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THE EFFECTS OF UNMANNED AND AUTONOMOUS WEAPONS

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THE EFFECTS OF UNMANNED AND AUTONOMOUS WEAPONS

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THE EFFECTS OF UNMANNED AND AUTONOMOUS WEAPONS

AIM

1. This service paper aims to explain the broad impacts that unmanned and autonomous platforms have on the future warfighting domains. Examples include the effectiveness of fighting drones facing off against crewed equipment and potential avenues the Canadian Armed Forces (CAF) can look at adapting to this threat. The discussion will focus on why the CAF needs to be cognizant of development in remote and autonomous drone developments in war.

INTRODUCTION

2. In late 2020, the conflict between Armenia and Azerbaijan in Nagorno-Karabakh marked a new stage of warfare; affordability.[1] Though military drones have been in regular use since Afghanistan (e.g., the General Atomics "Predator" and Northrop Grumman "Global Hawk"), they were often the mark of technologically superior forces with the research base to produce and support them. Their costs can range from $16M - $130M USD.[2] With other near-peer actors joining the defence industry, a wide array of capabilities is being brought to the budget market, specifically unmanned drones. The price of a Chinese Wing Loong II military drone ranges from $1-2M USD.[3] Poorer states have already begun to leap-frog over expensive air forces, moving straight to drone procurements, including Algeria, Nigeria, Jordan, Zambia, Ethiopia, Turkmenistan, Pakistan, and Myanmar.[4] Noting that these nations are not typically allies to Western countries, it begs to question how a conventional military force like Canada's would fare against such opponents.

3. Paired with these new systems is the advent of Artificial Intelligence (AI). Unmanned and AI-driven platforms fall into the autonomous weapon realm, previously only existing in science fiction. Already technologies such as facial/image recognition, Light Detection and Ranging (LIDAR), Global Positioning Systems (GPS), and AI networks are becoming prominent in smaller, ordinary, everyday devices. Military drones are now assuming more of these advances into their platforms.[5] Advancements in AI have increased the autonomous nature of military drones, with western defence manufacturers leading the charge. Yet, while ethical questions about using autonomous

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[1] Robyn Dixon, "Azerbaijan's Drones Owned the Battlefield in Nagorno-Karabakh — and Showed Future of Warfare," *Washington Post*, November 11, 2020, https://www.washingtonpost.com/world/europe/nagorno-karabkah-drones-azerbaijan-aremenia/2020/11/11/441bcbd2-193d-11eb-8bda-814ca56e138b_story.html.

[2] "Factbox: The Global Hawk Drone Shot down by Iran," Reuters, June 20, 2019, https://www.reuters.com/article/us-mideast-iran-usa-factbox-idUSKCN1TL29K; Greg Waldron, "China Finds Its UAV Export Sweet Spot," Flight Global, June 14, 2019, https://www.flightglobal.com/military-uavs/china-finds-its-uav-export-sweet-spot/132557.article.

[3] Greg Waldron, "China Finds Its UAV Export Sweet Spot."

[4] Sharon Weinberger, "China Has Already Won the Drone Wars," Foreign Policy, 2018, https://foreignpolicy.com/2018/05/10/china-trump-middle-east-drone-wars/.

[5] Robert Sparrow and George Lucas, "When Robots Rule the Waves?," *Naval War College Review* 69, no. 4 (2016): 64.

weapons in actual conflict are already surfacing, the West's adversaries would likely not feel the same restraint. This was demonstrated in the various war crimes committed in recent conflicts such as the Syrian civil war and its various foreign sponsors; extrapolation into the drone domain is not a far one.[6] By 2030, a nation like Canada will face challenges understanding drone advancements in the functional domains, barriers to its involvement in the technology, and questions in its attempts to counter them. With the advent of remote and autonomous technology in the 21st century, the CAF must be mindful of how each functional domain is affected and take steps today to understand this threat.

DISCUSSION

Advances across all domains

4. Remote drones are now available in all domains of warfare. Unmanned Aerial Vehicles (UAV) provide a widely available air-to-ground element in various sizes and configurations to support land forces. The smallest, like the Switchblade or Puma, can be carried by a single soldier and launched in almost any terrain.[7] These have a limited range (from 20 to 60 km) yet bring an Intelligence, Surveillance and Reconnaissance (ISR) capability to even the smallest ground force. These one-person drones can be weaponized in a kamikaze fashion depending on their payload. From this, UAVs only get larger. The larger variants can be equipped with multiple attack options (e.g., missiles) and can coordinate with other drone elements, as was witnessed in Nagorno-Karabakh.[8] When used in significant quantities, these systems currently pose the newest threat to personnel and armoured elements on the battlefield. On the ground itself, land-based Unmanned Ground Vehicles (UGV) have long been used in situations like bomb-defusal robots and the like, but have now grown into remotely controlled weapons like the Russian URAN-9 tested in Syria.[9] Though undoubtedly impressive, these systems are not a current concern as they suffer the same limitations of similar manned land-based machines (maintenance, terrain, fuel, etc.). In almost all cases today, the UAVs/UGVs require human operators for control, and the UAV is the most prominent drone-type established on the battlefield today.

5. Remarkable progress in drone development has been made in the maritime domain. Styled as Unmanned Surface Vehicles (USVs) or Unmanned Underwater Vehicles (UUVs), these have gone the furthest in the autonomous sphere. UUVs have, until recently, been the privy of maritime researchers for undersea exploration and accident recovery activities where the repetitive collection of data was required for an

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[6] "Fresh Evidence of War Crimes Committed by All Sides in Syrian Conflict, Probe Finds," UN News, July 7, 2020, https://news.un.org/en/story/2020/07/1067761.
[7] "Puma™ LE UAS," AeroVironment Inc., accessed February 5, 2021, https://www.avinc.com/tuas/puma-le.
[8] Dixon, "Azerbaijan's Drones Owned the Battlefield in Nagorno-Karabakh — and Showed Future of Warfare."
[9] Daniel Brown, "Russia's URAN-9 Robot Tank Reportedly Performed Horribly in Syria," Business Insider, accessed July 9, 2019, https://www.businessinsider.com/russias-uran-9-robot-tank-performed-horribly-in-syria-2018-7.

indefinite period. This was demonstrated during the deployment of the Bluefin-21 in its search for the missing Malaysia Airlines Flight 370.[10] These same technologies can be used almost seamlessly in a military context. In the UUV realm, systems such as the Sea Stalker and the Mark 60 CAPTOR have seen great success in several previously human-driven tasks.[11] This includes hull investigation, underwater reconnaissance, mine-clearing/laying and progress towards undersea attack. The first obvious advantage is the lack of crew; removing the training, human logistics requirements (oxygen, food, etc.) and the risk to human life. Expendability could mean the willingness to give up stealth to use sonar more actively to track enemy submersibles. In places such as the arctic shelf, sovereignty could be maintained for extended periods without the need for surfacing for oxygen as a limiting factor. USVs, like the Spartan Scout, could play their role in terms of reconnaissance or force protection.[12] Yet, like UGVs, their usefulness is still outweighed by human-operated craft as many USVs and UUVs are still in developmental stages. Both UUV and USVs are also costly and heavily technologically based and have yet to be considered affordable enough for vast proliferation.

6. The sea-to-air component is where the most nuanced and novel ideas are now coming from. Systems like the Blackwing can launch UAVs from a submerged posture, greatly expanding the ISR capability of a submarine while decreasing their risk of exposure.[13] Surfaced-launched UAVs can be used for reconnaissance past a ship's line of sight, and the Royal Canadian Navy (RCN) found success is such systems previously like the ScanEagle.[14] The transition from a primarily land-based use to a sea one is practical and has a low entrance cost. One of the greatest dangers to surface-based combatants is the air-to-sea attack aspect of a UAV. Their small radar profile, quantity, and potential payload make these systems a possible threat to naval vessels.[15] Like the UAV threat to tanks, the risk posed to a modern navy makes naval UAVs especially dangerous.

7. While fifth-generation fighter jets are already taking the field in the air domain, unmanned aerial combat vehicles are only recently taking shape. There are very few drones in the air-to-air realm, and none are currently competing with crewed aircraft. The most promising development is the "loyal wingman" program, a semi-autonomous system that is "slave" to a lead aircraft.[16] This mode would allow a pilot to give the drone targets to engage, as well as a suicidal shield that absorbs incoming enemy fire. Though

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[10] "Bluefin-21 Unmanned Underwater Vehicle (UUV)," General Dynamics Mission Systems, accessed February 5, 2021, https://gdmissionsystems.com/products/underwater-vehicles/bluefin-21-autonomous-underwater-vehicle; "Missing Flight MH370: Robotic Submarine to Begin Search," BBC News, April 14, 2014, https://www.bbc.com/news/world-asia-27017928.
[11] Sparrow and Lucas, "When Robots Rule the Waves?," 54–55.
[12] *Ibid.*, 51–55.
[13] "Blackwing™ - Tactical Missile System - Submersible Loitering Reconnaissance System," AeroVironment, Inc., accessed January 21, 2021, https://www.avinc.com/tms/blackwing.
[14] Conrad Edward Orr, "Can Unmanned Aircraft Systems Meet Canadian Air Power Needs?," *Royal Canadian Air Force Journal* 5, no. 3 (2016): 17.
[15] Patrice Deschênes, "The Rise of the Drones: Technological Development of Miniaturized Weapons and the Challenges for the Royal Canadian Navy," *Canadian Military Journal* 19, no. 2 (2019): 53.
[16] Boeing Australia, "Loyal Wingman Unmanned Aircraft System, Australia," Airforce Technology, accessed January 27, 2021, https://www.airforce-technology.com/projects/loyal-wingman-unmanned-aircraft/.

there is a lack of competition in this field, many gains are to be made in this domain. Even an experienced pilot can only take g-forces (g_0) in the magnitude of 8-9 g_0 with training, far below the mechanical stress limits that aircraft structures can handle.[17] Removing the human element would allow increased maneuverability, achieving tighter turns and speeds than any human can manage. Further advances in the autonomous realm are also expected. Concepts like the "Skyborg" or "Autonomy Engine" systems, networked AI architectures, are expected to be under trial within the next two years.[18] These systems represent the advancement of integrated battlespace management, where ISR assets from the other domains conduct the targeting while engagement is accomplished by an autonomous aircraft. In non-permissive environments where there is a lack of air superiority, this advancement is most welcome. This is still a technologically heavy and costly sector and is currently limited to the most advanced militaries. Unlike the other domains, rapid proliferation in the air-to-air environment is not expected in the near future as the advantages of production, quantity, and low cost are not yet realized.

Barriers to entrance and defence

8. Regardless of whether or not nations like Canada would enter the fray, the use of both unmanned and autonomous weapons introduces ethical and procurement challenges not previously considered. There are currently no international bans on autonomous drones. However, there have been several open letters from concerned scientists and citizens regarding the issue.[19] In addition, various motions have been brought up to the Convention on Prohibitions or Restrictions on the Use of Certain Conventional Weapons, a UN body held in Geneva, where several member states have brought up their objections.[20] The biggest concern for most interested parties is the lack of a human element to use lethal force. Considering the long chain of legal and strategic approvals used in current drone strikes and other missions, the thought of a program deciding whether someone lives or dies is inherently *inhuman*. A common worry is the use of image recognition technology to target members of an enemy population based on a set

[17] Peter Tyson, "All About G Forces," Nova Space+Flight, October 31, 2007, https://www.pbs.org/wgbh/nova/article/gravity-forces/.
[18] Joseph Trevithick, "These Three Companies Will Build Drones To Carry The Air Force's 'Skyborg' AI Computer Brain," The Drive, December 7, 2020, https://www.thedrive.com/the-war-zone/38015/these-three-companies-will-build-drones-to-carry-the-air-forces-skyborg-ai-computer-brain; Joseph Trevithick, "General Atomics Avenger Drone Flew An Autonomous Air-To-Air Mission Using An AI Brain," The Drive, December 4, 2020, https://www.thedrive.com/the-war-zone/37973/general-atomics-avenger-drone-flew-an-autonomous-air-to-air-mission-using-an-ai-brain.
[19] Mary Wareham, "The Campaign to Stop Killer Robots," December 16, 2020, https://www.stopkillerrobots.org/about/.
[20] "Autonomous Weapons That Kill Must Be Banned, Insists UN Chief," UN News, March 25, 2019, https://news.un.org/en/story/2019/03/1035381; "All Drone Strikes 'in Self-Defence' Should Go before Security Council, Argues Independent Rights Expert," UN News, July 9, 2020, https://news.un.org/en/story/2020/07/1068041; Gillian Linden, "Pathways to Banning Fully Autonomous Weapons – UNODA," United Nations - Office for Disarmament Affairs, October 23, 2017, https://www.un.org/disarmament/update/pathways-to-banning-fully-autonomous-weapons/; "First Committee Weighs Potential Risks of New Technologies as Members Exchange Views on How to Control Lethal Autonomous Weapons, Cyberattacks," UN Meetings Coverage and Press Release, October 26, 2018, https://www.un.org/press/en/2018/gadis3611.doc.htm.

of physical features that make up their ethnicity.[21] Though images of the atrocities of machines run amok were once thought to be fantasy, the chance of purposeful use in this manner is now becoming a reality. Though western nations have concerned publics and follow a rules-based order, many of the west's adversaries do not. Misusing automated weapon systems to gain an advantage over the west's perceived strength is a likely reality.

9. If the ethical considerations weren't enough, procurement of this technology in western nations is also a concern. Until recently, military drones were a highly specialized technology that did not demonstrate much savings than their manned counterparts. But as presented, the advances in UAVs, UUVs, USVs, and UGVs have produced gains in niche fields, and price points have changed across the board. Yet besides the cost, only a few of these systems have been proven in combat. This makes taking financial risks for these products hard for defence procurement processes to swallow. Yet, many of Canada's partners are doing so. The UK, US, and Australian air forces are investing in the loyal wingman concept, an unmanned autonomous system.[22] Canada is currently not part of any sizable multinational drone projects, and the failure of the CAF's previous Joint Unmanned Surveillance and Target Acquisition System (JUSTAS) project due to cost overruns and scope creep caused it to be canceled through it's own internal auditing mechanisms.[23] Yet, Canada's government is advancing the Remotely Piloted Aircraft System (RPAS) project as successor to the JUSTAS model.[24] Its projected completion is 2025 for initial operational capability.

10. Manned systems still show a clear advantage in almost all domains. Yet this will not always be the case. The most dangerous and emerging threat today is the cheap and efficient air-to-ground UAV. Defence against such systems is still being realized, and there are currently no cost-effective answers to face them. The recent conflict in Nagorno-Karabakh proved that conventional army weapons would not be sufficient.[25] Examination of Canada's current defences in a similar circumstance does not look pretty. Other than the shotgun, the CAF currently boasts zero air defence capability since the

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[21] Stop Autonomous Weapons, *Slaughterbots* (Stop Autonomous Weapons, 2017), https://www.youtube.com/watch?v=9CO6M2HsoIA.

[22] Andrew Chuter, "British Shell out Seed Funding for 'Loyal Wingman' Combat Drone," Defense News, January 25, 2021, https://www.defensenews.com/global/europe/2021/01/25/british-shell-out-seed-funding-for-loyal-wingman-combat-drone/; Greg Waldron, "Boeing Australia Pushes 'Loyal Wingman' Maiden Flight to 2021," Flight Global, December 20, 2020, https://www.flightglobal.com/defence/boeing-australia-pushes-loyal-wingman-maiden-flight-to-2021/141691.article; Garrett Reim, "US Air Force Launches Skyborg Competition, Artificial Intelligence for Loyal Wingman UAV," Flight Global, May 18, 2020, https://www.flightglobal.com/military-uavs/us-air-force-launches-skyborg-competition-artificial-intelligence-for-loyal-wingman-uav/138426.article.

[23] Department of National Defence, *Internal Audit of Joint Unmanned Surveillance and Target Acquisition System (JUSTAS) Project* (Ottawa: Chief Review Services, 2014), ii, https://www.canada.ca/en/department-national-defence/corporate/reports-publications/audit-evaluation/internal-audit-joint-unmanned-surveillance-target-acquisition-system-justas-project.html.

[24] Department of National Defence, "Remotely Piloted Aircraft System (RPAS)," Government of Canada, November 24, 2020, https://www.canada.ca/en/department-national-defence/services/procurement/remotely-piloted-aircraft-system.html.

[25] Dixon, "Azerbaijan's Drones Owned the Battlefield in Nagorno-Karabakh — and Showed Future of Warfare."

retirement of the Air Defence Anti-Tank System (ADATS) in 2012.[26] Even if it had still retained this system, the complement of only eight missiles would have been quickly exhausted by the numerous units that it would have had to engage. CF-18s could possibly engage drone targets. Yet drone radar profiles are minuscule, and like the ADATS, its limited air-to-air missile supply would reduce its effectiveness. Various militaries are looking into this threat, with systems such as laser defences and drone-vs-drone solutions being brought into the mix.[27] Canada is currently not part of any such program. With the advent of all near-peer actors accumulating and proliferating UAV technology, a solution to face this threat is currently out of Canada's reach.

CONCLUSION

11. The broad impacts of both unmanned and autonomous weapons will be significant in the conflicts to come. Their proliferation is limited to near-peer adversaries and failing states worldwide due to their effectiveness, ease of production, and affordability. Each environmental component faces advances and challenges with these technologies, and Canada is unprepared to face this threat in any of them. Examination and investment of this growing sector is recommended.

RECOMMENDATIONS

12. As stipulated in the paper, the general theme is that both unmanned and autonomous technologies will continue to advance and may soon be an operational arm of several militaries. Canada is not currently equipped to deal with this threat. Three suggestions could help Canada advance cautiously while taking the nation's values and legal concerns into account:

Raised awareness

13. Situational awareness of these technologies and their trends are currently held in academia, intelligence, or senior rank circles. None of this is helpful when tactical fighting forces may have to face an adversary utilizing these systems. If not using them ourselves, the CAF should adopt an awareness and training approach to identify and combat these threats. Like mine awareness training, Canada does not need to use them to mitigate their effects.

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[26] Department of National Defence, "Equipment," Canadian Army, July 20, 2009, https://web.archive.org/web/20110610131640/http://www.army.forces.gc.ca/land-terre/equipment-equipement/item-eng.asp?product=65; Murray Brewster, "Canada Needs Updated Anti-Aircraft Systems for the Modern Battlefield, Says Army Commander," CBC News, December 28, 2019, https://www.cbc.ca/news/politics/anti-aircraft-canadian-forces-1.5399461.

[27] "Laser-Focused Battlefield Defence," Boeing Directed Energy, accessed February 5, 2021, https://www.boeing.com/defense/missile-defense/directed-energy/index.page; Kyle Mizokami, "A Reaper Drone Shot Down Another Drone in First Unmanned Air-to-Air Kill," Popular Mechanics, September 19, 2018, https://www.popularmechanics.com/military/aviation/a23320374/reaper-drone-first-unmanned-air-to-air-kill/.

Investment in anti-drone defences

14. If not worse, Canada would have fared just as well if it was in Armenia's shoes. Canada has no dedicated anti-drone technology at this time. Such technology needs to detect small, mid-altitude, massed targets. It also has to engage them in quick succession. Several technologies such as Boeing's Compact Laser Weapon System are currently being offered as a solution, but no one nation has a silver bullet for this.[28] Investment by the CAF, and perhaps encouraging the local defence industry to investigate this problem, would be warranted.

Testing and trials

15. Not only does Canada need to defend against a drone threat, but it also should begin to participate in their advancement of them in the field to gain the advantages these systems bring and match other modern militaries. Though the CAF has previously purchased the Sperwer and the Heron, neither of these experienced continual use after Afghanistan.[29] The CAF's current use of the Raven-B system is limited to certain elements of the Canadian Army.[30] The risk aversion of Canada's defence procurement system can be avoided with small, controlled trials considering the systems' relatively inexpensive nature. Canada's Five Eye partners are already investing resources; contributing to the partnership would share some risks. Canada has yet to establish a strong industry of these kinds in the defence sector. Initiatives in Defence Research and Development Canada (DRDC) should be pursued if they are not already. The RPAS project shows great promise, yet its long timeframe (full operating capacity by 2030) and track record for government procurement does not bode well for near-term conflict.[31] Investments and trials in cheaper and similar systems could satisfy our nation's procurement system's risk-averse nature and open our industry and palate up to more complex purchases.

[28] "Laser-Focused Battlefield Defence."
[29] David Pugliese, "Heron and MQ-9 Drones Approved for Canadian Military Program," Ottawa Citizen, October 17, 2019, https://ottawacitizen.com/news/national/defence-watch/heron-and-mq-9-drones-approved-for-canadian-military-program.
[30] Orr, "Can Unmanned Aircraft Systems Meet Canadian Air Power Needs?," 17.
[31] Department of National Defence, "Remotely Piloted Aircraft System (RPAS)."

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