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ARMY OF THE FUTURE: ARTIFICIAL INTELLIGENCE AND ITS IMPACT ON ARMY OPERATIONS

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JCSP 44

PCEMI 44

SERVICE PAPER

ÉTUDE MILITAIRE

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Word Count: 2536

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AIM

1. This paper is intended for consideration by the Director General Land Force Development. Over the past few decades, Western forces have gained the upper hand over their adversaries with the help of their technological advantages. Tactical ground fighting armies have been driven to win battles thanks to their technological dominance. This technological dominance depends heavily on the evolution of the technologies and concepts that are associated with the Information Age. As such, it is expected that the constant evolution of information technologies will play an important driving force that will shape war fighting technologies between now and 2050. This service paper will highlight the impact of Artificial Intelligence (AI) as a transformative technology on the fundamental nature of Army operations over the next thirty years.

INTRODUCTION

2. Technology is evolving exponentially and Defence will continue to research and adopt the latest technology in order to remain ahead of its adversaries in the battlefield. In order to maintain the Canadian Armed Forces (CAF) a contender in the battlefield, it must adopt these technologies as they become mainstream. This is naturally a part of progress of industrial revolutions as they mark a major turning point in our history. We are currently embarking on the fourth industrial revolution, coined as *Industry 4.0*. Industry 4.0 is used to refer to the “digitisation of technology through concepts like cloud computing, the exploitation of *Big Data*,

and the *Internet of Things*.”¹ One of the emerging technologies that fall under this definition is AI. One can argue that the true fourth industrial revolution will be indeed AI.

DISCUSSION

3. Our ability to comprehend the future and to appreciate its impact on the way Defence is conducted is critical for the success of the National Defence. It is difficult however to truly imagine how the next thirty years will unfold, in particular on the topic of AI. By way of comparison, picture a soldier falling asleep in 1884 only to be awakened in 1916 in the middle of World War I – they would witness technological advances such as the machine gun, long-range indirect fire artillery, airplanes, field phones and the early beginnings of tanks.² Although certain concepts and elements of these technological advances existed in 1881, the achievements of technology observed by the time travelling soldier will be un-imaginable. In the same matter, this paper attempts to capture elements that partially exist today and which will completely change the battlefield in 2050.

4. In 2015, the US Army Research Laboratory assembled experts, intellectuals and leaders from the public, private and academic sector, to envision the future of the tactical ground battlefield in 2050.³ The group identified future capabilities that will influence the battlefield of the future. The following sections will summarise these capabilities since they will play a pivotal function in the future of AI and the Canadian Army (CA).

¹ Gerrard Cowan, "Industry 4.0: The 'Fourth Industrial Revolution': Companies Across the Defense Sector are Researching Ways in which 'Industry 4.0' can Support the Evolution of their Production Processes," *IHS Jane's Defence Weekly* 53, no. 48 (2016), 1.

² Alexander Kott et al., *Visualizing the Tactical Ground Battlefield in the Year 2050: Workshop Report*, 3.

³ Ibid.

Augmented Humans

5. The augmented human soldier will be a soldier that is:

. . . physically and mentally augmented with enhanced capabilities that improve their ability to sense their environment, make sense of their environment, and interact with one another, as well as with *unenhanced humans*, automated processes, and machines of various kinds.⁴

6. As such, the augmented human soldier will have been enhanced with cognitive skills, acute vision and auditory skills, physical enhancement with the help of exoskeletons and a computer-assisted decision making processes. In essence, the augmented human soldier will be smarter, stronger and able to integrate himself into a network of systems. Due to the advanced abilities the augmented human soldier will possess, traditional soldiers will be much fewer in numbers in the battlefield of the future.

Automated Decision Making and Autonomous Processes

7. The decision-making process that commanders make on a daily basis during the battle is critical to the success of the mission. The battlefield of the future will be significantly automated allowing for decision agents to be integrated in Command and Control (C2), the Operational Planning Process (OPP), the Intelligence Preparation of the Battlespace (IPB), the understanding of Intelligence, Surveillance and Reconnaissance (ISR), and Battle Damage Assessment (BDA). The agents will conduct tasks such as “filtering information, fact checking, fusion, dynamic access control (determining who has access to what information), and adaptive information

⁴ Ibid.

dissemination (who should receive specific pieces of information and/or notifications).” The battlefield of the future will have many sensors deployed and collecting information. The simplest forms are micro-aerial sensors that collect information and remotely send them back to its head quarters.⁵ Humans will not be able to process, understand, analyse and prioritise the inflow of the thousand of sensors. As such, automated agents will be capable of understanding the commander’s mission intent and thereby task specific sensors to deliver mission specific information. These agents will be then sort through the information and discard useless intelligence while retaining the most relevant and pertinent.

Misinformation as a Weapon

8. As highlighted in the previous paragraph, information from sensors will be abundant causing for operators to work in an *information-rich* environment. These may cause for an information overload in certain cases making it difficult for both human and AI to confirm the quality of the information. As such, information correctness, authenticity and security will be dependent on the reliability of the source. In the same way, misinformation can be used as a weapon. In an environment of information overload, it will be trivial to deceive the adversary by incorporating believable material that would be misleading and thereby undermining legitimate trust, causing confusion and delaying decisions.

⁵ For example, The Robot Dragonfly by TechJet is today’s first dragonfly size automated manoeuvrable that can capture video.

Micro-targeting and Weapons miniaturization

9. The concept of micro targeting implicates the “identification and surgical engagement of specific individuals employing either kinetic or non-kinetic means.”⁶ In today’s world, it is the equivalent of tailored news feeds or ads on a user’s browser based on their historical browsing metadata. In the battlefield of the future, micro-targeting will evolve to include the ability to *hack* the enemy in the cyber environments and *mine* information relating to their precise location. This, coupled with weapons miniaturization, will enable for precise engagement of the enemy resulting in less collateral damage.

Large-scale Self-organization

10. Large-scale self organization will occur as a new means to command and control. The battlefield of 2050 will see “individuals, teams, and software agents, . . . self-organize, dynamically creating and modifying collaborative processes.”⁷ Today, all users of smartphones experience small-scale self-organization where applications self-synchronize, collaborate with other applications and even dynamically adapt to the user’s habits. The battlefield of 2050, will see self-organized and autonomous entities dynamically evolving their behaviours in response to the changing environment. This truly redefines the *network enabled C2* concept and sets new limits to agility in the battlefield. Large-scale self-organization will be made possible with the help of *Deep Learning* (a branch of AI) where the agents will be able to learn algorithms and sets of architecture enabling them to automate the extraction of “complex representations without human intervention.”⁸ In fact, today there are several commercially available agents that already

⁶ Ibid.

⁷ Ibid.

⁸ Erica Wiseman, *Strategic Technical Insights: Deep Learning for Human Decision Support* National Research Council Canada, 2017), 5.

demonstrate deep learning capability. Google’s AphaGo machine, had a historic victory over a human in the ancient board game Go⁹ which demonstrates that a machine can have approximated human intuition and can outsmart the best human competitor in the game. With the help of deep learning, AI agents will be capable to continuously learn, adapt and overcome its adversaries in a networked fashion in order to win battles.

IMPACT ON FUNDAMENTALS OF ARMY OPERATIONS

11. Lieutenant-General Hainse states in his foreword to *Waypoint 2018 – The Canadian Army Advancing Toward Land Operations 2021* that “. . . in the digital age, network-enabled forces that can see, understand, and act more effectively in their operating environment will have a significant advantage over their adversaries.”¹⁰

This document has the purpose to assist the “Army leadership in making decisions for the modernization of the Canadian Army (CA)” as part of its transformation to realize the force employment concept articulated in *Land Operations 2021: A digitized and network-enabled land force capable of conducting effective Adaptive Dispersed Operations (ADO) in the future operating environment.*¹¹ The fundamentals of army operations listed in *Land Operations 2021* and *Waypoint 2018* were written purposefully with broad language in order to “meet an unpredictable future,”¹² this section will highlight the details given the predictable future explained in the previous section.

⁹ Ibid.

¹⁰ *Waypoint 2018: The Canadian Army Advancing Toward Land Operations 2021* National Defence and the Canadian Forces, 2015), ii.

¹¹ Andrew B. Godefroy and Canada. Dept. of National Defence, *Land Operations 2021: Adaptive Dispersed Operations : A Force Employment Concept for Canada's Army of Tomorrow* (Kingston, Ont: Directorate of Land Concepts and Doctrine,[2007]).

¹² *Waypoint 2018: The Canadian Army Advancing Toward Land Operations 2021*, 4.

Adaptive Dispersed Operations

12. The future battlefield will continue to be based on the conceptual designs of Adaptive Dispersed Operations (ADO) requiring Land Force intervention in the full spectrum of threats. Nevertheless, the balance of that spectrum will shift from the physical plane of today to the moral and informational plane. This will be primarily due to a significant shift of the battle space. Although battles will continue in air, land, and sea spaces, it will be natural that, due to industry 4.0, the battlespace balance will lean more towards the electromagnetic spectrum and the information environment. With the help of micro-targeting and large-scale self-organization, AI agents will be able to set favourable conditions prior to even contact with the enemy.

13. The fundamentals of dispersed operations of *find, fix, and strike* will be much easier to achieve in the battlefield of the future. AI sensors of all sizes and shapes with the ability to comprehend the mission's intent, will be able to task targeted sensors allowing for a precise, expedient find. Once again, the battlespace will not necessarily be limited to land, air and sea, but also the cyber domain. For example, an AI agent may place a digital sensor on e-mail traffic, continuously seeking key information that may potentially link to the enemy. Micro-targeting will thus be achievable with precise fixing and striking of the enemy, prior to contact in the physical plane.

14. A more important impact on the fundamentals of Army operations will be the commander's significant increase in Shared Awareness (SA). With the help of autonomous analysis of the sensory information, AI will be capable to implement decentralized decision making autonomously and instantly deliver the most relevant and precise SA to the command

staff. Commanders will thus be capable to make assisted decisions in order to continue winning in the battlespace.

15. ADO will thus be managed with the help of AI systems and agents that can mitigate the dispersion of the enemy with the help of its sensors while delivering detailed fix and strike effects. Nevertheless, human Command will be critical for the success of the mission through SA, as mentioned in Waypoint 2018, “The centrepiece of ADO remains the Canadian soldier, but the key enabler is its network.”¹³

Operational Functions

16. The five operational functions will still continue to form the fundamental framework of Army operations. Moreover, operational functions Sense and Act will evolve to be the strongest functions enabled by AI and autonomous agents. As AI becomes well integrated into our force structure and gains deep learning capabilities and the ability to conduct large-scale self-organization, human soldiers will have a very minor role to play in the *Sense* and *Act* functions.

17. The *shield* function will be shared between humans and AI agents in the physical and moral plane, leaving autonomous machines to provide the necessary protection for its own survivability and freedom of action. In the information environment however, it will be there that Cyber defence will play a pivoting role in the protection of AI systems in its most vulnerable plane.

¹³ Ibid.

18. As less human soldiers will exist on the battlefield, the *Sustain* function will evolve to exist in the information plane significantly more than the physical and moral plane. The provision of materiel and personnel support will become less of a requirement. Sustainment of AI agents on the other hand will require a specific expertise which may be beyond the future soldier's technical competency. As such, soldiers will either be required to gain technical robotics, programming and mechanical skills or DND will see the dependence on contractors and commercial services for the maintenance, training and re-generation of said AI systems. Furthermore, the requirement for first line support may no longer exist as AI systems will be capable of self diagnosing and self healing.

19. Finally, the centre of gravity of the future battlefield will still remain the *Command* function. It will be here that human commanders' role will be critical in shaping mission command and integrating all the other functions into the strategic, operational and tactical levels of the battle. After all, Command is the creative expression of human will necessary to accomplish a mission,¹⁴ and although the commander will be enabled in the decision making process, it is *human will* which will help in achieving the end state.

Human Dimension

20. An important question looms in the discussion of AI in defence: Will there be a requirement for humans in the battlefield of the future? Contrary to Hollywood and science fiction depiction, most certainly yes, humans will continue to play a critical role in the battlefield of tomorrow especially in humanitarian and peacekeeping operations. That said, full military

¹⁴ Carol McCann et al., "The Human in Command: Exploring the Modern Military Experience" Kluwer Academic/Plenum Publishers, 2000).

kinetic operations will certainly see a significant reduction in the quantity of soldiers reduced from the force structure. As the cost of soldiers continue to increase, it will be much more cost effective to employ AI, autonomous, deep learning systems and agents to accomplish missions. The kinetic battlefield of 2050 will see a force structure where the lowest level of human soldier on the ground would, most likely, be the equivalent of today's Platoon Commander, directing a set of automated AI enabled platforms.

21. The human dimension also plays an important role in that which can not be learned by AI. Attributes such as values, culture, relationships, soldier identity and “the psychological contract between the soldier and society”¹⁵ can not be replaced by artificial intelligence. The most important of all, is the human ability to deal with ethical dilemmas. How will AI deal with ethical dilemmas when placed in a lose-lose predicament? The famous example based on science fiction author Isaac Asimov in his classic story *Liar* where an AI robot struggles to respect two of three laws he was programmed to obey¹⁶ demonstrates that humans will indeed provide a compassionate and human aspect to the battlefield that would be otherwise irreplaceable.

Cyber Defence

22. The fourth industrial revolution will make AI available to the public and the commercial sector. As such, militaries and governments will not be the only operators in the informational environment and militaries will be equally exposed to the same threats they impose on their

¹⁵ *Waypoint 2018: The Canadian Army Advancing Toward Land Operations 2021*, 24.

¹⁶ In Asimov's *Liar*, the robot must obey the *three laws of robotics*; a robot may not injure a human being, a robot must obey orders given to it by a human being, and a robot must protect its own existence as long as such protection does not conflict with the first or second law. The robot's awareness of human feelings leads it to lie to people in order to avoid hurting their feelings. Eventually, the robot is confronted by a human who has experienced emotional distress due to one of these lies. The robot realises that by trying to respect the first law, it broke it and becomes catatonic.

adversaries. As mentioned earlier, the battlespace will be predominantly in the electromagnetic spectrum and information environment. This will thus oblige that cyber defence become a vital asset in order to preserve the integrity of our AI systems and prevent being victims of our systems turning against us. Equally, misinformation used as a weapon can be detrimental to the decision making process, causing for wrong courses of actions and leading to mission failure. Naturally, *Cyber* may become the fourth environment in the CAF and cyber defence may become a trade within which programs and AI systems will necessitate the shielding of the information environment.

CONCLUSION

23. Artificial intelligence will undoubtedly play a role in the CA of the future in one way or another. At the very least, by 2040, the CA should see initial variations of the Augmented Human highlighted above. For the most part, if employed correctly, AI can be completely changing ADO and with the help of its automated decision making, micro-targeting, large scale self-organizing and its ability to sort through endless data, it will enable the CA superiority in the battlespace. Moreover, Humans will continue to play an important role as they possess human attributes that will never be programmed into AI.

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