

Marines in the Age of Artificial Intelligence

Changing the character of war

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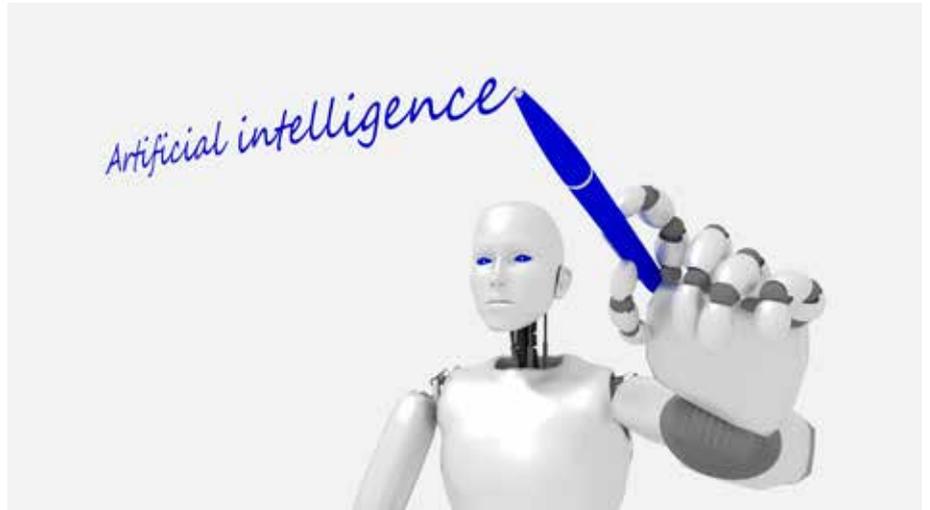
“It’s going to rip through this economy like a tsunami,” said Allstate CEO, Jim Wilson, referring to artificial intelligence (AI).¹ Same for defense. It is “in the midst of a technological tsunami,” said former-Deputy Secretary of Defense, Robert Work, also referring to AI.² Over the coming decade and beyond, AI will profoundly impact almost every aspect of the Marine Corps. It will change the character of war and possibly the long thought to be immutable nature of war. Preparation begins by studying and anticipating change now.

AI is here

While AI’s definition is debated, it is basically a machine that does functions requiring human intelligence. We have long used AI, from mechanical calculators to GPS route planners. But what is new about AI is machine learning. It uses data to teach itself to recognize faces, transcribe spoken words, and perform a litany of other specific tasks; the more data it gets, the better it gets. It resulted from a confluence of factors in the first half of the 2010 decade: improved algorithms, massive research and development funding, structured data, and increased computing power³—a trillion fold since 1956, when AI was formally conceived.⁴

In given functions, machine learning is outperforming humans. This new AI beat the top players in Chess, the complex Go game, China’s Sputnik moment⁵, and Texas Hold ‘Em poker with six players.⁶ Regarding the last, consider Clauzewitz: “War most closely resembles a game of cards.”⁷ But games were merely testbeds. Machine learn-

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(Photo purchased by author.)

ing has outperformed radiologists in diagnosing lung cancer⁸ and other diseases. In the fight against ISIS, machine learning rapidly scanned voluminous imagery, which previously overwhelmed analysts, and identified targets.⁹

AI expert, Andrew Ng, calls AI the new electricity.¹⁰ To a degree, he is correct. Like electrification, AI will permeate seemingly everything in our lives—and that’s begun already. News media use AI to write articles.¹¹ Banks use AI to assess loan applicants, analyze markets, and detect fraud.¹² And in June 2019, over 80 companies tested some 1,400 autonomous vehicles, which use AI, in 36 states.¹³

This commercial innovation has migrated into defense, accelerating processes. The joint staff leverages AI to assess tradeoffs and risks in addressing force requirements.¹⁴ The Air Force is pursuing a multi-domain, common operating picture that is fused with AI.¹⁵ In the Army, AI indicates when vehicle maintenance is needed.¹⁶ The Navy seeks AI to aid distributed maritime operations (formerly distributed lethality).¹⁷

The Marine Corps is also experimenting with AI for wargaming;¹⁸ readiness;¹⁹ logistics; planning fires with autonomous AI-enabled munitions; and autonomous AI-enabled machines, pro-

viding situation awareness for squads.²⁰ The harbinger of things to come is the expeditionary modular autonomous vehicle, which requires AI.

Unlike electricity, AI's transformation will be faster. Electrification of all American households took over 75 years. AI's transformation will occur over the 2020-30 decade, according to several reports.²¹ "The pace of innovation has accelerated," said the Council of Foreign Relations' 2019 *Innovation and National Security*. Our challenge will not be just keeping pace, but rather anticipating change as much as possible.

Additionally, AI will displace humans, but different from how electricity did. Electrification displaced brawn. AI will increasingly displace people performing cognizant functions. We want that in combat, too. The first thing through the breach should be a robot, as Bob Work said. However, AI will displace humans across economic sectors and globally. "Automation, artificial intelligence (AI), and other technological innovations threaten the existence of vast swaths of current jobs up and down the socioeconomic ladder," stated the National Intelligence Council's *Paradox of Progress*.²²

Bigger changes loom. Today's AI has its flaws; it is narrow, brittle, and can be spoofed. But it will improve and, like

other innovations, will combine with other developments and go in many unanticipated directions—significantly and rapidly changing our world in ways still unknown.

The Coming Decade and Beyond

According to a media report, half-a-dozen unmanned boats, using AI, communicated with each other and sensed and navigated their way off Wallops Island, VA, in October 2018. Conducted under the "Sea Mob" initiative, the Marine Corps' successfully demonstrated the potential for executing an unmanned, lethal assault.²³ But Sea Mob demonstrated more.

Consider MAGTF that is an Internet of things—or a "cyber-physical system." Industry is pursuing such systems for smart manufacturing, transportation, and more.²⁴ Using AI and a cyber network to orchestrate computers and physical systems, this system is able to rapidly sense and respond like an organism. Sensors feed data to AI-powered systems, which actuate functions, with Marines overseeing and adjusting. Additionally, AI at the MAGTF command level would assess data, inform decision making, and aid employment.

Now consider this cyber-physical MAGTF with AI-equipped, robotic systems. In 2016, airborne FA-18s re-

leased 103 hand-size drones in tests at China Lake, CA. They communicated with each other and possessed a collective intelligence, allowing them to swarm and execute four missions.²⁵ Such drone swarms could overcome enemy integrated defenses, like those with Russian S-400s—a possibility indicated by the less sophisticated drone and missile attack on Saudi Arabia's oil facilities. Such drone swarms could be the MAGTF's first to fight, with Marines in subsequent waves.

Developments will likely advance such AI-equipped automation over the next decade, to include:

- *Next generation of AI.* Google DeepMind AI learned Go, using a database of 30 million moves from games played by humans, and then played thousands of games against itself, before defeating the world champion.²⁶ DARPA is pursuing AI that needs less data and learns common sense and context.²⁷
- *AI learning from other AI.* Most AI-equipped systems assess data separately, even though networked with other AI-equipped systems. IBM's Watson and Microsoft Azure are multimodal platforms, with AI systems learning from each other. Such multimodal learning captures trends and make predictions that uni-modal systems cannot.²⁸
- *AI managing use of the radio spectrum.* Today, a network operates on a set frequency. DARPA seeks AI that will enable networks to select and use available frequencies, thus avoiding enemy jamming and interference from proliferating friendly networks.²⁹
- *Fifth generation (5G) mobile technologies.* These will increase network speeds possibly up to 100 times faster than today's networks, enabling downloads 1.3 gigabits-per-second. 5G technologies will aid interconnectivity, swarming of autonomous systems, and reduce latency of satellite-based communications and intelligence, surveillance, and reconnaissance.³⁰

Artificial general intelligence is a wild card. AI, today and in the foreseeable future, is narrow. It performs specific functions but has no ability beyond. Artificial general intelligence is seen



"In DARPA's Squad X, Marines experiment with autonomous systems and artificial intelligence to enhance situational awareness." (Photo provided by DARPA.)

as a machine that performs any task that a human can. It does not yet exist, but Google's Deep Mind and OpenAI are pursuing artificial general intelligence.³¹ When it emerges is hotly debated. Google's Ray Kurzweil estimates a 50 percent chance of artificial general intelligence being built in 2029, while other estimates average about 2099.³² Research will likely surprise us.

Quantum computing deserves attention. AI's potential depends on increasing computing power. Google claims that its quantum computer achieved "supremacy," solving a problem in minutes that would have taken a traditional computer 10,000 years to solve. While competitors dispute it, the event signals a coming wave of research.³³ Quantum computing may replace traditional computing, if the latter sees the end of Moore's Law—the microchip's power doubling every 18 to 24 months—as some expect.³⁴

The difficulty lies in implementing quantum computing. Yet, quantum research is yielding militarily relevant results. China claims it has quantum radar that detects stealth aircraft. Reportedly, China has also implemented "quantum key distribution," (communications that can't be intercepted) between its Micius satellite and ground stations, its terrestrial network between Beijing and Shanghai, and it seeks the same elsewhere.³⁵ "China will go black in two to three years," predicts Jonathan Dowling, a Louisiana State University physics professor, who spends part of the year as a visiting faculty member at the University of Science and Technology of China.³⁶

We are in a science race, more than an arms race.

The Imperatives

For multiple reasons, Marines must embrace AI—first and foremost, because of who they are. No matter what form of war, Marines have a genius for fighting, as LtGen Victor H. Krulak wrote. Marines innovate to ensure the viability of their service to the Nation.

Another big reason is the competition. Since 2017, China has pursued a whole-of-government strategy for AI, getting help from tech giants Baidu,



DARPA Squad X, Marines and autonomous robot. (Photo provided by DARPA.)

Alibaba, and Tencent, and from its universities. It is an effort unlike that of the United States, China's goal is to surpass the United States in AI and dominate globally by 2030. China is succeeding, according to many reports.³⁷ China is manifesting AI in multiple ap-

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plications, to include military, such as AI for decision support; AI-equipped munitions; sea and air drone swarms; and autonomous, lethal drones, which China is exporting.³⁸ The congressionally mandated, National Security Commission on Artificial Intelligence, in November 2019 stated,

Without a reversal of current trends, in the coming decade the United States could lose its status as the primary base for global AI research, development, and application ... the resulting disadvantage could endanger U.S. national security and global stability.

Marines and defense will need AI for hyper-war, resulting from use of new technologies and AI. Decision making and execution will occur in microseconds or less. At its 70th anniversary parade, China debuted hypersonic DF-17 missiles.³⁹ Reportedly,

they have Mach 5 to 7 speeds, glide vice traditional parabolic trajectories, and enhanced maneuverability—making them faster than manned defenses can respond with "bullet-to-bullet" engagements.⁴⁰ Defeating these missiles as well as swarming missile and drone attacks depends on AI-equipped, air- and/or space-based sensors rapidly detecting, tracking, and then cueing AI-controlled, directed energy systems to engage.

These and other sensors will need onboard, or "edge," AI for several reasons. First, they will process and exploit data onboard, faster than manned centers can today. AI on sensors also will save bandwidth, transmitting only when cueing weapons for target engagement. Compared to today's streaming sensor platforms, they present less of a target in an extensively monitored, electromagnetic environment.

The quests for speed, bandwidth savings, and reduced electronic signatures are driving the merging of sensors and weapons into a single AI-equipped system (read "autonomous"), compressing the O-O-D-A loop.

Defending cyber networks demands AI's speed. Relying on human intelligence alone in cyberspace is "a losing strategy" said then-Commander, U.S. Cyber Command, ADM Michael Rogers. Legacy cyber-defense tools match previous malicious codes to ongoing activities; thus, hackers can slightly modify codes to get past this defense.



Marines will need AI for managing complexity. (Photo provided by DARPA.)

But AI tools detect changes in network behaviors and anomalies, thus defending more broadly.⁴¹ Moreover, AI-defenses will be vital to countering AI-enhanced attacks that autonomously and rapidly mutate with the environment, navigate networks, and exploit vulnerabilities.⁴²

Furthermore, Marines will need AI for managing complexity. Conflicts, including war and gray zone operations, are waged in air, land, sea, space, cyber, and the electromagnetic spectrum. Operating in them will require AI not only for multi-domain awareness but also for monitoring, assessing, and alerting on threats that may attack simultaneously or be closely sequenced in multiple domains. Such AI-supported command and control can recommend weapons for defending or attacking in domains and may even autonomously defend against multi-domain attacks.

There is another reason for using AI. We must do something different. U.S. military technological advantage is eroding, as stated in the *National Defense Strategy*; the *National Military Strategy* assumes that demands on the force will continue to outstrip supply.⁴³ The costs of buying more manned systems and manned organizations are unaffordable, and allies know it. “America has an atrophying force that is not sufficiently ready, equipped or postured for great power competition in the Indo-Pacific,” stated a 2019 University of Sydney report.⁴⁴ AI offers the chance to reverse these trends.

The Implications

“It is unusual to have a technology that is so strategically important being developed commercially by a relatively small number of companies,” said Dr. Ed Felten of the Center for Strategic and International Studies.⁴⁵ The Marine Corps must get close to these companies and reduce barriers to rapid acquisition. Additionally, it must rapidly test AI that

To develop new organizations and warfighting concepts, Marines need an understanding of AI. Some need a basic understanding, others should be informed users, and others must be specialists. Technically literate Marines coupled with specialists can exploit AI for solving warfighting problems; determine when humans decide and act, and when machines do; and design organizations with both. Marines must immerse themselves in AI, just as interwar Marines did with technologies, enabling the amphibious assault.

“To begin intellectually equipping their personnel for the Fourth Industrial Revolution, military organizations should start providing a baseline level of education in artificial intelligence,” writes Australian Army MajGen Mick Ryan, a product of Marine Corps education. Moreover, education must help students keep pace with accelerating technology developments. Yet, most military education barely mentions AI. Ryan underscored the criticality of education: “In this environment, where all sides may possess artificial intelligence

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was developed primarily for commercial uses and not the life-and-death situations and rigorous combat environments that Marines experience.

Marines must develop and use AI in keeping with their ethos—every Marine a warrior, adhering to the core values of honor, courage, and commitment. What that AIs use will be? Nobody knows yet, but it must be kept foremost in mind. “The greatest threat that humanity faces from artificial intelligence is not killer robots, but rather, our lack of willingness to analyze, name, and live to the values we want society to have today,” said John C. Havens, Executive Director, IEEE Global Initiative on Ethics of Autonomous and Intelligent Systems.⁴⁶

and autonomous systems, the race will go to the intellectually swift.”⁴⁷

Moreover, AI means rethinking war. AI will change the character of war, which has always been influenced by technology and more. But it may even change Clausewitz’s long thought to be immutable nature of war: a violent and uncertain contest of human wills, fundamentally political. Consider Russia’s Gen V. Gerasimov’s statement:

Tomorrow’s battlefields will be filled with walking, crawling, jumping, and flying robots. In the near future it is possible a fully robotized unit will be created, capable of independently conducting military operations.⁴⁸

Seemingly, AI and autonomy eventually could make war a violent contest



A drone swarm. (Photo provided by DARPA.)

of machines, with lightening speeds reducing the role of humans from tactical to political levels. Referring to AI and autonomy changing the nature of war, three notable Marines also stated:

- Dr. Frank Hoffman: “Autonomy will change the nature of war in several ways.”⁴⁹

- Former-Deputy Secretary of Defense, Robert Work: “I am starting to believe very, very deeply that it is also going to change the nature of war.”⁵⁰

- Former-Secretary of Defense: James N. Mattis: “I’m certainly questioning my original premise that the fundamental nature of war will not change.”⁵¹

If so, we do not know the consequences of such change, but they demand study and awareness before they occur. In the age of artificial intelligence, human intelligence will be far more important.

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