





HOW SHOULD THE RCAF ADOPT AUTONOMOUS WEAPONS SYSTEMS?

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AIM

1. The aim of this paper is to propose considerations for a Royal Canadian Air Force (RCAF) concept on Autonomous Weapons Systems (AWS). As the international community continues to discuss the impact of these systems, the technologies upon which they are based continue to improve. By following internationally developed principles related to international law, allied autonomy initiatives, and Canada's military ethos, the RCAF can begin a critical analysis on how to adopt these emerging technologies.

INTRODUCTION

The adoption of AWS will not be a simple task as illustrated by their 2 technological complexity, by the varied perspectives on their use, and the potential pitfalls of their development and employment. Autonomous systems are increasingly pervasive in today's society, often without any second guessing. However, the introduction of increased autonomy in military platforms capable to using deadly force, such as unmanned aircraft systems (UAS), raises serious concerns from legal and ethical perspectives. The United Nations Institute for Disarmament Research (UNIDIR) describes a number of drivers behind military adoption of autonomous technologies, such as reducing risk to forces during 'dirty and dangerous' missions, reallocating forces from dull and repetitive tasks to those requiring human action, increasing decision-making speed over and above an adversary, and stricter adherence to international law in the application of force.¹ One could also describe those drivers as military objectives for AWS. The RCAF is no different, and requires a sound strategy from which project staffs, scientists, industry, government and society can clearly see our approach and maintain their trust in the profession of arms.

3. An AWS can be lethal or non-lethal. Lethal AWS are simply weapon systems capable of using deadly force autonomously, while non-lethal ones are those that augment decision-making and planning, including target selection. The RCAF, in its desire to operate armed Remotely Piloted Aircraft Systems (RPAS), must participate in AWS discussions at the national level to communicate its requirements of both lethal and non-lethal AWS, and to ensure it meets obligations established in national and international laws. This paper will summarize international proceedings on lethal AWS, identify key challenges, and outline some considerations for the RCAF to adopt AWS.

¹ The United Nations Institute for Disarmament Research, *Framing Discussions on the Weaponization of Increasingly Autonomous Technologies* (n.p., 2014), 6.

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DISCUSSION

Summary of International Proceedings

4. UNIDIR began working on autonomy issues in 2014, defining autonomy as "a characteristic of technology, attached to a function or functions, not an object in itself."² Looking at autonomy as a characteristic of technology is an important distinction that society does not yet fully understand, and that the military can help frame through dialogue. The North Atlantic Treaty Organization (NATO) defines autonomy as "a system's ability to function, within parameters established by programming and without outside intervention, in accordance with desired goals, based on acquired knowledge and an evolving situational awareness."³ Both UNIDIR and NATO identify similar and complementary dimensions to the autonomy spectrum. Firstly, the degree of autonomy depends on the level of human involvement. Secondly, the degree of autonomy depends on the complexity of the task and of the computing required to accomplish that task, somewhat akin to technical capabilities. Lastly, the degree of autonomy depends on the tasks or functions that are given autonomy, that is, where a machine is given the freedom to decide how to accomplish specific tasks or functions. Not surprisingly, the dimensions are similar since the nations that participate in NATO discussions also participate in those at the UN. NATO's definition contains important terms such as 'system,' 'goals,' and 'acquired knowledge'. These terms help differentiate traditional scripted computing from Artificial Intelligence (AI), a common foundation of autonomous systems (but not the only one). NATO defines AI as "the capability of a functional unit to perform functions that are generally associated with human intelligence such as reasoning and learning."⁴ The complexities involved in machine learning are beyond the scope of this paper, but important to note that some levels of AI processing are not intuitive or even traceable. Therefore, predicting AWS behaviour is not always possible. Current AI systems can only complete a limited number of tasks and rely on human-machine interactions, though they are expected to become more sophisticated and capable as technology and our understanding of it improves.

Global Challenges

5. A number of international organizations, including the UN, NATO, and the International Committee of the Red Cross (ICRC) identify legal and ethical issues associated with lethal AWS. These issues are not the responsibility of the RCAF to resolve, but are international obligations that the RCAF should be aware of in defining requirements, in testing and verification, and in employing lethal AWS. International Humanitarian Law governs "combatant behaviour and the choice of means and methods

² *Ibid.*, 4.

³ North Atlantic Treaty Organization Terminology Office, "NATOTerm," record 39145, last accessed 27 October 2019, https://nso.nato.int/natoterm/Web.mvc.

⁴ North Atlantic Treaty Organization Terminology Office, "NATOTerm," record 32120, last accessed 27 October 2019, https://nso.nato.int/natoterm/Web.mvc.

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of warfare, including weapons."⁵ AWS, lethal or not, when used in conflict must meet the principles of distinction (combatants from civilians), proportionality (just enough force to counter threats) and precaution (minimize injury/death of civilians and damage to civilian objects).⁶ Just because an AWS meets these legal obligations does not necessarily mean its use is moral. International Human Rights Law, on the other hand, looks at weapons systems from a moral standpoint by asking 'should it be used?' Human dignity is an accepted core principle in the Universal Declaration of Human Rights. The fact that autonomous machines could decide to take a human life without human involvement concerns members of the international community. Such acts perceive to minimize human dignity by treating humans as objects.⁷

Strategic Guidance

6. Strong, Secure, Engaged (SSE) identifies a future security environment that includes data analytics, deep learning, and autonomous systems.⁸ SSE also addresses the legal and ethical concerns in using AWS mentioned above:

Canada is committed to employing new technological capabilities in a manner that rigorously respects all applicable domestic and international law, is subject to proven checks and balances, and ensures full oversight and accountability.⁹

7. SSE further implies that the RCAF, when acquiring and operating RPAS, must consider "maintaining appropriate human involvement in the use of military capabilities that can exert lethal force."¹⁰ This mandate aligns with the concept of Meaningful Human Control put forward by the UN in 2014 as well as the stance taken by the Red Cross regarding an ethical basis for human control over lethal AWS.

8. Air Force Vectors directs collaboration with the United States (US) who are investing in research and development areas such as deep learning machines, human-machine collaboration, advanced human-machine teaming, and semi-autonomous weapons.¹¹ The US Navy already teams their P-8 Poseidon aircraft with their MQ-4C Triton UAS. Both aircraft cooperate and are networked, although the teaming is not yet mature. The US Air Force envisions "introducing greater autonomy and its fundamental

⁵ International Committee of the Red Cross, "Weapons," last accessed 27 October 2019, https://www.icrc.org/en/document/weapons.

⁶ Andre Haider, "Autonomous Weapon Systems in International Humanitarian Law," *JAPCC Journal* 27, (2018): 48-49, https://www.japcc.org/autonomous-weapon-systems-in-international-humanitarian-law/.

⁷ International Committee of the Red Cross, *Ethics and autonomous weapon systems: An ethical basis for human control?* (Geneva, 3 April 2018), 10-11.

⁸ Department of National Defence, *Strong, Secure, Engaged – Canada's Defence Policy* (Ottawa: DND Canada, 2017), 55.

⁹ *Ibid*.

¹⁰ *Ibid.*, 73.

¹¹ Department of National Defence, Air Force Vectors (Ottawa: DND Canada, 2019), 19.

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enabler, AI, into the information-intensive functions of warfighting,^{"12} This does not mean retiring manned platforms in favour of adopting autonomous ones, but the deliberate introduction of autonomy in an incremental manner as technology improves. **Potential RCAF Uses for AWS**

9. The RCAF can exploit lethal and non-lethal AWS in a number of ways. Firstly, the military intelligence function relies on increasing amounts of data. From a human resource perspective, the RCAF cannot process, exploit and disseminate all of it. There is simply too much data and too few people; it will only get worse. The RCAF could adopt non-lethal AWS to assist human analysts in the processing, exploitation, and dissemination (PED) cycle. This will permit human analysts to focus more on only the important information identified by autonomous systems.

10. Secondly, non-lethal AWS could be adopted to improve planning at the strategic, operational and tactical levels. Each level uses different information to develop plans, and the information for each level varies. At the strategic level, AWS could analyze global security and economic indicators to recommend where Canada and the Canadian Armed Forces (CAF) should focus on building relationships or deploying forces. At the operational level, AWS could assist in determining optimal force mixes and bed-down locations considering terrain, logistics requirements, historical weather patterns, current weather forecasts, own force capabilities, desired results, enemy capabilities, enemy courses of action, etc... many of the factors used in the Operational Planning Process. Perhaps AWS could perform weather forecasting, determine possible enemy actions, and participate in battle management. At the tactical level, AWS could assist in determining the best aircraft for each mission, specific mission planning, target detection and identification (including hypersonic threats), and keeping aircraft in a safe and optimal flight profile (e.g. separation from terrain, severe weather, other aircraft, and enemy antiair capabilities). AWS could also collaborate with manned aircraft at the tactical level through human-machine teaming.

11. Lastly, both lethal and non-lethal AWS could be adopted in environments where the risk is too great for humans, including chemical, biological, radiological, nuclear and explosive environments, and where communications are denied. Lethal AWS could focus on destruction of the enemy using kinetic means, while non-lethal AWS could exploit the electromagnetic spectrum in conducting offensive and defensive electronic warfare. These systems could also be employed when no such risk exists simply to obtain an advantage over the enemy. Lethal and non-lethal AWS could also perform weaponeering; however, only lethal systems would attack.

12. Cyber capabilities using AWS (e.g cyber attacks using autonomous algorithms) are beyond the scope of this paper and currently outside RCAF control, but are nonetheless interesting applications.

¹² Department of Defense, *Autonomous Horizons - A Way Forward* (Maxwell AFB: Air University Press, 2019), 35.

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RCAF Considerations in Adopting AWS

13. Training AWS consisting of deep learning algorithms (a form of machine learning used in AI) requires vast amounts of data.¹³ What data needs to include a 'Canadian bias' and what data must not include any bias? The RCAF might not want an AWS, lethal or non-lethal, to behave like a USAF system. Although AWS can learn, their training might have been skewed from the outset resulting in behaviour not reflective of the Canadian military ethos.

14. Testing and verification will ensure AWS meet airworthiness requirements (technical and operational). The traditional method of comparing actual with expected results would prove extremely challenging with AWS since, firstly, their behaviour is not always predictable due to hidden processes within their algorithm. Secondly, their behaviour is therefore not always repeatable due to their ability to learn and to modify their behaviour. What amount of deviation is acceptable? Thirdly, in meeting obligations under international law, how much error is acceptable knowing that humans fail to behave ethically on occasion? Lastly, how often should AWS be verified to ensure compliance with airworthiness requirements and international law considering their learning ability?

The final consideration is likely the most important one, and is divided into three 15. related schools of thought: risk acceptance, military ethos, and the profession of arms. Firstly, the Canadian government mandated human involvement in decisions to use lethal force. Where in the chain of command does that decision occur? Is there sufficient human involvement if the human operator selects an option permitting the machine to attack on its own? Humans do not necessarily have the technical knowledge and the cognitive abilities to properly supervise autonomous systems designed to operate faster than human abilities, nor are humans always able to determine AWS behaviour ahead of time due to hidden processes inside deep learning machines.¹⁴ At what level does the risk to use lethal AWS in the first place get accepted? How does one qualify or quantify the risk of using a weapon system that can adapt its behaviour? Secondly, military ethos establishes "the trust that must exist between the Canadian Forces and Canadian society."¹⁵ The RCAF cannot be seen as irresponsible and not accountable for the actions of lethal and non-lethal AWS. Breaking that trust has dire consequences for the RCAF and for the CAF. Lastly, the profession of arms relies on predictable behaviour, obedience to lawful orders, and transparent actions to succeed.¹⁶ Could AWS erode the profession if we get it wrong?

CONCLUSION

¹⁴ Regina Surber, Artifical Intelligence: Autonomous Technology (AT), Lethal Autonomous Weapons Systems (LAWS) and Peace Time Threats (Zurich: ICT4Peace Foundation, 2018), 6.

¹⁵ Department of National Defence, A-PA-005-000/AP-001, *Duty with Honour* (Ottawa: DND Canada, 2009), 26.

¹⁶ *Ibid.*, 26-33.

¹³ The United Nations Institute for Disarmament Research, *The Weaponization of Increasingly Autonomous Technologies: Artificial Intelligence* (n.p., 2018), 3-4.

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16. AWS have the potential to benefit the RCAF by mitigating personnel shortfalls, by assisting human analysts sift through large amounts of data, by assisting decision-makers in selecting options which are calculated to have optimal outcomes, and by contributing to continued use of force in areas deemed too dangerous for humans. Although the legal and ethical concerns of the international community are not yet resolved, the RCAF is mandated by government through defence policy to include humans in the decision to use lethal force associated with lethal AWS such as armed RPAS. Our US allies are developing advanced autonomous technologies and intend to introduce them incrementally. The RCAF cannot lag too far behind; technology is improving too quickly and our adversaries seek to exploit those same technologies. An RCAF concept, informed by this paper, could describe in detail how the doctrinal functions of Command, Sense, Act, Shield, Sustain and Generate would be impacted by adopting AWS. Such systems, however, are not without challenges that should not be ignored.

RECOMMENDATIONS

17. <u>Recommendation 1 - Joint Efforts</u>. The RCAF cannot act alone in its quest for AWS. Other environmental services are also seeking to exploit autonomous systems in some fashion. Knowledge and lessons must be shared between organizations to achieve better results in less time and with fewer frustrations. The RCAF should work with defence scientists, the Navy, the Army, the Special Operations Forces, and Chief of Force Development staff on joint AWS issues.

18. <u>Recommendation 2 - US Collaboration</u>. Strategic guidance does not suggest the RCAF design and manufacture AWS within the Department of National Defence as it is a costly endeavour. Instead, Air Force Vectors directs the RCAF to collaborate with the US to leverage their technological developments. This collaboration should begin soonest to establish relationships and to transfer knowledge, possibly through exchange positions.

19. <u>Recommendation 3 - RCAF AWS Concept</u>. The RCAF needs to show its members, the CAF at large, military allies, the Canadian government and the Canadian people how it intends to adopt lethal and non-lethal AWS. The RCAF should develop an AWS concept to inform key stakeholders in RCAF force development and the profession of arms.

20. <u>Recommendation 4 - Implementation of AWS</u>. The RCAF should implement AWS in a manner similar to the US Air Force where advanced technologies are introduced in an incremental manner as they mature, beginning with increasing the autonomy in manned functions. This will reduce the increasing workload on human operators and freeing up their capacity to focus on human aspects of warfare. As technologies advance, the RCAF should investigate the next steps for adopting increasing levels of autonomy.

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