The U.S. Army Development Command Ground Vehicle Systems Center showcases robotic and autonomous technological advancements for subterranean environments during a demonstration 2 December 2021 in Rolla, Missouri. Deploying autonomous and sensor-enabled robotic systems can provide the warfighter a tactical advantage through the ability to perform remote reconnaissance and other specific mission tasks while decreasing overall human exposure to risks and lessening physical and cognitive load. (Photo by VIDS Corp, U.S. Army)

Realize the Future

L. Lance Boothe

Now is the time for revolutionary change. Times are changing, and the U.S. military must change with them or lose the next war.[1]

If the above assertion is disconcerting, or even provocative, then consider what happened in the recent Nagorno-Karabakh conflict between longtime enemies Azerbaijan and Armenia. Autonomous and remote-controlled drones defeated manned systems and soldiers throughout the battlespace at every echelon of war.[2] The fight between drones and manned systems was not even close—drones won decisively. Armenian losses were 185 T-72 tanks, 90 armored fighting vehicles, 182 artillery pieces, 73 multiple rocket launchers, 26 surface-to-air missile systems (including a Tor system and five S-300s), 14 radars or jammers, one SU-25 fighter-bomber, four drones, and 451 other types of military vehicles to 25 drones lost by the Azerbaijanis.[3] This represents a watershed moment in warfare.[4]

Here is what the first postmodern war of the twenty-first century teaches: other professional militaries are operationalizing the potentiality of robotic and autonomous systems (RAS). They realize the future.

The skeptic or cynic (or both) may say drones are nothing new. The difference is autonomous systems made a debut in relative mass, and in the clash between two ostensibly professional armies, one decimated the other with remote-controlled and autonomous systems to an extent never seen before. The Nagorno-Karabakh conflict was not a fight between a superpower with complete domain dominance and a bunch of tribesmen from the third world, or imported jihadists interspersed amongst insurrectionists from a defunct third-rate military. In addition, vaunted Russian electronic warfare prowess never materialized despite its availability to both belligerents. By all accounts, Azerbaijani drones were not electronically interdicted in any meaningful way or otherwise jammed off the airwaves. They proved accurate and deadly. In fact, Azerbaijani success alarmed the Russians into brokering a ceasefire, or as the assessment from the George C. Marshall European Center for Security Studies bluntly states, "Turkey won the war for Azerbaijan but lost the peace to Russia."[5] It behooves the U.S. military to take notice.

AI and RAS—A Common Understanding

Alexander Kott, the chief scientist at the U.S. Army Research Laboratory, asserts that artificial intelligence (AI) is a new form of sentient intelligence on Earth.[6] Kott and David Alberts from the Institute for Defense Analysis further assert that not only will humans find themselves "to be merely a particular species of intelligent entities, in fewer and fewer numbers in relation to other intelligent things," but "some of these intelligent species need to be considered, from a management perspective, as entities with decision-making responsibilities, similar to human individuals to be accounted for in the design of our organizations."[7] The Futures and Concepts Center of U.S. Army Futures Command produced a concept on operationalizing robotic and autonomous systems for multi-domain operations.[8] Their concept demonstrates that for several years, the U.S. Army recognized RAS potentiality, investing time, money, and intellectual energy to explore this revolutionary technology, unfortunately without significant, comprehensive implementation. However, RAS is just half of the equation. AI is the logical fit to RAS. RAS must be intelligent, not an automaton running off unidimensional coding.

Before venturing into artificial intelligence remote autonomous systems (AI-RAS) capabilities, AI and RAS need definition. Artificial intelligence is software that perceives its environment and takes actions that maximize its chance of successfully achieving its goals. AI mimics cognitive functions that humans associate with other human minds, such as learning and problem solving, often incorporating a greater multitude of variables at superhuman speed.[9] Remote autonomous systems are unmanned machines, which sense, decide, and act without human intervention after receiving initial guidance. AI is the brain. RAS provides the muscle through sensory perception.

While the following AI-RAS capabilities discussed herein are by no means exhaustive, they are a start point. They are the most significant. The U.S. military must invest heavily, retooling the entire joint portfolio, to comprise AI-autonomous munitions, AI-autonomous weapon platforms, and AI-RAS sustainment.

The joint force must operate in communications- and GPS-denied environments. It is obvious that the U.S. military over-relies on satellite communications. Equally obvious is that the United States is losing the space race, which it once led. U.S. adversaries know these shortcomings and factor them into their antiaccess/area denial (A2/AD) strategies and capabilities. Besides denying the U.S. military air supremacy, denying it the means to communicate strategically, operationally, and tactically is of equal value and perhaps more feasible, cost effective, and damaging. So having a munitions suite that can engage targets at strategic and operational ranges without GPS or satellite communications is imperative.

The Same Old, Same Old or Revolution

The services are vying for scarce resources, which is hard to imagine given a budget of over $700 billion annually; nevertheless, the infighting largely rages over investments in sunset capabilities, not truly cutting-edge capabilities like AI-RAS. The current planning, programming, budgeting, and execution process promotes parochialism. The planning, programming, budgeting, and execution is hidebound, overly bureaucratic, and inflexible. This is not how the joint force realizes the future.

A real revolution in military affairs needs to start immediately. It begins with a wholesale, unabashed embrace of AI-RAS. What does this portend for the joint force? Everything, including changes in organizational structures, command and control (C2), operational employment, and personnel requirements. Even the overall character and relationships of the armed services will change. Some services may go, and the ones that remain will be radically altered. Perhaps the days of just an army and navy will return but not in current form or as once known.

Sunset capabilities like manned aircraft, large surface combat ships, and personnel-intensive brigade combat teams will give way to AI-RAS. Planning, organization, and C2 functions and functionaries like the Napoleonic staff, the seventy-two-hour air tasking order cycle, and large centralized headquarters (attempting to command a vast array of forces in near real-time) will also yield to the march of technology. Warfare does not respect tradition, sentimentality, or outmoded capabilities and functions. The hard truth is that peer adversaries will force the U.S. military to embrace AI-RAS with all the radical changes across the doctrine, organization, training, materiel, leadership and education, personnel, facilities, and policy spectrum it entails. AI-RAS presents an existential challenge. The wave of the future in warfare is AI-RAS.

AI-RAS does not require expensive, large, maintenance-intensive delivery platforms. Airplanes that cost tens of millions of dollars, even hundreds of millions, are simply not economical. Ships that cost billions are worse. The pacing items around which the services revolve will change (or disappear) as AI-RAS come online. Why have an air force with billions of dollars of obsolete manned fighter-bomber aircraft? Multiple launch rocket systems are significantly cheaper, and they fire more munitions in the aggregate. They can deliver AI-RAS munitions more economically and with far less risk/cost to personnel and equipment. Why have surface ships with enormous electronic signatures? If the United States is going to spend billions on a navy, at least invest in its real strength: undersea warfare where the U.S. Navy rules the waves. Aircraft carriers may project strength, but they are not strong, and they are not required to launch AI-RAS. A submarine that can approach the littorals through stealth is a far more viable delivery mechanism.

If senior military leaders and policy makers take a cold, hard, rational look at AI-RAS potentiality and the demands of a future operating environment dominated by AI-RAS, it becomes rather obvious as to what capabilities stay and what capabilities go. The U.S. military must break the chains of parochialism. U.S. Army Futures Command's experiments, studies, and tabletop exercises are relatively conclusive. The future operating environment is not a place conducive to manned aircraft, lumbering brigade combat teams, or vast surface fleets. However this reorganization falls out, and it will happen, the U.S. military is in for significant structural and operational changes, once AI-RAS is fully realized.

Enter AI-Autonomous Munitions

AI-autonomous munitions are optimal for operating in "black out" periods when communications are disrupted or denied.[10] As the Center for Security Studies asserts, "Future combat drones will be able to penetrate adversary's air defenses and operate in contested battlespace."[11] Without reliance on external long-range radio frequency communications, AI-autonomous munitions are programmed with attack guidance to engage designated targets through onboard databases, significantly mitigating any interference across the electromagnetic spectrum (EMS). Electromagnetic pulse hardening and EMS protections for AI-autonomous munitions will most likely be expensive initially, but as more and more munitions are produced the price point reduces and the technology improves.

AI-autonomous munitions perceive and analyze the environment in which they are employed, evading detection and interception, and then acquire designated targets independent of human direction. These are the ultimate "fire and forget" weapons. These weapons can scan and think, evading countermeasures, and they are impervious to EMS interference. AI-autonomous munitions maneuver onto targets through internal navigation and data processing capabilities linked to an array of onboard sensors (electro-optical, infrared, audio, and high-frequency electromagnetic waves), striking designated targets more accurately and more reliably than current guided munitions while achieving greater effects on targets by analyzing and engaging target vulnerabilities for maximum lethality. AI-autonomous munitions employ or contain countermeasures to interdiction such as reflective surfaces, electromagnetic pulse hardening, radar detection, and terrain conforming and concealing flight.

AI-autonomous munitions are most effectively employed in "wolf packs" that communicate among

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themselves through lasers to determine the best attack profile to overwhelm countermeasures, striking at target vulnerabilities and massing effects.[12] Target engagement becomes an even more brutal and systematic team sport where endurance and efficiency are prized equally with destructive force. AI-autonomous munitions hunt within designated target areas, attacking targets in accordance with programmed priorities to achieve desired effects. If targets are not acquired within the primary target area, the munition seeks targets in other areas.

A U.S. Marine Corps Hero-400 loitering munition drone is staged before flight 25 May 2022 on San Clemente Island, California. Department of Defense entities are beginning to incorporate the Hero-400 into specific mission sets. (Photo by Lance Cpl. Daniel Childs, U.S. Marine Corps)

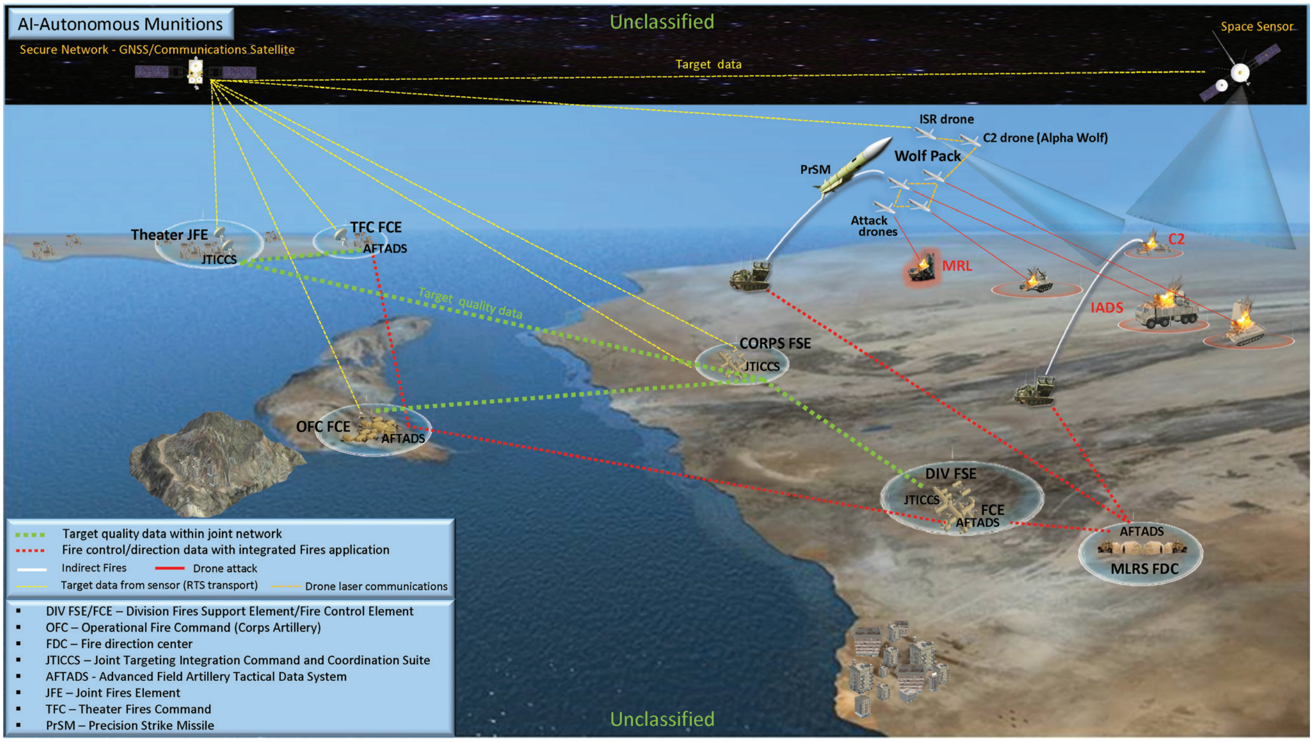
AI-autonomous munitions can be individually delivered directly from a weapon platform onto a target or as submunitions expelled from a larger munition bus, extending their range and speed into target areas. AI-autonomous munitions can produce area effects or engage targets with hit-to-kill precision. The flexibility of AI-autonomous munitions is key. If the munition runs out of energy before acquiring a target, then either it can self-destruct or land to become a mine based on programmed guidance, all based on the munition's assessment of commander's intent, utilizing mission, enemy, terrain, troops, time, and civilian factors. If desired, a munition wolf pack can be programmed to create a minefield for area denial. If range permits, unused munitions can return to friendly areas for recovery and reuse, signaling their return to the appropriate C2 node.[13] The cost savings from recovering and reusing unexpended munitions is obvious. Turning the drones into a minefield once their fuel/energy cell is expended for flight probably constitutes the most cost-effective use of AI-autonomous munitions if return to friendly territory is not possible due to range or EMS countermeasures.

The foremost employment principle for AI-autonomous munitions is mass within target areas to overwhelm threat integrated air defense systems and other countermeasures. AI-munitions are employed in a phased approach to check interdiction and sow destruction on primary, secondary, and tertiary targets. There is no need for manned aircraft or ocean surface vessels when AI-autonomous munitions can be fired from ground-based RAS platforms or subsurface RAS vehicles. These platforms are smaller, cheaper, and expendable. There is no need to expose soldiers or sailors at the tactical edge of battle when an intelligent machine will do and can do the job without bias, fatigue, or human error.

If AI-autonomous munitions are frightening and disconcerting, they should be. War is not for the faint of heart as Carl von Clausewitz reminds us. Ominous weapons and the will to use them constitute deterrence.[14]

Enter AI-Autonomous Weapon Platforms

AI-autonomous weapon platforms operate through an array of onboard sensors like those on AI-autonomous munitions.[15] Sensory input allows the onboard AI to manage and negotiate terrain (or the ocean deep) in all weather conditions, though it is doubtful that climatic conditions factor much into undersea operations.



(Graphic by author)

AI-Autonomous Munitions Operations Overview

Aerial or ocean surface delivery systems are replaced by ground-based and undersea AI-RAS. The paradigm shift away from manned aircraft and surface combat vessels is an obvious cost saver. And just as important, ground-based and undersea AI-RAS provide commanders greater flexibility to engage the enemy in highly contested battlespace, allowing for more effective operations within A2/AD zones to close range gaps or extend munition ranges to gain advantage over threat systems. AI-autonomous weapon platforms are expendable, easier to replace, and do not require training to prepare for combat.

AI-autonomous weapon platforms employ countermeasures against visual, audio, and infrared detection through rapid movement, terrain masking, regulating internal system functions to diffuse heat signatures, or shutting down when not in operation. Ground-based AI-autonomous weapon platforms carry a combination of counter-unmanned aircraft system capabilities such as directed energy (DE) weapons, high-powered microwave (HPM) weapons, guns, low-cost interceptors, and counterdrones.[16] Undersea systems employ acoustic dampeners and countermeasures to include active decoys to confuse or otherwise divert threat sonar.[17]

AI-autonomous weapon platforms are programmed by manned C2 nodes to maneuver within the battlespace to execute assigned missions. This type of AI-RAS assesses and reacts to METT-TC (mission, enemy, terrain and weather, troops and support available–time available and civil considerations) factors within programming parameters to get into the optimal position for target engagement, and then conducts survivability moves, resupply actions, and relocates to other positions to continue assigned missions. Firing solutions are derived onboard the system for the initial launch of AI-autonomous munitions within the system's payload. These are rudimentary calculations to get the munitions clear of the system and onto a heading toward designated target areas. Guidance as to what targets to engage, and when, is sent directly to the munition from the manned C2 node controlling the weapon platform. The AI in the weapon platform interfaces with the AI in the munition to decide the best way to execute received commands.

AI-autonomous weapon platforms contain internal fail-safe controls, which redirect system command functions, trigger automatic redirection protocols, or cut power in the event programming falters, a sensor suite malfunction occurs, or enemy cyber-electromagnetic activities somehow compromise the system. AI-autonomous weapon platforms manage ammunition, coordinating resupply with sustainment RAS, or manned robotic logistical systems through instructions from manned C2 nodes. Communications occurs through low power, directional radio frequency (RF) once sustainment RAS are within proximity to weapon platforms. Identification and security protocols are executed between systems, ensuring secure and efficient sustainment operations.

The foremost employment principle for AI-autonomous weapon platforms is to minimize communications between C2 nodes and systems to mitigate detection and interdiction, allowing the system to execute independently within programmed guidance. This type of AI-RAS can receive and transmit over extended distance, but predominately operates in receive mode to mitigate its electromagnetic signature. Fire commands are one-way transmissions and treated as such by AI-RAS. Mission fired reports are transmitted by the system through short digital bursts while in movement. If the C2 node fails to acknowledge receipt of reports, AI-RAS continues to transmit at random intervals, but not indefinitely. Complete loss of contact with C2 nodes triggers recall protocols within the system to establish contact at designated rally points.

Sustaining the Fight

While discussing logistics is boring, sustainment operations are essential to employing AI-RAS, requiring discussion. Also, in sustainment operations, AI-RAS might find its greatest application.

Sustainment RAS require interaction with manned logistics systems and personnel at logistics sites. Hardwire communications through a tether facilitate the movement and control of sustainment RAS in restricted terrain, RF-denied environments, or operations in proximity to personnel and equipment. RF control occurs in environments where terrain and/or enemy action permits RF use without compromising force protection. Tethered control is attachable and detachable between manned and unmanned systems, or between sustainment RAS and personnel operating on the ground alongside the system.

Sustainment RAS are programmed and managed by supporting personnel. Sustainment RAS receive control data via RF and/or hardwire, or programming through onboard control panels.

Sustainment RAS operate over extended distances along resupply routes, within battle positions, and at designated logistical resupply points (LRPs) within programming parameters through sensory input processed by onboard AI. Sustainment RAS are equipped with the same sensor suite as AI-autonomous weapon platforms. Sustainment RAS are programmable for independent operations at the tactical edge, linking-up with AI-autonomous weapon platforms for refueling (or recharging) and ammunition transfer/upload. Undersea sustainment RAS link-up with weapon platform counterparts at designated areas along the ocean bed or in open sea at depth for logistics support. Both AI-autonomous weapon platforms and sustainment RAS are hardened against electromagnetic pulse destruction or other electromagnetic spectrum interference to include spoofing, jamming, or hacking. Onboard AI derives the most effective sustainment solutions through system monitoring and analysis without human bias or error to execute logistical operations at designated sites. Sustainment RAS reduce manpower requirements, and enable logistical operations in contested battlespace, exposing fewer soldiers to surveillance and interdiction by direct and indirect fire. Undersea sustainment RAS conducting open sea logistical operations expose no sailors to harm. Sustainment RAS report logistical status at routine intervals, manage internal and external stocks, and coordinate LRP operations directly with AI-autonomous weapon platforms for quick and efficient resupply under all environmental conditions as far forward in the battlespace as possible.

The foremost employment principle for sustainment RAS is resupply in the fight, taking logistics at the tactical edge to the next level with minimal human intervention. The communications package for sustainment RAS is extensive, allowing the system to interface with C2 nodes over extended distance. This type of AI-RAS can have a significant electromagnetic footprint and discernable pattern of life. Countermeasures to surveillance occur through rapid movement, cover, concealment, and randomized LRPs where RF communications cease entirely and the systems involved rely on AI to make all decisions regarding logistical operations by remotely attaching communications cables, or tethered by sustainment personnel at the location, if operating on land. Ground-based sustainment RAS also contain onboard counter-unmanned aircraft system defeat mechanisms such as DE, HPM, gun, low-cost interceptors, and counter-drones in a combination appropriate to the sophistication of the threat. If programming or sensor malfunction occurs, the sustainment RAS ceases operations and signals for recovery or maintenance support. AI-autonomous maintenance systems (maintenance RAS) are dispatched throughout the battlespace to assess disabled platforms and fix mechanical problems under battle conditions, or recover disabled platforms to higher level maintenance depots if they cannot be repaired in the field or at sea.

Maintenance RAS are one dimensional because of size and mission, executing on command from a C2 node. Maintenance RAS are large with external robotics capable of repairing most AI-autonomous weapon platforms and sustainment RAS mechanical problems. Maintenance RAS maintain stocks of replacement parts. Maintenance RAS link-up with disabled systems by homing in on distress signals and refining their location through electro-optical/infrared sensors. Communications between the disabled platform and the maintenance RAS occurs initially through RF. Once at the disabled system, the maintenance RAS interfaces with the disabled system through its control panel (either by hardwire or RF), running diagnostics and getting into the best position for repair. After repairs are complete, the maintenance RAS transmits reports, discards defective parts, and returns to designated logistical areas to replenish stocks. If repairs cannot be done on the battlefield due to enemy action or the extent of the damage is too great for the programming of the maintenance RAS to fix, or the parts are not on hand to affect repair, then the maintenance RAS attempts to recover the damaged system. If recovery proves impractical or impossible, then the maintenance RAS reports the location of the damaged system to the controlling C2 node and moves on to the next assignment.

Maintenance RAS repair AI-autonomous munitions. In the event the munitions cannot be repaired at the weapon platform, the maintenance RAS recovers defective munitions to higher-level depot.

The foremost operating principle for maintenance RAS is to get to the disabled platform quickly and repair it (or its munitions) on the spot with the least amount of disruption to operations, reducing sustainment footprints by eliminating equipment collection points within contested battlespace. Where sustainment RAS resupply in the fight, maintenance RAS maintain in the fight, achieving a holistic approach to logistical operations at the tactical edge and back.

> Once at the disabled system, the maintenance RAS [robotic and autonomous systems] interfaces with the disabled system through its control panel (either by hardwire or RF [radio frequency]), running diagnostics and getting into the best position for repair.

To Control or Not Control

As indicated in the three significant areas of AI-RAS application, the degree of independence varies. Where threat interdiction is greatest because AI-RAS must penetrate A2/AD capabilities deep in contested battlespace, AI-autonomous munitions are enclosed systems fully capable of independent action to identify and destroy designated targets within programming parameters. This is the pinnacle of adaptive, learning, intelligent machine technology capable of decision-making with no external input, relying on its onboard sensor suite and internal circuitry running "learning" algorithms to process terrain and environment, recognize and evade threats, and identify and attack targets. It is optimized to operate in the dark zone when communications are disrupted or nonexistent. Communications between firing system and munition are restricted to programming prior to firing; after that, the AI-munition is on its own.

AI-autonomous weapon platforms receive mission objectives (and limited tactical commands) from

Lance Cpl. Tom Alexander (*center*), a combat engineer with the UK 22nd Engineer Regiment, 8th Engineer Brigade, shows Lt. Col. Jesse Curry (*left*) and Capt. Nick Hyde, both with the 82nd Brigade Engineer Battalion, 2nd Armored Brigade Combat Team, 1st Infantry Division, how to remotely operate a Terrier armored digger during a multinational joint equipment training exercise 2 April 2018 at Grafenwoehr Training Area, Germany, in preparation for a Robotic Complex Breach Concept demonstration. The Robotic Complex Breach Concept includes the employment of robotic and autonomous systems in intelligence, suppression, obscuration, and reduction. (Photo by Spc. Hubert D. Delany III, 22nd Mobile Public Affairs Detachment)

manned C2 nodes. These nodes program the onboard munitions accordingly. AI-autonomous weapon platforms operate with a man-on-the-loop because they require more mission guidance monitoring. This guidance allows the weapon platform to de-conflict its maneuver with other systems, receive fire commands to execute fire missions at precise times, provide redundancy, and coordinate for logistical and maintenance support; therefore, this form of AI-RAS is not an enclosed system. It is required to communicate with other RAS, in particular sustainment and maintenance RAS and manned systems to execute assigned missions and sustain its operations. Once given orders, AI-autonomous weapon platforms conduct independent operations to gain range and engage designated targets within the parameters of programmed guidance and execute resupply functions to maintain mission readiness.

Sustainment and maintenance RAS interface with AI-autonomous weapon platforms, manned robotic logistical systems, and C2 nodes. This form of AI-RAS is the least independent, containing sophisticated multimodal communications capabilities, ultimately utilizing laser and quantum communications technologies. Programmed independent action focuses on traversing terrain, employing countermeasures to detection or engagement, and rendezvousing with AI-autonomous weapon platforms at LRPs on land or at sea to conduct resupply operations or make repairs, and then returning to other logistical areas throughout the battlespace to replenish stocks. Within ammunition holding areas, cache sites, or ammunition exchange points outside battle positions, sustainment RAS operate under the direct control of soldiers or sailors. Yet the overriding employment principle for all AI-RAS is to minimize human intervention at the tactical edge, allowing the systems to function as designed.

AI-RAS are the solution to executing combat operations in a disrupted, degraded, or denied GPS or communications environment. AI-RAS are more lethal. AI-RAS are more efficient. AI-RAS do not fatigue. AI-RAS are faster, stronger, more intelligent, and more rational than humans.

Embracing the HAL 9000 Factor

If the application of AI-RAS proposed in this article seems fantastic, it is not. Currently, IBM's Watson does more than just manage airline maintenance. Watson has moved into operations.[18] Intelligent machines like Watson are steadily moving into areas traditionally seen as the purview of human management. Science fiction is becoming reality. HAL of *2001: A Space Odyssey* is coming just in time for the twenty-first century. Yet the U.S. military continues to invest in GPS-dependent guided munitions, manned platforms (which are logistics intensive), and large numbers of personnel, all geared to maintaining and employing sunset capabilities, which are no match for AI-RAS, or even remote-controlled drones. It should not take a spat between two second-rate powers to illuminate the shifting sands of postmodern warfare, yet here we are.

> "Whatever moral and ethical reservations U.S. policy makers and military leaders may have about the unrestrained use of AI-RAS in warfare will be quickly disabused when our adversaries employ it en masse and without compunction."

War is hardnosed practicality. Whatever moral and ethical reservations U.S. policy makers and military leaders may have about the unrestrained use of AI-RAS in warfare will be quickly disabused when our adversaries employ it en masse and without compunction. The debate between realists and moralists is ongoing. As the Center for Security Studies points out,

> the ongoing robotization of armed forces raises questions about the desirability of autonomous systems with lethal capacity. Lethal autonomous weapon systems (LAWs) are understood as fully autonomous weapons that can decide about selecting and engaging targets based on sensor inputs and without human control. Academics, legal scholars, and policymakers are vigorously debating whether the advent of LAWs will bring about a 'robopocalypse' of dehumanized warfare and how this should be prevented.[19]

So while "human control" (which, by the way, is the point of programming) or humanizing the de facto dehumanizing essence of war continues to be debated, the day of unconstrained AI-RAS warfare is coming as the 2020 Nagorno-Karabakh conflict demonstrated.

Hearkening back to Clausewitz,

> Kind-hearted people might of course think there [is] some ingenious way to disarm or defeat an enemy without too much bloodshed, and might imagine this is the true goal of the art of war. Pleasant as it sounds, it is a fallacy that must be exposed: war is such a dangerous business that the mistakes which come from kindness are the very worst. The maximum use of force is in no way incompatible with the simultaneous use of the intellect. *If one side uses force without compunction, undeterred by the bloodshed it involves, while the other side refrains, the first will gain the upper hand.* That side will force the other to follow suit; each will drive its opponent toward extremes, and the only limiting factors are the counterpoises inherent in war. This is how the matter must be seen. It would be futile—even wrong—to try and shut one's eyes to what war really is from sheer distress at its brutality.[20]

AI-RAS will not make war bloodless. Enemies will aim to draw blood at each other's industrial, agriculture, and energy underbelly—the true center of gravity for any nation. Once the people who make life possible are dead and the associated infrastructure is destroyed, the means to resist is shattered. To presume the advent of AI-RAS will turn warfare into an intelligent machine on intelligent machine melee is folly. Clearing an adversary's intelligent machines from the battlespace is just the prelude to attacking the center of gravity. AI-RAS jeopardize a nation's center of gravity as never before because intelligent machines are relentless and precise killing machines, taking war to maximum effectiveness and to its logical conclusion without nuclear holocaust.

Professional soldiers and policy makers can debate about what constitutes a center of gravity and the ethics of AI-RAS warfare, but the debate was over before it began. AI-RAS are here, and they are only going to proliferate into the hands of those who do not share in, nor care about, our debate. As Chantal Grut writes in the *Journal of Conflict & Security Law*,

> As weapons technology becomes more and more advanced, humans are moving further and further away from the battlefield. We already live in a world of robotic warfare, in which a pilot sitting in an operating room … can control an unmanned aerial vehicle or 'drone' to conduct lethal targeting operations on the other side of the world. In a sense, weapons development has always been moving in this direction, with the goal of removing human personnel as far from the risk of harm as possible. The next step may remove the human from the process altogether.[21]

This is the logical conclusion of AI-RAS. However, Grut gets it wrong: removing people from risk is not going to happen. The unpleasant truth is humans are more at risk than ever before, both combatants and noncombatants. The machines are not just built to fight other machines. They are built to attack the center of gravity. Joe Strange of the Marine Corps War College got it right, because Clausewitz is right: "Clausewitz clearly allowed for multiple centers of gravity and advised that they should be traced back to a single center of gravity, *if possible*."[22] For nation-states, particularly developed states (peer competitors); food, fuel, and products rule the day. The people who feed society, fuel society, and bring society its daily necessities are the linchpin to life. Attacking that which sustains society brings society to its knees.

Realism drives war. Since Napoleon Bonaparte, warfare has been the "nation in arms," so everyone at the center of gravity is fair game.[23] For one nation to defeat another, war must be taken to its logical conclusion. We should bear in mind, the United States dropped atomic weapons on Japan to shatter that nation in arms and bring the worst world conflagration in mankind's history to a victorious end. In war, there is *no substitute for victory*, and the unmitigated employment of AI-RAS is the next, best, means to victory.

In multi-domain operations, and with the advancement of computational and material sciences, the joint force can capitalize on AI-RAS technologies to achieve much greater warfighting effectiveness as well as operational efficiency with potential cost savings. By grasping AI-RAS potentiality, the joint force becomes an even greater deterrent in competition and a dominating force in conflict, all while utilizing fewer operational resources and less manpower. The time is now to realize the future. The pacing technology of that future is AI-RAS. ■

Notes

1. However, the United States has not won a war since World War II, but I suppose we should aspire to victory, or what is the point of sacrificing blood and treasure? Even Carl von Clausewitz's cynicism allows war to be about more than politics. The primordial hatred that motivates people to fight is the oft less acknowledge aspect of the Clausewitz's unholy trinity. Postmodern men think either they have evolved beyond it or it is too unpleasant to admit. I agree with the psychologists, it is cognitive dissonance—American society's neurosis.

2. David Hambling, "The 'Magic Bullet' Drones Behind Azerbaijan's Victory over Armenia," *Forbes* (website), 10 November 2020, accessed 12 April 2022, https://www.forbes.com/sites/davidhambling/2020/11/10/the-magic-bullet-drones-behind--azerbaijans-victory-over-armenia/?sh=d77fa475e571; Robyn Dixon, "Azerbaijan's Drones Owned the Battlefield in Nagorno-Karabakh-and Showed Future of Warfare," *Washington Post* (website), 11 November 2020, accessed 12 April 2022, https://www.washingtonpost.com/world/europe/nagorno-karabkah-drones-azerbaijan-aremenia/2020/11/11/441bcbd2-193d-11eb-8bda-814ca56e138b_story.html; Shaan Shaikh and Wes Rumbaug, "The Air and Missile War in Nagorno-Karabakh: Lessons for the Future of Strike and Defense," Center for Strategic and International Studies, 8 December 2020, accessed 12 April 2022, https://www.csis.org/analysis/air-and-missile-war-nagorno-karabakh-lessons-future-strike-and-defense. Table 2, CSIS table: Azerbaijan's missiles, drones, and rocket artillery–the Harop is a SEAD-optimized loitering munition that operates in autonomous or "man-on-the-loop" mode; the Bayraktar TB2 is capable of autonomous flight or remote control; the Orbiter 1K and -3 are remote-controlled loitering munitions capable of independent flight and attack; SkyStriker is a fully autonomous unmanned aircraft system (UAS) that can locate, acquire, and strike operator-designated targets with a 5kg warhead installed inside the fuselage; the Hermes-900 and

-450 are medium-altitude, long endurance UAS that are remote controlled; and Heron (Machatz-1) is another medium-altitude, long endurance UAS controlled by remote. All these drones were used in varying numbers by the Azerbaijanis, and whether in fully autonomous mode or controlled by remote (man-on-the-loop), their use was not just effective, but devastating—the game changer in the war. The evidence is before us.

3. David Hambling, "The 'Magic Bullet' Drones Behind Azerbaijan's Victory over Armenia"; Robyn Dixon, "Azerbaijan's Drones Owned the Battlefield in Nagorno-Karabakh-and Showed Future of Warfare."

4. "U.S. Army Futures Command Character of Warfare 2035 Seminar," assessment by Alexander Kott, PhD, Chief Scientist, US Army Combat Capabilities Development Command's Army Research Laboratory (17 November 2020).

5. Stanly Johny, "Explained: Who Won the War Over Nagorno-Karabakh," *The Hindu* (website), 18 November 2020, accessed 12 April 2022, https://www.thehindu.com/news/international/explained-who-won-the-war-over-nagorno-karabakh/article33125724.ece; Dumitru Minzarari, "Russia's Stake in the Nagorno-Karabakh War: Accident or Design?," German Institute for International and Security Affairs, 11 December 2020, accessed 12 April 2022, https://www.swp-berlin.org/en/publication/russias-stake-in-the-nagorno-karabakh-war-accident-or-design; Andrew Osborn, "Russia Says Islamist Fighters in Nagorno-Karabakh Conflict Pose Threat to Moscow," Reuters, 6 October 2020, accessed 12 April 2022, https://www.reuters.com/article/us-armenia-azerbaijan-russia/russia-says-islamist-fighters-in-nagorno-karabakh-conflict-pose-threat-to-moscow-idUSKBN26R1WE; Fred Weir, "Russia Losing Its Influence? Nagorno-Karabakh Fighting Test Limits," *The Christian Science Monitor* (website), accessed 12 April 2022, https://www.csmonitor.com/World/Europe/2020/1008/Russia-losing-its-influence-Nagorno-Karabakh-fighting-tests-limits; Richard Giragosian, David Lewis, and Graeme Herd, "Russian Crisis Behavior, Nagorno-Karabakh and Turkey?," *Perspectives*, no. 19 (January 2021), accessed 12 April 2022, https://www.marshallcenter.org/en/publications/perspectives/russian-crisis-behavior-nagorno-karabakh-and-turkey-0.

6. "U.S. Army Futures Command Character of Warfare 2035 Seminar."

7. Alexander Kott and David Albertsm, "How Do You Command an Army of Intelligent Things?," *Computer* 50, no. 12 (2017): 96–100, https://doi.org/10.1109/MC.2017.4451205.

8. "Operationalizing Robotic and Autonomous Systems in Support of Multi-Domain Operations White Paper" (Fort Eustis, VA: Army Capabilities Integration Center–Future Warfare Division, 30 November 2018).

9. IBM Cloud Education, "Artificial Intelligence (AI)," IBM Cloud Learn Hub, 3 June 2022, accessed 13 April 2022, https://www.ibm.com/cloud/learn/what-is-artificial-intelligence. This definition is not my slant on AI. According to computer experts, "artificial intelligence leverages computers and machines to mimic the problem-solving and decision-making capabilities of the human mind." So says IBM. According to futurists, "the reality is we're creating God." Blasphemous, but bold, and as the folks over at Futurism warn, AI development is "the inevitable birth of a vengeful god"; Dan Robitzski, "Former Google Exec Warns that AI Researchers are 'Creating God,'" Futurism, 29 September 2021, accessed 27 April 2022, https://futurism.com/the-byte/google-exec-ai-god. How comforting.

10. AI-autonomous munitions can be monitored and directed when communications exist. When communications are disrupted, the munitions hunt autonomously within programmed guidance, reverting to a fully enclosed posture. Preferably, decisions to enclose the system or establish communications links to outside nodes are taken prior to launch. An enclosed posture prevents electromagnetic spectrum interdiction. The optimal method of engagement is for the munitions to launch enclosed, communicating only with one another to hunt as a wolf pack.

11. Dominika Kunertova, "From Robots to Warbots: Reality Meets Science Fiction," *CSS Analyses in Security Policy*, no. 292 (October 2021), accessed 12 April 2022, https://css.ethz.ch/content/dam/ethz/special-interest/gess/cis/center-for-securities-studies/pdfs/CSSAnalyse292-EN.pdf.

12. Wolf pack hunting replicates the same single-minded ruthlessness and efficiency with which wolves take down prey in coordinated action, recognizing only members of the pack; hence the descriptor. AI deciphers incoming communications transmissions, distinguishing between encoded transmissions from other drones within the wolf pack and outside transmissions from other sources. Optimally, AI-munitions are instructed prior to launch to ignore all transmissions external to the pack. Once the enclosed posture is chosen or invoked, it is a lock. The munition hunts until it runs out of energy, either self-destructing, becoming a mine, or returning to friendly territory for recovery (if range permits).

13. This option is not applicable to AI-munitions expelled as sub-munitions from a rocket or missile. Recovery is for runway independent systems or larger munitions delivered independently from a weapon platform onto specified targets. These drones return to ground by parachute.

14. *Oderint dum metuant*—Lucius Accius (Let them hate as long as they fear). The Romans understood deterrence.

15. Subsurface remote autonomous systems (RAS) predominately use sonar until the next innovation in undersea navigation comes along.

16. Counter-drones interdict unmanned aircraft systems through aerial combat.

17. Active decoy drones deploy from the primary undersea AI-RAS to make tracking the primary system difficult, if not impossible. These decoys overcome sonar through flooding it with returns, producing acoustics easily confused with marine life, seismic activity, or surface vessels, or mimicking the primary system's signature to lead tracking systems away from its course.

18. Roger Mogford and Christopher Codella, "Using IBM's Watson in the Airline Operations Center," AMES Research Center, accessed 13 April 2022, https://human-factors.arc.nasa.gov/groups/AORG/download/Watson_Flight_Ops_v2b.pdf.

19. Kunertova, "From Robots to Warbots."

20. Carl von Clausewitz, *On War*, ed. and trans. Michael Howard and Peter Paret (Princeton, NJ: Princeton University Press, 1976), 75–76. (emphasis added)

21. Chantal Grut, "The Challenge of Autonomous Lethal Robotics to International Humanitarian Law," *Journal of Conflict & Security Law* 18, no. 1 (2013): 5–23, https://doi.org/10.1093/jcsl/krt002.

22. Joe Strange, *Centers of Gravity & Critical Vulnerabilities: Building on the Clausewitzian Foundation So That We Can All Speak the Same Language*, Marine Corps University Perspectives on Warfighting No. 4, 2nd ed. (Quantico, VA: Marine Corps University, 1996), xv, accessed 12 April 2022, https://apps.dtic.mil/sti/pdfs/ADA502026.pdf.

23. Hugh Nibley, *Brother Brigham Challenges the Saints*, ed. Don E. Norton and Shirley S. Ricks (Salt Lake City: Deseret Book, 1994), 295.