

(U.S. Army photo by Gertrud Zach taken July 26, 2019) U.S. Army Spc. Jude Ndudi, Regimental Engineer Squadron, 2nd Cavalry Regiment, moves a RQ-7B Shadow tactical unmanned aircraft system to the launching ramp at Balli UAS Airfield, Rose Barracks, Vilseck, Germany, July 26, 2019.

Warfare: 2050

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C echnology has integrated itself into the daily lives of humans across the globe. It is influencing new generations, shaping the culture of civilizations, and even dictating how nations wage war. It is possible autonomous weapons platforms will replace the need for Soldiers to be physically present in future conflicts. The U.S. must prepare for tomorrow's battlefields by advancing doctrine and the study of math, physics, science, and artificial intelligence (AI) in order to retain its competitive edge. This will ensure the U.S. and its allies are equipped to operate autonomously in austere environments, combining the art of war with the science of war.

Introducing a New Era of Warfare

The world is growing increasingly connected through modern technology. According to *Training and Doctrine Command* (TRADOC) *Pamphlet* (PAM) 525-92: *The Operational Environment and the Changing Character of Warfare*: The U.S. military, and therefore, the U.S. Army, finds itself at a historical inflection point, where disparate, yet related elements of the OE are converging, creating a situation where fast-moving trends across the DIMEspheres are rapidly transforming the nature of all aspects of society and human life – including the character of warfare. These trends include significant advances in science and technology, where new discoveries and innovations are occurring at a breakneck pace. (Department of the Army, 2019, p.5)

The U.S. has enjoyed military supremacy in the post-cold war era, but near-peer rivals look to challenge its reign in the new era of advancing technology (Department of the Army, 2018). The U.S. Army, recognizing future technological threats, established the Army Futures Command (AFC) in 2018. The AFC capitalizes

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on the tech industry to synchronize innovative ideas and technical solutions to meet the demands of future warfare (Army Futures Command, 2019).

In *TRADOC PAM 525-92*, the continuum of warfare is separated into two categories: The era of accelerated human progress, and the era of contested equality (Department of the Army, 2019).

The Era of Accelerated Human Progress

The era of accelerated human progress is defined as the period in which near-peer competitors will contest the technological edge held by the U.S., from present day until approximately the year 2035 (Department of the Army, 2019). A current example of this era in action is Russia and China maximizing opportunities to integrate technology into their militaries while the U.S. was focused on counterinsurgency operations during the wars of Iraq and Afghanistan (Colby & Ochmanek, 2019; Wortzal, 2019).

According to the *Summary of the 2018 National Defense Strategy of the United States of America*, China "will continue to pursue a military modernization program that seeks Indo-Pacific regional hegemony in the near-term and displacement of the United States to achieve global preeminence in the future" (Department of Defense, 2018, p. 2). And Russia is using "emerging technologies to discredit and subvert democratic processes in Georgia, Crimea, and eastern Ukraine..." (Department of Defense, 2018, p.2). There is also North Korea and Iran pursuing nuclear arsenals, as well as terrorist networks acquiring technology and weapons to



(U.S. Army photo by Staff Sgt. Mylinda DuRousseau taken June 28, 2019) A U.S. Army Soldier with 5th Armored Brigade, First Army Division West uses an electromagnetic jamming device to counter a drone during a training exercise at McGregor Range Complex, New Mexico, June 28, 2019.

disrupt global order. This technological warfare race by multiple nations and terrorist organizations will push the world into the future era of contested equality.

The Era of Contested Equality

The era of contested equality, predicted to occur between the years 2035 to 2050, is when technological advances overtake traditional warfighting methods. This will lead to a new type of AI-dependent, science-based warfare. This era will present commanders with scenarios too fast for human comprehension. AI will be relied upon to make instant decisions (Department of the Army, 2019).

The Army Research Laboratory (ARL) explains that Quantum Information Science (QIS) — the study of quantum effects in physics involving computation, communication, precision measurement, and fundamental quantum science — will redefine traditional command and control, military communications, intelligence gathering, and reconnaissance (Kott et al., 2018). This coming era will introduce technology currently difficult to imagine, but will reshape the future operating environment (OE).

Future Operating Environment

The convergence of technology in 2050 will impact the way humans interact, live, and ultimately, how they fight. Information will be shareable across world populations instantaneously, posing operational security risks (Department of the Army, 2019). The future landscape will be an information-rich, hyper-connected, densely

populated urban environment. A report by the United Nations projects 68% of humanity will live in urban settings by 2050, up from 55% in 2018 (2018). In *Field Manual 3-0: Operations*, the increased number of megacities will present new challenges for militaries such as subterranean operations, population control, situational awareness and communications, and survivability for ground troops and aviation assets (Department of the Army, 2017; South, 2019). Using QIS, the U.S. will be able to plan for and adapt to these future problems caused by urban migration.

Math, Physics and Science in Warfare

The understanding of QIS will prepare the U.S. for future warfare. The ARL explains that quantum physics can break through traditional limits on wartime assets such as sensors, networks, and communications (Kott et al., 2018). QIS will connect science and research to the advanced weaponry expected to present itself in the future.

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Impacts of QIS in Austere Environments

Today's militaries rely on global positioning systems (GPS) in all aspects of operations to include missiles, jets, tanks, dismounted elements, and more. Adversaries recognize this and are developing technology to attack GPS assets, but QIS can provide positioning, navigation, and timing capabilities in GPS-denied environments (Kotts, 2018; Waxler, 2019). Developing the QIS field will enable the U.S. to operate without satellite assets, shape future weapon systems, and revolutionize military concepts.

Uncrewed Technology on the Battlefield

The next era of warfare will rely more on technology and AI and less on individual Soldiers. This article

examines three areas of technological focus: unmanned aerial systems (UASs), unmanned underwater vehicles (UUVs), and unmanned ground vehicles (UGVs).

Unmanned Aerial Systems

UASs are operating systems that remotely control vehicles often referred to as drones. These are commonly used by the military for their reconnaissance and kinetic strike capabilities (Sabbagh, 2019). The introduction of UASs during the wars of Iraq and Afghanistan changed the dynamics of the OE and allowed for increased reconnaissance times on target (often up to 24 hours), maximized efficiency with greater strike ranges and flight times than manned systems, and minimized air crew casualties (Guilmartin, n.d.).

Unmanned Underwater Vehicles

UUVs supply intelligence, surveillance, reconnaissance, surveys, mine warfare, and security. According to JR Wilson at *Military & Aerospace Electronics*, "UUVs are driving pioneering research in artificial intelligence underwater communications, autonomous navigation, and unmanned swarm technologies" (Wilson, 2019, para. 1). UUVs will serve in offensive and defensive roles, and with further development of QIS, operate autonomously alongside the Navy's inventory of crewed warships and submarines.

Unmanned Ground Vehicles

TRADOC PAM 525-92 predicts unmanned systems will comprise most combatant forces in the future (Department of the Army, 2019). The AFC is currently



(U.S. Army photo by Spc. Jonathan Perdelwitz taken July 21, 2019) U.S. Army Spc. Joshua Baringer, an Unmanned Aerial Vehicle (UAV) pilot with 224th Brigade Engineer Battalion, 2nd Infantry Brigade Combat Team, 34th Infantry Division, controls a Shadow UAV during eXportable Combat Training Capability rotation at Camp Ripley, Minnesota, July 21, 2019.

experimenting with both connecting UGVs to other unmanned systems to complete dynamic joint tasks, and developing robots to complete squad and platoon-level tasks (Tucker, 2019).

Artificial Intelligence

To maintain dominance in the technological arms race, the U.S. is working to make AI robotics completely autonomous. *TRADOC PAM 525-92* predicts the future will produce technology connecting the human brain to AI-centered interfacing systems (Department of the Army, 2019). If unmanned systems connect remotely to humans, the need for physical Soldiers on the battlefield will be reduced, saving countless lives.

Doctrine of 2050

The complex OE of the future will require interoperability among all warfighting functions across the five domains: Land, Sea, Air, Cyber, Space. The Department of Defense must address advances in technology through comprehensive joint doctrine development or risk falling behind its adversaries (Prewitt, 2020).

The Summary of the 2018 National Defense Strategy identifies that the U.S. military's advantages in warfare are diminishing and predicts Russia and China will rely heavily on cyber attacks to penetrate the United States' military capabilities (Department of Defense, 2018). Utilizing QIS, the U.S. could produce an independent network impenetrable by adversaries, creating secured lines of communications across the joint force and ensuring uncrewed vehicles freedom of maneuver.

As technology becomes more globally accessible,

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(U.S. Army photo by Sgt. Daniel Cole taken May 15, 2016) U.S. Army paratroopers assigned to 503rd Infantry Regiment, 173rd Airborne Brigade adjust communications equipment during Exercise Noble Partner at Vaziani Training Area, Georgia, May 15, 2016.

Army doctrine must account for autonomous uncrewed vehicles and robots, especially considering the complexities of operating in megacities (The United States Governmental Accountability Office, 2019). Robots enhanced with AI can move through the OE quicker than human Soldiers, and process information exponentially faster. Army doctrine will need to advance concurrent with technology to prepare for the battlefield of 2050.

Conclusion

Technology is revolutionizing how war is waged. The Department of Defense must maximize its development of QIS, autonomous uncrewed vehicles and platforms, AI-infused robotics, and evolving doctrine to address future threats. This will ensure the U.S. and its allies are prepared for the technical and multi-dimensional battle-field of the future.

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Mav 2020