek, U.S. Army, is an Army War College Fellow at Stanford University, where he researches artificial intelligence and strategic competition between the United States and China. He holds a BS from West Point and an MPP from the University of Chicago. In recent assignments, Glonek served as the division operations officer for the 10th Mountain Division; commander of the 2nd Battalion, 87th Infantry Regiment; and the chief speechwriter to the secretary of defense.

China's approach to developing military technology is a strategy of military-civil fusion characterized by direct military involvement in research and development with private Chinese businesses synchronized by centralized government control. (AI image by Gerardo A. Mena Jr., Army University Press)

of sentences during training, these models become effective in predicting the arrangement of words in a coherent manner.[16] Ask ChatGPT to write a book report, create a business plan, or compose poetry and it will do so near instantaneously with a high degree of effectiveness. And because words are simply a form of data, these new techniques are not limited only to language. New applications of generative AI are emerging with the capability to create images and videos, compose music, and write computer code.

In recent years, advancements in AI have led to significant achievements. In 2016, Google DeepMind's AlphaGo computer program defeated world champion Go player Lee Sedol in a five-game match. During the second game, AlphaGo made an unorthodox move that onlooking experts initially thought was a mistake. As the game progressed, it became apparent that the "mistake" proved pivotal to the machine's victory.[17] Yet another milestone was achieved in 2020 when an AI-agent decisively defeated an elite human fighter pilot in a Defense Advanced Research Projects Agency-sponsored virtual dogfight competition. When asked about his repeated losses, the human pilot responded, "The standard things that we do as fighter pilots aren't working."[18] These feats are not only stunning demonstrations of AI prowess in complex scenarios, but they also show how AI is capable of learning new techniques and strategies that outwit even the best humans.

The Race to Develop Military AI

Across a variety of narrow applications, AI is already winning. Both the United States and China understand this and are racing to incorporate AI into their military strategies. In 2018, the DOD released its first *Artificial Intelligence Strategy*, intended to accelerate the adoption of AI by the U.S. military. The report highlighted the

In a different approach to that of the People's Liberation Army, the U.S. Department of Defense is largely reliant on private enterprise and economic competition between competing private businesses in its programs of defense technology development. This approach assumes free enterprise promotes greater freedom in creativity and innovation. (Illustration courtesy of DroneXL, https://www.dronexl.co)

fact that China was "making significant investments in AI for military purposes," which "threaten to erode our technological and operational advantages."[19] In 2019, China published a defense white paper, which argued a "Revolution in Military Affairs with Chinese characteristics" was underway.[20] Aided by new advancements in emerging technologies, the report emphasized the importance of AI in future warfare as big data, cloud computing, and the internet of things were "gathering pace in the military field."[21] The idea that AI would transform the character of warfare was now at the forefront of both nations' military strategy.

Unlike some important military innovations of the past such as the longbow, gunpowder, or the tank, which had relatively specific uses, AI is a general-purpose technology with a diverse array of applications.

A soldier uses a handheld device to employ artificial intelligence for data analysis to guide rapid planning and execution of tactical-level operations. (AI image by Gerardo A. Mena Jr., Army University Press)

More akin to the advent of electricity, which generated advances in lighting, heating, transportation, and communications, AI will diffuse across many other technologies, greatly increasing their capability and effectiveness. Today, in both the U.S. and Chinese defense sectors, there is a proliferation of AI research and development pursuing a variety of military uses, including autonomous vehicles, intelligence collection, predictive logistics, cybersecurity, and command and control. The outcome of the AI race will not be decided based upon one specific application but rather will be determined by the side that can best integrate AI across a variety of systems and processes in all domains of warfighting.

The United States has long been the world leader in the development of military hardware, enabled by a strong culture of innovation and well-established defense industrial base. In recent years, China has made significant progress with a deliberate state focus on military modernization. Both nations, however, are facing a new challenge in the race for AI-enabled military systems. Unlike many technological innovations of the past that were developed through government-sponsored research programs, the most cutting-edge AI technology today currently resides in the private sector. Gaining access to this technology requires the DOD and PLA to forge new partnerships with commercial firms to develop dual-use applications. Traditional defense contractors and state-owned enterprises in both the United States and China simply can't keep up with the pace of AI innovation in the private sector.

China's approach to solving this problem is to exploit the power of the state to deepen public-private integration through a strategy of military-civil fusion.[22] Over recent years, several facets of the strategy have successfully contributed to closer integration between the PLA and private Chinese businesses. These include the establishment of joint laboratories to facilitate dual-use research among military, academic, and commercial enterprises; creation of the Agile Innovation Defense Unit, which focuses on providing the PLA access to commercial technologies; and PLA sponsorships of challenges and competitions intended to promote creative solutions to military problems.[23] Furthermore, military-civil fusion is proving successful in expanding the PLA's reach into the commercial sector. One recent study from the Center for Security and Emerging Technology found that the PLA acquired the majority of its AI-related equipment from private Chinese technology companies, not legacy state-owned enterprises.[24] While corruption and bureaucratic inefficiencies remain limitations of China's authoritarian system, impressive progress has been made thus far.

In contrast to the Chinese top-down approach, the U.S. strategy is to leverage its vibrant and innovative market-based economy to generate new AI-enabled military technologies. In doing so, the DOD seeks to rebalance the force away from legacy combat platforms that are exquisite, manned, and high cost toward a new generation of systems that are expendable, autonomous, and relatively inexpensive. Through an initiative dubbed "Replicator," the DOD has established a goal of fielding these systems at a scale of "multiple thousands, in multiple domains, within the next 18–24 months."[25] Intended to offset the PLA's conventional advantage in mass, Replicator seeks to complement U.S. conventional capabilities with large concentrations of AI-enabled systems that can effectively operate in highly contested environments.

Serving as the lead for the development of these technologies is the Defense Innovation Unit (DIU), which was created to foster closer partnership between the DOD and the private sector. In 2023, the DIU was elevated to a direct reporting unit to the secretary of defense in order to "catalyze engagement with and investment into private sector communities where commercial technology can be adapted and applied to meet our warfighters' requirements."[26] In places like Silicon Valley, the best commercial AI companies in the world possess the expertise to develop dual-use applications of their technologies but are often hindered by the DOD's cumbersome acquisition procedures. DIU helps to overcome this challenge by streamlining the process, drawing more nontraditional companies into the defense sector. This enables greater innovation, a wider variety of AI applications, and faster adoption of these systems into the military. As the Replicator initiative proceeds, DIU will play a leading role in coordinating the development of AI technologies that are tailored to the needs of the military services and combatant commanders.

Seeing through the Fog of War

Military operations are characterized by a prevailing "fog," which exists due to the inherent uncertainty of war.[27] The inability to predict how battle will unfold is part of war's essential nature and cannot be completely eliminated. Some of the fog, however, is the result of an enormous amount of data and information that cannot be processed fast enough to clearly understand its meaning. After action reviews from combat training centers routinely highlight the shortcomings of units that become overwhelmed by cascades of information. Rarely are staffs able to effectively synthesize the abundance of data in ways that bring clarity to the overall situation. The question "who else needs to know?" is commonly asked, as a technique to offset the tendency of information to remain isolated in functional "stovepipes." Despite the development of knowledge management procedures designed to better identify, organize, store, and disseminate information, the fundamental problem of data overload still exists.

On today's modern battlefield, sensors are nearly ubiquitous, constantly streaming information to military command posts. Staffs struggle to keep pace with the sheer volume of data that is available: information, surveillance, and reconnaissance assets provide data on enemy forces through a combination of imagery, video feeds, signal intercepts, and electromagnetic detections; friendly forces provide status updates and requests for support over a variety of command-and-control systems; and other factors, such as changes to the weather, the presence of civilians on the battlefield, or the introduction of disinformation, add further complexity to the operational environment. The flood of available data can create a state of "analysis paralysis" that stymies effective decision-making. By the time decisions are finally made, they are no longer relevant to the current conditions.

This is where AI can help. Today's AI systems and the high-power computers that run them can process vast quantities of data at unprecedented speeds. Tasks that would normally take humans days or weeks can be done by AI in a matter of seconds. Take the banking industry, for example. Financial institutions use AI to track credit card usage in real time. When irregular buyer behavior is identified, transactions are denied before fraud can occur.[28] Compared to traditional methods that rely on manual human verification, the resulting efficiency gains are enormous. Furthermore, AI systems are proving more accurate than human experts in a variety of areas. For example, in the medical field, machine learning systems are demonstrating greater accuracy in predicting cancer than highly trained clinicians.[29] Applying these same technologies to common military tasks can produce similar gains in efficiency and effectiveness. In essence, AI can help clear some of the fog of war.

These productivity gains will ultimately enable more rapid and effective decision-making, a critical advantage in warfare. John Boyd characterized military competition through a process known as the observe, orient, decide, act (OODA) loop.[30] Boyd's idea was that whichever side executed the process faster could get inside an opponent's decision cycle and achieve a relative military advantage. AI systems will greatly accelerate the OODA loop process by increasing situational awareness, rapidly processing large amounts of information, calculating decision options, and automating operations. Intelligence analysts will use computer vision to filter through scores of images and videos to locate enemy forces. Operators will employ autonomous swarms of drones to overwhelm enemy defenses. Logisticians will use data analytics to optimize resupply missions or equipment maintenance. Military planners will use large language models to draft operations orders and generate decision briefs. Cyber warriors will leverage machine learning to identify anomalies and deny adversary network intrusions. These are just a few of the many coming military applications of AI.

Determining just how fast the OODA loop accelerates will depend, in part, on the level of trust humans place in AI. As with any new technology, AI is subject to error and will require refinement over time as it continues to evolve and mature. For the foreseeable future, there is good reason to maintain human control and oversight, also known as "human in the loop." For one, AI demonstrates the ability to "hallucinate," producing outputs or answers that are plausible but nevertheless do not correspond to reality.[31] This occurs when an AI model makes a statistical inference based on its training data that leads to inaccurate results when applied to a real-world environment. For an AI program aiding in military activities, the consequences of a spurious output could be severe. Another challenge with many AI models is that they lack "explainability," meaning the system is unable to describe the logic and data underlying its conclusions.[32] As a result, decisions appear to be made inside a "black box," preventing users from tracing the system's thought process. This lack of transparency will require trust in military AI to be built over time through experience. AI is also vulnerable to spoofing where an adversary could adjust data inputs, leading the model to draw false conclusions.[33] Imagine using computer vision software for targeting that is manipulated into concluding that friendly forces or civilians are enemy high-payoff targets. For all these reasons, most near-term applications of military AI will likely augment, rather than replace the role of humans.

Although the United States and China have enacted AI governance, cultural differences may influence the speed of adoption. A recent survey found that 78 percent of Chinese citizens believed AI had more benefits than drawbacks, as opposed to only 35 percent of Americans.[34] In 2020, the DOD adopted a series of ethical principles for the use of AI intended to guide the development of new technologies in a safe and responsible manner.[35] The PLA has not released a similar set of principles and appears to be less constrained by the risks posed by AI. In contrast to the robust debate in the United States on the ethics of employing autonomous military systems, discussion of this topic is largely absent from Chinese open sources.[36] These contrasting perspectives in AI ethics and regulation may influence the rate at which the United States and China adopt and integrate AI into their respective militaries. While the United States appears more cautious and deliberate in its approach, China seems to be less constrained by the potential risks of AI.

Conclusion

While technology alone does not guarantee the outcome of war, throughout history, militaries that best innovate have a decisive advantage on the battlefield.[37] The American military has long enjoyed

In the global operational environment of the future, AI will play a significant role in military analysis and decision-making at the strategic, operational, and tactical levels of command and control. (Illustration by NIWC Pacific, 7 April 2018)

technological superiority over its adversaries, however, this advantage is now diminishing. China's national-level focus on AI innovation has manifested in significant technological advancements, enabling the PLA toward achieving its goal of becoming a world-class military. Within this ongoing geopolitical rivalry, the competition to harness the power of AI will shape the global balance of power for years to come.

Preserving U.S. miliary overmatch requires an acceleration of AI development across the DOD. Strengthened partnership with the private sector is essential to making the progress needed to outpace the PLA. Although China's military-civil fusion strategy has yielded impressive results, the most capable AI companies reside in the United States. These firms, with their highly skilled workforce and cutting-edge research, have the potential to produce the most advanced military applications of AI. The United States' market-based system holds a distinct advantage in fostering innovation, but the DOD must continue to adapt to fully harness its potential. The ongoing Replicator initiative represents the DOD's biggest bet in AI development. Its success is crucial for the future of the U.S. military.

While new technologies are always under development, rarely do they pose as much potential as AI. Military advantage is normally gained by the side that better understands the environment, the enemy, and themselves. Battles are typically won by commanders who make timely, well-informed decisions. AI is a technology that will enable all of this.

The military AI revolution has only begun. How it proceeds—and whether the United States ultimately prevails—will depend upon the urgency with which we approach this opportunity, the adaptability of our organizations, and the perseverance of our people. The potential of AI is limitless but only if we have the foresight to understand it and the fortitude to embrace the challenge. ■

Notes

Epigraph. "Ukraine's Commander-in-Chief on the Breakthrough He Needs to Bear Russia," *The Economist* (website), 1 November 2023, https://www.economist.com/europe/2023/11/01/ukraines-commander-in-chief-on-the-breakthrough-he-needs-to-beat-russia.

1. National Defense Strategy Commission, *Providing for the Common Defense: The Assessment and Recommendations of the National Defense Strategy Commission* (Washington, DC: United States Institute of Peace, 2018), 10, https://www.usip.org/sites/default/files/2018-11/providing-for-the-common-defense.pdf.

2. M. Taylor Fravel, "China's 'World-Class Military' Ambitions: Origins and Implications," *Washington Quarterly* 43, no. 1 (Spring 2020): 85, https://doi.org/10.1080/0163660X.2020.1735850.

3. Oriana Skylar Mastro, "The Military Challenge of the People's Republic of China," in *Defense Budgeting for a Safer World: The Experts Speak*, ed. Michael Boskin, John Rader, and Kiran Sridhar (Stanford, CA: Hoover Institution Press, 2003), 37.

4. Office of the Secretary of Defense, *Military and Security Developments Involving the People's Republic of China, 2023: Annual Report to Congress* (Washington, DC: U.S. Department of Defense [DOD], 2023), 139.

5. Ibid., 140.

6. Elsa Kania, "Artificial Intelligence in China's Revolution in Military Affairs," *Journal of Strategic Studies* 44, no. 4 (2021): 515, https://doi.org/10.1080/01402390.2021.1894136.

7. Giulio Douhet, *The Command of the Air*, ed. Joseph Harahan and Richard Kohn (Tuscaloosa: University of Alabama Press, 2009), 30.

8. Michael Wooldridge, *A Brief History of Artificial Intelligence: What It Is, Where We Are, and Where We Are Going* (New York: Flatiron Books, 2020), 24.

9. Rockwell Anyoha, "The History of Artificial Intelligence," Science in the News Special Edition: Summer 2017, 28 August 2017, https://sitn.hms.harvard.edu/flash/2017/history-artificial-intelligence/.

10. Chris Miller, *Chip War: The Fight for the World's Most Critical Technology* (New York: Scribner, 2022), 31.

11. Rekha Jain, "Expert Systems: A Management Perspective," *Vikalpa* 14, no. 4 (1989): 17, https://doi.org/10.1177/0256090919890404.

12. U.S. Government Accountability Office (GAO), *Artificial Intelligence: Status of Developing and Acquiring Capabilities for Weapon Systems*, GAO-22-104765 (Washington, DC: U.S. GAO, 2022), 5, https://www.gao.gov/products/gao-22-104765.

13. Pamela McCorduck, *Machines Who Think: A Personal Inquiry into the History and Prospects of Artificial Intelligence* (Natick, MA: A. K. Peters, 2004), 511.

14. U.S. GAO, *Artificial Intelligence*, 5.

15. Mustafa Suleyman, *The Coming Wave: Technology, Power, and the 21st Century's Greatest Dilemma* (New York: Crown Publishing, 2023), 60.

16. Ibid., 63.

17. Wooldridge, *A Brief History of Artificial Intelligence*, 128.

18. Patrick Tucker, "An AI Just Beat a Human F-16 Pilot in a Dogfight – Again," Defense One, 20 August 2020, https://www.defenseone.com/technology/2020/08/ai-just-beat-human-f-16-pilot-dogfight-again/167872/.

19. U.S. DOD, *Summary of the 2018 Department of Defense Artificial Intelligence Strategy: Harnessing AI to Advance our Security and Prosperity* (Washington, DC: U.S. DOD, 2018), 5, https://media.defense.gov/2019/Feb/12/2002088963/-1/-1/1/SUMMARY-OF-DOD-AI-STRATEGY.PDF.

20. State Council Information Office of the People's Republic of China, *China's National Defense in the New Era* (Beijing: State Council Information Office of the People's Republic of China, 2019), 5, https://english.www.gov.cn/archive/whitepaper/201907/24/content_WS5d3941ddc6d08408f502283d.html.

21. Ibid., 5.

22. Alex Stone and Peter Wood, *China's Military-Civil Fusion Strategy: A View from Chinese Strategists* (Montgomery, AL: China Aerospace Studies Institute, 2020), 26, https://www.airuniversity.af.edu/CASI/Display/Article/2217101/chinas-military-civil-fusion-strategy/.

23. *China's Pursuit of Defense Technologies: Hearing Before the U.S.-China Economic and Security Review Commission*, 118th Cong. 48 (2023) (statement of Elsa Kania, Adjunct Senior Fellow, Technology and National Security Program at the Center for a New American Security).

24. Ryan Fedasiuk, Jennifer Melot, and Ben Murphy, *Harnessed Lightning: How the Chinese Military Is Adopting Artificial Intelligence* (Washington, DC: Center for Security and Emerging Technology, 2021), 32, https://cset.georgetown.edu/publication/harnessed-lightning/.

25. "Deputy Secretary of Defense Kathleen Hicks' Remarks: 'Unpacking the Replicator Initiative' at the Defense News Conference (As Delivered)," U.S. DOD, 6 September 2023, https://www.defense.gov/News/Speeches/Speech/Article/3517213/deputy-secretary-of-defense-kathleen-hicks-remarks-unpacking-the-replicator-ini/.

26. Office of the Secretary of Defense, memorandum, "Realignment and Management of the Defense Innovation Unit," 4 April 2023, https://media.defense.gov/2023/Apr/04/2003192904/-1/-1/1/REALIGNMENT-AND-MANAGEMENT-OF-THE-DEFENSE-INNOVATION-UNIT.PDF.

27. Carl von Clausewitz, *On War*, ed. and trans. Michael Howard and Peter Paret (Princeton, NJ: Princeton University Press, 1984), 101.

28. J. P. Pressley, "Why Banks Are Using Advanced Analytics for Faster Fraud Detection," BizTech, 25 July 2023, https://biztechmagazine.com/article/2023/07/why-banks-are-using-advanced-analytics-faster-fraud-detection.

29. Bo Zhang, Huiping Shi, and Hongtao Want, "Machine Learning and AI in Cancer Prognosis, Predictioin, and Treatment Selection: A Critical Approach," *Journal of Multidisciplinary Healthcare* 16 (2023): 1779, https://doi.org/10.2147/JMDH.S410301.

30. Brian R. Price, "Colonel John Boyd's Thoughts on Disruption: A Useful Effects Spiral from Uncertainty to Chaos," *Journal of Advanced Military Studies* 14, no. 1 (2023): 99, https://doi.org/10.21140/mcuj.20231401004.

31. Herbert S. Lin, ed., *The Stanford Emerging Technology Review 2023: A Report on Ten Key Technologies and Their Policy Implications* (Stanford, CA: Stanford University, 2023), 26, https://setr.stanford.edu/.

32. Ibid., 25.

33. Ibid., 26.

34. Nestor Maslej et al., *Artificial Intelligence Index Report 2023* (Stanford, CA: Institute for Human-Centered Artificial Intelligence, 2023), 322, https://aiindex.stanford.edu/report/.

35. "DOD Adopts Ethical Principles for Artificial Intelligence," U.S. DOD, 24 February 2020, https://www.defense.gov/News/Releases/Release/Article/2091996/dod-adopts-ethical-principles-for-artificial-intelligence/.

36. James Johnson, "Artificial Intelligence and Future Warfare: Implications for International Security," *Defense and Security Analysis* 35, no. 2 (2019): 158, https://doi.org/10.1080/14751798.2019.1600800.

37. Andrew Krepinevich, *The Origins of Victory: How Disruptive Military Innovation Determines the Fates of Great Powers* (New Haven, CT: Yale University Press, 2023), 3.

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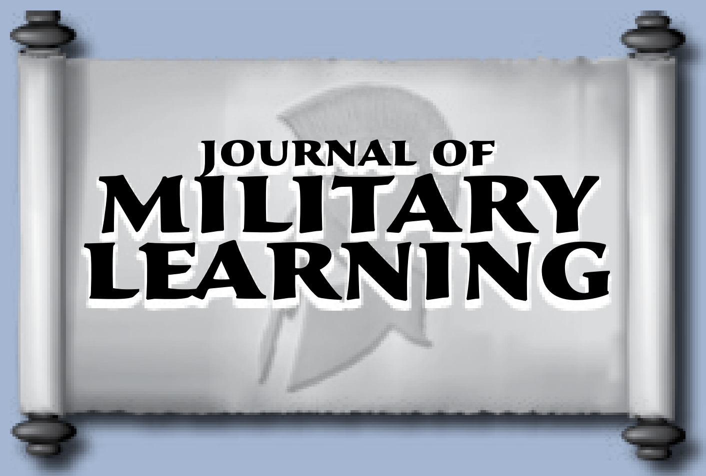

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Advancing the U.S. Army's Counter-UAS Mission Command Systems to Keep Pace with Modern Warfare

Maj. Gen. Joel B. (J. B.) Vowell, U.S. Army
Maj. Anthony R. Padalino, U.S. Army

As of this writing, units in Combined Joint Task Force-Operation Inherent Resolve have been attacked over one hundred times by one-way unmanned aircraft systems and have learned much in the way of establishing defensive and protective measures using various systems and techniques.

"Attention in the BDOC! Four unknown tracks bearing 216 degrees, altitude 250' AGL, range thirteen kilometers, 151 knots, estimated time to impact two minutes forty-seven seconds!" Spc. Jones, an infantryman serving as a base defense operation center (BDOC) C-UAS system operator, stared at his computer screen as his heart began to race. "Attention in the BDOC! Another four tracks just populated ten kilometers to our west, same altitude and speed—less than two minutes to impact."

Jones quickly selected a track on his screen to mark it hostile and then selected through the appropriate software menus to launch an interceptor—this manual process had to be repeated for each individual track. "Sir, I clicked on the wrong drop-down menu on the fourth track, the interceptor failed to launch, and I didn't have enough time to engage tracks seven and eight with interceptors … estimated impact in fifteen seconds." 1st Lt. Kane, the BDOC officer in charge, turned over to his NCO in charge (NCOIC) and said, "Announce brace over the Big Voice!" Seconds later, three Shahed-131 UAS slammed into life-support areas on their outpost—the payloads exploded, instantly killing and wounding multiple soldiers moving from their living quarters to the nearest bunker.

Jones's heart sank as he watched the BDOC raid camera screens display the images of his mortally wounded brothers-in-arms lying on the ground, as the BDOC NCOIC beside him began to coordinate with crisis response units. "There has got to be a faster way to knock these one-way UAS down," thought Jones. Just then his eyes widened as he looked back at his screen—three more tracks had appeared while he was busy attempting to intercept the last eight air tracks, "Sir, three more tracks inbound, thirty seconds to impact."

One of the emerging characteristics of warfare is the proliferation of one-way unmanned aircraft systems (UAS). In both Ukraine and Iraq/Syria,

Two variants of the Coyote 2C drone interceptor are fired during testing at the Yuma Proving Ground, Arizona, in 2021. The kinetic interceptors provide the U.S. Army with a flexible short-range counter-unmanned aircraft system capability. (Photo courtesy of the U.S. Army)

the ongoing fights consist of cheaply produced unmanned aircraft packed with explosives that fly on GPS or Global Navigation Satellite System (GLONASS, the Russian equivalent to GPS) to exact target locations hundreds of kilometers away from a safe launch point. However, existing mission command systems fielded to counter enemy UAS lack necessary technological capabilities to adequately defend combat power on today's battlefield. Mission command systems for counter-UAS (C-UAS) require artificial intelligence (AI), machine learning, and automation to assist operator decision-making and enable simultaneous employment of defeat mechanisms. Furthermore, current fielded systems lack data interoperability with emerging industry detection and defeat systems, resulting in base defense operation centers (BDOC) having multiple "closed" networks to defeat a common threat.[1]

This article identifies the requirement to implement AI, machine learning, and automation into U.S. Army C-UAS mission command systems. Current C-UAS mission command systems rely on operators to complete a manual identification and engagement process that occurs sequentially for each threat and is impractical for scenarios with multiple threats attempting to overwhelm defensive capabilities. By implementing the recommendations in this article, the U.S. Army will have a mission command system with a competitive advantage in countering current and future enemy UAS threats and tactics.

Definition of Terms

Automation. The "use of technology to perform tasks with minimal human input" and reduced or eliminated human intervention. Process automation uses rules-based decision-making based on human system input parameters.[2]

Artificial intelligence. The 2018 *Department of Defense [DOD] Artificial Intelligence Strategy* defines AI to be "the ability of machines to perform tasks that normally require human intelligence—for example, recognizing patterns, learning from experience, drawing conclusions, making predictions, or taking action—whether digitally or as the smart software behind autonomous physical systems."[3]

Machine learning. The machine learns from data using a training algorithm to gain "knowledge" that is not programmed by humans. The system will learn from environmental examples rather than being specifically programmed.[4]

Human in the Loop versus Human on the Loop

In the context of modern warfare, the terms "human on the loop" and "human in the loop" refer to the level of human involvement in decision-making and control over a system that leverages AI or automation. The difference between these two approaches lies in the degree of autonomy granted to the system and the level of human oversight and control.

Human in the loop. A human is directly involved in the decision-making process and has "complete control over starting or stopping any action performed" by the system.[5] This approach is often favored for safety, task precision, responsibility, and control. However, there are situations where having a human in the loop may not be practical or effective.[6] The current C-UAS process is an example of human in the loop, where operators must perform every task and parameter input to create an action by the system.

Human on the loop (HOTL). A human provides oversight of an automated system, but the automation can take action without human preapproval. This approach allows for faster decision-making and response times, which will be vital in the future of rapidly evolving threats. In high-stress situations that impact a human's ability to apply micromotor skills and sound judgment, a supervised autonomous mode (HOTL) will be more effective than relying solely on human decision-making.[7] Aegis Combat System and the MK 15 Phalanx Close-In Weapons System used on Navy ships are examples of HOTL defensive weapon systems.[8] Once activated and under supervision by a human, these systems can independently attack missiles, helicopters, and aircraft that pose a threat to the ship or other protected assets.[9]

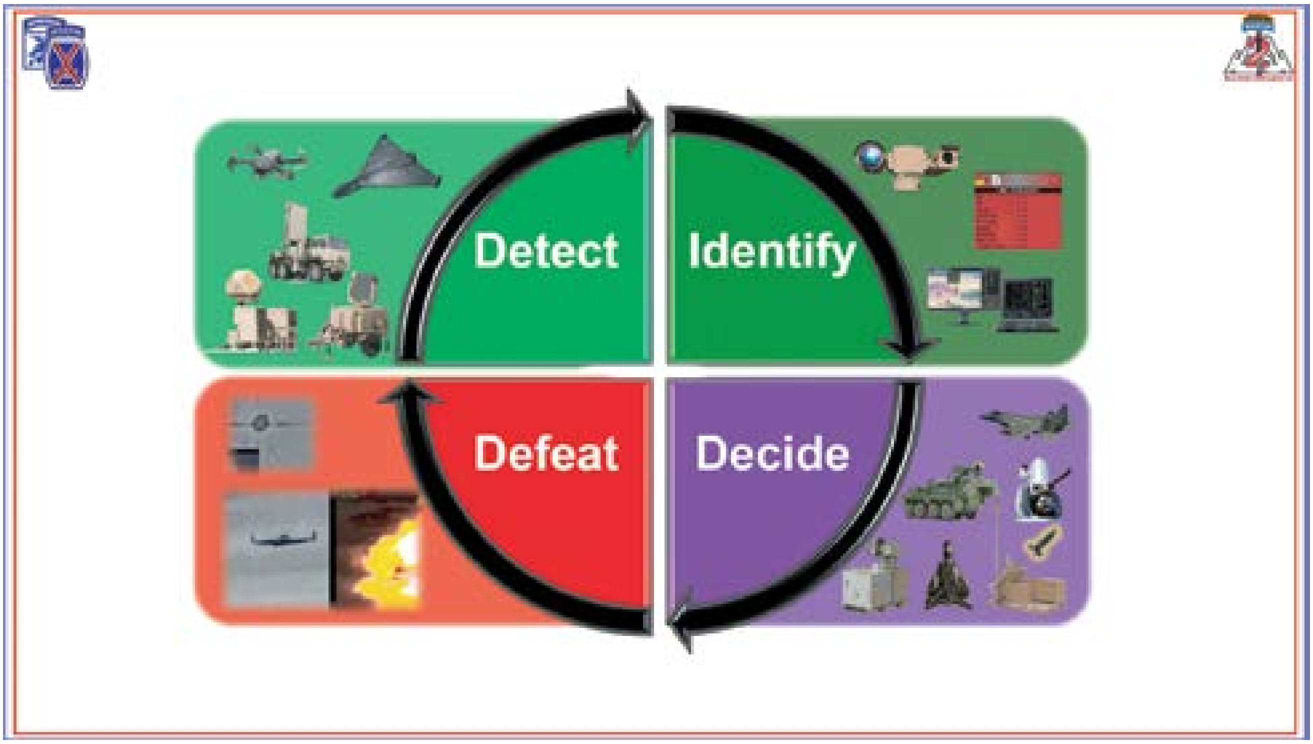
Counter-Unmanned Aircraft System Process

The C-UAS process employs active defense measures in a process with four distinct elements: detect, identify, decide, defeat. This sequence provides a useful framework for evaluating threats posed by UAS across diverse operational environments and the potential application of automation to enhance operator actions. Within the joint force, this process is actively applied inside BDOCs that serve as the responsible coordination, management, and employment node of C-UAS assets and systems.[10]

Detect. The first step in the C-UAS process is to detect the presence of air tracks in the area of operations. This is done through various radar

Maj. Gen. Joel (J. B.) Vowell, U.S. Army, is the commander of Combined Joint Task Force-Operation Inherent Resolve. He received his commission from the University of Alabama in 1991 and is a career infantry officer. He has been stationed in Europe, the Pacific, and many posts across the United States. His last assignment was the commanding general of U.S. Army Japan, Camp Zama, Japan. Vowell has been on three combat tours in Afghanistan and two in Iraq, including both surge campaigns. He commanded the 3rd Brigade Combat Team (Rakkasans) of the 101st Airborne Division at Fort Campbell, Kentucky, and Afghanistan. Vowell was a War College Fellow at Stanford University and was the Army chief of staff's Senior Fellow to the Brookings Institution.

Maj. Anthony Padalino, U.S. Army, is an operations officer in 2nd Battalion, 15th Field Artillery, 2nd Brigade Combat Team, 10th Mountain Division, deployed forward to Al-Asad Airbase, Iraq, in support of Operation Inherent Resolve. He holds a BS from Western Michigan University and an MS from Embry-Riddle Aeronautical University. During his career, he has deployed to the U.S. Central Command area of operations four times, and he has served with the 4th Infantry Division, the 101st Airborne Division, and Human Resources Command.



(Graphic by Maj. Anthony R. Padalino, U.S. Army)

Counter-Unmanned Aircraft System Process

sensing and tracking methods, including aerial and ground sensors. Raytheon, for example, developed the 360-degree AN/MPQ-64 Sentinel radar that provides detection of UASs, rotary-wing aircraft, and fixed-wing aircraft with identification friend or foe interrogation capabilities. Raytheon also developed the 360-degree Ku-band Radio Frequency System (KuRFS) that can sense and track aircraft, rocket, artillery, and mortars. The KuRFS radar supports multiple kinetic and nonkinetic C-UAS weapon systems such as the Palletized High-Energy Laser, Land-based Phalanx Weapon System, and the Raytheon Coyote interceptor.[11]

Identify. When an air track is detected, the next step is to analyze the track and determine if it is friendly or hostile. This is done through identification friend or foe interrogation of the track using identification friend or foe capable radars (such as the Q-64 mentioned above), airspace controlling agencies (air traffic control, combined air operations command), or hostile characteristics. Distinguishing between friendly and hostile threat tracks is a complex process that uses one of two methods, positive and procedural.[12] Positive identification is the most preferred and does not require visual identification to determine a suspect air track—digital identification (physics-based) using known hostile characteristics can be used to determine if a track is a hostile UAS.[13] Procedural identification uses geography, heading time, and aircraft flight path to determine friend or foe—usually paired with an air tasking order and/or operational graphics.

Decide. Two decisions are made in this phase: first, to determine whether there is a requirement to engage (rules of engagement, geopolitical situation, tactical situation, etc.); and second, to determine what method will be used to intercept the threat. If an operator identifies an air track as hostile, he or she decides to use a kinetic or nonkinetic weapon to intercept the identified threat. The bearing, altitude, range, and speed of each individual threat is evaluated to determine the requirement to engage and employ the appropriate weapon for the most efficient and effective engagement.

Defeat. Operators achieve successful kinetic or nonkinetic effects on identified hostile tracks in this

The Forward Area Air Defense Command and Control user interface provides a common air picture. (Photo courtesy of Northrop Grumman)

phase. Visual confirmation of intercept or digital confirmation are the methods used to determine positive or negative effects in this phase. If a hostile track is not defeated, the operator employs additional assets until he or she defeats the threat or it impacts its intended target.

Manual Engagement Challenges

The Forward Area Air Defense Command and Control (FAADC2) is the U.S. Army's current mission command system that provides the network architecture to detect, identify, and employ kinetic and nonkinetic defeat effects.[14] The FAADC2 has been in use by the Department of Defense since 1989.[15]

The FAADC2 system's current use of manual engagement processes in the identify, decide, and defeat phases significantly inhibits the effective and efficient defeat of enemy threats, especially when given mere seconds to make a decision. The operator must manually interrogate each radar track and manually process each defensive system individually against a hostile target, which is time-consuming and prone to human error.

This manual process prevents simultaneous engagements that will be required in rapidly evolving combat scenarios. The time expended in manual engagements will allow a swarm of UAS to attack and penetrate defensive layers unimpeded. BDOC operators often face task saturation and an increased likelihood of human error when simultaneously contending with multiple UAS attacks, potential friendly air traffic, transitioning between weapon systems, assessing other threats, and managing current engagements.

The FAADC2 system requirement for manual operator engagements distracts operator focus on critical air track identification and further exacerbates human error and inefficiency to defeat UAS. Improvements in threat UAS attack speeds (jet-powered Shahed-238) and use of terrain masking to avoid early radar detection further diminish the effectiveness of manual methods and will lead to a breakdown in C-UAS intercept success.

Recommendations to Advance C-UAS Mission Command Systems Artificial Intelligence–Assisted Identification

AI should be integrated into mission command systems for enhanced operational efficiency in detecting hostile air tracks. This integration assists operators by providing continuous analytical capabilities to interrogate air tracks within a base defense zone. The strength of AI is its ability to analyze and identify patterns from previously recorded data. C-UAS mission command systems should store previously recorded threat data on a secret cloud-based repository to enable theater-wide access by AI identification systems to integrate air track data at a velocity and precision unattainable by human operators.

AI's capability to recognize and identify threat air tracks and promptly alert human operators will reduce task saturation and allow operators to retain final track identification authority. Incorporating AI into track identification will enhance the accuracy of operator identification and will reduce the time taken to identify threats, increasing the time to alert ground forces of imminent threat and resulting in the preservation of combat power.

Machine learning algorithms will play a vital role in the identification phase by enhancing the mission command system's ability to assist operators to discriminate between hostile and nonhostile air tracks over time by analyzing physics-based radar track data, full-motion video, and other forms of detection data. Machine learning algorithms will improve AI's ability to alert operators of threat tracks while also ensuring operators are aware of likely friendly tracks based of recognized data characteristics.

Failing to integrate AI and machine learning algorithms into mission command systems will result in BDOCs that perform only as well as the human operator—which is not at the system's maximum potential. Human operators who lack the benefit of AI and machine learning tools are at a disadvantage. They risk failure to quickly identify tracks and they risk failure to ensure the successful interception of hostile tracks to prevent UAS from striking their intended targets. While humans can perform interrogation and identification manually, they are not able to perform tasks with the same precision, speed, and consistency as AI.

Automated Engagement: Advancing the Decide and Defeat Phases

To address the limitations of the current manual FAADC2 engagement process, the U.S. Army should implement automation processes into the decide and defeat phases once an operator confirms an air track is hostile. By incorporating automation, the FAADC2 system will automatically engage with the appropriate method until the threat is defeated. This automated engagement capability would significantly reduce engagement response times and enable the operator to focus on threat identification and airspace deconfliction while the system selects and monitors defeat options for the most efficient means of intercept—free of human error. Moreover, the C-UAS process retains HOTL to ensure a human remains involved in the decision to launch.

Automated engagement would remove the requirement for a human operator to manually select each individual track and perform the multiple-step sequential process to launch an interceptor and fire a Land-based Phalanx Weapon System or a Palletized High-Energy Laser for each assessed threat. With an automated decide and defeat capability, the operator provides human supervision of engagements of human-confirmed hostile tracks, while the C-UAS decide and defeat system has the ability to conduct simultaneous engagements using multiple weapon systems to mass against multiple threats and achieve a true combined arms defensive fires capability. Automated defeat capability will increase UAS intercepts, decrease engagement times, substantially reduce human error, and significantly increase the probability of defeating a UAS swarm attack.

Critics of automated engagement may cite the need for operators to manually engage identified threats to ensure systems are acting within the laws of armed conflict and the rules of engagement.[16] However, these reservations are mitigated within the identify phase of the C-UAS process, where a human determines the threat as hostile and directs machine intervention. We propose that hostile tracks will not be engaged unless an operator (1) confirms the track as hostile and (2) authorizes the system to engage (human "on the loop" vs. human "in the loop").

C-UAS Future: AI-Assisted Identification, Automation Decides and Defeats

AI will provide human operators the ability to identify multiple tracks in congested airspace within the full potential of radars. The only limitation of threat identification will be the radars' performance in detecting UAS attempting to evade or mask their signature. Human operators still could interrogate tracks manually and will retain the final authority to classify air tracks as friendly or hostile.

Automation in the decide and defeat phases will enhance the C-UAS mission command system's effectiveness by enabling autonomous and simultaneous engagements of UAS after a human confirms an air track as hostile. Real-time data fusion through cloud-based repository storage and advanced machine learning algorithms that evolve with threat tactics, techniques, and procedures will enable automated systems to evaluate the threat level posed by an air track marked hostile by a human operator and determine the appropriate response, such as the employment of a kinetic system like an interceptor or the activation of electronic warfare countermeasures. This automation would not only save valuable engagement time but also reduce the burden on human operators, enabling human focus on threat identification and defeat supervision.

Enhancing Future Warfare Capabilities

The integration of machine learning and automation into the identify, decide, and defeat phases of the FAADC2 mission command system should be immediately implemented by the U.S. Army. By leveraging automation, AI, and machine learning technology available today, mission command systems can adapt and learn from current threats observed in combat and increase UAS intercept success rates. Similar advancements in commercial automotive technology have led to vehicles equipped with AI and machine learning that enable autonomous driving capabilities. Vehicles harnessing AI and machine learning technology are able to learn from the surrounding environment, access data real-time through repositories, improve decision-making, learn object classification, and provide operator alerts.[17] Automation process technology exists within the DOD as well; one just has to look to the U.S. Navy Aegis Combat System ships. We must apply emergent technology to advance our industrial age systems to innovate at the speed of warfare.

Decreased threat identification times, increased intercept capability, and enhanced accuracy achieved through automation will provide a tactical advantage in countering emerging UAS technologies and threats, especially those aimed at strategic assets, troop concentrations, and high priority locations. As adversaries continue to innovate and deploy UAS, to include jet-powered Shahed-238 UAS, operators will have seconds to correctly detect, identify, decide, and defeat hostile air tracks. The U.S. Army must stay ahead of threats versus waiting to adapt.

Conclusion

The FAADC2 mission command system has played a crucial role in countering air threats and managing airspace since 1989. However, the industrial-age manual engagement process utilized by our current system poses challenges in terms of efficiency for current tactics, techniques, and procedures observed on the battlefield in Ukraine, Iraq, and Syria and ultimately threaten the survivability of our personnel. By incorporating AI, machine learning, and automation technologies, the FAADC2 system will advance C-UAS defeat abilities beyond the threat capabilities of our adversaries. Automated engagements placing operators on the loop enables a C-UAS combined arms defense with tactical and technical decision speeds that human operators cannot perform by themselves.

The risk to not advancing C-UAS mission command systems and maintaining manual C-UAS processes will allow malign state and nonstate actors to compete with the United States along the conflict continuum at a relatively low-cost/high-reward trade-off. As seen in recent events in the Middle East, malign state and nonstate actors' ability to conduct precision strikes on U.S. forces with low cost UAS places a risk to force with strategic-level impacts and places our national interests at risk. The risk to mission in large-scale combat operations is the attrition of formations from the port to the front line of troops. Intervention capabilities lacking the speed and precision of the digital age will fail to prevent the mass destruction of logistical nodes and combat power, requiring additional resources for combatant commanders to achieve a desired military end state. Incorporating AI, machine learning, and automation into the C-UAS fight is a high-priority effort requiring immediate attention to stay ahead of adversaries in this rapidly evolving threat environment. ■

Notes

1. Deputy Secretary of Defense, memorandum, "Creating Data Advantage," 5 May 2021, https://media.defense.gov/2021/May/10/2002638551/-1/-1/0/DEPUTY-SECRETARY-OF-DEFENSE-MEMORANDUM.PDF; Department of Defense (DOD), *Department of Defense Data, Analytics, and Artificial Intelligence Adoption Strategy: Accelerating Decision Advantage* (Washington, DC: U.S. DOD, November 2023), https://media.defense.gov/2023/Nov/02/2003333300/-1/-1/1/DOD_DATA_ANALYTICS_AI_ADOPTION_STRATEGY.PDF. The inability to pass data between mission command and defensive systems is in direct contradiction to the deputy secretary of defense's 2021 "Creating Data Advantage" directive to Pentagon senior leaders and combatant commands, and the 2023 *Department of Defense Data, Analytics, and Artificial Intelligence Adoption Strategy*.

2. "What Is Automation?," IBM, accessed 19 March 2024, https://www.ibm.com/topics/automation.

3. DOD, *Summary of the 2018 Department of Defense Artificial Intelligence Strategy* (Washington, DC: U.S. DOD, 2018), 4, https://media.defense.gov/2019/Feb/12/2002088963/-1/-1/1/SUMMARY-OF-DOD-AI-STRATEGY.PDF.

4. Greg Allen and Jack Shanahan, *Understanding AI Technology* (Washington, DC: DOD Joint Artificial Intelligence Center, 2020), 7, https://www.ai.mil/docs/Understanding%20AI%20Technology.pdf.

5. Jackson Barnett, "AI Needs Humans 'On the Loop' Not 'In the Loop' for Nuke Detection, General Says," FedScoop, 14 February 2020, https://fedscoop.com/ai-should-have-human-on-the-loop-not-in-the-loop-when-it-comes-to-nuke-detection-general-says/.

6. Jean-Michel Verney and Thomas Vinçotte, "Human-On-the-Loop," *Joint Air and Space Power Conference 2021 Read Ahead* (May 2021), https://www.japcc.org/essays/human-on-the-loop/.

7. Barnett, "AI Needs Humans 'On the Loop.'"

8. "AEGIS Weapon System," Navy.mil, last updated 20 September 2021, https://www.navy.mil/Resources/Fact-Files/Display-FactFiles/Article/2166739/aegis-weapon-system/; "MK 15 - Phalanx Close-In Weapon System (CIWS)," Navy.mil, last updated 20 September 2021, https://www.navy.mil/Resources/Fact-Files/Display-FactFiles/Article/2167831/mk-15-phalanx-close-in-weapon-system-ciws/.

9. Amitai Etzioni and Oren Etzioni, "Pros and Cons of Autonomous Weapons Systems," *Military Review* 97, no. 3 (May-June 2017): 72–81, https://www.armyupress.army.mil/Journals/Military-Review/English-Edition-Archives/May-June-2017/Pros-and-Cons-of-Autonomous-Weapons-Systems/.

10. "Counter-Unmanned Aircraft Systems (C-UAS)," Department of Homeland Security, 2 July 2023, https://www.dhs.gov/science-and-technology/counter-unmanned-aircraft-systems-c-uas; Army Techniques Publication (ATP) 3-01.81, *Counter-Unmanned Aircraft System (C-UAS)* (Washington, DC: U.S. Government Publishing Office, 2023), https://armypubs.army.mil/epubs/DR_pubs/DR_a/ARN38994-ATP_3-01.81-000-WEB-1.pdf.

11. "KuRFS: Ku-band Radio Frequency Sensor," Raytheon, accessed 19 March 2024, https://www.rtx.com/raytheon/what-we-do/integrated-air-and-missile-defense/kurfs.

12. ATP 3-01.81, *Counter-Unmanned Aircraft System (C-UAS)*.

13. Ibid.

14. "Northrop Grumman's FAAD C2 System Enables Integrated Short Range Air Defense in Baltic Region," Northrop Grumman, 5 June 2023, https://news.northropgrumman.com/news/releases/northrop-grummans-faad-c2-system-enables-integrated-short-range-air-defense-in-baltic-region.

15. U.S. General Accounting Office (GAO), *Battlefield Automation: Army's Air Defense Command and Control System Status and Program Issues*, GAO-NSIAD-90-12BR (Washington, DC: U.S. GAO, 20 December 1989), https://apps.dtic.mil/sti/tr/pdf/ADA292160.pdf.

16. Jovana Davidovic, "What's Wrong with Wanting a 'Human in the Loop'?," War on the Rocks, 23 June 2022, https://warontherocks.com/2022/06/whats-wrong-with-wanting-a-human-in-the-loop/.

17. Kaviraj Sankar, "Automotive Radar Advancements with AI—Revolutionizing Safety & Perception (Part 1)," Multicoreware, 5 September 2023, https://multicorewareinc.com/automotive-radar-advancements-with-ai-revolutionizing-safety-perception-part-1/.

Taking off from an undisclosed location 25 April 2021, the 332nd Air Expeditionary Wing blazed new trails when they configured six F-15E Strike Eagles to carry extra bombs to bare base locations. This new configuration allows the U.S. Air Force to increase combat capabilities by carrying more munitions than the F-15E can use on one mission for storage on small, dispersed operating bases. (Photo by Tech. Sgt. Paul Duquette, U.S. Air Force)

Artificial Intelligence and Agile Combat Employment

Lt. Col. Benjamin "Buzz" Hagardt, U.S. Air Force

In 2018, the U.S. Secretary of Defense published the *National Defense Strategy* (*NDS*), signifying a strategic reawakening for the United States in which the primary concern to national security is "the *reemergence of long-term, strategic competition* by … revisionist powers."[1] Russian and Chinese military modernization efforts have shifted the global security environment, displacing the United States as the uncontested or dominant superpower of the world.

Among many lines of effort, the *NDS* calls for developing a more lethal, resilient, and rapidly innovating force capable of dynamic employment and unpredictable operations that will challenge adversary decision-makers.[2] The threats presented by enemy weaponry, pervasive surveillance technology, and cross-domain long-range fires have motivated the U.S. Air Force (USAF) to apply its operational resiliency framework to the new scheme of maneuver called *agile combat employment* (ACE).[3] This posture of resiliency enables the ability to deploy our forces using small, dispersed, and adaptive basing techniques to survive and operate in all domains.[4]

The *NDS* also calls for rapid innovation in advanced autonomous systems, including artificial intelligence (AI) and machine learning (ML).[5] China declared its intent to be the world leader in AI by 2030, investing hundreds of billions of dollars to apply AI across the range of military decision-making, deductions (e.g., wargaming), and defense equipment.[6] Opposing this Chinese threat, the 2018 *Department of Defense* [DOD] *Artificial Intelligence Strategy* outlines the intention of the United States to use AI-enabled information systems to create agile and resilient logistical systems that empower our military leaders.[7] These initiatives, while in their early stages, present opportunities to prepare for strategic employment as the technology matures. Commercial businesses have already proven to be the leading edge of AI innovation and strategic integration. Leveraging their success could serve as the military's pathway to dominating the "intelligentized" battlefield of the future.

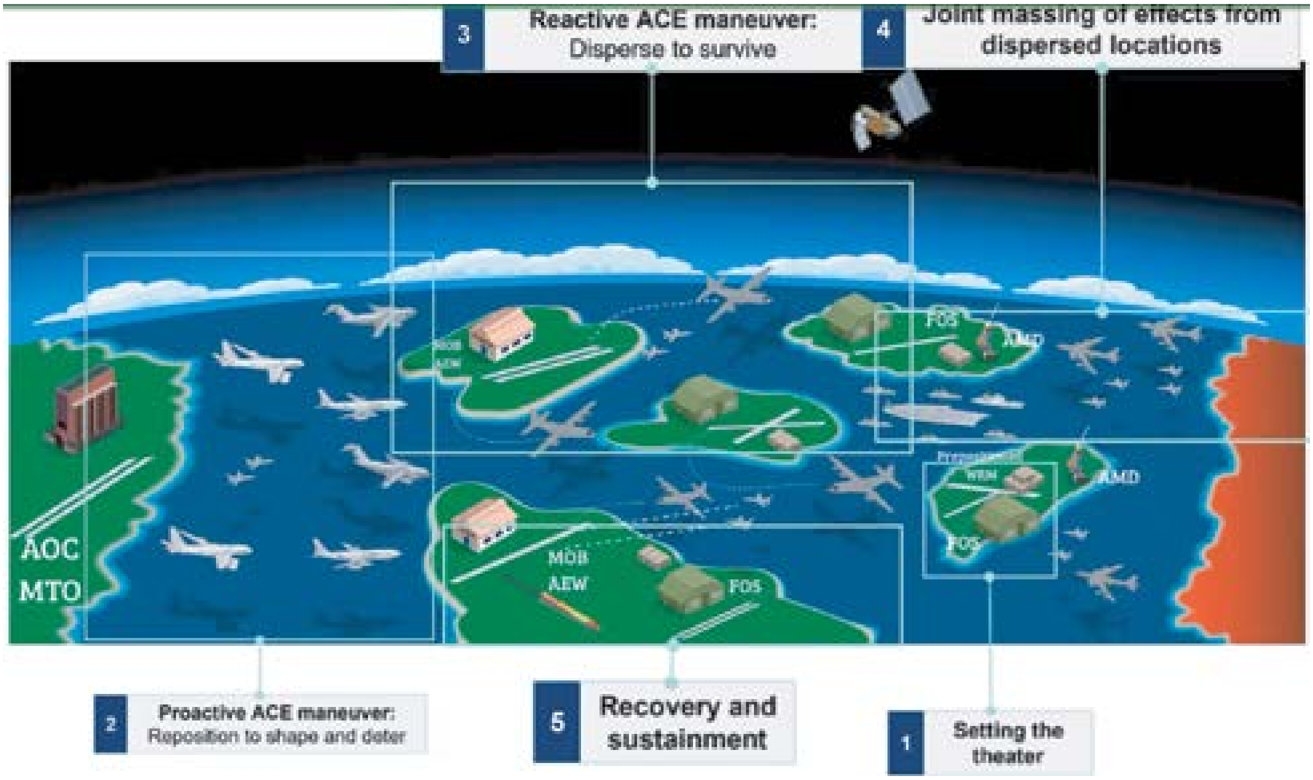
ACE and AI Integration Vignette

Imagine the United States is involved in a contingency operation during which escalations in force are imminent. Over several months, senior leaders have utilized AI and ML systems to assess enemy movements and design a countering force structure to respond. Main operating bases (MOB) and contingency locations (CL) are designated, and military big data sources report the availability of resources and optimal delivery methods in that theater of operations. Air operations directives and commander's intent are published, allowing the AI to make suggestions on how to apply airpower to achieve objectives. Commanders select and approve a course of action that orders the posturing of assets and support equipment to those locations to prepare for ACE operations.

Enemy targets are identified to be struck by friendly forces with precision weapons in the next twenty-four hours. The ACE logistics engine processes the desired effect, knowing what aircraft and munitions are available, pairing specific aircraft based on weapons load, proximity to the target, and follow-on missions. Meanwhile, additional algorithms are calculating the impacts of weather around the target area and the availability of other assets that could be retasked to that assignment if the paired asset was destroyed. This information is being "pushed" proactively to decision-makers rather than waiting for assessments to be requested.

The threat engine calculates potential enemy responses that could either preemptively destroy the friendly paired aircraft before takeoff or while flying to the mission area. The threat database contains extensive information on the known enemy aircraft (e.g., types, numbers, weapons, locations, combat radius, historical flight patterns, pilot proficiency, day/night

Lt. Col. Benjamin "Buzz" Hagardt, U.S. Air Force, is the command air battle manager evaluator for Air Combat Command Standardization Branch, Flight Operations Division, Langley Air Force Base, Virginia. He holds a BA from the University of Arizona and an MA from Air University. As a senior air battle manager, he has over 1,300 flight and combat hours operating on Airborne Warning and Control System and Control and Reporting Center platforms. He has served with operational units to include the 964th Airborne Air Control Squadron, 966th Airborne Air Control Squadron, 607th Air Control Squadron, and 752nd Operations Support Squadron.



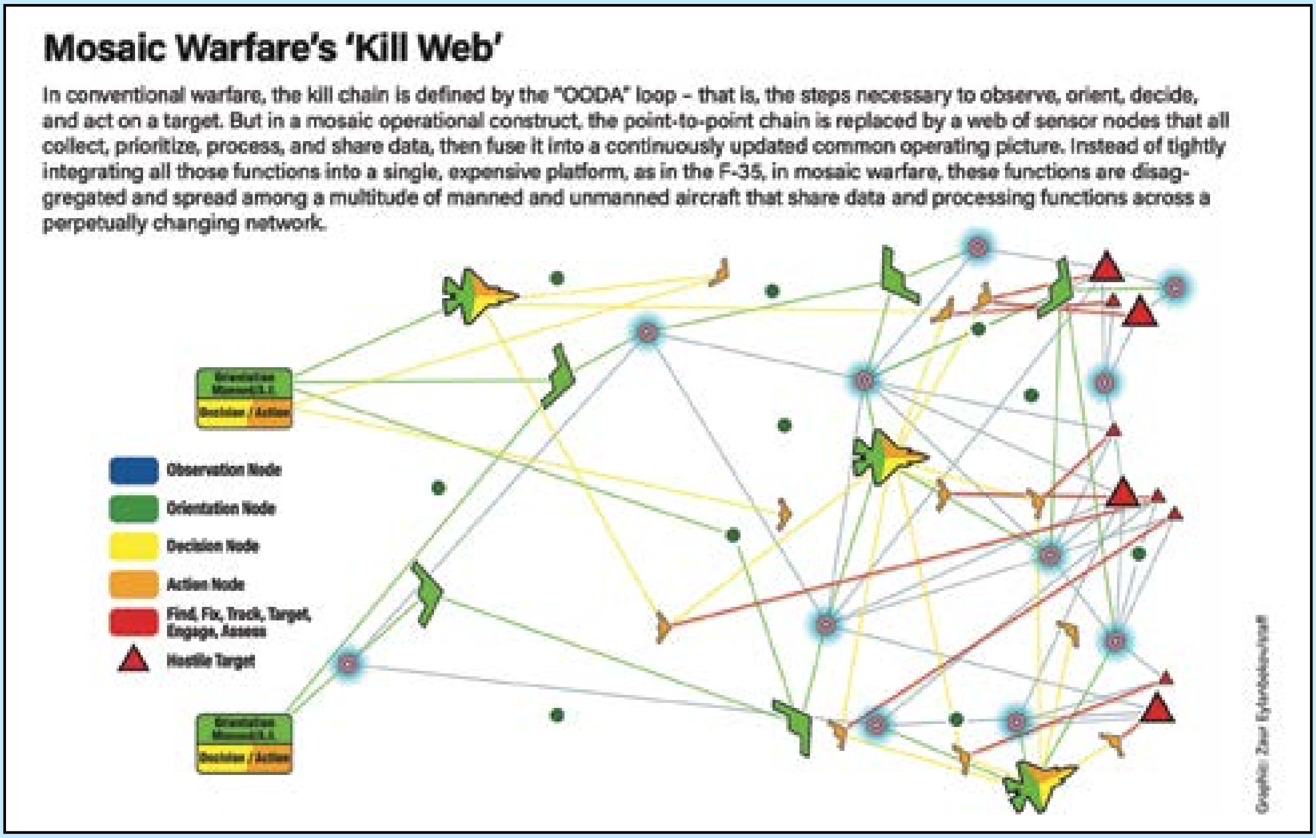
A screen capture from a 15 December 2022 U.S. Air Force online briefing outlines the Agile Combat Employment concept using a simulated scenario with illustrative phases demonstrating decentralized control by dispersing pared-down forward-deployed command-and-control elements over a broad geographical region. Decentralized control mitigates the threat of entire networks of operational control being dramatically degraded or eliminated entirely. The ability to operate, sustain, defend, and project power will be reshaped as new connectors and different ways of using aviation assets, including expanded reach from leveraging seabasing, drive both force redesign and operations innovation for force distribution and integration. (Public affairs video by James Self, U.S. Air Force)

limitations) and surface-to-air weapons that could intercept the strike package. When it merges this information together, the AI system recommends various options based on acceptable levels of risk (e.g., low, moderate, significant, high, extreme) to the available assets. If senior leaders choose to adjust risk levels, the system will automatically adjust to include updated solution profiles and suggest new courses of action. When it anticipates the enemy response from previous attacks, the AI suggests movements of supporting assets (including supplies and delivery system) to new CLs to increase survivability.

ACE Elements with AI

ACE relies on four essential themes: agility, posture, protection, and joint all-domain command and control (JADC2). These themes are further applied to our forces through five core elements: posture, command and control, movement and maneuver, protection, and sustainment.[8] ACE distributes assets and support resources among forward operating bases with decentralized control to ensure survivability and limit adversary disruption. This prevents the elimination of central hubs that would cripple entire networks of operations.

The comparison of e-commerce AI to ACE is relevant because business marketing involves performance relative to another competitor with complex networks of relationships composed of allies and adversaries. ACE and e-commerce logistics share similar challenges and benefit from the same technological advantages. Although this framework can be applied to how support equipment might reach friendly forces facing a peer global power adversary (similar to packages reaching customers), it can also be thought of in terms of delivering kinetic or nonkinetic effects (e.g., bombs or electronic attack jamming) to specific targets like enemy troops or weaponry.



(Graphic by Zaur Eylanbekov, courtesy of *Air & Space Magazine*)

Agile combat employment distributes assets and support resources among forward operating bases with decentralized control to help create a "Kill Web" in operations against adversaries that also limits adversary disruption of command and control and fosters base survivability.

ACE Posture with AI

The posture element of ACE establishes the starting positions from where operations will take place, creating strategic predictability and operational fluidity. Initial actions redistribute theater-assigned assets and follow-on forces from MOBs to optimal forward CLs for mission execution. These CLs can either be preplanned or ad hoc based on the threat environment and tasking requirements. This large network of flexible and multiplatform-enabled bases must also be able to support entire mission sets (e.g., refueling operations), not just specific aircraft types (e.g., KC-10 or KC-135 tankers). This complex planning and decision-making process can benefit from the application of ML techniques. The same algorithms that analyze e-commerce suppliers within smart production and supply chain management can assist in selecting ideal locations to operate military activities from. These criteria could include dozens of factors such as runway conditions, geography (e.g., distance to friendly/enemy forces or relation to priority objectives), vulnerability to attack, existing supply inventories and resupply options, means of communication, and life support capabilities (e.g., medical treatment, food, shelter).

To maximize the effectiveness of these algorithms, vast data sources similar to the big data framework that e-commerce uses are required. The combination of existing military information systems (e.g., Defense Readiness Reporting System, Deliberate Crisis Action Planning and Execution Segments, Logistics Module), civilian networks, internet-of-things technology, and sharing agreements with allies or partner nations would satisfy the critical component allowing the ML process to filter, sort, and group decision-making criterion for ACE. ML algorithms could also assist with CL selection by grouping them into categories of primary, alternate, contingency, emergency options for increased planning flexibility. Armed with this information, senior

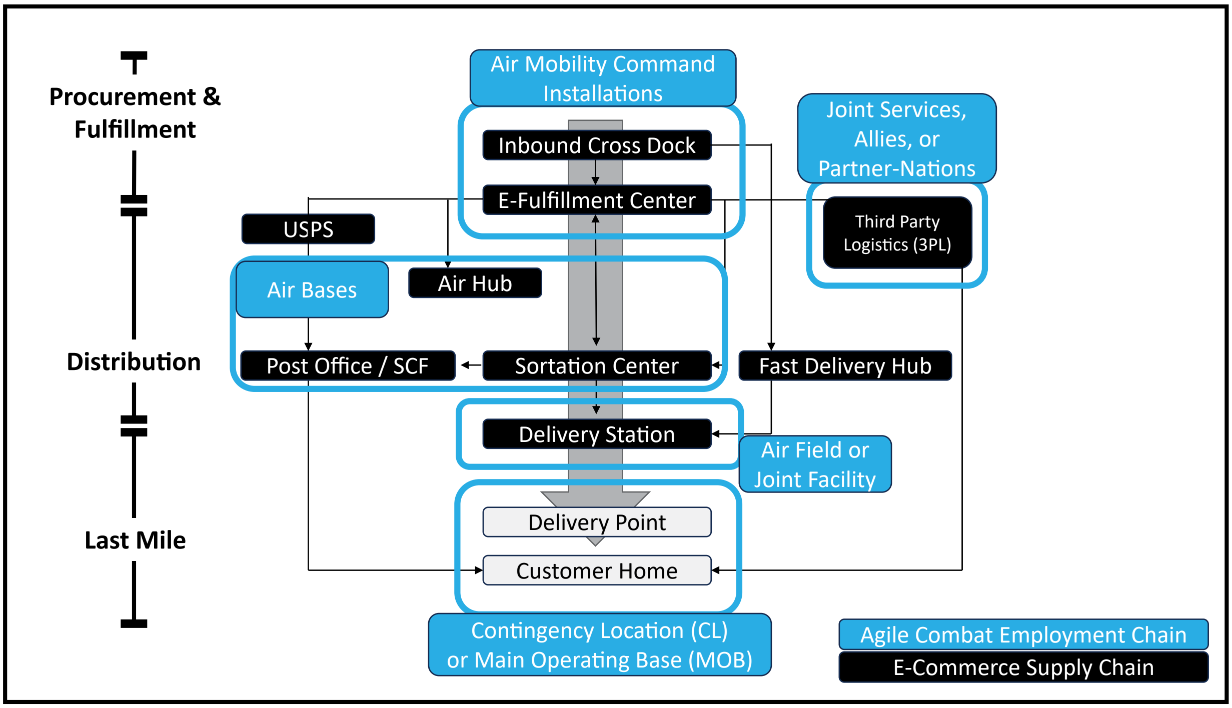
An aircrew from the 489th Attack Squadron performs preflight safety checks before initiating the automated takeoff and loading capability for an MQ-9 Reaper at Creech Air Force Base, Nevada, 3 August 2021. Advanced technological developments in the use of drones and employment of artificial intelligence facilitate decentralized command and control of operational platforms. (Photo by Staff Sgt. Omari Bernard, U.S. Air Force)

Air Force leaders can help shape the needs of their forces by determining the demand signal for resources and awareness of what is readily available.

ACE Posture with AI Supply/ Demand Forecasting

The enabling support forces required to meet the demands of ACE operations are referred to as agile combat support (ACS). The ACS community is undergoing a similar transformation to this new adaptive mindset, exploring ways to shift from MOBs to CLs and platform-agnostic support methods. Since the mid-1990s, the Expeditionary Aerospace Force concept has leveraged forward-based equipment to organize combat power into leaner deployment packages called *unit type codes* (UTCs).[9] These predefined package UTCs of personnel and equipment offered commanders the ability to ask for specific capabilities and quantities of aircraft or supporting assets. Although this created easier human-based planning, it also increased the likelihood of perceptual oversights, personal biases, and human error resulting in force shortages or wasted oversupply.

AI ML systems, similar to Google's DeepMind, offer creative solutions by generating predictive figures to discern future resource needs and automatically assemble equipment packages tailored to meet those force requirements.[10] This could replace legacy UTCs and extensive inventory stockpiles, saving money on hidden storage expenses while optimizing supply inventories. In the event certain supplies are not available via organic military sources, the algorithms can expand search criteria to include compatible civilian equivalents or that of our partner nations and allies. Furthermore, any resource gaps or emerging requirements identified during this process would be reported to decision-makers to immediately invest into production contracts. The urgency of the requirement would determine whether the request for proposal would follow standard contracting channels or emergency selection by military council based on AI



(Figure by author; modified from Jean-Paul Rodrigue, "The Distribution Network of Amazon and the Footprint of Freight Digitalization")

Figure. E-Commerce Supply Chain of Amazon (*in black*) with Agile Combat Employment (*in blue*) Comparison

trend analysis of performance histories, relatability to existing contracts, and total cost. New design prototypes would be run through ML simulations and predictive analytic tools to solve design flaws long before they enter mass production for warfighter implementation.

These advantages also enable the command-and-control and protection ACE elements by ensuring self-protection and communication equipment are sourced and available. The longer these ML techniques are utilized, the more accurate their data becomes. This enables solution recommendations for anticipated issues from historical analysis and give leaders more time to make decisions. Once these UTC packages are configured, their positioning relative to other MOBs and CLs becomes just as critical as their content.

ACE Maneuver and Movement with AI

The maneuver and movement element of ACE seeks to outpace an adversary by consistently moving to fight from positions of advantage. This requires forces to flow between dispersal bases (e.g., MOBs to CLs, between CLs, and back to MOBs) to increase survivability or mass forces for strategic objectives. AI-based systems have proven invaluable for optimizing this sort of movement between e-commerce warehouses to sorting centers and the end-stage consumers. Amazon organizes this hierarchical supply chain process first into *procurement and fulfillment*, then *distribution*, and finally the *last mile*.[11] Procurement and fulfillment use massive cross-dock facilities (average size 855,000 sq. ft.) that transfer to hundreds of e-fulfillment centers. Distribution focuses on taking products from those e-fulfillment centers and allocating them among air hubs and sorting centers (average size 350,000 sq. ft.). The last mile involves the delivery stations (average size 91,200 sq. ft.) that take products from sorting centers to the final delivery location.[12]

The figure depicts the flow between each facility and illustrates their approach to solving an incredibly complex logistical problem set.[13] It also shows how the military could adopt a similar construct for movement and maneuver logistics through the same ML and AI systems. Large U.S. Air Mobility Command installations (e.g., Travis Air Force Base in California or McGuire

Airmen with the 35th and 55th Combat Communications Squadrons replace a feed boom on a Ranger 2400 Flyaway Multi-Band Terminal during Exercise Agile Blizzard-Unified Vision 2023 near Comox, British Columbia, Canada, 19 June 2023. The satellite dish allows for quick setup satellite communications that are necessary when operating in a semi-austere location where communications are limited. (Photo by Tech. Sgt. Betty R. Chevalier, U.S. Air Force)

Air Force Base in New Jersey) could act as ACE cross docks or e-fulfillment center equivalents. Smaller air bases outside of the United States could serve as air hubs or sorting centers with smaller airfields or joint facilities as the final delivery stations taking resources to CLs. This would involve both intertheater and intratheater transportation coordination to ensure the global deployment capabilities of U.S. forces.

ACE Maneuver and Movement with AI Distribution

Although the USAF has reduced its overseas bases from ninety-three to thirty-three since the end of the Cold War, it retains the ability to project forces through agreements with allies or partner nations to provide access, basing, and overflight.[14] The "logistics sprawl" that Amazon achieved in their distribution market can be applied to ACE basing networks. Training AI systems to identify where resources can be sent to directly support CLs will enable them to reduce distribution costs and optimize shipping systems (i.e., the closer the supplies can get to CLs, the faster and easier it will be to receive them when requested). This also enables USAF senior leaders and logisticians to design optimal CLs in relation to these known supporting networks. Any threats that would displace U.S. forces from that CL can relocate to the alternative location within the hub-and-spoke design, creating the desired operational resiliency ACE advocates seek.

ACE Maneuver and Movement with AI Delivery

The method of delivering force support materials is just as critical as its sourcing. What cannot be transported by USAF assets is either assisted by joint services or contracted out to nonmilitary companies. Considering that ACE involves global operations, both intratheater and intertheater transportation methods must be carefully planned as time-phased force deployment data. This time-phased force deployment data outlines how equipment, aircraft, and personnel will flow into an operational area (e.g., airlift, sealift, land convoy). As ACE shifts away from traditional air bases to temporary CLs, the level of complexity in successfully planning and executing operations is exponential. AI-driven third-party logistics can identify the most efficient means of accomplishing this feat (e.g., contractors, joint services, allies, partner-nations), while predicting the needs of future movements based on predetermined threat or mission profiles. In 2021, the commander of U.S. Transportation Command—responsible for providing air, land, and sea transportation to meet national security needs—supported the exploration of AI systems for the intertheater transport problem set.[15]

A machine capable of understanding the logistical requirements to move personnel, cargo, and aircraft to a forward location within a specific amount of time for an intended duration can easily determine the most efficient means of getting there. Then once these hub-and-spoke locations are established, military planners can coordinate the movement between locations to achieve mission objectives or react to enemy activities. Incorporating AI feedback systems that report degradation to the transportation scheme (e.g., enemy destruction of major bridges or obstructed waterways) would return recommendations to USAF leaders to adjust the method of transportation (e.g., planned sealift updated to airlift). Generally, a short-notice change to these transportation plans would incur a significant amount of strain on logisticians to reproduce load plans while addressing cascading delays for follow-on shipments. However, training ML models to recognize the loading dimensions, weight, and characteristics of that cargo can enable machines to automatically reflow the transportation plans to available aircraft down to the exact airworthiness inspection requirements needed to load the equipment.

For intratheater travel, training ML systems to recognize the best access methods of CLs is critical. With limited airfields available in dynamic areas, vertical takeoff and landing vehicles such as the CV-22 Osprey or HH-60 Pave Hawk are ideal but can only transport small amounts of cargo and personnel. However, if these same AI systems process the duration for how long each CL requires support, the algorithms can account for this and tailor the supply delivery plan accordingly.

Loss of friendly forces from mishaps and enemy attack is a reality to be expected from warfare with China or Russia. AI tracking of fluctuating aircraft inventories will provide senior leaders with data to adjust strategic movements or know when to request additional support from allied forces. Conversely, ML and AI systems applied to allied or partner-nations would also assist in predicting when those forces would need U.S. intervention or assistance.

ACE Sustainment with AI

The foundation of the entire ACE framework rests upon the ability to continue operations through sustainment. In the face of overwhelming adversity, contested domains, and extreme distributed mission operations, innovative solutions are required to ensure resources are proactively maintained to fight tomorrow's battles. AI and ML integration enables the level of information superiority required to meet the complex logistical demands of ACE while bolstering joint force capabilities. Current UTC packages are staffed and supplied with enough resources to operate for thirty days until further support is required and sustainment begins.[16] However, that model was designed for continuous operations from established air bases, where long-standing support infrastructure and protection is assumed to be available. ACE breaks that mold and further challenges the logistical planning process. ACE from a CL could be as short as twenty-four hours or longer than thirty days depending on the effectiveness of the supply chain and the influence of enemy threats.

ACE Sustainment with AI Supply Chain Management

Although supply chain management spans the entire logistics process, the effectiveness is largely determined by two critical factors: flow of information and flow of products. Therefore, without a means of communicating the need for a product or a method of delivery, supply chain management is irrelevant. AI and ML systems enable these processes by either forecasting outcomes or identifying patterns of information that saves human decision-making time.[17] The analysis of big data and algorithms that make proactive future indicators is where machine augmented decision-making best serves ACE. This is especially true when considering the risk-management aspect capabilities of AI applied to ACE.

ACE Sustainment with AI Supply Chain Risk Management

The comparison of risk management between civilian and military domains is challenging because peacetime and wartime operations involve completely different mentalities. Although both experience routine safety hazards and equipment malfunctions, ACE "logistics-under-fire" transitions from competition to armed-conflict hostilities with another nation. In this sense, risk management has more potential applications to ACE than general commercial logistics. The ability to identify, monitor, and mitigate these vulnerabilities is paramount, lest the United States lose much more than profit margins and stock market shares. Acceptable levels of risk are decisions that senior USAF leaders are familiar with and expect from any system.

Artificial neural networks are special algorithms designed to measure complex degrees of a criteria rather than simple binary pathways. Instead of equipment being broken or functional (e.g., 0 or 1), it can be expanded to levels of "brokenness" (e.g., 0.2, least functional; 0.5, partly functional; 0.9, mostly functional). In this way, ACE can use these algorithms for detecting routine aircraft maintenance issues, analyze defects in high-failure-rate items, expedite work orders, and save the need for expensive service contracts or pricey damage repairs resulting from those breakdowns. In 2018, the U.S. Army predicted these AI systems could save up to $100 million per year by determining the most time- and cost-efficient means of transporting repair parts alone.[18]

Quality assurance machines have endless applications from assembly line equipment manufacturing to chemical warfare gear packaging, life support equipment testing, and aircraft munitions loading. Although these systems are very capable, they may not be transferable to every CL, likely reserving their pertinence for peacetime operations and training military personnel. During wartime operations, the biggest risk to U.S. forces becomes the enemy itself.

The biggest risk to U.S. forces during ACE is the adversary that operations are designed against. The ability to predict outcomes is the strength of AI and ML, enabling the resiliency to survive disruptions and attack. Applying the same artificial neural networks to a threat, but expanding parameters to variables such as size (e.g., number of units), location (e.g., airbase, ship, forward location) maneuverability (e.g., dismounted, armored vehicle, ship, aircraft), munitions (e.g., conventional munitions or electronic attack), capabilities (e.g., speed, combat radius, radar cross-section), and vulnerabilities (e.g., armor piercing rounds, small diameter bombs, precision guided munitions) allows these AI systems to learn how to pair weapons against enemy forces and calculate risk probabilities of attack or engagement results. Instead of spending hundreds of hours with dozens of intelligence analysts sifting through a myriad of metrics and designing enemy courses of action, ML techniques generate actionable information in near real-time without human biases or perceptual errors.

Conclusions

Conclusion 1. AI can be integrated into ACE operations. The results of this exploratory research demonstrated that AI can be integrated into ACE operations, particularly the elements of posture, movement and maneuver, and sustainment. This was illustrated through an evaluation framework comparison of e-commerce logistical elements supply/demand, distribution/delivery, and sustainment. These AI systems successfully integrated a mixture of supervised/unsupervised ML techniques and linear/nonlinear algorithms to augment human decision-making. As a result, companies benefited from its massive data processing, error detecting, adaptive problem solving, and predictive pattern analysis. These capabilities align precisely with the ACE Air Force doctrine note calling to transform USAF logistics systems. Air Force Doctrine Note 1-21, *Agile Combat Employment*, emphasizes the need to "push" proactive information, "anticipate limitations to standard means of distribution and transportation, and leverage an adaptive logistic system to support operations."[19]

Although this report focuses on the Air Force, successful integration would undoubtedly expand to all services. The Joint Artificial Intelligence Center (JAIC) is the primary organization responsible for refining and training these algorithms to meet component-level initiatives.

Conclusion 2. AI and ACE integration elicits numerous advantages. Integration of AI into ACE has widespread advantages beyond those discovered in this report and is likely to create compounding effects on all military operations. As the catalyst for these transformations, the advantages can be grouped into three themes: logistical resiliency, decision superiority, and financial efficiency.

Logistical resiliency is the most critical aspect of ACE's ability to prepare an area of operations, deploy forces, and maneuver forces while withstanding enemy disruptions. AI systems can collect, filter, and fuse seemingly limitless amounts of digital information gathered from every source imaginable. These data sets can forecast demand; balance supply; improve quality assurance; streamline maintenance; predict and solve problems; recycle resources; expedite resupply; and identify, manage, and mitigate risk to ensure continuity of operations.

Decision superiority is what machine augmentation offers senior Air Force leaders executing ACE through AI. Military strategist John Boyd's "observe-orient-decide-act loop" revolutionized how humans approached the battlefield decision cycle, and AI would further usher this concept into a new age. AI and ML algorithms armed with the proper data sets give leaders access to a higher number of quality information sources in near real time. These systems can identify patterns, predict outcomes, and assess risks based on historical analysis that far exceed what human cognition could perform unaided. This would enable machines to complete the cumbersome observing and orienting while freeing human military strategists to decide and act in a constantly changing environment.

The financial efficiencies gained from automation and process optimization are perhaps the most appealing advantages to budgetary defense planners. AI and ML techniques used by Google, Amazon, and others have proven to reduce waste and optimize resource recycling that eliminates hidden business costs and the manpower associated with it. As more functions of the logistical equation become increasingly automated, stakeholders can expect hundreds of millions of dollars in savings that will continue to compound exponentially. These funds can then either be apportioned to other priority projects or reserved for reinvestment back into improving equipment packages associated with ACE or AI technology.

Conclusion 3. AI integration better prepares the United States for great power competition. Integrating AI into ACE is not only possible but necessary to maintain the competitive edge over our adversaries in great power competition. China and Russia are eager to apply AI technology to improve their military weapons and infrastructure. Failing to invest time and resources toward integrating AI into USAF doctrine may leave our legacy equipment irrelevant on the battlefield, jeopardizing our national security and defense.

War cannot be won with machines alone, but it cannot be won without them.

Recommendations

Recommendation 1. Invest in DOD-owned systems, cybersecurity, and ACE case studies. Artificial narrow intelligence (designed to accomplish limited tasks) is constantly evolving but is mature enough for reliable integration into current military information systems. With thousands of ongoing private-sector research and DOD AI projects, there may already be significant advancements in these lines of effort. To successfully integrate AI into ACE, the USAF must consider investing in these technological initiatives: USAF- or DOD-owned AI algorithms, common language operating systems, and cybersecurity defense.

To develop and maintain control over military AI expansion, the USAF or DOD must use an open architecture system to allow flexibility for change without proprietary constraints. Relying on companies with strict technological patents would cripple the U.S. military's AI growth and likely be delayed by years of acquisition contract legal battles. DOD-owned open architecture ensures they are not legally tied to one company or contract and can evolve with technological breakthroughs.

With potentially hundreds or thousands of different data stream types, the AI machine will require a common language to process, interpret, and share the information for use. With dozens of current logistics programs (e.g., Defense Readiness Reporting System, Logistics Module), the central AI processor must be trained on how to understand their outputs. Not all systems need to speak the same machine language, but the central AI machine must be able to understand all the others. This paves the way for a military big data ecosystem that algorithms can use to provide effects.

The only task more important than creating this technology is defending it. Although no research was conducted to determine civilian cyber protective measures, any military integration will involve advanced classification and encryption systems. Cybersecurity is paramount considering how proficient our adversaries are in stealing intellectual properties and military patents for their benefit. The only situation worse than the AI systems being stolen is if the United States never had them in the first place, with our enemies having developed them first. A cross-domain solution to enable unclassified and classified data flow is vital; as well as having a strong defense architecture (e.g., blockchain technology) and high-capacity (e.g., high-speed 5G) networks.

Future research is required in each of these areas to determine the best way to integrate them into ACE. An important case study to consider is the 2022 invasion of Ukraine by Russian forces and their military's logistical errors. Exploring the missteps and failures of their military is critical to understanding the potential vulnerabilities of ACE and how AI can be designed to remedy them. Successful integration of AI systems into ACE will also enable its expansion to counterintelligence and threat awareness as a heightened form of risk management against strategic competitors.

Recommendation 2. Integrate AI using three distinct phases. Designing complex and sophisticated AI algorithms while integrating them into an emerging military concept is no simple task. However, the innovations pioneered by commercial companies combined with ACE doctrine in its early stages allow time to develop them in parallel. Using a phased approach, the USAF should consider dividing AI integration efforts into three phases focused on technology, processes, and assessments.

The technology associated with AI systems, algorithms, machines, and equipment must come first. It is the most challenging and lengthy task that will continue to evolve based on feedback from the other phases. The speed at which technology advances will also determine the pace of how quickly the entire program progresses. Continued partnerships with the Defense Advanced Research Projects Agency and the RAND Corporation will be vital to translating theoretical concepts into formal sciences. Human-in-the-loop automation should be the primary focus until enough trust in the AI models allow for higher levels of automation.

The processes are supported by the technology, but they also define the requirements in which the devices are built to complete. Imagine ACE as a game of chess, where the pieces are USAF assets, the board is the area of operations, and movement decisions are the AI construct. The first process to examine is the ACE element of posture, where chess pieces of ACE are placed on the board with AI determining the initial placement. Then the element of movement and maneuver will determine where each piece moves after the initial placement based on inputs from AI. Finally, sustainment will address how new pieces will be placed on the board and how AI can optimize the survivability of those pieces while defeating an opponent.

Assessments are critical to determining the effectiveness of AI and ACE integration. Continuing the chess analogy, if the game is never played against an opponent, there is no way to know where the vulnerabilities and deficiencies are. Wargaming is an excellent means of AI testing and can be done in simulations or with real-world exercises. Plans of action and milestones will be set and measured by the JAIC to determine success and share best practices.

Continuity during these phases is paramount and cannot be understated. The JAIC was designed to manage these processes but the team that drives innovation should be comprised of (but not limited to) expert logisticians, command-and-control professionals, maintenance technicians, and cybersecurity specialists. If ACE continues to be the USAF's primary strategy against our global power competitors, then investments into AI integration and training will help establish the foundation for its application and accelerate the delivery of this capability to the joint force. ■

The recommendations expressed are those of the author and do not reflect the official policy or position of the U.S. Air Force, the Department of Defense, or the U.S. government.

Notes

1. Department of Defense (DOD), *Summary of the 2018 National Defense Strategy of the United States* (Washington, DC: U.S. DOD, 2018), 2 (emphasis in original), https://dod.defense.gov/Portals/1/Documents/pubs/2018-National-Defense-Strategy-Summary.pdf.

2. Ibid., 1–6.

3. Air Force Doctrine Note (AFDN) 1-21, *Agile Combat Employment* (Maxwell Air Force Base, AL: Curtis E. LeMay Center for Doctrine Development and Education, 23 August 2022), 1, https://www.doctrine.af.mil/Portals/61/documents/AFDN_1-21/AFDN%201-21%20ACE.pdf.

4. Michael E. Canfield, "Contingency Basing for Great Powers Competition," Wild Blue Yonder, 5 March 2021, https://www.airuniversity.af.edu/Wild-Blue-Yonder/Article-Display/Article/2526242/contingency-basing-for-great-powers-competition/.

5. DOD, *Summary of the 2018 National Defense Strategy*, 7.

6. Alexander Daly, *Recent AI Adoption in the U.S. Government* (Boston: PTC, 2020), 3, https://www.ptc.com/-/media/Files/PDFs/aerospace-and-defense/Recent-AI-Adoption-in-the-US-Government.pdf; Elsa B. Kania, "Chinese Military Innovation in Artificial Intelligence," testimony from *Technology, Trade, and Military-Civil Fusion: China's Pursuit of Artificial Intelligence, New Materials, and New Energy, Before the U.S.-China Economic and Security Review Commission* (7 June 2019), 3, https://www.cnas.org/publications/congressional-testimony/chinese-military-innovation-in-artificial-intelligence.

7. DOD, *Summary of the 2018 Department of Defense Artificial Intelligence Strategy* (Washington, DC: U.S. DOD, 2018), 4, https://media.defense.gov/2019/Feb/12/2002088963/-1/-1/1/SUMMARY-OF-DOD-AI-STRATEGY.PDF.

8. Canfield, "Contingency Basing"; AFDN 1-21, *Agile Combat Employment*, 5.

9. Patrick Mills et al., *Building Agile Combat Support Competencies to Enable Evolving Adaptive Basing Concepts* (Santa Monica, CA: RAND Corporation, 2020), 6, https://www.rand.org/pubs/research_reports/RR4200.html.

10. "About," Google DeepMind, accessed 5 March 2024, https://deepmind.google/about/.

11. Jean-Paul Rodrigue, "The Distribution Network of Amazon and the Footprint of Freight Digitalization," *Journal of Transportation Geography* 88 (October 2020): 5, https://www.sciencedirect.com/journal/journal-of-transport-geography/vol/88/suppl/C.

12. Ibid., 6–8.

13. Ibid., 5.

14. AFDN 1-21, *Agile Combat Employment*, 1.

15. Theresa Hitchens, "TRANSCOM Head Envisions Increased Intra-Theater Lift Demand," Breaking Defense, 25 May 2021, https://breakingdefense.com/2021/05/transcom-head-envisions-increased-intra-theater-lift-demand/.

16. Patrick Mills, *Building Agile Combat Support Competencies*, 46–47.

17. Petri Helo and Yuqiuge Hao, "Artificial Intelligence in Operations Management and Supply Chain Management: An Exploratory Case Study," *Production Planning and Control* 33, no. 1 (2021): 14, http://dx.doi.org/10.1080/09537287.2021.1882690.

18. Kelley M. Sayler, *Artificial Intelligence and National Security*, CRS Report No. R45178 (Washington, DC: U.S. Congressional Research Service [CRS], 10 November 2020), 9, https://crsreports.congress.gov/product/pdf/R/R45178/10.

19. AFDN 1-21, *Agile Combat Employment*, 10.

Automating the Survival Chain and Revolutionizing Combat Casualty Care

Human-Technology Teaming on the Future Battlefield

Maj. Gen. Michael J. Talley, U.S. Army
Col. Jennifer M. Gurney, MD, FACS, U.S. Army
Col. Jeremy C. Pamplin, MD, FCCM, FACP, U.S. Army*
Capt. Travis M. Polk, MD, FACS, U.S. Navy
Col. Sharon L. Rosser, DSc-PA, PA-C, U.S. Army
Lt. Col. Patricia M. Schmidt, PhD, RN, U.S. Army
2nd Lt. Mason H. Remondelli, U.S. Army*
Matthew T. Quinn

Like the concept of automating the "kill chain" that executes lethal force faster than the enemy, the "survival chain" can be automated to accelerate critical decisions about casualty care and maximally preserve combat power (see figure 1).[1] The accelerated execution of this medical construct through automation requires an uncomfortable paradigm shift for the Military Health System (MHS) that has achieved heroic casualty outcomes over the past twenty years of war but now faces a reckoning from challenges posed by large-scale combat operations against near-peer adversaries.[2] The challenges faced in this context—high frequency and volume of casualties; prolonged care in resource-limited settings; inadequate numbers of

Every second matters during the European Best Medic Competition, and neither Spc. Connor Ignozzi nor Spc. Carl Cleveland assigned to the Headquarters and Headquarters Troop, 1st Squadron, 1st Cavalry Regiment, 2nd Armored Brigade Combat Team, 1st Armored Division, waste any time as they assess a simulated rollover casualty in Grafenwöhr, Germany, on 7 December 2023. Artificial intelligence can enhance casualty care in a variety of ways to include casualty assessment, data transmission and processing, patient monitoring, and medical evacuation, to name just a few. (Photo by Spc. Trevares Johnson, U.S. Army)

trained medical providers; elevated potential for chemical, biological, radiological, nuclear, and directed energy events; increase in disease nonbattle injuries (e.g., endemic diseases, infection, and orthopedic injuries); and the near-constant threat of attack—demand a rethinking about how artificial intelligence, robotics, and human-technology teaming can accelerate the survival chain and facilitate commanders' forward momentum to achieve overmatch on the future battlefield.[3]

This new paradigm is a significant departure from current expectations of single casualties managed by multiple warfighters who are removed from the fight; it must evolve to a future state that maintains similar casualty outcomes but with fewer human resources needed to achieve them (see figure 2). The technologies necessary to achieve this require massive amounts of real-time data about casualty care that are accurate and reliably obtained in all care contexts at the sharp edge of medicine: the casualty-caregiver interaction.

The Data Problem

Unfortunately, the MHS does not collect such data. Like civilian health care, current data collection, focused on documentation for billing and historical accountability, is primarily human-derived, validated by humans for medical-legal purposes, and has been shown to be inaccurate and unreliable necessitating significant effort to transform it for research or machine-learning purposes.[4] Likewise, documentation is currently focused on longitudinal requirements (documentation of diagnosis, injuries, treatments, and outcomes). Records do not include real-time information about the context of care (number and type of caregivers, location, resources, mission requirements,

Automation Stack:	Sense	Understand	Decide	Act	Organize and Optimize	Measured Outcomes
Warfighter Or Casualty	Location Environment "Status" (position, movement, injuries, physiology, mental status, etc.)	"In the fight" (Optimal, Normal, Degraded) "Casualty" (Rapid RTD, Delayed RTD, EVAC Home) Trajectory (Better, Same, Worse)			Triage Category based on digital twin's probabilistic trajectory through the current system based on time, location, and resources (system level)	RTD Rate (immediate vs. delayed) Evacuation rate per injury pattern Survival Quality of Life Mission Success Commander Satisfaction
Caregiver Or Care Team	Location Environment "Status" (sleep, physiology, training, proficiency, etc.)	Numbers available Stress Task Saturation Expectations	Specific Treatment or Intervention or Additional Assessment Prioritization and Plan Next step	Provide LSI (e.g. TQ, Blood, Surgery, etc.) Provide Medication Document Provide non-LSI (e.g. bandage, package for transport, etc.) Coordinate Care	What needs to be done when, and by whom at a systems level? System Casualty Prioritization System Task Planning	Time on Priority Task Time on Non-Priority Task Number of Caregivers Needed/Casualty Caregiver Satisfaction
Resources *Local & System*	Location Blood Products Tourniquets IVs, bandages Medications Clinician Type and Number	Time-to-Resource Resupply Needs Triage Framework	Priority of Resupply Priority of Evacuation Priority of Platform	Execute resupply mission Execute MEDEVAC Mission Task Evacuation platform	Where should it be done? How to best *optimize* the probability of success at a systems level? Evacuation Prioritization Evacuation Location Evacuation Platform	Optimal time to task Minimal Resource Waste (less resupply, lest cost, etc.) Time to Resupply Commander Satisfaction

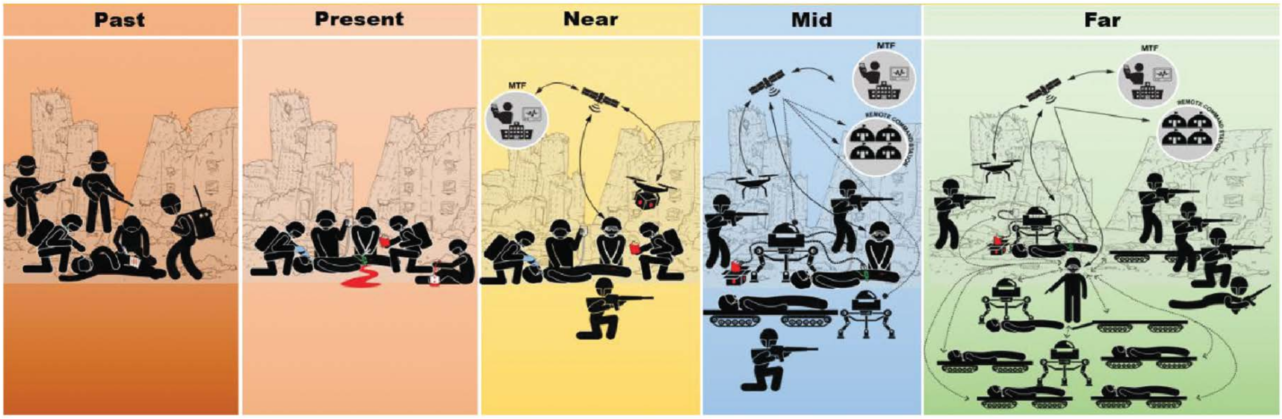
(Figure by Raymond Samonte)

Figure 1. The Survival Chain and the Automation Stack Paradigm

kinetic activity on the battlefield, etc.), or any data about clinicians'/care teams' actions and when they occur. In essence, these current data collection practices do not provide the type of information necessary for modernizing casualty care in the age of artificial intelligence (AI).

Lack of accurate and reliable data is a principal challenge to building trustworthy AI. Current data sources within the MHS include the electronic health record, Tactical Combat Casualty Care Card (DD Form 1380), and tape with handwritten notes that all require humans to complete at the expense of performing other casualty care tasks. Less than 20 percent of the thirty thousand casualties in Iraq and Afghanistan had any form of prehospital documentation because, when given the choice, task-saturated caregivers chose to return fire, provide casualty care, and perform other tasks over documentation (personal experience of the authors).[5] Furthermore, when documentation is completed, it is nearly always completed after casualty care and is thus delayed and often incorrect or biased.[6] Given these constraints, the entire Department of Defense (DOD) Joint Trauma System's Trauma Registry, collected between 2006 and 2023, is less than one gigabyte in size (personal knowledge of authors). For comparison, autonomously driving cars such as Waymo (Google Self-Driving Car Project), collect three gigabytes of data every minute from twenty-five sensors, which is a total of thirty-two terabytes of data daily (figure 3).[7]

In large-scale combat operations, human-inputted documentation will fail because humans will be task-saturated providing lifesaving care to casualties. Consequently, systems that rely upon data from electronic medical records and anticipated near-term digital documentation tools, such as the U.S. Air Force's Battlefield Assisted Trauma Distributed Observation



*N.B. size and configuration of robots, drones, and evacuation vehicles are notional and do not reflect teaming, future miniaturization, or multi-purpose functionality

(Figure by Raymond Samonte)

Figure 2. Human Resources Needed for Point of Injury Casualty Care over Time

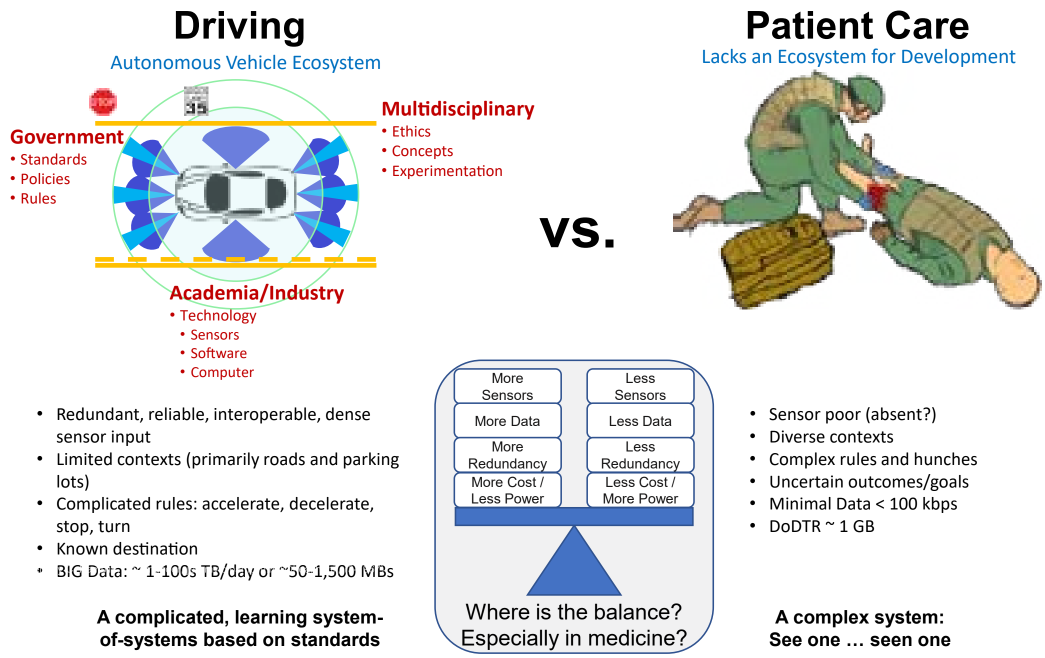
Kit (BATDOK), will not provide the information needed for optimal care, to learn passively and continuously, and they will not be available for real-time use.[8] Instead, accurate and reliable time-series data collected passively from sensors about casualty status, resource use/consumption, caregivers and their actions, and care context across the care continuum are needed. This foundational data set provides data for more precise predictive model development for triage, evacuation, logistic resupply, medical command and control, and medical force projection.

A New Paradigm: Automating the Survival Chain

Human-technology teaming alone achieves faster processes by fusing data, humans, and technology into solutions that optimize system performance.[9] Automating processes further improves performance and efficiency.[10] The survival chain model parallels the automation stack (compare figures 1 and 4). It is a framework for understanding how to create and accelerate human-technology teaming in casualty care. Like the observe, orient, decide, act loop, the automation stack begins with passive data collection using sensors.[11] We can then use data from these sensors to understand the 5 Ws of casualty care:

- *Who* is present in the care context (casualties and caregivers),
- *What* is wrong with the casualty (injuries, physiology, etc.) and *what* does the caregiver do about it (actions),
- *When* does the casualty's status change and *when* does a caregiver perform an action,
- *Where* is the care occurring (location, temperature, altitude, and environment), and
- *Why* does the casualty's status change and *why* does a caregiver perform an action (status and actions are tightly connected and correlated to available resources and care context)?

Clinicians combine sensing and understanding data into an *assessment* used to decide what clinical action to take. Intelligent (AI enhanced) and unintelligent (enhanced visualizations, rule-based decision trees, etc.) decision-support tools can improve clinical decision-making. Hardware (robotics and medical devices) and AI-based software can assist caregivers by offloading human tasks to machines. Similarly, treatments may be offloaded to intelligent or unintelligent machines. For example, current treatments that are commonly offloaded to unintelligent medical devices include the monitoring, intravenous fluid, and medication administration via intravenous pumps, and the use of mechanical ventilators for breathing assistance. In the future, robotics will help caregivers manage casualties by identifying them, monitoring them with physiologic sensors and imaging modalities, assisting them with surgery, aiding with lifesaving interventions, and intelligently tasking resupply and medical evacuation missions.[12] We imagine that these types of innovations will be particularly beneficial in environments contaminated by chemical, biological, radiological, nuclear, and directed energy threats.



(Figure by Raymond Samonte)

Figure 3. Comparison between Automating Driving and Automating Casualty Care

Optimizing the entire survival chain is necessary to manage casualties across the care continuum and achieve the best outcomes. Automation will provide future commanders with the necessary speed, agility, and resources to maintain overmatch and win. If we successfully obtain the data necessary for automation, we can also produce a curated dataset to digitally twin casualties. Producing digital twins involves creating a sophisticated digital replica of a real-world entity, such as a human, which can then be applied to service members and combat casualties.[13] By doing so, we can achieve even more efficiency and better outcomes.

Revolutionizing Combat Casualty Care with Digital Twins

Revolutionary change in casualty care, however, will come when data collected provides trustworthy predictive analytics about an *individual* casualty's future state and how to optimize it across time by efficiently matching needs to resources. These forecast models are *casualty digital twins* (CDTs).[14] To understand what happens at the point of care (e.g., under a bush, on a beachhead, or at the bedside) and produce real-time models to aid decisions and automate care, data must be passively collected (see figure 5). Real-time, passive data collection that provides for an accurate and reliable assessment of casualties, caregivers, and resources across the care continuum can iteratively evolve the survival chain and automate tasks at each step of the survival chain (e.g., documentation, triage, evacuation coordination).

Casualty digital twins provide the MHS with a unique opportunity to close the gap between the physical and digital worlds. Through digital replicas of casualties (twinning), the MHS gains access to the understanding of a casualty's projected (future) condition and needs by applying the learned experience of previously treated patients and adapting it as a continuously learning system (see figure 6). This virtual representation, infused with information about resource availability at echelon and operational considerations for evacuation that impact time, can form the basis for personalized, data-driven decisions that can optimize our battlefield trauma system's capability and capacity to manage large volumes of casualties. Casualty digital twins in turn lead to the development of decision-support tools and automation algorithms that facilitate

Automation Stack	Possible Solutions	Timeline (interim products)
Act • **AKA:** Treat, Intervene • **Concepts:** Reassessment, Physical Action **Human and/or Machine**	• Autonomous/remote controlled ICU • Autonomous/remote assisted MEDEVAC • Robotic assistance • Telesurgery in network limited environment	2028-2035
Decide • **Concepts:** Decision support, hypothesis testing, AoA/COAs **Human, HITL, HOTL, Machine**	• Precision resupply? • Intelligent triage of casualties, resources, evacuation? • Digital twinning	2026-2030
Understand • **AKA:** Orient, learn, "assess" • **Concepts:** Visualizations, dashboards, models, algorithms **Machine-Human, Machine**	• **First solution**: Automated documentation of the 1380 • Others: Casualty status, resource consumption, caregiver actions pre-Role 2	2025
Sense • **AKA:** Observe, "see," "assess," perceive • **Concepts:** Sensors and devices **Machine**	• Trusted (accurate, reliable) passive data collection in real time in all domains	2024

(Figure by Raymond Samonte)

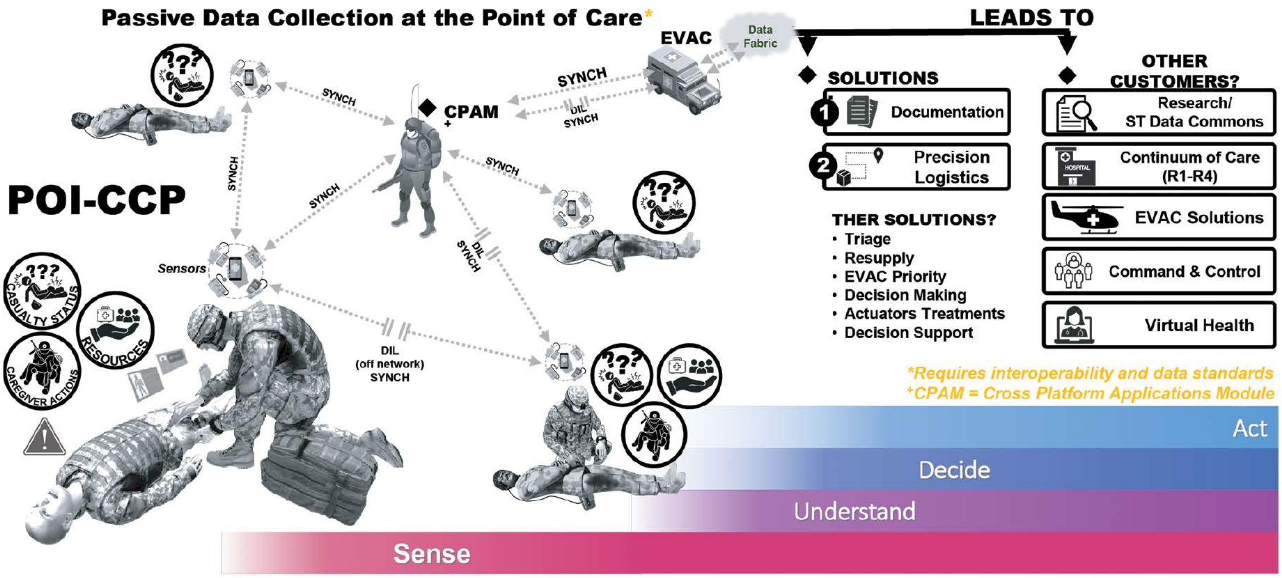
Figure 4. The Automation Stack and a Concept of Time to Achieve Solutions

faster, more accurate decisions and interventions tailored according to an individual casualty's needs and balanced with the needs of other casualties in the system, ultimately producing an optimized survival chain that assesses situations, makes faster decisions, and gives more appropriate treatments within the context of the resource availability across the care continuum to achieve the best outcomes.

AI-Enhanced Casualty Care

Currently, the MHS manages casualties across the care continuum in a linear fashion using the NATO roles of care guidelines (Roles 1-4). Doctrinally, this evacuation system has increasing capability and capacity at each level of care; in execution, however, it is asymmetric and requires significant communication and human input at all levels to be successful. In the future, the doctrinal roles of care are likely to be disrupted, which can lead to multiple points of failure. Primarily, it relies on rapid evacuation, proper communication, and freedom of maneuver. However, future warfare will preclude casualties from moving through a linear progression of battlefield care as has been seen in Africa and currently within Ukraine.[15] Advanced medical and surgical care, and the ability to hold patients for prolonged periods prior to evacuation, may be required much closer to the point of injury and networked across the battlespace to maintain system resiliency.

Recently, Gen. (Ret.) Mark A. Milley wrote, "The next conflict will be characterized by ubiquitous sensors with *mass data collection and processing ability* [emphasis added]."[16] To maintain optimal care through the survival chain, even amidst a disrupted medical support structure, requires that casualty digital twinning begins before a potential injury. Therefore, health



(Figure by Raymond Samonte)

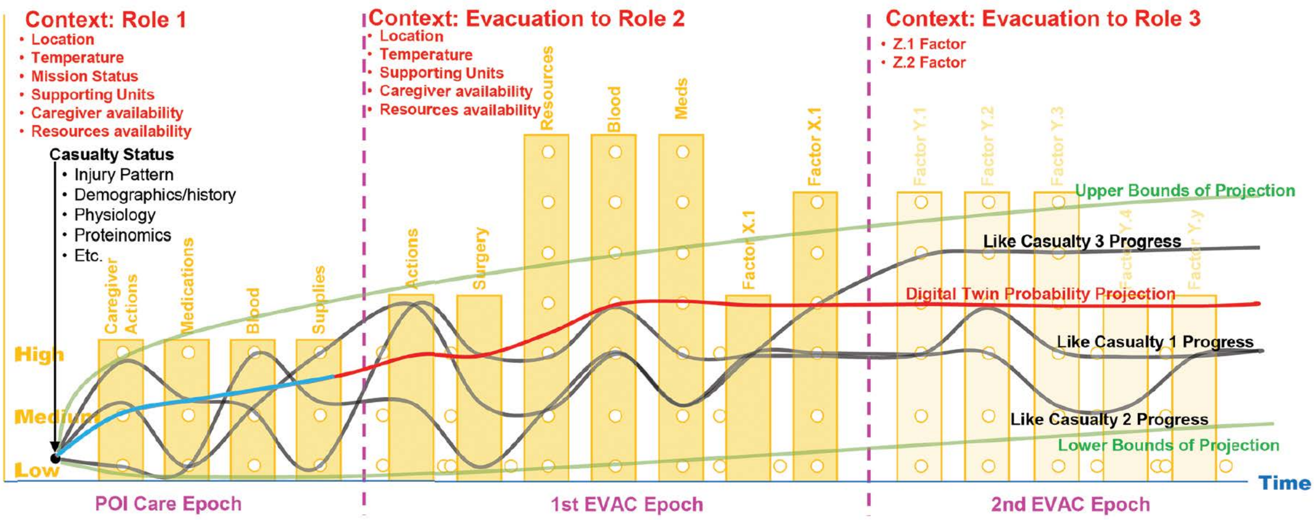
Figure 5. Passive Data Collection at the Edge and Possible Automation Solutions That Can Be Derived from It

data about warfighters *must* be collected from wearable sensors not only from casualties but also from warfighters in a *precasualty state*. We propose this precasualty state of health management as a new role of care, "Role 0." This role of care represents the majority of a warfighter's "life space" as well as their baseline health from which future AI will recognize variance as illness or injury. In this future state, the MHS will be responsible for helping commanders optimize health to avoid illness or injury and to return casualties to duty faster.

Consequently, a future state that incorporates "ubiquitous sensors with mass data collection and processing ability" will not only enable better Role 0 health and more rapid return to duty but will also combine with the predictive power of CDTs to optimize how casualties move through the evacuation chain.

Delivering casualty care utilizing CDTs will facilitate a better understanding of military medical support and enable evidence-based performance improvement made possible by the DOD Joint Trauma System. The predictive power of CDTs will evolve over time as part of a learning health-care system to optimize care on the twenty-first-century battlefield by rapidly influencing combat casualty care guidelines and reshaping how we train warfighters to deliver casualty care.[17] Ultimately, the following principles guide success:

- Data necessary to identify casualty conditions, track decision-making, treatments, resource consumption, and care synchronization is not the same as retrospective *documentation* of illness/injury patterns and treatment rendered. Documentation is *delayed*; data for care management must be real-time and include caregiver performance, which should not be captured in an individual patient's medical record.
- A single solution is unlikely to address the nuances of patient care in different contexts (e.g., care under fire versus in a helicopter versus in an operating room versus in an intensive care unit versus on a ship versus in the arctic). Different care domains necessitate different workflows, information needs, caregiver training, and experience. The technology solutions used to support care in various work domains must earn the trust of medical professionals through the incorporation of rigorous user-centered design that optimizes efficiency and effectiveness of use by different users in different contexts of use.[18] The approach to achieving success is not one solution but a system of solutions that is



(Figure by Raymond Samonte)

Figure 6. Casualty Digital Twinning Concept

interoperable (e.g., a secure, standards-based, plug-and-play "internet of medical things" built to operate as a system versus a series of disparate medical products integrated on an ad hoc basis).[19] This "system of systems approach requires increased coordination with diverse battlefield governance … common data standards and message formats … [to form] a continuous, seamless link between administrative and tactical systems through the continuum of DoD, VA, civilian hospitals, and coalition partners."[20]

- Solutions incorporated into the survival chain system must address care across the continuum and at each point within it to produce a comprehensive understanding of resource utilization and care synchronization. Research is still necessary to understand what data needs to move between echelons; at what frequency; according to what standard(s); and ultimately how data will be analyzed, visualized, and used for decision support, forecast model development, and automation. Ongoing research and rigorous application of user-centered design can continually assess and improve the value and effectiveness of data sources, models, algorithms, visualizations, and decision-support tools to accelerate the survival chain as novel and different sensors, tools, and visualizations become available.
- The sensors used on the battlefield must also be used during training. Utilizing these sensors to understand the care that trainees provide and getting trainees familiar with the decision-support tools that CDTs enable will dramatically impact training paradigms.
- It is essential to lower technical and administrative barriers for academia, industry, and DOD laboratories to enter this space. Doing so will generate collaboration and competition that iteratively enhances component parts of the system rather than utilizing single entities to develop and enhance the entire system. Current processes, especially with respect to authorities to operate on the network delay progress and choke innovation by conditioning research, development, interoperability testing, and iterative solution improvement on a linear process instead of a continuous, development-operations cycle nested within a cybersecurity framework (DevSecOps cycle).[21]
- Technology must be cyber secure from a hardware, software, and network perspective. Furthermore, the electronic signature of these devices must be consistent with military specifications to minimize the risk of identification and attack. Ensuring that components of the survival chain are built as part of an interoperable, standards-based, plug-and-play system of systems

allows proactive threat modeling and mitigation of risks.[22]

- Research and solution development across the MHS is fragmented due to competing perspectives, responsibilities, resource allocation, and multiple labs studying similar issues, which makes research dollars not prudently spent. For example, funding and accountability for care at the point of injury through Role 3 is assigned to the DOD services; whereas all care documentation and care beyond Role 3 is assigned to the Defense Health Agency. Similarly, resourcing of care is a logistics function that aims to improve gross resource availability, but not resource use at the individual casualty or caregiver level. Requirements generators, researchers, advanced developers, program managers, and policymakers can utilize the survival chain paradigm to piece together more consistently a medical system that optimizes decision-making, and therefore maximizes outcomes, over time and with the most modern technology. *A key question to ask is, What portion of the survival chain is a technology intended to improve and how does that improvement affect the other components of the chain?*

Conclusion

The scale, severity, and prolonged nature of combat casualty care in multidomain operations against near-peer adversaries requires modernizing the MHS. The survival chain is a concept that can help the MHS reframe battlefield medicine and iteratively develop technology solutions across the care continuum. A data and technology-enabled survival chain akin to a convergent kill chain requires passive data collection now that enables decision support and automated actions in the future. Progress is contingent on rapidly producing a foundational casualty care dataset—from training, research, and real-world care—made available to developers that will begin the process of automating the survival chain. ■

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Notes

1. Christian Brose, *The Kill Chain: Defending America in the Future of High-Tech Warfare* (New York: Hachette Books, 2020); Jennifer M. Gurney et al., "The 'Survival Chain': Medical Support to Military Operations on the Future Battlefield," *Joint Force Quarterly* 112 (1st Quarter, 2024): 94–99, https://ndupress.ndu.edu/Media/News/News-Article-View/Article/3679354/the-survival-chain-medical-support-to-military-operations-on-the-future-battlef/.

2. Russ S. Kotwal et al., "The Effect of a Golden Hour Policy on the Morbidity and Mortality of Combat Casualties," *JAMA Surgery* 151, no. 1 (January 2016): 15–24, https://doi.org/10.1001/jamasurg.2015.3104.

3. Mason H. Remondelli et al., "Casualty Care Implications of Large-Scale Combat Operations," *Journal of Trauma and Acute Care Surgery* 95, no. S2 (Supp. 1) (2023): S180, https://doi.org/10.1097/ta.0000000000004063; Aaron Epstein et al., "Putting Medical Boots on the Ground: Lessons from the War in Ukraine and Applications for Future Conflict with Near Peer Adversaries," *Journal of the American College of Surgeons* 237, no. 2 (2023): 364–73, https://doi.org/10.1097/XCS.0000000000000707.

4. William R. Hogan and Michael M. Wagner, "Accuracy of Data in Computer-Based Patient Records," *Journal of the American Medical Informatics Association* 4, no. 5 (September 1997): 342–55, https://doi.org/10.1136/jamia.1997.0040342; Nicole Gray Weiskopf and Chunhua Weng, "Methods and Dimensions of Electronic Health Record Data Quality Assessment: Enabling Reuse for Clinical Research," *Journal of the American Medical Informatics Association* 20, no. 1 (January 2013): 144–51, https://doi.org/10.1136/amiajnl-2011-000681; Xinggang Liu et al., "Improving ICU Risk Predictive Models through Automation Designed for Resiliency Against Documentation Bias," *Critical Care Medicine* 51, no. 3 (March 2023): 376–87, https://doi.org/10.1097/CCM.0000000000005750.

5. Jon B. Robinson et al., "Battlefield Documentation of Tactical Combat Casualty Care in Afghanistan" *U.S. Army Medical Department Journal* (April-September 2016): 87–94.

6. Laurie Lovett Novak et al., "Understanding the Information Needs and Context of Trauma Handoffs to Design Automated Sensing Clinical Documentation Technologies: Qualitative Mixed-Method Study of Military and Civilian Cases," *Journal of Medical Internet Research* 22, no. 9 (2020): e17978, https://doi.org/10.2196/17978; Sean M. Bloos et al., "Feasibility Assessment of a Pre-Hospital Automated Sensing Clinical Documentation System," *American Medical Informatics Association Annual Symposium Proceedings* 2019 (2019): 248–57; Brian J. Eastridge et al., "We Don't Know What We Don't Know: Prehospital Data in Combat Casualty Care," *U.S. Army Medical Department Journal* (April-June 2011): 11–15.

7. Matthew Schwall et al., "Waymo Public Road Safety Performance Data," arXiv, 30 October 2020, https://doi.org/10.48550/arXiv.2011.00038.

8. "B.A.T.M.A.N. Program: Battlefield-Assisted Trauma Distributed Observation Kit (BATDOK)," Air Force Research Laboratory, accessed 11 March 2024, https://afresearchlab.com/technology/human-performance/batman-program/.

9. "Human-Machine Teaming," Defense Innovation Marketplace, accessed 11 March 2024, https://defenseinnovationmarketplace.dtic.mil/technology-interchange-meetings/autonomy-tim/human-machine-teaming/; H. James Wilson and Paul R. Daugherty, "Collaborative Intelligence: Humans and AI Are Joining Forces," *Harvard Business Review*, July-August 2018, https://hbr.org/2018/07/collaborative-intelligence-humans-and-ai-are-joining-forces.

10. James C. Walliser et al., "Team Structure and Team Building Improve Human–Machine Teaming with Autonomous Agents," *Journal of Cognitive Engineering and Decision Making* 13, no. 4 (2019): 258–78, https://doi.org/10.1177/1555343419867563.

11. James Johnson, "Automating the OODA Loop in the Age of Intelligent Machines: Reaffirming the Role of Humans in Command-and-Control Decision-Making in the Digital Age," *Defence Studies* 23, no. 1 (2023): 43–67, https://doi.org/10.1080/14702436.2022.2102486.

12. Jeremy C. Pamplin et al., "Augmenting Clinical Performance in Combat Casualty Care: Telemedicine to Automation," in *Augmented Cognition: Users and Contexts*, ed. Dylan D. Schmorrow and Cali M. Fidopiastis, part II (Gewerbestrasse, CH: Springer International, 2018), 326–38.

13. Riccardo Miotto et al., "Deep Patient: An Unsupervised Representation to Predict the Future of Patients from the Electronic Health Records," *Scientific Reports* 6, no. 1 (May 2016), https://doi.org/10.1038/srep26094; Devika Menon, Bharath Anand, and Chiranji Lal Chowdhary, "Digital Twin: Exploring the Intersection of Virtual and Physical Worlds," *IEEE [Institute of Electronics and Electronic Engineers] Access* 11 (July 2023), 75152–72, https://doi.org/10.1109/ACCESS.2023.3294985.

14. Menon, Anand, and Chowdhary, "Digital Twin."

15. Epstein et al., "Putting Medical Boots on the Ground"; Joseph L. Votel et al., "Unconventional Warfare in the Gray Zone," *Joint Force Quarterly* 80, no. 1 (1st Quarter, January 2016): 101–9, https://ndupress.ndu.edu/JFQ/Joint-Force-Quarterly-80/article/643108/unconventional-warfare-in-the-gray-zone/; Jamie Riesberg, Doug Powell, and Paul Loos. "The Loss of the Golden Hour," *Special Warfare* 30, no. 1 (January-March 2017): 49–51, https://prolongedfieldcare.org/2017/03/16/special-warfare-magazine-articles-loss-of-the-golden-hour-18d-the-lifeline/.

16. Mark A. Milley, "Strategic Inflection Point: The Most Historically Significant and Fundamental Change in the Character of War Is Happening Now—While the Future Is Clouded in Mist and Uncertainty," *Joint Force Quarterly* 110, no. 9 (3rd Quarter, July 2023): 6–15, https://ndupress.ndu.edu/JFQ/Joint-Force-Quarterly-110/Article/article/3447159/strategic-inflection-point-the-most-historically-significant-and-fundamental-ch/.

17. Mary Ann Spott, Cynthia R. Kurkowski, and Zsolt Stockinger, "The Joint Trauma System: History in the Making," *Military Medicine* 183, no. S2 (2018): S4–7, https://doi.org/10.1093/milmed/usy166.

18. International Organization for Standardization (ISO) 9241-210:2019, "Ergonomics of Human-System Interaction: Part 210: Human-Centred Design for Interactive Systems" (Geneva: ISO, July 2019), https://www.iso.org/standard/77520.html.

19. Christopher Nemeth et al., "Support for ICU Resilience Using Cognitive Systems Engineering to Build Adaptive Capacity," *2014 IEEE International Conference on Systems, Man, and Cybernetics* (2014), 654–58, https://doi.org/10.1109/SMC.2014.6973983.

20. U.S. Army Futures Command, *Army Medical Modernization Strategy* (Austin, TX: U.S. Army Futures Command, May 2022), 7, https://www.army.mil/e2/downloads/rv7/about/2022_Army_Medical_Modernization_Strategy.pdf.

21. Abhijit Sen, "DevOps, DevSecOps, AIOPS-Paradigms to IT Operations," in *Evolving Technologies for Computing, Communication and Smart World: Proceedings of ETCCS*, ed. Pradeep Kumar Singh et al. (Singapore: Springer Singapore, 2021), 211–21.

22. Elaine Bochniewicz et al., *Playbook for Threat Modeling Medical Devices* (McLean, VA: MITRE Corporation; Arlington, VA: Medical Device Innovation Consortium, 2021), https://www.mitre.org/sites/default/files/publications/Playbook-for-Threat-Modeling-Medical-Devices.pdf.

Maj. Gen. Michael J. Talley, U.S. Army, is the chief of staff and deputy commanding general (support) of the U.S. Army Medical Command. Previously, he served as the commanding general and commandant of the U.S. Army Medical Center of Excellence, Joint Base San Antonio, Texas, and as commanding general of the United States Army Medical Research and Development Command and Fort Detrick, Fort Detrick, Maryland. Talley is a national-board-certified respiratory therapy practitioner and holds two master of military arts and sciences degrees, a Master of Strategic Studies, and a Master of Health Services Management. He has held key leadership positions at combat training centers, the Army Special Operations Command, the Defense Logistics Agency, the Office of the Surgeon General, and Army Forces Command.

Col. Jennifer M. Gurney, MD, FACS, U.S. Army, is the chief of the Department of Defense's Joint Trauma System. Prior to assuming this position, she was a surgeon at the U.S. Army Institute of Surgical Research Burn Center. Gurney was the first chair of the Defense Committee on Trauma and the chair of the Committee on Surgical Combat Casualty Care. She joined the U.S. Army while at Boston University Medical School on a Health Professions Service Program scholarship. She completed her general surgical residency at Walter Reed Army Medical Center and a surgical critical care fellowship at Stanford University Hospital. Gurney has deployed seven times, most recently serving as the theater trauma director in Operation Inherent Resolve in her last deployment to Iraq.

Col. Jeremy C. Pamplin, MD, FCCM, FACP, U.S. Army, is the commander of the Telemedicine and Advanced Technology Research Center. He has held significant assignments as director of Virtual Critical Care, chief of clinical trials in Burns and Trauma, and as the medical director of the U.S. Army Burn Intensive Care Unit at the U.S. Army Institute of Surgical Research. He has been the medical director of several surgical and medical intensive care units since completing his critical care medicine fellowship at Walter Reed Army Medical Center. He helped create the National Emergency Tele-Critical Care Network, the Joint Tele-Critical Care Network, and the Advanced Virtual Support for Operational Forces Program. He deployed to Iraq in 2008 and Afghanistan in 2013. He received a BS from West Point and his medical degree from the Uniformed Services University. **Pamplin is a primary author of this article.*

Capt. Travis M. Polk, MD, FACS, U.S. Navy, is the director of the Combat Casualty Care Research Program at the U.S. Army Medical Research and Development Command. He received his Bachelor of Science in Nursing from Norwich University in 1997 and his Doctor of Medicine from the Uniformed Services University in 2001. He completed his general surgery training at Naval Medical Center Portsmouth in 2008 and a fellowship in traumatology, surgical critical care, and emergency surgery at the University of Pennsylvania in 2012. He is an assistant professor of surgery at the Uniformed Services University and is board certified in general surgery with an added qualification in surgical critical care.

Col. Sharon L. Rosser, DSc-PA, PA-C, U.S. Army, is the deputy commander at the Telemedicine and Advanced Technology Research Center. She received her BS from the University of Nebraska. She also holds a Master in Physician Assistant Studies from University of Nebraska Medical Center and a Doctor of Science in Physician Assistant Studies with a focus in emergency medicine from Baylor University. She completed a one-year fellowship in emergency medicine/critical care point of care ultrasound at Brooke Army Medical Center. Rosser is a graduate of the Command and General Staff College and the Army War College.

Lt. Col. Patricia M. Schmidt, PhD, RN, U.S. Army, is the chief of the Center for Nursing Science and Clinical Inquiry (CNSCI) at Brooke Army Medical Center. Her most recent assignment was as the nurse scientist and chief of the Medical Modeling, Simulation, Informatics, and Visualization Division at the Telemedicine and Advanced Technology Research Center. Previously, she was the deputy chief of research and evidenced based practice for the CNSCI at Tripler Army Medical Center, Honolulu, and for Brooke Army Medical Center, Fort Sam Houston. Her clinical nursing experience is in burns and trauma in both critical care and medical-surgical settings. She received her Bachelor of Science in Nursing from Marquette University and her Doctor of Philosophy in Nursing Science from the Uniformed Services University.

2nd Lt. Mason H. Remondelli, U.S. Army, is a third-year medical student at the Uniformed Services University (USU) of the Health Sciences in Bethesda, Maryland. He graduated magna cum laude from the U.S. Military Academy at West Point with a BS in life sciences with honors and a minor in nuclear science. As a medical student, he conducts research within the USU Department of Surgery focusing on the advancement of combat casualty care, irregular warfare medicine, and battlefield trauma systems for the future multidomain environment. **Remondelli is a primary author of this article.*

Matthew T. Quinn is the science director for the Telemedicine and Advanced Technology Research Center. He previously served as senior advisor for health technology at the Health Resources and Services Administration and as the East Coast managing director for Intel's Healthcare and Life Sciences business and director of Healthcare Initiatives for the Federal Communications Commission. He received his Bachelor of Science in Engineering from the U.S. Military Academy at West Point and an MBA from Colorado State University.

Army Medicine and Artificial Intelligence

Transforming the Future Battlefield

Col. Vanessa Worsham, U.S. Army Nurse Corps
Lt. Col. Elvis Gonzalez, U.S. Army Medical Service Corps
Lt. Col. Margaret Kucia, U.S. Army Specialist Corps
Lt. Col. Megan Matters, U.S. Army Nurse Corps
Maj. Thomas Hansen, U.S. Army Medical Service Corps
Maj. David Preczewski, U.S. Army Medical Service Corps
Maj. Martin Smallidge, U.S. Army Dental Corps
Dr. Edward Michaud, U.S. Army Civilian Corps

Artificial intelligence (AI), machine learning (ML), and robotics mutually enhance human performance and military readiness through the development of intelligent software and machines.[1] The ongoing evolution of AI and related technologies continue to influence popular culture, science, robotics, finance, marketing, supply chain, and health care.[2]

AI mimics human intellect and processing functions such as language, learning, and problem-solving, through repetitive pattern recognition.[3] ML and neural network processes ingest large data sets, which "train" algorithms and develop adaptive "intelligence."[4] Quantitative studies and applied research demonstrate the efficacy of AI, ML, and human-machine integration, and in military settings, human-machine integration increases lethality through range, endurance, payload, survivability, and adaptability, significantly changing employment strategies.[5]

In 2022, AI revolutionized modern culture and social dynamics through the release of ChatGPT by OpenAI. The generative AI platform established this once distant, science-fiction concept within the public domain, with widespread availability for anyone with a network connection. In the wake of such rapid developments, future applications provide unlimited potential, and in particular, this technology is assessed to support human cognition through enhanced military leaders' decision-making, improved situational awareness, and optimized resource replenishment to fight and win on current and future battlefields. AI provides military decision-makers with valuable insights and analysis based on algorithms that process vast amounts of high-velocity, high-volume data, identifying trends and patterns that outpace human cognition, especially on a mass scale and at echelon.

Of significant impact, AI could provide solutions for the extreme challenges of providing medical care

A patient is loaded into a UH-60A Black Hawk medevac aircraft. AI will play an integral role in increasing the accuracy and efficiency of patient movement by reducing the number of pilots and crew required for medevac missions as well as by performing administrative functions and monitoring patients en route. (Photo by Maj. David Preczewski, U.S. Army)

during large-scale combat operations (LSCO). Army Futures Command has described the challenges facing the Army Health System (AHS) in the future operational environment, including high casualty rates, delayed evacuation and replenishment, and the lethality of multidomain and novel complex terrain environments.[6] To mitigate the challenges, the AHS will support forces contested in all operational domains. Our enemies' antiaccess and aerial denial capabilities will limit U.S. air, land, and sea force projection. In the cyber domain, AHS assets are threatened by enemy access to force structure and patient data, weaponized misinformation, and cyberattacks that interrupt network access. During conflict, the AHS will face a hyperactive, lethal, and kinetic fight preventing stable and stationary medical treatment operations. These challenges of the future operational environment will strain the AHS's ability to complete its enduring mission to conserve the fighting strength.

Recent experiments indicate overwhelming casualty rates, which have not been suffered since World War II: in future LSCO, the Army could lose twenty-one thousand soldiers, a corps-size element, in seven days.[7] These experiments establish the need for the AHS to increase evacuation and treatment holding on the future battlefield while simultaneously conserving the force's lethality by returning a high percentage of service members with illness or injury to the front line as swiftly as possible.

The AHS has three operational imperatives to address the challenges of the future operational environment, each of which can be supported through the application of AI. First, the AHS must clear the battlefield of casualties as a means to unencumber the combat force to move and operate; mobility is paramount in future fights. To conserve fighting strength after clearing the battlefield, the AHS must maximize return to duty as far forward as possible, which starts in garrison with the AHS force health protection (FHP) task. Home station care provides medical readiness to reduce service member risk for complications from disease, exposure to infection, and injury, which ensures service members perform effectively even before deployment. In forward environments, the AHS incorporates a sustainment capability by treating those sick or injured through health service support (HSS) tasks performed by operational medical organizations. Finally, the AHS must overcome the expected threat of contested logistics. Military medical resupply will not outweigh resupply needs of the maneuver force, so the AHS system must remain agile and flexible in its management of medical logistics, especially in mitigating expected mass casualty events.[8] Only by addressing all three interwoven imperatives will the AHS fulfill its role in conserving the fighting strength, and AI will be a revolutionary instrument for the AHS to solve information, risk, and decision-making challenges of LSCO.

Command and Control

Just as technology growth has rapidly accelerated over the last few decades, the Army increasingly relies on data to inform decisions and gain information advantage. From a command-and-control (C2) perspective, there are opportunities to leverage AI to process data rapidly. This is seen today through deep learning, pattern recognition, decision-making through repetition, and AI ability to distinguish unique attributes and elements of an image.[9] Follow-on applications of deep learning lead to an ability to automate, incorporate unmanned systems, and reduce human error by offloading and accelerating information across a battlefield. AI accelerates the provision of data to warfighters via rendering faster computers, algorithmic improvements, and access to large amounts of highly-accurate and well-established data-enabled advances in ML and deep learning.[10]

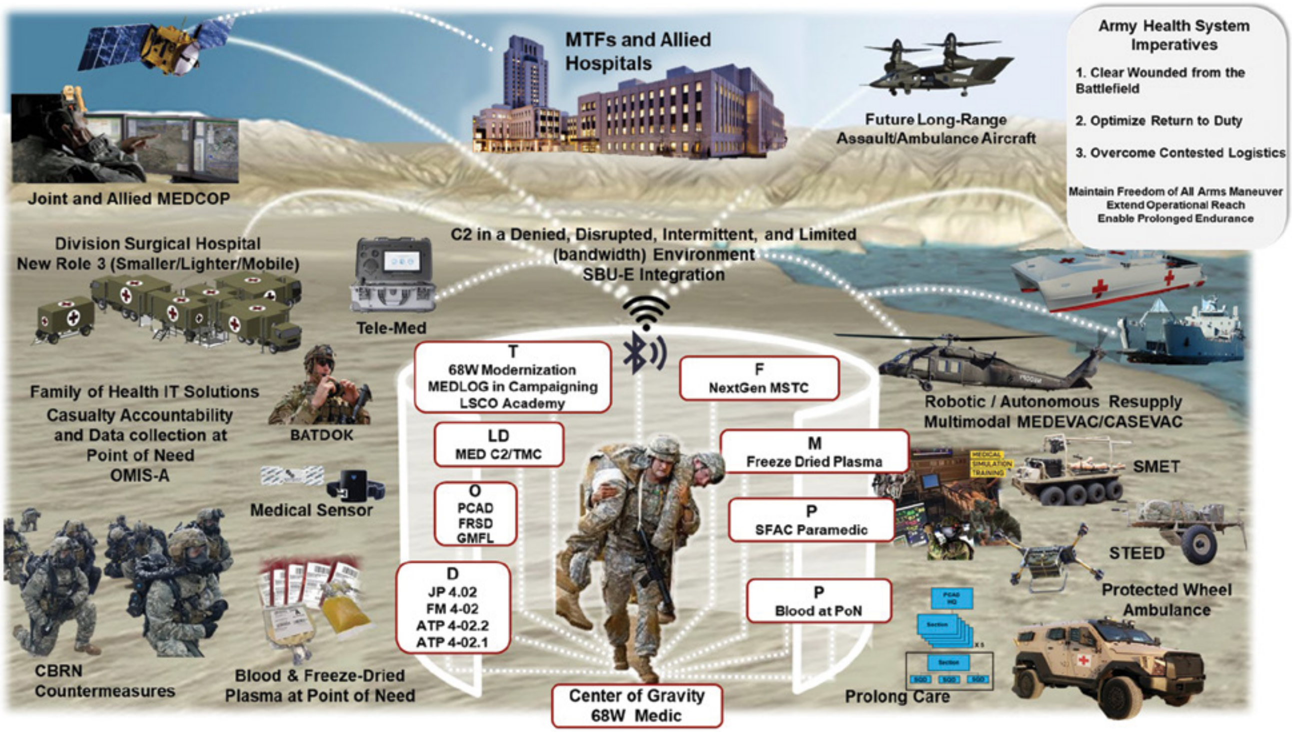
The U.S. military's ability to regain and maintain information and decision advantage relies on the Combined Joint All-Domain Command and Control (CJADC2) concept. CJADC2 provides a coherent approach for shaping joint force C2 and producing the warfighting capability to sense, make sense, and act at all levels and phases of war, across all domains, and with partners and allies to deliver the information advantage at the speed of relevance while acting inside an adversary's decision cycle.[11]

Sense is the ability to discover, collect, correlate, aggregate, process, and exploit data from all domains and sources—friendly, adversary, and neutral—and then share the information to support decision-making. Sensemaking refers to analyzing data to understand better and predict the operational environment, the actions and intentions of an adversary, and the actions of our friendly forces. Sensemaking data transforms into information, which transforms into knowledge that enhances the decisions of the joint force and partners.[12] When human assessment is combined with the technical means to perceive and understand, leaders are better able to take action against adversaries.

The intersection of AI and AHS can potentially revolutionize how military medical professionals operate on the battlefield.[13] With advancements in AI technology, health-care systems hold the potential to become more efficient, accurate, and responsive, saving lives and improving the overall outcomes for wounded soldiers. AI supports the AHS to meet the future challenges by improving surveillance, rapidly treating patients, moving wounded more efficiently, and enabling accurate resupply.

Maximize Return to Duty

Early, precise intervention maximizes a warrior's ability to functionally return to duty and increases survivability on and off the battlefield. Health-care technology constantly evolves: systems are more accurate, less expensive, faster, smaller, and can reach further than humans alone. Health care leverages data to support clinical decision-making acutely, routinely, and emergently; incorporating AI will add limitless value. Like most health systems, the AHS are trained professionals whose mission requires aggregating data quickly, often under immense pressure, to treat and save people and animals—our military warriors. These overarching functions rely on humans to capture, consolidate, interpret, analyze, and utilize data to inform care. The cornerstone of military health care remains its people, the most complex and expensive assets in the military organizations, however, given constrained resources and feasible data saturation expected in the future fight, AI will enhance manpower with machine power. AI across AHS will function as a health-care multiplier, enhancing cost-efficiency, bridging personnel shortages, expanding limited medical capabilities, reducing error, optimizing workflows, improving data processing and analysis, and facilitating precision medicine. AI has the clinical and operational potential to transform AHS health care across surveillance and delivery



BATDOK—Battlefield assisted trauma distributed observation kit
C2—Command and control
CBRN—Chemical, biological, radiological, and nuclear
CASEVAC—Casualty evacuation
FRSD—Forward resuscitative surgical detachment
GMFL—Global medical field laboratory
LSCO—Large-scale combat operations
MEDCOP—Medical common operating picture
MEDEVAC—Medical evacuation
MEDLOG—Medical logistics
MSTC—Medical Simulation Training Center
MTF—Medical treatment facility
NextGen—Next generation
OMIS-A—Operational medical and information system
PCAD—Prolonged care augmentation detachment
SBU-E—Sensitive but unclassified-encrypted
SFAC—Security Force Assistance Command

(Figure by authors)

Medical Capability Development Integration Directorate Concept to Support Army of 2030/2040

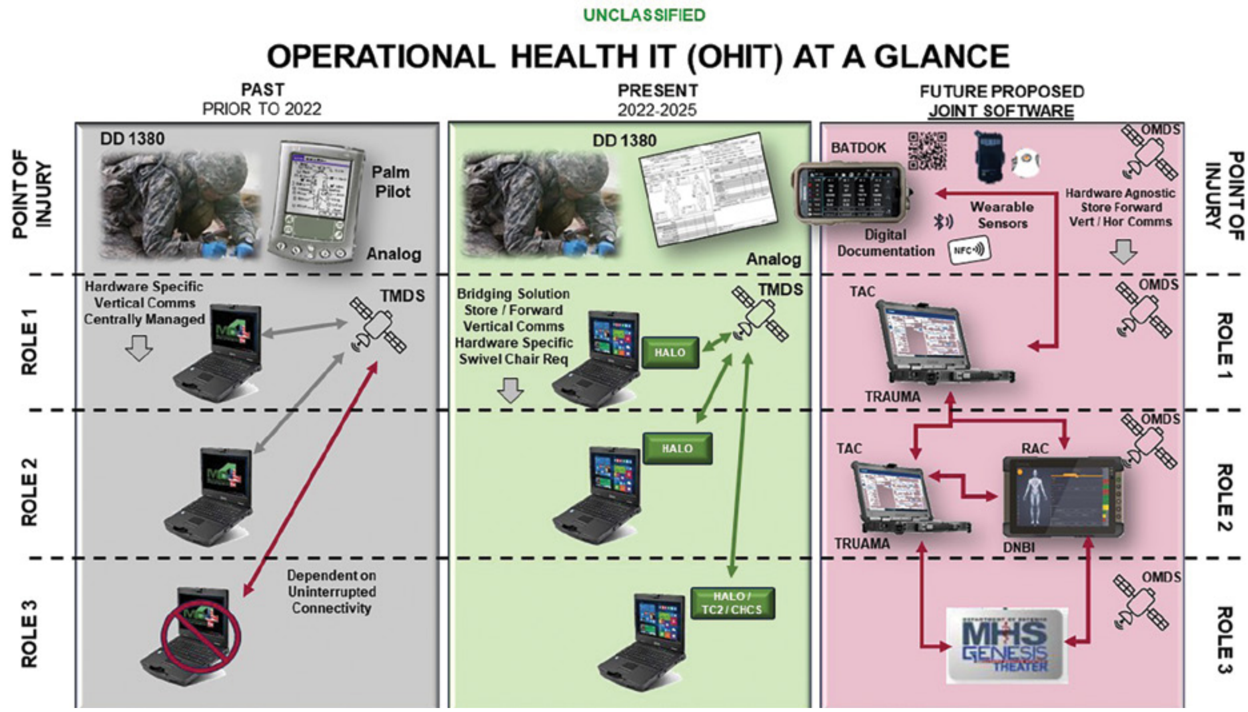
areas. AI will enhance productivity and efficacy of care across FHP at home and through HSS abroad while in the fight.

Force Health Protection: Surveillance

AI will enhance FHP through retrospective and prospective health surveillance and disease prevention programming. By analyzing data, AI informs medical planning and identifies potential health risks to populations and individuals.

AI applications range from predictive analytics to data consolidation to prediction of disease progression for those at high risk and prevention measure recommendations. These predictions will allow clinical and nonclinical leaders to intervene early and potentially reduce progression or prevent adverse outcomes altogether.

AI can also look at biometric data aggregation to inform disease processes, drug administration reactions, and the need to perform interventions or diagnostics early. One element that will increase data to provide treatment rests within wearable biometric sensor technology, like an individually worn wrist or ring monitor. This live-data source will give providers real-time and cumulative information and education to patients on how best to conduct their health,



BATDOK—Battlefield assisted trauma distributed observation kit

CS—Composite health care system

DNBI—Disease nonbattle injury

HALO—Health assessment lite operation

OMDS—Operational medicine data store

RAC—Routine ambulatory care

TC2—Tactical command and control

TAC—Trauma acute care

TMDS—Theater medical data store

(Figure by authors)

Operational Health Information Technology at a Glance

rehabilitation, and in battle inform treatment. More robustly, this wearable data source input within the military will provide physical and occupational therapists, nutritionists, behavioral health specialists, primary care providers, and emergency providers information to improve their treatment plans and help guide optimal interventions and therapies while automatically populating the patient's longitudinal health record.

Real-time medical surveillance with trends will accompany actionable recommendations for leaders by echelon. Clusters of abnormal vital signs may signal a man-made or natural environmental exposure and will alert appropriate leaders with suggested causes and related recommendations. These records, informed by aggregate data from all countries and all sources, including national ministries of health, the World Health Organization, and nongovernmental organizations, can provide a more comprehensive health intelligence preparation for the battlefield.

Clinical data from medical sensors will enable medical leaders across the battlespace to access clinical data and assess the performance of their respective organizations. AI will enable clinical data interpretation, identify patterns linked with outcomes, develop predictive analytics, and propose solutions to clinical and nonclinical leaders.

In military medical care, to include capabilities outside a hospital such as veterinary and dentistry capabilities, generating an AHS provider necessitates initial schooling, which is an intensive, manpower-heavy task, but AI can help ease this burden. Instead of individual public health and preventative screening exams such as monthly examinations conducted by AHS providers, screenings performed by nonmedical technicians assisted by AI could provide a cost-effective health risk assessment. Screenings are a public health activity that cannot give the individual patient a diagnosis for intervention but provides a risk assessment for how likely the person is to have a particular disease. A population-level oral disease surveillance system could enhance the screening process by eliminating human screening decision-making for tens of thousands of soldiers annually. Leveraging AI to inform this and other systems like it can expand the reach of a single trained dentist or provider across the AHS. Additionally, AI will utilize patient data to identify a soldier's risk factors throughout their career and additional health factors are added to the calculation. When a soldier is prepared for deployment, AI-enhanced risk assessment will again become helpful in identifying those most at risk of disease and referring them to a treatment facility for diagnosis and treatment. Within the behavioral health footprint alone, AI has the potential to identify those at risk early and often.

AI enhances FHP through retrospective and prospective health surveillance and disease prevention programming. AI in FHP informs medical planning.

Health Service Support: Treatment

Like nonmilitary health care and advances in medical uses for AI employment, AHS can leverage AI to improve treatment and hospital management. AI, deep learning, natural language processing, and ML capabilities have proven efficacy in nonoperational health-care settings through improved diagnostic accuracy, treatment plans, risk factor assessment, health communication, and health-care administration.[14] AI algorithms quickly identify trends, patterns, and insights. This is applicable at the point of injury, at the bedside, and for C2 oversights to inform survivability and future AHS improvements. The AHS and military medicine can benefit significantly from tailoring these analysis tools to operational medicine mission sets.

Fully expanding and incorporating the current levels of AI infrastructure available within health care will directly apply to treatment and care at war. Current integrated efforts include using ML algorithms for medical diagnostics, predictive modeling, and personalized treatment plans digesting inputs into electronic health records. Employing these tools and others will facilitate expanded clinical decision support systems, more widely incorporate evidence-based care, and rapidly narrow differential diagnoses while providing precision treatment plans at scale. Challenges of the future operational environment of warfare require the provision of prolonged care in a limited resource environment and incorporate evolving objective mass casualty plans. AI as a tool will empower AHS providers at any level of care to tailor care rapidly and adaptively to disease diagnostics and patient management and immediately advise within the triage process. For providers from combat medic to neurosurgeon, AI has the potential to synchronize and standardize care plans and systematically inform the most significant survivability potential with limited resources.

Today, the adoption of AI into military medicine is slow yet present, but incorporating AI in AHS will maximize return to duty and save lives, while also informing future clinical practice recommendations AI enables health-care teams at all levels to work at the top of their scope, saving lives by mitigating the austerity of future battlefields.

Clear the Battlefield

The unencumbering of maneuver forces relies significantly upon the ability to clear the battlefield and regulate patient flow throughout the AHS. AI will play an integral role in increasing the accuracy and efficiency of processing patient movement requests (PMR) . AI can drastically shift the movement of AHS patients, from initiating patient care enroute through providing definitive care.

When initiating a PMR or "9-Line," data input technologies such as a biometric wearable will transmit data into the Army data fabric. This early notification of PMR allows health-care teams to better prepare for patient needs, and data can be shared in near-real time through near-field communication devices or low-orbit satellites such as drones and balloons to ensure a common operating picture is available for decision-making. As the medic is alerted of a potential casualty, AI automatically completes triage and populates the PMR, allowing the medic to focus on patient care versus processing or dispatching administrative data. The AI algorithms consolidate and summarize injury patterns, survivability triage, transport times, medical supply accessibility, and available hospital bed spaces to inform the best evacuation movement decisions. This information will help the medic determine the appropriate care

A Sikorsky UH-60A Black Hawk flies over Fort Campbell, Kentucky, on 5 February 2022 during its first unmanned flight as part of the Defense Advanced Research Projects Agency's Aircrew Labor In-Cockpit Automation System program. (Photo courtesy of DARPA)

provision at the point of injury as well as the best patient packaging for transport. This is further supported by AI intelligently tasking a transport platform to the PMR and alerting all roles of care.

AI integration into evacuation platforms can take many forms. Fully autonomous vehicles can operate without requiring oversight from a human-in-the-loop. Semiautonomous platforms can reduce the number of drivers or pilots required for the platform by reducing the workload for the crew. Incorporating human machine teaming will unload the physical burden required of our medical forces.

Overcome Contested Logistics

Quality health care, no matter the environment, requires medical supplies (Class VIII). The issue of contested logistics encompasses the dichotomy of an obstructed supply chain with an inability to gain dominance in one or more domains on the battlefield. For medical logistics, there is a requirement to move blood rapidly and Class VIII across vast distances with a high probability that the equipment will not be flown due to a contested air domain thus increasing the delivery time between resupplies. Delivering health care in multidomain operations is further complicated by weather, road conditions, and water crossings, increasing the lag time. In this unforgiving battlefield landscape, integrating AI into the delivery of Class VIII becomes a key driver of innovation and efficiency. It is imperative to explore how AI and ML can revolutionize supply chain management in austere environments and reshape traditional processes that must be replicated in such conditions.[15]

To overcome contested logistics, AHS will require a robust and integrated medical C2 system that leverages data inputs from biometric wearable sensors, electronic health record systems, and sustainment systems to turn reactive logistics into predictive logistics when coupled with ML and AI.

AI has redefined how the civilian sector predicts and demands plans for decades. Like in health-care treatment, AI has enhanced supply chain management in non-war environments for years. AI algorithms provide significantly more precise demand forecasts by examining external factors, market trends, and historical data.[16] ML models, such as those used in shipping container yards, constantly learn and adapt to improve predictive logistics.[17] Incorporating AI and ML will help reduce excess inventory while enhancing overall supply chain output.

AI facilitates precise and effective inventory management for sustainers at the echelon. Through real-time data analysis and predictive analytics, AI can enable C2 and precision sustainment to optimize inventory levels, reduce processing times and costs, improve just-in-time distribution, and save lives. Planners will have the tools to detect patterns and variances, providing timely information for commanders to aid in proactive decision-making.[18] Units on the ground will limit the need to pull when it comes to resupply when AI will consolidate data and push anticipated needs easier.

ML, a branch of AI, can be leveraged to redefine forecasting and demand planning due to its ability to analyze enormous amounts of data in real-time. This will result in extraordinary accuracy, enabling sustainment organizations to adapt quickly at all levels.

ML can be crucial in autonomous decision-making in a contested environment where supply chains become increasingly complex. Algorithms will sift through intricate datasets and provide an operating picture that will guide strategic decisions, improving risk management and flexibility.[19] Leaders will possess the tools to identify potential risks and implement preemptive measures that strengthen supply chains against unforeseen threats.

Optimizing logistics challenges using AI, AHS, and the military can maximize the return to duty rate, increase survivability, and ultimately save warriors' lives on the battlefield.

Barriers to Artificial Intelligence in the Army Health System

Though the potential benefits of AI in supporting the AHS in LSCO are straightforward, several challenges remain. Communications are expected to be denied, degraded, intermittent, and of limited bandwidth; maneuver force data often retains bandwidth priority over health data transmission. Operational medicine generates significant amounts of data, but current AI systems may still need to be adequately capable of prioritizing high volumes and velocities of such health data. Similarly, AI and related applications crucially rely on large amounts of "training data" to discern patterns and relationships. Modern health-care data based on casualty flow, injury patterns, and health resources in LSCO and MDO do not yet exist to inform this pattern learning.[20] As a modern technology, AI tools and systems are not yet routinely available in all military medical training or clinical settings. The need for AI understanding in medical care and education is evident. However, military health-care teams will also require realistic training, updated instruction plans, and deliberate, sustained exposure to be ready to adopt AI processes and systems across all operational medicine functional areas.[21]

Electronic health-care data also requires additional safety and security protocols to ensure data security, as the HIPAA Security Rule describes, currently limiting the open transfer of health data across interoperable battle management command and control information systems.[22] Medical data generated in operational settings will be compiled within a service member's longitudinal service health record. While AI supports tools that improve operational health-care practice, evacuation, logistics, and return to duty, AI does not surmount the need for health data to be secure, private, unbiased, authentic, and accurate, together with being fed high-quality, reliable data.[23] Protection of operational health data is even more important than in garrison, as operational data may create risk by revealing troop locations, combat effectiveness, and even the identities of clandestine or high-value personnel.

Additional barriers to AI implementation in the AHS mirror the challenges of AI use in the civilian sector. AI relies on high-volume data storage systems that are accessible, secure, and extremely expensive.[24] In addition to the need for data stewardship and governance, AI in the AHS must comply with additional military-specific regulations while remaining valuable and relevant to operational needs.[25] Further, the development of AI tools and processes must still be well-integrated into Army operations as well as in austere health-care settings during conflict. Teams and professionals, such as graduates of the Army Software Factory, and the development of corps-level chief data officers promote the Army's data-centric culture.[26] Though the recognition of the need for technical specialists is present, this remains in nascent stages within AHS and without robust, dedicated technology teams to iteratively develop, deploy, and maintain such dynamic tools. While the benefits of AI are apparent in the provision of care, using such systems to support military medicine broadly requires significant investment in a larger military medical data strategy.

Ethics of Using Artificial Intelligence

Firms within the defense industrial base tend to coordinate with the U.S. government customers' legal and policy compliance experts to help ensure that AI systems comply. The defense industry's AI systems comply with effective utilization of traceable and reliable systems and continue to produce equitable, unbiased results throughout their mission life.

ML systems train on collected datasets that include bias and may exhibit these biases upon creating algorithmic bias. Human language is known as biased; machines trained on the human language are highly likely to be personal, which can lead to prejudices. Bias and prejudices are preventable using policies and datasets that do not contain discriminatory language. Despite uncertainties and unknowns in developing AI systems. the U.S. government has a work-in-progress to establish policies to determine if an AI model is sufficiently safe, secure, and ethical for Department of Defense use.[27]

Trusting the data allows warfighters to exercise their informed decision-making space to act and defeat adversaries during the mission. However, AI/ML algorithms will not fully compensate for gaps in physical understanding. While AI offers numerous benefits, there are ethical considerations to address. Questions arise regarding the moral implications of using AI in health care and the potential impact on human elements such as empathy and compassion. AI is a way to augment, rather than replace, the compassionate and dedicated provision of military operational health care.[28]

The consideration of using AI in the delivery of health care and health-care decision-making should require a policy update within the joint force. Army Medical Concepts for the Future articulates the necessity of incorporating automation into health care to ensure we do the greatest good for the greatest number of patients. The moral argument remains regarding how "involved" AI and humans remain in decision-making. On one hand, there is an ethical obligation to leverage emerging technologies to create the highest level of care for our soldiers.[29] Suppose emerging AI technologies provide greater good than harm, and the principle of immediacy deems algorithmic care triage and autonomous evacuation as a justified means in LSCO. In that case, one can argue that it is ethical so long that humans remain in the loop.[30]

Conclusion

Artificial intelligence, machine learning, and human-machine integration can provide information dominance on the battlefield and enable warfighters to make informed decisions at the speed of relevance while projecting power. AI facilitates a common operating picture across the battlefield; AI and ML are critical catalysts for fusing data. AI/ML significantly improve decision-making and the kill-chain timeline. Human machine teaming allows humans and machines to train together, ensuring the warfighter's trust in the machine. AI and human machine teaming reduce the warfighter's cognitive load, directly optimizing an informed decision-making process while enabling joint force overmatch.

The intersection of AI and AHS can revolutionize military medical support on the battlefield. AI holds immense potential for enhancing military operations and ensuring the well-being of every soldier. AI technologies such as algorithmic care, medical surveillance, evacuation, and predictive analytics can transform how medical support is provided to the frontlines. By deploying AI systems, the AHS can significantly improve the speed and accuracy of diagnostics, treatment, and decision-making processes. AI algorithms quickly analyze vast amounts of medical data, extending care and evacuation reach, reducing human error, mitigating the risks associated with high-stress combat environments, and enabling health-care professionals to improve outcomes for wounded soldiers and save lives.

AI can enhance the efficiency of logistics and supply chains in the AHS. By leveraging predictive analytics, AI algorithms can anticipate medical supply needs, optimize inventory management, and streamline the delivery of critical resources across the battlefield. This proactive approach ensures medical personnel have access to the necessary equipment and medications, enabling them to provide adequate and timely care to wounded soldiers.

AI continues to evolve, making it crucial to address the ethical implications and potential risks associated with its use on the battlefield. Safeguards and professional technical oversight must be implemented to ensure that AI systems are developed and used responsibly. Transparency, accountability, and a robust governance framework are essential in maintaining the ethical integrity of an AI-enabled AHS. By harnessing the immense power of AI technologies, the AHS has the potential to completely transform military medical support, leading to the preservation of countless lives and playing a critical role in achieving victory in future conflicts. ■

Notes

1. Laszlo Monostori, "Artificial Intelligence," in *CIRP Encyclopedia of Production Engineering*, ed. Sami Chatti et al. (Berlin: Springer, 2019), 73–76, https://doi.org/10.1007/978-3-662-53120-4_16703.

2. "Homage to John McCarthy, the Father of Artificial Intelligence (AI)," Teneo.ai, accessed 21 March 2024, https://www.teneo.ai/blog/homage-to-john-mccarthy-the-father-of-artificial-intelligence-ai.

3. Christopher Collins et al. "Artificial Intelligence in Information Systems Research: A Systematic Literature Review and Research Agenda," *International Journal of Information Management* 60 (2021): Article 102383, https://doi.org/10.1016/j.ijinfomgt.2021.102383.

4. Greg Allen, *Understanding AI Technology* (Washington, DC: Department of Defense Joint Artificial Intelligence Center, April 2020), https://www.ai.mil/docs/Understanding%20AI%20Technology.pdf.

5. Thomas Davenport and Ravi Kalakota, "The Potential for Artificial Intelligence in Healthcare," *Future Healthcare Journal*, 6 no. 2 (June 2019): 94–98, https://doi.org/10.7861/futurehosp.6-2-94.

6. Army Futures Command Pamphlet 71-20-12, *Army Futures Command Concept for Medical 2028* (Austin, TX: U.S. Army Futures Command, 4 March 2022), https://api.army.mil/e2/c/downloads/2022/04/25/ac4ef855/medical-concept-2028-final-unclas.pdf.

7. Todd South, "21,000 Casualties in Seven Days: The Push to Update Medic Training," Army Times, 6 October 2023, https://www.armytimes.com/news/your-army/2023/10/06/21000-casualties-in-seven-days-the-push-to-update-medic-training/.

8. James Jones, "Mass Casualty Evacuation and Treatment 18th MDO Gap Decision Brief," October 2023, Joint Base San Antonio – Fort Sam Houston, Texas.

9. Yann LeCun, Yoshua Bengio, and Geoffrey Hinton, "Deep Learning," *Nature* 521 (2015): 436–44, https://doi.org/10.1038/nature14539.

10. Simon London, "Ask the AI Experts: What's Driving Today's Progress in AI?," McKinsey, 7 July 2017, https://www.mckinsey.com/capabilities/quantumblack/our-insights/ask-the-ai-experts-whats-driving-todays-progress-in-ai.

11. U.S. Department of Defense, *Summary of the Joint All-Domain Command and Control Strategy* (Washington, DC: U.S. Department of Defense, 17 March 2022), 2, https://media.defense.gov/2022/Mar/17/2002958406/-1/-1/1/SUMMARY-OF-THE-JOINT-ALL-DOMAIN-COMMAND-AND-CONTROL-STRATEGY.PDF; J. Stuckey, "Artificial Intelligence Design Engineering for People and Technology (ADEPT): Open Framework for Implementing AI Engineering" (AI Engineering Symposium: AAAI Spring Symposium Series 2022, Pittsburgh, PA, 23 March 2022).

12. U.S. Department of Defense, *Summary of the Joint All-Domain Command and Control Strategy*, 7.

13. Benjamin P. Donham, "It's Not Just About the Algorithm: Development of a Joint Medical Artificial Intelligence Capability" *Joint Force Quarterly* 111 (4th Quarter, October 2023), https://ndupress.ndu.edu/JFQ/Joint-Force-Quarterly-111/Article/Article/3569597/its-not-just-about-the-algorithm-development-of-a-joint-medical-artificial-inte/.

14. Thomas Davenport and Ravi Kalakota, "The Potential for Artificial Intelligence in Healthcare," *Future Healthcare Journal* 6, no. 2 (June 2019): 94–98, https://doi.org/10.7861/futurehosp.6-2-94.

15. C. J. Lovelace, "Army Medical Logistics Participates in DOD AI Research and Development," Army.mil, 19 April 2022, https://www.army.mil/article/255821.

16. Ben Unglesbee, "AI Opens New Frontier in Supply Chain Planning," Supply Chain Dive, 23 May 2023, https://www.supplychaindive.com/news/inventory-demand-forecasting-ai-machine-learning/650781/.

17. Frankie Youd, "Artificial Intelligence to the Rescue: Assisting the Shipping Container Crisis," Ship Technology, 18 November 2021, https://www.ship-technology.com/features/artificial-intelligence-to-the-rescue-assisting-the-shipping-container-crisis/?cf-view.

18. C. J. Lovelace, "Army Medical Logistics Participates in DOD AI Research and Development."

19. Clint Reiser, Chris Cunnane, and Steve Banker, "The Rise of Machine Learning," Supply Chain Exchange, 21 August 2019, https://www.thescxchange.com/articles/1996-the-rise-of-machine-learning.

20. Jonathan Spirnak and Sameer Antani, "The Need for Artificial Intelligence Curriculum in Military Medical Education," *Military Medicine* (20 October 2023): usad412, https://doi.org/10.1093/milmed/usad412.

21. Ibid.

22. "Health Information Privacy," U.S. Department of Health and Human Services, accessed 25 March, 2024, https://www.hhs.gov/hipaa/for-professionals/security/index.html.

23. Robbie Hammer, "Defense Health Agency Paving the Way for Digital-First Health Care Delivery," Health.mil, 12 October 2023, https://www.health.mil/News/Dvids-Articles/2023/10/12/news455622.

24. Damco Solutions, "7 Biggest Barriers to AI Adoption & Their Solutions," IoT for All, 30 June 2022, https://www.iotforall.com/barriers-to-ai-adoption-and-solutions.

25. Ibid.

26. Army Software Factory, accessed 21 March 2024, https://soldiersolutions.swf.army.mil/.

27. Rick Robinson, "AI Ethics: Building Security and Responsibility into Intelligent Systems," Northrop Grumman, accessed 21 March 2024, https://www.northropgrumman.com/what-we-do/ai-ethics-building-security-and-responsibility-into-intelligent-systems/.

28. Hammer, "Defense Health Agency Paving the Way for Digital-First Health Care Delivery."

29. Army Futures Command, *Army Medical Modernization Strategy 2022* (Austin, TX: U.S. Army Futures Command, 1 May 2022).

30. John Ramiccio, "The Ethics of Robotic, Autonomous, and Unmanned Systems in Life-Saving Roles" (Newport, RI: Naval War College, 12 June 2017), 1–35, https://apps.dtic.mil/sti/pdfs/AD1041802.pdf.

Col. Vanessa Worsham, U.S Army Nurse Corps, is the director of the Army Capability Manager—Army Health Systems Medical Capability Development Integration Directorate, Futures Concept Center, Army Futures Command, at Joint Base San Antonio, Texas. She holds a Bachelor of Science in Nursing from Howard University, a Business of Nursing graduate certificate from Johns Hopkins University, a master's degree in national security and resource strategy and a graduate certificate in national security interagency leadership from the Dwight D. Eisenhower School at the National Defense University.

Lt. Col. Elvis Gonzalez, U.S. Army, is the Army capability manager for the Army Health System for Medical Logistics at Joint Base San Antonio, Texas.

Lt. Col. Margaret Kucia, U.S. Army, is the Army capability manager for the Army Health System for Treatment at Joint Base San Antonio, Texas.

Lt. Col. Megan Matters, U.S. Army, is the Army capability manager for the Army Health System for Hospitalization at Joint Base San Antonio, Texas.

Maj. Thomas Hansen, U.S. Army, is the Army capability manager for the Army Health System for Medical Command and Control at Joint Base San Antonio, Texas.

Maj. David Preczewski, U.S. Army, is the Army capability manager for the Army Health System for Medical Evacuation at Joint Base San Antonio, Texas.

Maj. Martin Smallidge, U.S. Army, is the Army capability manager for the Army Health System for Dental at Joint Base San Antonio, Texas.

Dr. Edward Michaud is a senior clinical consultant to Army capability managers for the Army Health System at Joint Base San Antonio, Texas.

Using Open Access AI to Create Military Training from POW Experiences

Col. John P. Albano, MD, U.S. Army, Retired

Cmdr. Steven E. Linnville, PhD, U.S. Navy, Retired*

Lt. Jacob R. Westerberg, PhD, U.S. Navy

Travis V. Meyer

ChatGPT is the flagship product of the American artificial intelligence organization OpenAI. As a natural language processing program, ChatGPT leverages artificial general intelligence to generate complex informational responses based on user input.[1] When prompted to describe artificial general intelligence (AGI), ChatGPT stated,

> In simple terms, Artificial General Intelligence (AGI) refers to highly autonomous systems or machines that possess the ability to understand, learn, and apply knowledge across a broad range of tasks at a level comparable to human intelligence. Unlike specialized or narrow AI, which is designed for specific tasks, AGI aims to exhibit general cognitive abilities similar to those of humans. It involves machines that can adapt, reason, problem-solve, and learn in diverse situations, much like how humans can apply their intelligence to various activities without being limited to a specific domain. AGI represents a level of artificial intelligence where machines can handle complex tasks across different domains, demonstrating a versatile and human-like understanding of the world.[2]

Reminiscent to "HAL" 9000 (a.k.a. Heuristically Programmed Algorithmic Computer) in Stanley Kubrick's 1968 movie *2001: A Space Odyssey*, AGI has made the leap from science fiction to science fact.[3] The goal of OpenAI is to provide society cutting-edge, interactive computer programs that are safe and beneficial to use by anyone.[4] One way this technology may be useful in a military environment is in developing timely educational curriculum. The application of this technology to support education has already been examined in a military context by way of graduate medical education.[5]

This study explores the use of AGI for curriculum development to prepare military personnel to survive a captivity experience. The data used in this study were from books published by former U.S. prisoners of war (POWs) held in Vietnam between 1964 and 1973. These POWs represented all branches of U.S. military service, most of whom were aviators. Their experiences

U.S. prisoners of war stand in the yard at Hanoi's Nga Tu So prison during an inspection visit in March 1973 by international observers and invited Western journalists. The prison, surrounded by a high brick wall topped with barbed wire, had been a government building before the Vietnam War. Each cell housed about a dozen prisoners of war, and beds consisted of wooden platforms with mats. (Photo by Horst Faas, Associated Press)

included prolonged torture, malnourishment, and periods of isolation.

Of these POWs, many wrote and published works about their captivity experiences and their life experiences afterward. The advancement of AGI has provided a novel avenue to compile their published experiences to identify teaching objectives that could be used by military members through a method of instruction on survival and resilience. Here, survival is defined as "the state or fact of continuing to live or exist especially in spite of difficult conditions," and resilience is defined as "the process and outcome of successfully adapting to difficult or challenging life experiences, especially through mental, emotional, and behavioral flexibility and adjustment to external and internal demands."[6] For the purposes of this study, survival is considered an ongoing process during an event and resilience is a process that can occur both during and after an event. These are two critical themes necessary to train military personnel in preparation for combat and life post-combat.

Method

This analysis included works exclusively written by former POWs about their captivity experiences in Vietnam. For this pilot study, four published books were selected.[7] Approximately 80 percent of each book was digitally scanned and uploaded into the freely available ChatGPT version 3.5. Due to text analysis limitations per a single command prompt, segments of each book were uploaded separately. For each segment, ChatGPT was asked to identify ten common themes from the text. Once a set of common themes were developed for each book, all forty themes from the four books were inputted again into ChatGPT. The program was then prompted to develop a set of twelve common themes across them. Next, from these twelve themes, an intermediary set of themes were developed—one set on survival and another set on resilience. From these latter two themes, teaching objectives were developed focused specifically on survival and resilience.

Results

Table 1 (at the end of the article) shows the themes generated from the writings (the "narrators" are the four authors). The themes gathered include military training, internal and external struggles, comradery with other POWs, cultural and language differences with their captors as barriers, the constant fear and survival they had, not knowing when and if they would be released, and reflections at the time of writing and while in captivity.

From these twelve themes, two sets of themes were prompted, one set for survival (table 2) and one for resilience (table 3), with ChatGPT adding a thirteenth theme in resilience. Both the survival and resilience themes indexed both internal (memory, emotions, identity, and instinct) and external (physical, informational, and unity/support) themes (tables 2 and 3). These intermediary themes were generated for the final stage, which was to develop teaching objectives in these two areas (table 4).

In a side-by-side comparison of the survival and resilience objectives, the differences between them are in bold and italicized. For each of the thirteen themes, the objectives would require students to understand a difference between the two objectives and discuss in detail each of these objectives using these perspectives. The goal would be for students to develop a deeper level of understanding of these areas and how to reflect on and address them in their own learning process.

Discussion

This study was the first of its kind to use AGI technology to derive a set of common themes for captivity-related curriculum development. The major contributions of this study follow:

- First, it is the only research to date to leverage AGI to understand the experience of captivity among former American POWs from their perspective.
- Second, this work demonstrated the ability for AGI to generate domain-specific curriculum based on user inputs relevant to a military context. The use of this novel technology could be leveraged for content generation and instructional design to support instruction to military personnel as part of their military training. This has implications for military schoolhouses responsible for teaching survival, evasion, resistance, and escape curriculum.
- Third, from a methodological perspective, this study has outlined a process to analyze voluminous works

Col. John P. Albano, MD, U.S. Army, retired, is the program director for the Robert E. Mitchell Center (REMC) for POW Studies at Naval Air Station, Pensacola, Florida. He holds an MD from the University of South Dakota, an MPH from the University of Texas, and is board certified in aerospace medicine. He ended his twenty-five-year Army career as the command surgeon for the U.S. Army Space and Missile Defense Command. He has served at the REMC since 2012.

Cmdr. Steven E. Linnville, PhD, U.S. Navy, retired, received his psychology PhD from Southern Illinois University, Carbondale. His twenty-six-year Navy Medical Service Corps career involved HIV research on military performance, studying prolonged low-frequency sonar effects, teaching at the Army's West Point as a Navy assistant professor, and exploring psychological resilience among Vietnam-era U.S. POWs at the Robert E. Mitchell Center, Pensacola. Post-retirement, he consults on cognitive performance and aviator health. **He is the primary author of this article.*

Lt. Jacob R. Westerberg, PhD, U.S. Navy, serves as associate director and research psychologist at the Robert E. Mitchell Center for POW Studies at Naval Air Station, Pensacola, Florida, where he leads research on resilience, team dynamics, and leadership among former U.S. prisoners of war to support warfighter development.

Travis Meyer, MBA, has worked for the Department of Defense for the past eighteen years in both civilian and military roles. He is currently office manager at the Robert E. Mitchell Center for POW Studies at Naval Air Station, Pensacola, Florida, and a key contributor in the development of this article.

quickly with face validity from a cohort to produce shared themes across individuals with a shared experience. Future research in this area should consider cataloging all available works from cohort members for inclusion into data analysis. This additional effort will likely generate more comprehensive and nuanced insights. This study showed both the relevance and promise of leveraging novel AGI technologies to support military-related curriculum development. Moreover, such use of AGI is a major technological advancement in the twenty-first century and the way ahead for civilization. ■

Notes

1. Dinesh Kalla et al., "Study and Analysis of Chat GPT and Its Impact on Different Fields of Study," *International Journal of Innovative Science and Research Technology* 8, no. 3 (March 2023): 827–33, https://papers.ssrn.com/sol3/papers.cfm?abstract_id=4402499.
2. "ChatGPT," OpenAI, accessed 7 March 2024 [login required], https://chat.openai.com/.
3. Aaron M. Lamb, "Through the Lens of HAL 9000: Using Stanley Kubrick's *2001: A Space Odyssey* as a Modeling Tool to Create a Precursive Sapient Quotient to Foster Humanity's Moral Obligation to Evolve into Machines" (PhD diss., Johns Hopkins University, 2022), https://jscholarship.library.jhu.edu/items/9e87418f-d4a6-4bd9-88b0-8f0e9e35e687.
4. "OpenAI Charter," OpenAI, accessed 7 March 2024, https://openai.com/charter.
5. Jonathan R. Spirnak and Sameer Antani, "The Need for Artificial Intelligence Curriculum in Military Medical Education," *Military Medicine* (website), 20 October 2023, https://academic.oup.com/milmed/advance-article/doi/10.1093/milmed/usad412/7326531.
6. *Britannica Dictionary Online*, s.v. "survival," accessed 13 March 2024, https://www.britannica.com/dictionary/resilience; "Resilience," American Psychological Association, accessed 7 March 2024, https://www.apa.org/topics/resilience.
7. Everett Alvarez Jr. and A. S. Pitch, *Chained Eagle: The Heroic Story of the First American Shot Down Over North Vietnam* (Lincoln, NE: Potomac Books, 2005); Charles J. Plumb, *I'm No Hero, a POW Story As Told to Glen DeWerff* (self-pub., 1995); John Borling, *Taps on the Walls: Poems from the Hanoi Hilton* (Chicago: Master Wings Publishing, 2013); Frank Anton and Tommy Denton, *Why Didn't You Get Me Out? A POW's Nightmare in Vietnam* (New York: St. Martin's Paperback, 2000).

Table 1. ChatGPT Facilitated Common Themes Analysis

Theme	Analysis
1. War and Captivity	Central theme involving narrator's experiences as a POW detailing physical and emotional challenges
2. Interrogation and Resistance	Narration highlights interrogations, the resistance to providing information, and consequences of such resistance
3. Physical and Emotional Struggles	Vivid descriptions of the narrator's physical pain, discomfort, and emotional struggles
4. Cultural Divide	Theme of cultural differences and misunderstandings between the American narrator and Vietnamese captors
5. Comradeship and Support	Portrays camaraderie among prisoners, emphasizing interactions, shared experiences, and mutual support
6. Survival Instinct	Exploration of the narrator's instinct for survival, both physically and mentally, amidst the challenges of being a prisoner of war
7. Flashbacks and Reflections	Reflection on past experiences, including training and previous conversations, providing context and insights
8. Communication Barriers	Language barriers contributing to the challenges faced by the narrator, adding complexity to the narrative
9. Loss and Destruction	Touches on the loss and destruction caused by war, including the destruction of the squadron and its impact
10. Uncertainty and Fear	Pervasive theme of uncertainty regarding the narrator's fate, war progress and conditions of captivity. Fear is a constant companion
11. Military Training and Simulation	Describes the intense and realistic conditions pilots undergo during training to prepare for actual missions
12. Combat Experience and Unforeseen Events	Reflection on a combat mission, emphasizing the unpredictability of warfare and the impact of unforeseen events

(Table by authors)

Table 2. ChatGPT Facilitated Common Themes on Survival Analysis

Theme	Analysis
1. Reflection on Personal History	*Survival of Memory:* The narrator's reflection on personal history is a survival of memory, preserving the experiences and lessons learned during the Vietnam War. The ability to reflect on past events contributes to the survival of the narrator's identity and understanding.
2. War and Captivity	*Physical Survival:* The central theme revolves around the physical survival of the narrator during captivity. The challenges faced, both physically and emotionally, highlight resilience required for survival in a hostile environment.
3. Interrogation and Resistance	*Survival of Information:* The narrator's resistance during interrogations is a form of survival, as withholding certain information becomes crucial for personal safety and the well-being of fellow prisoners.
4. Physical and Emotional Struggles	*Dual Survival:* The text vividly describes the dual nature of survival–physical endurance in the face of injuries, hunger, and harsh conditions, as well as the survival of emotional well-being amidst the mental toll of captivity.
5. Cultural Divide	*Survival of Identity:* The theme of cultural differences and misunderstandings showcases the narrator's struggle to survive not only physically but also to preserve his identity as an American amid the cultural divide with the Vietnamese captors.
6. Comradeship and Support	*Survival through Unity:* The camaraderie among prisoners is a testament to the survival through unity. The mutual support, sharing of experiences, and comfort provided by fellow inmates contribute to the collective survival mindset.
7. Survival Instinct	*Innate Survival Drive:* The exploration of the narrator's survival instinct emphasizes the primal drive to survive, both physically and mentally, as a prisoner of war.
8. Flashbacks and Reflections	*Survival of Meaning:* The flashbacks and reflections serve as a survival of meaning, providing context to the current situation. They contribute to the narrator's mental resilience by connecting past experiences to the present.
9. Communication Barriers	*Survival through Understanding:* Overcoming communication barriers becomes essential for survival. The difficulty in understanding and conveying information adds a layer of complexity, and the ability to navigate this contributes to the narrator's survival.
10. Loss and Destruction	*Survival through Endurance:* The theme of loss and destruction underscores the survival through endurance. The narrator faces the challenge of surviving not only the physical destruction caused by war but also the emotional toll of losing comrades.
11. Uncertainty and Fear	*Survival in Uncertainty:* The pervasive theme of uncertainty underscores the survival in an unpredictable environment. The constant fear becomes a companion and navigating through it becomes essential for survival.
12. Military Training and Simulation	*Preparation for Survival:* The narrative beginning with military training emphasizes the intense conditions pilots undergo to prepare for actual missions, highlighting the importance of training for survival in combat situations.
13. Combat Experience and Unforeseen Events	*Survival in Unpredictability:* The protagonist's reflection on a combat mission underscores the unpredictability of warfare. Survival becomes a result of adapting to unforeseen events and making split-second decisions.

(Table by authors)

Table 3. ChatGPT Facilitated Common Themes on Resilience Analysis

Theme	Analysis
1. Reflection on Personal History	*Resilient Memory:* The narrator's reflection on personal history demonstrates the resilience of memory. Despite the passage of time and the traumatic nature of war experiences, the narrator persists in recalling and making sense of the past.
2. War and Captivity	*Resilience in Adversity:* The central theme of physical survival reflects the resilience required to endure the harsh conditions of captivity. The narrator's ability to withstand physical and emotional challenges showcases an overarching resilience in the face of adversity.
3. Interrogation and Resistance	*Mental Resilience:* The narrator's resistance during interrogations speaks to a mental resilience that enables them to withstand pressure and protect vital information. This mental fortitude is a form of resilience against psychological stress.
4. Physical and Emotional Struggles	*Dual Resilience:* The dual nature of survival–both physical and emotional–underscores the resilience needed to navigate the challenges. Enduring physical hardships while maintaining emotional well-being reflects a remarkable level of resilience.
5. Cultural Divide	*Resilience of Identity:* The theme of cultural differences highlights the resilience needed to preserve the narrator's identity amidst a challenging cultural divide. The narrator's struggle signifies a resilient determination to retain their American identity.
6. Comradeship and Support	*Collective Resilience:* The camaraderie among prisoners signifies a collective resilience. The mutual support and shared experiences contribute to the resilience of the entire group, helping each member cope with the difficulties of captivity.
7. Survival Instinct	*Innate Resilience:* The exploration of the narrator's survival instinct emphasizes an innate resilience, a primal drive that enables them to adapt and persevere in the face of threats and challenges.
8. Flashbacks and Reflections	*Resilience through Reflection:* The flashbacks and reflections serve as a form of resilience through meaning-making. The narrator's ability to reflect on past experiences demonstrates resilience in the face of trauma, finding purpose and understanding.
9. Communication Barriers	*Adaptive Resilience:* Overcoming communication barriers requires adaptive resilience. The narrator's ability to navigate the complexity of language barriers and convey information demonstrates resilience in communication.
10. Loss and Destruction	*Enduring Resilience:* The theme of loss and destruction underscores the enduring resilience of the narrator. Coping with the emotional toll of losing comrades and facing physical destruction requires a profound level of resilience.
11. Uncertainty and Fear	*Navigating Resilience:* The pervasive theme of uncertainty underscores the resilience required to navigate unpredictable circumstances. The narrator's ability to face constant fear and uncertainty signifies a resilient approach to survival.
12. Military Training and Simulation	*Prepared Resilience:* The emphasis on military training highlights a prepared resilience. The intense conditions of training prepare individuals to be resilient in combat situations, emphasizing the importance of mental and physical readiness.
13. Combat Experience and Unforeseen Events	*Adaptable Resilience:* The protagonist's reflection on a combat mission emphasizes adaptable resilience. Survival in the unpredictability of warfare requires the ability to adapt quickly to unforeseen events, showcasing a resilient mindset.

(Table by authors)

Table 4. ChatGPT Facilitated Common Teaching Objectives on Survival and Resilience Analysis

Theme	Survival	Resilience
1. Reflection on Personal History	*Objective:* Students will analyze the narrator's reflection on personal history to understand ***how the survival of memory contributes to the preservation of identity and lessons learned during the Vietnam War.***	*Objective:* Students will analyze instances of the narrator's reflection on personal history to understand ***and discuss how resilience is portrayed through the persistent recall and sense-making of past traumatic experiences.***
2. War and Captivity	*Objective:* Students will examine the *challenges* ***faced by the narrator during captivity, focusing on the physical and emotional aspects, to recognize the resilience required for survival in a hostile environment.***	*Objective:* Students will examine ***the central theme of physical survival in war and captivity, identifying and discussing the resilience required to endure harsh conditions. They will explore how the narrator's ability to withstand challenges showcases an overarching resilience in the face of adversity.***
3. Interrogation and Resistance	*Objective:* Students will explore the narrator's resistance during interrogations ***as a form of survival, emphasizing the importance of withholding information for personal safety and the well-being of fellow prisoners.***	*Objective:* Students will analyze the narrator's resistance during interrogations, ***focusing on the mental resilience required to withstand psychological stress. Discussions will center on the strategies employed by the narrator and the implications of mental fortitude in resisting pressure.***
4. Physical and Emotional Struggles	*Objective:* Students will analyze the dual nature of survival ***depicted in the text, emphasizing the narrator's physical endurance and emotional well-being amidst the harsh conditions of captivity.***	*Objective:* Students will explore the dual nature of survival—***both physical and emotional. Through the narrator's experiences, they will discuss and analyze how maintaining emotional well-being while enduring physical hardships reflects a remarkable level of resilience.***
5. Cultural Divide	*Objective:* Students will examine the theme of cultural differences and misunderstandings ***to understand the narrator's struggle to preserve his identity as an American amid the cultural divide with the Vietnamese captors.***	*Objective:* Students will examine the theme of cultural differences and discuss ***the resilience needed to preserve the narrator's identity amidst a challenging cultural divide. The focus will be on the narrator's struggle and determination to retain their American identity.***
6. Comradeship and Support	*Objective:* Students will assess the importance of camaraderie among prisoners ***as a form of survival through unity, highlighting how mutual support, shared experiences, and comfort contribute to a collective survival mindset.***	*Objective:* Students will analyze the camaraderie among prisoners ***and discuss how mutual support and shared experiences contribute to the collective resilience of the group. Discussions will explore the role of companionship in helping individuals cope with the difficulties of captivity.***
7. Survival Instinct	*Objective:* Students will explore the narrator's survival instinct, ***emphasizing the primal drive to survive both physically and mentally as a prisoner of war.***	*Objective:* Students will explore the narrator's survival instinct, ***discussing the concept of innate resilience as a primal drive that enables adaptation and perseverance in the face of threats and challenges. The focus will be on understanding the biological and psychological aspects of resilience.***

(Table by authors)

Table 4. ChatGPT Facilitated Common Teaching Objectives on Survival and Resilience Analysis (continued)

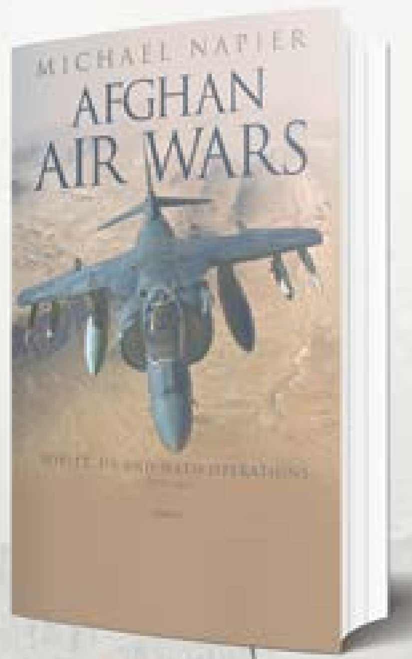
Theme	Survival	Resilience
8. Flashbacks and Reflections	*Objective:* Students will analyze the role of flashbacks and reflections ***as a survival mechanism, understanding how they provide meaning and contribute to the narrator's mental resilience.***	*Objective:* Students will analyze the role of flashbacks and reflections in the narrative, ***focusing on how they serve as a form of resilience through meaning-making. Discussions will explore how the narrator's ability to reflect on past experiences demonstrates resilience in the face of trauma.***
9. Communication Barriers	*Objective:* Students will explore ***the challenges posed by communication barriers and recognize the importance of overcoming them for survival, emphasizing the complexity added by difficulty in understanding and conveying information.***	*Objective:* Students will explore ***the theme of overcoming communication barriers and discuss the adaptive resilience required. The focus will be on the narrator's ability to navigate language complexities and convey information, emphasizing the importance of resilience in communication.***
10. Loss and Destruction	*Objective:* Students will examine the theme of loss and destruction, ***emphasizing survival through endurance as the narrator faces both physical and emotional challenges caused by war and the loss of comrades.***	*Objective:* Students will examine the theme of loss and destruction, ***discussing the enduring resilience of the narrator. The focus will be on coping with the emotional toll of losing comrades and facing physical destruction, highlighting the profound level of resilience required.***
11. Uncertainty and Fear	*Objective:* Students will analyze the pervasive theme of uncertainty ***and fear, understanding how survival in an unpredictable environment requires navigating through constant fear and uncertainty.***	*Objective:* Students will explore the pervasive theme of uncertainty, ***discussing the resilience required to navigate unpredictable circumstances. Analysis will focus on the narrator's ability to face constant fear and uncertainty, signifying a resilient approach to survival.***
12. Military Training and Simulation	*Objective:* Students will explore the narrative beginning with military training ***to understand the importance of intense preparation for survival in combat situations.***	*Objective:* Students will analyze the emphasis on military training ***and discuss how it highlights prepared resilience. The focus will be on understanding how intense training conditions prepare individuals to be resilient in combat situations, emphasizing the importance of mental and physical readiness.***
13. Combat Experience and Unforeseen Events	*Objective:* Students will analyze the protagonist's reflection on a combat mission ***to understand how survival is a result of adapting to unforeseen events and making split-second decisions in the unpredictable context of warfare.***	*Objective:* Students will explore the protagonist's reflection on a combat mission, ***emphasizing adaptable resilience. Discussions will focus on how survival in the unpredictability of warfare requires the ability to adapt quickly to unforeseen events, showcasing a resilient mindset.***

(Table by authors)

Afghan Air Wars

Soviet, US and NATO Operations, 1979–2021

Michael Napier, Osprey Publishing, Oxford, UK, 2023, 320 pages



Matthew Kiefer, Fort Leavenworth, Kansas

At first blush, air wars in Afghanistan may not seem like an intuitive topic for air power theorists to consider. When one thinks of the record of the Afghan Air Force, images of World War II-style dogfights between the Allies and Luftwaffe during the Battle of Britain don't immediately spring to mind. Nor did the Taliban infrastructure present an industrial base warranting a strategic bombing campaign on the scale of those against Imperial Japan or North Vietnam.

However, the time from the beginning of 1979 through the end of 2021 is a remarkably dynamic one in the advancement of air combat technology and combat tactics that range from surface-to-air weapons to the introduction of unmanned aircraft systems. Furthermore, the successive combat operations of first the Soviet Union in the 1980s and then the U.S.-led coalition after the 9/11 attacks encompass a broad range of military missions for both fixed-wing and rotary-wing air power, including airborne logistics, rapid troop deployment, surveillance and reconnaissance, in-flight refueling, and aeromedical evacuation.

Additionally, the physical environment of Afghanistan poses unique challenges for air combat operations. Many airfields, such as those at Kabul and Bagram, are at significant altitude above sea level where thinner air impacts engine performance and wing lift, potentially lengthening takeoff distances and reducing load capacity. High summer month temperatures—when ground combat in Afghanistan and the ensuing need for close air support is historically at its peak levels—further exacerbate the aerodynamic challenges. Afghanistan's mountainous terrain and limited road and rail infrastructure curtail surface transit in ways that necessitate air transport even for nonmilitary purposes. All of these factors provide a rich environment for a student of air power to learn from and to inform the future of air combat.

Michael Napier's *Afghan Air Wars: Soviet, US and NATO Operations, 1979–2021*, is a richly illustrated coffee table book that tackles this topic. The primary value of this book is in the extensively curated, high-resolution, glossy photographs

Matthew Kiefer is an academic chair and faculty liaison at the U.S. Army Command and General Staff College. He has two decades of experience as a federal employee in various capacities for the Department of Defense, including work at the Joint Staff and three combatant commands.

of all types of aircraft, which appear on almost every page of the approximately three hundred-page book. It is a story told principally in five parts: the Soviet era during the 1980s, the initial coalition invasion in the early 2000s, the growth of the Taliban insurgency in the mid-2000s, the Obama-era Surge in the early 2010s, and the drawdown in the late 2010s through the eventual U.S. withdrawal in 2021.

Many of the book's key narrative moments will be familiar to those who have followed the Afghan conflict through other lenses of ground combat or covert action. The Soviet invasion in the 1980s was one-sided in the sky until the U.S. provision of surface-to-air missiles to the Afghan resistance, when during a roughly year-and-a-half turning point in 1984–85, a tenfold increase in surface-to-air missile launches forced a drastic reevaluation of Soviet tactics and deployments. In the twenty-first century, the use of unmanned systems like the Predator drone, initially deployed as prototypes under the shadowy guise of intelligence services and then more generally as widespread tools in the Department of Defense arsenal, became a critical part in the United States' counterterrorism hunt for al-Qaeda and its associates.

Perhaps less well appreciated generally were the workhorses of modern combat: the air cargo and tanker craft. These were crucial for the U.S. coalition first to provide timely logistics to the battlefield in a landlocked country, and then eventually for the withdrawal from that same country in 2021. These cargo craft as well as their flight and ground crews were critical to sustaining military and humanitarian logistics supplies for two decades. At the strategic level, cargo planes brought material into and out of Afghanistan as an alternative to navigating sometimes politically challenging ground routes through Central and South Asia. Within Afghanistan, fixed- and rotary-wing transport provided routine supply to austere locations and rapidly provided material to forward units in contact to press operational advantages. Because flights sometimes originated from basing in the Gulf States or involved naval units in the Indian Ocean, in-flight refueling was a critical extender for range and duration of flight missions.

In 2021, these logistics craft had a last mission, steadily bringing people and supplies out of the country. That June, approximately nine hundred C-17 loads left Bagram before the United States closed that air base. At Kabul airport, with its lone runway for both takeoffs and landings and at constant risk from potential ground antiaircraft fire, approximately thirty to fifty international flights left daily during the last month of the U.S. mission, evacuating an average of 7,500 people with them according to the author's figures. During August drawdown operations, one C-17 heroically flew with a load of 823 people in a memorable photograph naturally included in this book, which is about three times its normal safe passenger count. In the final few short weeks of the U.S. mission, aviation was responsible for moving the equivalent of half of Afghanistan's fifth largest city out of the country—a wildly successful achievement by any measure and a noncombat mission for military aircraft that should be deeply appreciated by aviation aficionados.

A reader critical of this book would focus on the extensive use of jargon that will alienate a casual reader. The text makes heavy use of specific terminology for unit designations and weapons armaments without context for the layman on what they are or why they matter. Narrative anecdotes mention specific pilots by name without any introduction or epilogue to explain the level of detail. In many places, the book reads like a compilation of mission logs, contrasting in writing style with other air power books that are a tactical analysis of competing weapons systems or a journalistic memorializing of medal-winning heroism. Furthermore, the production quality could be improved, as there are several typographical errors, and the binding feels like it might not hold up over time due to being laid open in ways that showcase the richness of the photography. ■

Ghost Army Honored

U.S. Speaker of the House Rep. Mike Johnson presents the Congressional Gold Medal to Seymour Nussenbaum (*seated left*) and Bernie Bluestein, veterans of the 23rd Headquarters Special Troops and the 3133rd Signal Services Company, known as the Ghost Army, on 21 March 2024 at a ceremony at the U.S. Capitol in Washington, D.C. (Photo by Sgt. David Resnick, U.S. Army)

For more than forty years after World War II, the Ghost Army's activities remained highly classified and garnered little public recognition. That changed on 21 March 2024 when these veterans were awarded the Congressional Gold Medal at the U.S. Capitol in Washington, D.C. The Congressional Gold Medal is the highest civilian honor that Congress can bestow. Three of the known seven surviving members—Bernard Bluestein, 100; John Christman, 99; and Seymour Nussenbaum, 100—made the journey to Washington to accept the award.

The "Ghost Army," comprised of the 23rd Headquarters Special Troops and its sister unit, the 3133rd Signal Service Company, was cited for its "unique and highly distinguished service in conducting deceptive operation in Europe during World War II."[1] Many of these soldiers were initially recruited from art schools, advertising agencies, communications companies, and a variety of other creative and technical professions.[2] This 1,100-member unit, active between June 1944 and March 1945, could simulate two units totaling some thirty thousand soldiers by employing visual, sonic, and radio deceptions. The Ghost Army carried out more than twenty missions, using inflatable tanks and vehicles, sound trucks, fake radio transmissions, and the like to give units the time needed to maneuver.[3] Ultimately, it deceived Hitler's forces and misled them of the size and location of the Allied forces preparing for the D-Day invasion.

A U.S. Mint reproduction of the Ghost Army's Congressional Gold Medal. (Photo courtesy of the U.S. Mint)

"The actions of the Ghost Army helped change the course of the war for thousands of American and Allied troops and contributed to the liberation of a continent from a terrible evil," Secretary of the Army Christine Wormuth said during the ceremony. "Even though technology has changed quite a bit since 1944, our modern techniques build on a lot of what the Ghost Army did, and we are still learning from your legacy."[4]

To learn more about the Ghost Army and its Congressional Gold Medal, visit https://www.congress.gov/117/plaws/publ85/PLAW-117publ85.pdf. ■

Notes

1. "Congressional Gold Medal Recipients," History, Art, and Archives, U.S. House of Representatives, accessed 29 March 2024, https://history.house.gov/Institution/Gold-Medal/Gold-Medal-Recipients/.

2. Ghost Army Congressional Gold Medal Act, Pub. L. No. 117-85, 136 Stat. 11 (1 February 2022), https://www.congress.gov/117/plaws/publ85/PLAW-117publ85.pdf.

3. Ibid.

4. Jamie Stengle, "Ghost Army Members Who Deceived Nazis with Battlefield Ruses in WWII Given Congressional Gold Medal," Associated Press, 21 March 2024, https://apnews.com/article/ghost-army-congressional-gold-medal-ceremony-world-war-ii-7a2deaf1686bca3194d46c77fa0bccb9.