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DEUS EX MACHINA: LEVERAGING ARTIFICIAL INTELLIGENCE IN SUPPORT OF COMMAND

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AIM

1. The aim of the service paper is to argue the need for further research and early adoption of artificial intelligence (AI) support in support of command. While intuitively clear that AI may also offer benefit to the other operational functions of act, shield, sustain, and sense, this paper will specifically focus on leveraging current and near term AI capability support of command, and how civilian industry could be leveraged to meet the technological demand.

INTRODUCTION

2. Artificial intelligence has been used by modern militaries since the Second World War, with the level of delegated “command” entrusted to these systems markedly increasing proportionate to enabling technological improvements.¹ Today, benefiting from huge advances in computing technology, and massive investment by government and private industry,² artificial intelligence promises to offer radically enhanced command support mechanisms to those with both the technological means and courage to accept AI encroachment into the realm of military command.

3. Presently AI is limited to Artificial Narrow Intelligence (ANI), where AI only functions at or above human levels within a specific band of tasks, as opposed to Artificial General Intelligence (AGI), where AI can perform at human levels across all tasks.³ Machine intelligence such as AGI is not likely feasible for at least another twenty years,⁴ due to an inability to “imbue computers with true knowledge and expert-based behaviours, as well as limitations in perception sensors,”⁵ limiting its current utility as a human substitute in highly variable and volatile environments such as war.⁶ As such, this paper will solely focus on the Canadian Army (CA) leveraging ANI in support of command, leaving discussion on ANI in support of other operational functions and hypothesizing on the potential of military AGI and for future discussion. Specific areas highlighted within this paper include AI as an information management and decision making tool, AI as a planning aide, and AI in support of routine combat process automation. The paper will also discuss how industry can be leveraged to help meet the Canadian Army’s (CA) AI needs, and will broach the major ethical concerns of institutionalization AI in combat command.

DISCUSSION

¹Greg Allen and Taniel Chan, *Artificial Intelligence and National Security*, Research Project, (Harvard, MA: Harvard Kennedy School - Belfer Center for Science and International Affairs, 2017): 13.

²Stephan De Spiegeleire, Matthijs Maas, and Tim Sweijjs, *Artificial Intelligence and the Future of Defense: Strategic Implications for Small and Medium Sized Force Providers*, (The Hague, The Netherlands: The Hague Centre for Strategic Studies, 2017): 35-36.

³ *Ibid.*, 30.

⁴ Vincent C Müller and Nick Bostrom, "Future Progress in Artificial Intelligence: A Survey of Expert Opinion." In *Fundamental Issues of Artificial Intelligence*, by Müller V. (eds), (Berlin: Synthese Library, 2016): 555.

⁵ M.L. Cummings, *Artificial Intelligence and the Future of Warfare*. Research Paper, (London: Chatam House - The Royal Institute of International Affairs, 2017):12.

⁶ *Ibid.*, 12.

4. The command function, as explained in *B-GL-300-001/FP-001 - Land Operations*, is the “integration through the planning, direction, coordination and control of military forces and other elements as allocated.”⁷ While this paper does not advocate the devolution of command responsibility, it is important to discuss how through application AI, the analytical capacity of machines can be leveraged in both automated and limited autonomous processes to support command. Specific to the operational function of command, AI shows immense potential as an information management tool, a planning and decision making assistant, and as a process control manager.

5. According to Canadian defence policy, a commander’s ability to “collect, understand and disseminate relevant information and intelligence has become fundamental to the military’s ability to succeed on operations.”⁸ In complex, multidimensional battlefields, sifting through enormous volumes of information and developing succinct understandings of problem spaces is amongst the most daunting tasks facing commanders. It is estimated that the amount of data stored on Earth doubles every two years.⁹ The true value of AI is the ability to confer data from multiple streams and data sets and create decision support systems to make sense of it in a way that is useful to a human commander,¹⁰ and AI can support command by patterning this unstructured data in such a way as to “draw out useful information that would otherwise be elusive, and this potentially superior quality of information may consequently lead to better wartime decision making.”¹¹ The ability to rationalize data and make decisions from it while operating “sequentially and via parallel processing at speeds that are orders of magnitude faster than humans,”¹² offers the commander a fused understanding from across all domains – land, sea, air, space and cyber - and can be a decided advantage over his adversaries.¹³

6. Integrated machine learning and AI will also “allow for faster, more effective – and more accurate – targeting decisions”¹⁴ than are possible by human staffs. AI increases battlefield lethality through decidedly more thorough and rapid decision-action cycles, “possibly outpacing the opponent’s ability to understand the environment and respond in kind if the opponent is relying solely on human judgment.”¹⁵ Algorithmic targeting in particular promises to improve the rapidity and fidelity of battlefield decision making. Algorithmic targeting manages complex battle spaces on behalf of the commander by fusing immense databanks of stored information and current sensor data on existing friendly military and civilian entities, and applies learned

⁷ Canada. Department of National Defence, *B-GL-300-001/FP-001 - Land Operations*. (Kingston: Army Publishing Office, 2008), 4-19.

⁸ Canada. Department of National Defence, *Strong, Secure, Engaged - Canada's Defence Policy*, (Ottawa: National Defence Canada, 2017), 63.

⁹ Greg Allen, and Taniel Chan, *Artificial Intelligence and National Security*. . . , 27.

¹⁰ Bil Hallaq *et al*, "Artificial Intelligence Within the Military Domain and Cyber Warfare." *Proceedings of 16th European Conference on Cyber Warfare and Security*, (Dublin, Ireland: Academic Conferences and Publishing International Limited, 2017), 154.

¹¹ Daniel S Hoadley and Nathan J Lucas, *Artificial Intelligence and National Security*. Congressional Research Service Report for Members and Committees of Congress, (Washington: Congressional Research Service, 2018), 27.

¹² Kareem Ayoub and Kenneth Payne, "Strategy in the Age of Artificial Intelligence." *Journal of Strategic Studies*, (2016): 799, <https://doi.org/10.1080/01402390.2015.1088838>.

¹³ Daniel S Hoadley and Nathan J Lucas, *Artificial Intelligence and National Security*. . . , 11.

¹⁴ Stephan De Spiegeleire, Matthijs Maas, and Tim Sweijjs, *Artificial Intelligence and the Future of Defense: Strategic Implications for Small and Medium Sized Force Providers*. . . , 89.

¹⁵ Daniel S Hoadley and Nathan J Lucas, *Artificial Intelligence and National Security*. . . , 27.

pattern analysis to automatically minimize false alarms and detect and target hostile entities.¹⁶ Such AI systems have the capacity to dynamically synthesize volumes of data and make rational predications, to “see the patterns through the chaff . . . [and] respond at extreme speed and under rapidly shrinking engagement windows”¹⁷ empowering commanders with streamlined and efficient decision cycles and offers a competitive edge over adversaries.

7. Military planning can also be enhanced through AI. AI programs have the capacity to create “micro worlds” that conceptually replicate physical operating environments, military orders of battle, and enemy reactions.¹⁸ In creating these virtual worlds, AI systems can break down massive problem sets into constituent parts, “quantify enemy intent, and compare situational data to a stored database of hundreds of previous wargame exercises and live engagements . . . [offering] access to a level of accumulated knowledge that would otherwise be impossible to accrue.”¹⁹ Unlike a human team, AI can simulate unlimited permutations of proposed courses of action simultaneously, making the process of war gaming significantly more thorough and efficient than can be done by strictly human staff.²⁰ The result of such war games is a probabilistic outcome of success, which would enable a commander to make decisions based on a quantifiable assessment of risk in consideration of the determined relevant factors.²¹ War gaming could also be used predictively for contingency planning and course of action development. With access to vast whole of government databases of regional information and a myriad of national and allied sensors, AI can fuse information into useful understanding for operational and strategic decision makers, allowing defense planners to better anticipate emerging threats and potentially act pre-emptively to mitigate them.

8. Machine war gaming can also assist in removing human emotion and bias from plans. “Emotional states such as fear, disorientation, confusion, anger and the desire for revenge can and do lead to poor decisions,”²² but machines do not possess these weaknesses. Additionally, human intuition can often be incorrect and can tend towards poor assumptions in cases of “causal complexity and information ambiguity [which] often serve to render our predictions haphazard when it comes to a larger canvass, involving big social groups and volumes of ambiguous information.”²³ In such cases, the cold calculus of AI pattern recognizing algorithms can lead to a more subjective, systematic and methodical evaluation of factors, their linkages and meanings. In short, when it comes to prediction of outcomes, in many instances AI can do war gaming better than a human expert.²⁴

¹⁶ Stephan De Spiegeleire, Matthijs Maas, and Tim Sweijs, *Artificial Intelligence and the Future of Defense: Strategic Implications for Small and Medium Sized Force Providers*. . . , 88.

¹⁷ *Ibid.*, 85.

¹⁸ Kareem Ayoub and Kenneth Payne, "Strategy in the Age of Artificial Intelligence." . . . , 803.

¹⁹ Bil Hallaq *et al.*, "Artificial Intelligence Within the Military Domain and Cyber Warfare." *Proceedings of 16th European Conference on Cyber Warfare and Security*. . . , 154

²⁰ Kareem Ayoub and Kenneth Payne, "Strategy in the Age of Artificial Intelligence." . . . , 803.

²¹ *Ibid.*, 804.

²² United Nations Institute for Disarmament Research, *The Weaponization of Increasingly Autonomous Technologies: Considering Ethics and Social Values*, Position Paper, (Geneva, Switzerland: United Nations Institute for Disarmament Research, 2015): 9.

²³ Kareem Ayoub and Kenneth Payne. "Strategy in the Age of Artificial Intelligence." . . . , 803.

²⁴ *Ibid.*, 799.

9. AI can serve to automate low risk command and control functions; however, care must be taken to understand and consider, from both a technical capability and ethical suitability point of view, which processes can and should be supervised by humans and which can be delegated to AI control.²⁵ Such human-machine collaboration frees the commander to focus his expertise and creativity on “higher cognitive tasks of processes such as mission analysis, operational planning, and assessments.”²⁶ AI assisted control and information dissemination can also facilitate flatter organizational structures. Tactical entities are enabled greater autonomy to engage in direct contact with their operating environment, without necessitating constant commander input. Improved lethality could result from the rapidity of AI generated decision cycles, speeding reaction times of tactical entities. Decentralized command of disparate battle elements working towards a human commander’s common intent via AI synchronized control, could enable war fighters to be more agile and “effective in the face of a dynamic situation, unexpected circumstances, or sustaining damage,”²⁷ a combat condition normal in the context of CA operations.

10. AI is recognized by major allies and strategic competitors alike as a potential transformative military technology.²⁸ The Chinese, leaders in the field of AI technology and a strategic competitor, are investing heavily in AI and argue that “the world has passed from the Industrial Era of warfare into the Information Era, in which gathering, exploiting, and disseminating information will be the most consequential aspect of combat operations.”²⁹ Canada’s defence policy *Strong, Secure, Engaged* (SSE) echoes this sentiment, without specifically identifying AI as a priority, and predicts “greater emphasis on information technologies, data analytics, deep learning, autonomous systems,”³⁰ throughout all phases of war and across all operating environments. SSE calls for technologically advanced joint command and control systems (Initiatives 62 and 68) operating as a “networked, joint system of systems”, interconnected between platforms and headquarters.³¹ While technology exists within the military domain to enable limited AI support of these objectives, the experts in the field of AI reside within civilian industry.³² Global defence investment in AI is a fraction of civilian investment in AI, with defense and aerospace research and development (R&D) at around 15% that of the civilian investment in information and communications. Accordingly, civilian multinational companies are the AI technology leaders, not governments.³³ Unless significant integration with industry partners occurs, there is risk that the military will lose a technological edge in AI to corporations, who may not share this technology for militarized applications.³⁴

²⁵ M.L. Cummings, *Artificial Intelligence and the Future of Warfare*. . . , 4.

²⁶ F.G. Hoffman, "Will War's Nature Change in the Seventh Military Revolution?" *Parameters* 47(4) (Winter 2017–18, 2018): 22, https://ssi.armywarcollege.edu/pubs/parameters/issues/Winter_2017-18/5_Hoffman.pdf.

²⁷ David Alberts,. "Agility, Focus, and Coverage: The Future of Command and Control." *The International C2 Journal* 1, no. 1, (2007): 23.

²⁸ Daniel S Hoadley and Nathan J Lucas, *Artificial Intelligence and National Security*. . . , 36.

²⁹ *Ibid.*, 37.

³⁰ Canada. Department of National Defence, *Strong, Secure, Engaged - Canada's Defence Policy*. . . , 55.

³¹ *Ibid.*, 41, 65.

³² Stephan De Spiegeleire, Matthijs Maas, and Tim Sweijjs, *Artificial Intelligence and the Future of Defense: Strategic Implications for Small and Medium Sized Force Providers*. . . , 36.

³³ M L Cummings, *Artificial Intelligence and the Future of Warfare*. . . , 10.

³⁴ *Ibid.*, 11.

11. In April 2018, the Department of National Defence launched the Innovation for Defence Excellence and Security (IDEaS) program, with a view to explore “new innovative approaches to build sophisticated defence and security capabilities responsive to today’s emerging challenges.”³⁵ The Department of Defence recognizes that it does not have the expertise or scope to solve the myriad of emergent national security problems, and seeks to build collaborative networks to “bring together the best minds across Canadian universities, industry and other partners” to help “the free flow of ideas critical to solving modern defence and security challenges.”³⁶ Such initiatives must be leveraged to provide focused engagement with field experts, and should also be expanded to include world leaders in the AI sector. This will ensure the military is at least included in future discussions on AI and can benefit from emerging technological discoveries.

12. A core aversion towards machine control of military power is the “instinctual revulsion against the idea of machines “deciding” to kill humans.”³⁷ There is significant concern as to whether an AI engaged in making such decisions has the capacity to resolve ambiguous situations and achieve intended and acceptable outcomes.³⁸ Human studies suggest that persons incapable of normal emotional responses, presumably operating in a manner similar to an AI system, may “have difficulties with problem solving and judgment” and may have “difficulty recognizing when there is a problem or difficulty changing their way of thinking.”³⁹ AI can be exceptional at making decisions, but as “AI preserves the biases inherent in the dataset and its underlying code”⁴⁰ there is potential for AI to apply precise applications of faulty rationality to critical decisions. Due to the speed of AI decision making, mistakes that happen can occur “much faster than humans can monitor and restrain them . . . [and] because of autonomous systems’ high speed, unexpected interactions and errors can spiral out of control rapidly,”⁴¹ which could result in catastrophic consequences if AI systems are delegated autonomy over kill chains.

13. There is also significant doubt if AI support systems would be capable working within the confines of International Humanitarian Law without human oversight and expert judgement.⁴² This is a particularly relevant concern as AI processes continue to increase in efficacy, and humans become increasingly removed from the AI decision loop in favour of increasing process automation and reaction speed. The Statement of Defence Ethics demands that in the course of their duties soldiers respect the dignity of all persons.⁴³ If a machine makes

³⁵ Canada. Department of National Defence, *Innovation for Defence Excellence and Security (IDEaS)*, October 05, 2018, <https://www.canada.ca/en/department-national-defence/programs/defence-ideas.html> (accessed October 10, 2018).

³⁶ *Ibid.*

³⁷ United Nations Institute for Disarmament Research. *The Weaponization of Increasingly Autonomous Technologies: Considering Ethics and Social Values*. . . , 7.

³⁸ M.L. Cummings, *Artificial Intelligence and the Future of Warfare*. . . , 7.

³⁹ United Nations Institute for Disarmament Research. *The Weaponization of Increasingly Autonomous Technologies: Considering Ethics and Social Values*. . . , 8.

⁴⁰ Kareem Ayoub and Kenneth Payne, "Strategy in the Age of Artificial Intelligence." . . . , 799.

⁴¹ Greg Allen and Taniel Chan, *Artificial Intelligence and National Security*. . . , 24.

⁴² Bil Hallaq *et al.*, "Artificial Intelligence Within the Military Domain and Cyber Warfare." *Proceedings of 16th European Conference on Cyber Warfare and Security*. . . , 155.

⁴³ Canada. Department of National Defence, *Statement of Defence Ethics*, (Ottawa: Department of National Defence, n.d).

a mistake and decisions are taken that result in loss of innocent life, are the victims' lives respected and who is to blame - the machine, the programmer, the commander?⁴⁴ Assigning accountability when an AI makes an error could be legally problematic.

14. An argument in favour of AI in war is that nations may be in fact morally obligated to use such technology, if it operates with sufficient reliability. AI decision support systems can interpret more factors more quickly than any human team. Their optimized solutions ensure maximum stewardship of resources and military options that yield the least overall harm.⁴⁵ Additionally, while AI may not always arrive at better decisions than human experts, many field experts argue that “that militaries that use AI at scale to make acceptable decisions may gain a significant advantage over adversaries who choose not to adopt AI.”⁴⁶ Gaining such military advantage via rapidly generated and acceptable solutions could enable militaries to terminate hostilities more efficiently, ultimately safeguarding human lives and national capital in the process. There are also processes which do not require constant command attention and can be automated by AI. This would save the commander's limited decision space for focusing his expertise and judgement on the ordered use of military force, including ethical dilemma resolution, in consideration of all relevant factors.⁴⁷ Ethical risk can be lessened by keeping AI systems semi-autonomous (commander in the loop, with AI requiring input at key junctures) or human supervised (commander on the loop, with supervision and override capability); ensuring commanders maintain control of key decision points and mitigating both legal and ethical concerns.⁴⁸

CONCLUSION

15. The need to research and identify opportunities for leveraging AI processes in support of command is pressing. Rapid increases in technology are drastically increasing the capacity of AI to improve the efficiency and efficacy of military command. Not only can AI fundamentally change and improve the manner in which data is synthesised into understanding for commanders, it also promises to increase the quality and pace of military decision making.⁴⁹ Civilian industry is the leader in the field of AI, and they must be engaged to ensure that defence considerations are included in future discussions on AI, and that defence shares in the benefits of their technological advances. Failure to investigate and move towards AI supported command, risks being outpaced and outmaneuvered by adversaries who are heavily invested in this contested space. At stake are “tremendous economic, scientific, military and geopolitical rewards.”⁵⁰

⁴⁴ Bil Hallaq *et al*, "Artificial Intelligence Within the Military Domain and Cyber Warfare." *Proceedings of 16th European Conference on Cyber Warfare and Security*. . . , 156.

⁴⁵ United Nations Institute for Disarmament Research. *The Weaponization of Increasingly Autonomous Technologies: Considering Ethics and Social Values*. . . , 11.

⁴⁶ Daniel S Hoadley and Nathan J Lucas, *Artificial Intelligence and National Security*. . . , 27.

⁴⁷ Canada. Department of National Defence, *A-PA-005-000/AP-001, Duty with Honour — The Profession of Arms in Canada*. 2nd ed, (Kingston: Canadian Defence Academy, 2009): 17.

⁴⁸ Daniel S Hoadley and Nathan J Lucas, *Artificial Intelligence and National Security*. . . , 25.

⁴⁹ Daniel S Hoadley and Nathan J Lucas, *Artificial Intelligence and National Security*. . . , 11.

⁵⁰ Stephan De Spiegeleire, Matthijs Maas, and Tim Sweijjs, *Artificial Intelligence and the Future of Defense: Strategic Implications for Small and Medium Sized Force Providers*. . . , 53.

RECOMMENDATION

16. It is highly recommended that the CA pursue research into the application of artificial intelligence in support of command. In the increasingly complex, multidimensional battle space that the CA operates within, it behooves us as stewards of Canada's profession of arms to find the most efficient means to expend national resources – equipment and personnel – in defense of our nation. AI as a command support tool can assist commanders in quickly optimizing complex problem sets and maximizing resource utilization. Leveraging existing civilian industry where possible, significant strides must be made in harnessing the incipient power of AI and its latent potential.

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