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Opportunities for Automation Across the Canadian Armed Forces

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Exercise Solo Flight

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THE NEW WORKFORCE: EXPLORING OPPORTUNITIES FOR AUTOMATION ACROSS THE CANADIAN ARMED FORCES

INTRODUCTION

Humans in the Fourth Industrial Revolution[1] are fast becoming the greatest liability in business processes; and yet, they are also capable of creativity and resourcefulness that are yet unmatched by machine labour.[2] It is therefore not surprising that business leaders would invest in technologies that complement the human workforce and make up for its natural limits to improve efficiency and quality, while reducing risk. It is precisely this vision, that has led to the emergence of robotic process automation (RPA). Though the concept first surfaced in the business world, it transfers seamlessly to defence, where its multiple applications have already been acknowledged by Canada's allies.

This paper seeks to highlight the need and explore opportunities for RPA within the Canadian Armed Forces (CAF), while specifying the conditions for its successful implementation. It argues that opportunities abound in terms of both institutional and tactical applications, but while RPA aligns conceptually with current pan-governmental and departmental policies, optimal implementation is hampered by a lack of understanding, vision, and systemic agility.

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[1] The term was coined by Klaus Schwab, the executive chairman of the World Economic Forum, and is now frequently used to describe the new global environment, transformed by interconnectivity and smart technologies. It replaces the Third Industrial Revolution, which introduced computerization, and is considered distinct based on the level of disruption that it creates.

[2] While "one of the perceived dividing lines between human intelligence and machines was the seemingly unique ability that humans have to be creative," even this statement is now being challenged by some experts. Nevertheless, the body of literature on the topic generally recognizes in humans a unique ability in terms of creativity. See Glennn Moy, Slava Shekh, Martin Oxenham & Simon Ellis-Steinborner, *Technical Report: Recent Advances in Artificial Intelligence and their Impact on Defence*, Defence Science and Technology Group, (Canberra: Australian Department of Defence, 2020): 18, https://www.dst.defence.gov.au/sites/default/files/publications/documents/DST-Group-TR-3716_0.pdf.

To support this thesis, the paper first summarizes the strategic context of Canada and some of the macro-challenges currently facing the CAF. It then defines RPA before exploring its merits and acknowledging its critics. Noting a parallel between Canada and Australia, this paper then details the progress of the latter, given that Australia has embraced automation to varying degrees since at least 2015. Finally, it explores the ways in which the CAF could implement RPA successfully, drawing primarily upon recommendations in the literature and the Australian experience.

STRATEGIC CONTEXT

In introducing the need for a new strategic concept, the North Atlantic Treaty Organization (NATO) stated that "the world has fundamentally changed in the past decade."[3] This forthcoming concept is to be articulated within the greater vision of NATO 2030, which seeks to bolster the Alliance's readiness and unity in an "era of increased global competition."[4] The resulting uncertainties and threat to the rules-based international order, coupled with the fact that "emerging technologies are changing the nature of peace, crisis, and conflict"[5] are common themes of the Western understanding of conflict in the Fourth Industrial Revolution, and Canada is no exception. In its current defence policy *Strong, Secure, Engaged* (SSE), the Government of Canada identifies three macro security trends of relevance: "the evolving balance of power, the changing nature of conflict, and the rapid evolution of technology."[6] In turn, these trends result in a

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[3] NATO, "NATO 2022 Strategic Concept," last accessed 24 March 2022, https://www.nato.int/strategic-concept/index.html.
[4] NATO, "NATO 2030 Factsheet," published June 2021, last accessed 24 March 2022, https://www.nato.int/nato_static_fl2014/assets/pdf/2021/6/pdf/2106-factsheet-nato2030-en.pdf.
[5] *Ibid*.
[6] Canada, DND, *Strong, Secure, Engaged: Canada's Defence Policy*, (Ottawa: DND, 2017): 49, http://dgpaapp.forces.gc.ca/en/canada-defence-policy/docs/canada-defence-policy-report.pdf.

defence environment that is faster, broader, less symmetrical, and notably more complex.[7] The consensus across Western defence literature is that adapting to this evolving environment requires integrated institutions, force structures, personnel, and capabilities capable of expediting planning, decision-making, and the resulting actions across all domains.

For Canada however, adapting the military force to remain relevant through the Fourth Industrial Revolution is not the only challenge. As it is, the CAF have significant personnel shortages as they struggle to re-establish their credibility in the wake of successive scandals,[8] accounting for approximately 12,000 unfilled positions or 11.8% of their authorized strength.[9] The result is a force that is overburdened, with "large pockets within the organization who are running on overdrive as they underpin [the] operational and institutional demand."[10] Staff shortages within the CAF are long standing, predating both the COVID-19 pandemic and recent revelations of its inappropriate culture.[11] With the organization's immediate focus squarely on recovering from these circumstances, it is not clear how many years will be required to address the issues underlying the shortfalls in recruitment and retention.

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[7] Martin Charette, "Unfulfilled Potential: Reflection on the Canadian Armed Forces Adaptability in the Age of Accelerations," (Joint Command and Staff Programme Paper, Canadian Forces College, 2021): 3.
[8] National Post, "Defence Chief 'Seeing Some Cracks' as Canadian Military Hit with Multiple Challenges," published 3 June 2021, last accessed 24 March 2022, https://nationalpost.com/news/canada/cracks-appearing-as-canadian-military-faces-confluence-of-challenges-defence-chief.
[9] National Post, "Military Dealing with More Than 10,000 Unfilled Positions amid Growing Pressures," published 18 January 2022, last accessed 24 March 2022, https://nationalpost.com/pmn/news-pmn/canada-news-pmn/military-dealing-with-more-than-10000-unfilled-positions-amid-growing-pressures.
[10] Canada, DND, "March 5: Message from the Acting Chief of the Defence Staff (A/CDS)," published 5 March 2021, last accessed 24 March 2022, https://www.canada.ca/en/department-national-defence/maple-leaf/defence/2021/03/march-5-acting-chief-of-the-defence-staff.html.
[11] The issues of CAF recruitment and retention were such in the years following the termination of the Afghanistan mission that it justified an audit by the Office of the Auditor General, who delivered its report in 2016. See Canada, Office of the Auditor General, "Report 5, Canadian Armed Forces Recruitment and Retention—National Defence," completed 28 September 2016, last accessed 24 March 2022, https://www.oag-bvg.gc.ca/internet/English/att__e_41860.html.

The Department of National Defence (DND) and the CAF are arguably left with the option to address these issues sequentially or simultaneously. However, an enduring lack in capability and readiness in national defence pending institutional reforms is unlikely to be palatable, especially in light of recent Russian expansionism and the call by NATO for Canada "to do more."[12] Considering the implication is for Canada to literally *do more with less*, avenues to augment the workforce beyond its current capabilities should be investigated. Thankfully, disruptive technologies present as many opportunities as they do challenges, making RPA an alluring recourse that is in accordance with the call by SSE to leverage new technologies.[13]

ROBOTIC PROCESS AUTOMATION: AN OVERVIEW

RPA is a subset of business process automation (BPA), or the "automation of complex business processes and functions . . . through the use of advanced technologies."[14] One way to view RPA is as "the process by which a software bot uses a combination of automation, computer vision, and machine learning to automate repetitive, high-volume tasks that are rule-based and trigger-driven."[15] While RPA necessarily involves a sensing and learning software,[16] its output could be digital or

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[12] CBC, "NATO Head urges Canada, Other Allies to do More on Defence Commitments," published 20 March 2022, last accessed 24 March 2022, https://www.cbc.ca/news/politics/nato-commitments-defence-spending-canada-1.6391402.
[13] Canada, DND, *Strong, Secure, Engaged* . . ., 55.
[14] Gartner, "Gartner Glossary: Business Process Automation (BPA)," last accessed 18 March 2022, https://www.gartner.com/en/information-technology/glossary/bpa-business-process-automation.
[15] The Enterprisers Project, "How to Explain Robotic Process Automation (RPA) in Plain English," published 30 July 2020, last accessed 18 March 2022, https://enterprisersproject.com/article/2019/5/rpa-robotic-process-automation-how-explain.
[16] This basic assertion is countered by some sources, which is indicative of the various perspectives regarding RPA. For instance, KPMG, a British-Dutch professional services firm with offices across the globe, declares of RPA that it is "the simplest form of automation [and that] this technology cannot learn, adapt or make decisions." Given the purpose of this paper to inform possible changes within the CAF, the

physical (i.e. action by an automaton).[17] In the simplest of terms, RPA is thus the employment of an attended or unattended "virtual robot copycat"[18] with significant variance in complexity and refinement,[19] leading to the categorization of RPA as either *assisted*, *unassisted*, *autonomous*, or *cognitive*.[20, 21] A similar concept–that of Robotics and Autonomous Systems (RAS)–captures broadly the means to achieve RPA.[22]

As a subset of BPA, RPA aims to optimize business processes by improving their efficiency, consistency, and the quality of their outputs, while reducing the risks associated with both human error and exposure. The replacement of humans in some contexts can also alleviate security concerns, notably when it comes to handling sensitive data.[23] Practically, RPA is focussed towards "automating some of the most mundane and

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broader, more dominant perspective regarding RPA was retained. See KPMG, "The Augmented Workforce," last accessed 14 April 2022, https://home.kpmg/xx/en/home/insights/2018/06/augmented-workforce-fs.html.

[17] Australia, Australian Army Research Centre, "Future Land Warfare Collection 2021: Joint Logistics Through Robotic and Autonomous Systems - Opportunities and Risks," published 29 July 2021, last accessed 24 March 2022, https://researchcentre.army.gov.au/library/land-power-forum/future-land-warfare-collection-2021-joint-logistics-through-robotic-and-autonomous-systems-opportunities-and-risks.

[18] The Enterprisers Project, "How to Explain Robotic Process Automation (RPA) in Plain English . . .

[19] Numerous authors and researchers note the confusion that results from "the absence of an internationally agreed scale of autonomy". This is particularly true in areas where most capabilities are individual components within a broader "system of systems", such as defence. Can one capability be considered truly autonomous when it relies on other systems that are not? See Australia, Australian Army Research Centre, "Future Land Warfare Collection 2021: Joint Logistics Through Robotic and Autonomous Systems . . .

[20] Medium, "Evolution of Robotic Process Automation (RPA): The Path to Cognitive RPA," published 29 August 2018, last accessed 18 March 2022, https://medium.com/@AIMDekTech/evolution-of-robotic-process-automation-the-path-to-cognitive-rpa-c3bd52c8b865.

[21] This evolution from virtual *assistants* to a virtual *workforce* has led some analysts to distinguish RPA from the more cognitively driven Intelligent Process Automation (IPA), though the two concepts vary only in technological terms. Given the overlap between these expressions, they are used interchangeably in this paper.

[22] The Australian Army defines RAS as "the application of software, artificial intelligence and advanced robotics to perform tasks as directed by humans." It amplifies this definition by stating that "autonomy is the ability of a machine to perform a task without human input. Thus an autonomous system is a machine, whether hardware or software, once activated performs some task or function on its own." RAS is the sum of the means to achieve RPA, though literature often fails to capture this nuance, preferring one term over the other. See Australia, Army, *Robotics & Autonomous Systems Strategy*, (Australian Department of Defence, 2018): 5, https://researchcentre.army.gov.au/sites/default/files/2020-03/robototic_autonomous_systems_strategy.pdf.

[23] Process Fusion, "6 Robotic Process Automation (RPA) Trends to Watch Out for in 2020," published 3 January 2020, last accessed 18 March 2022, https://www.processfusion.com/en/5-robotic-process-automation-rpa-trends-2020/.

repetitive computer-based tasks and processes in the workplace."[24] David Landreman, Chief Technology Officer at Olive–an automation company dedicated to developing the "first healthcare [Artificial Intelligence, (AI)] workforce"[25]–thus articulated four criteria for determining the suitability of existing processes to RPA conversion. According to him, processes that are worthwhile targets of automation must be "rule-based, . . . repeated at regular intervals, or have a pre-defined trigger, . . . have defined inputs and outputs, . . . [and yield] sufficient volume."[26]

When considering RPA as a practical convergence of several disruptive technologies,[27] the potential for business application appears vast. This is all the more apparent from the magnitude of investment into process automation, with sources listing yearly spending in the billions and an annual growth rate in excess of 40%.[28] Furthermore, upwards of 70% of business leaders "plan to invest more in the deployment and development of RPA."[29] It is clear however, that the potential of increasingly cognitive automation is not limited to the public sector. A case in point is the 2018 memorandum from the Director of the Executive Office of the President of the United States regarding the pan-departmental shifting from low-value to high-value work, which specifically encourages RPA as part of "reforms to eliminate unnecessary or obsolete compliance requirements and reduce the cost of mission-support operations."[30] And

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[24] The Enterprisers Project, "How to Explain Robotic Process Automation (RPA) in Plain English . . .
[25] Olive, "About Us: Olive Knows Healthcare Deserves Better," last accessed 18 March 2022, https://oliveai.com/about-us.
[26] The Enterprisers Project, "How to Explain Robotic Process Automation (RPA) in Plain English . . .
[27] RPA leverages, for instance, AI, machine learning, the Internet of Things, big data, augmented/virtual reality, and optical character recognition.
[28] Process Fusion, "6 Robotic Process Automation (RPA) Trends . . .
[29] *Ibid*.
[30] United States, Director - Executive Office of the President, M-18-23 *Memorandum for Heads of Executive Departments and Agencies: Shifting from Low-Value to High-Value Work*, issued 27 August 2018: 2, https://www.whitehouse.gov/wp-content/uploads/2018/08/M-18-23.pdf.

while automation is being implemented across the US government, it is particularly appealing to the Department of Defence (DoD), within which every military department now employs RPA in some capacity.[31] For defence leaders, who are consistently concerned with operational security and force protection, and who value tempo as a means to maintain the initiative, RPA can present both a managerial advantage and a tactical one. Thus, RPA in a military setting presents distinct applications, which this paper categorizes as either *institutional* (i.e. corporate management) or *tactical* (i.e. the application of combat power across all domains). This view is shared by Jim Walker, Chief Technology Officer and Director Public Sector Marketing at UiPath, who recognizes RPA as both a "back-office tool [and] an essential part of front-line mission work."[32, 33]

For all its promises, RPA does have its critics. For instance, some academics decry how defence communities hold on to unfounded beliefs regarding automation. They argue that automation in defence often fails to deliver on its promises, creates more tasks than it eliminates, does not actually save costs, and generates new problems that require the implementation of new solutions.[34] These beliefs endure because they are convenient, they make it "possible to blame operators or crews for mishaps,"[35] and therefore only highlight the need for further automation to reduce human involvement.

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[31] Government Technology Insider, "Enabling the Warfighter: How the DoD is Embracing RPA," published 26 October 2020, last accessed 18 March 2022, https://governmenttechnologyinsider.com/enabling-the-warfighter-how-the-dod-is-embracing-rpa/.
[32] As of 2022, UiPath remains the leading automation platform in the US government, providing services to 92 US federal department (including the DoD) and agencies across 28 US states. For more details on the company profile, see https://www.uipath.com/solutions/industry/public-sector-automation.
[33] Government Technology Insider, "Enabling the Warfighter: How the DoD is Embracing RPA . . .
[34] Robert R. Hoffman, Nadine Sarter, Matthew Johnson & John K. Hawley, "Myths of Automation and their Implications for Military Procurement," *Bulletin of the Atomic Scientists* 74, no. 4 (2018): 255-261, https://www.tandfonline.com/doi/full/10.1080/00963402.2018.1486615.
[35] *Ibid*., 259.

The use of popular automation software also has a notable downside: for proprietary reasons, automation is typically locked in the software, creating departmental dependency on a specific service provider.

While factually accurate, these arguments are unconvincing, as they do not contend against the potential of automation so much as warn against its hasty and ill-informed adoption. This is one reason why the US DoD felt it necessary to invest in digital and AI literacy through the Joint Artificial Intelligence Center (JAIC) and its AI Education Strategy.[36] Moreover, literature regarding RPA is clear that its goals are neither to reduce the size of the workforce, nor the number of tasks.[37] Rather, it adapts structures and processes to alleviate "the need to [dedicate] human capital for manual repetitive tasks, so that human resources can be allocated to higher priority tasks"[38] beyond the capacity of robots. The result is that, "at its best, *automation . . . makes jobs more human* [emphasis added], empowering employees with new capabilities through analytics and AI and freeing up time for creativity and critical thinking."[39]

REDUCTION WITHOUT LOSS: THE ADF CASE STUDY

Located in a region that "is in the midst of the most significant strategic realignment since World War II,"[40] Australia has recently published a transformation strategy for its defence enterprise in anticipation of escalating major power competition,

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[36] United States, JAIC, DoD, "2020 Department of Defence Artificial Intelligence Education Strategy," published September 2020, last accessed 18 March 2022, https://www.ai.mil/docs/2020_DoD_AI_Training_and_Education_Strategy_and_Infographic_10_27_20.pdf.
[37] Both are possible consequences of the implementation, but they are not objectives per se.
[38] Process Fusion, "6 Robotic Process Automation (RPA) Trends . . .
[39] Harvard Business Review, "Intelligent Process Automation Can Give Your Company a Powerful Competitive Advantage," published 21 January 2022, last accessed 18 March 2022, https://hbr.org/sponsored/2022/01/intelligent-process-automation-can-give-your-company-a-powerful-competitive-advantage.
[40] Australia, DoD, *Lead the Way: Defence Transformation Strategy*, 2020: 3, https://www.defence.gov.au/sites/default/files/2020-11/Defence-Transformation-Strategy.pdf.

among other emerging threats.[41] This strategy seeks to improve the defence culture and realign resources according to "priority reform areas of focus"[42] enlightened by the 2020 Defence Strategic Update.[43] One notable requirement of the transformation is the "adaptation of . . . business processes to improve efficiency and ensure that [the] workforce is focused on core priority activities, including greater use of digitisation . . . ."[44] The fact that RPA aims to achieve just that was not lost on the Australian Defence Force (ADF). Acknowledging the findings of a 2020 government technical report that called for the *need* for it to "invest in a number of areas that will be critical for future AI systems,"[45] the ADF published its concept for RAS later in the year.[46] The foremost reason stated for pursuing the development and acquisition of RAS is its "opportunity to achieve greater combat power within [the] planned budget by increasing . . . physical and non-physical mass."[47] While all forms of automation are considered by the ADF concept, its "central idea is that Defence will operate RAS in human-machine teams."[48]

This however was not the starting point of the ADF's venture into RPA. By 2020, each service within the ADF already employed their respective innovation cells to consider opportunities for automation as a means to retain a technological edge over adversaries and either enhance or complement the natural abilities of their human

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[41] *Ibid*.
[42] *Ibid*., 21.
[43] Australia, DoD, *2020 Defence Strategic Update*, 2020, https://www.defence.gov.au/sites/default/files/2020-11/2020_Defence_Strategic_Update.pdf.
[44] Australia, DoD, *Lead the Way: Defence Transformation Strategy* . . ., 44.
[45] Glennn Moy, Slava Shekh, Martin Oxenham & Simon Ellis-Steinborner, *Technical Report: Recent Advances in Artificial Intelligence and their Impact on Defence* . . ., iii.
[46] Australia, ADF, *Concept for Robotic and Autonomous Systems*, 2020, https://tasdcrc.com.au/wp-content/uploads/2020/12/ADF-Concept-Robotics.pdf.
[47] *Ibid.*, 9.
[48] *Ibid*, 28.

workforce. But whereas this research was conducted independently by each service with a varying understanding of the strategic context, the Defence Transformation Strategy and the ADF's Concept for RAS provide an overarching vision and established the commitment of Australia's DoD towards such ventures. For the ADF, this translated into significant funding, "with Army being allocated up to $11 billion for future autonomous vehicles, Air Force investment in teaming air vehicles of up to $4 billion, and Navy committing to an uncrewed suite of capabilities."[49] The following sections summarize some of these initiatives with a view to establish a basis upon which to discuss RPA opportunities for the CAF.

The Royal Australian Air Force

Plan Jericho is the Royal Australian Air Force's (RAAF) initiative to invest in fifth-generation technologies and gain "the edge to protect Australia from technologically sophisticated and rapidly morphing threats."[50] Launched in 2015, it asserts that "humans alone cannot cope with the deluge of data or respond to events happening at speeds and in domains beyond human comprehension."[51] The plan was built with the combination of humans and machines in mind using the concepts of augmented intelligence and machine teaming, and a view to shift "the Air Force from one that uses humans to operate machines . . . to a force in which humans and machines operate together."[52]

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[49] Australia, Australian Army Research Centre, "Future Land Warfare Collection 2021: Joint Logistics Through Robotic and Autonomous Systems . . .
[50] Australia, RAAF, "Plan Jericho – At the Edge," last accessed 27 March 2022, https://www.airforce.gov.au/our-mission/plan-jericho.
[51] Australia, RAAF, *At the Edge: Exploring and Exploiting our Fifth-Generation Edges*: 4, http://view.publitas.com/jericho/fifth-generation-edges/page/1.
[52] *Ibid*.

The first significant announcement thereafter was the Australian investment in the Joint Strike Fighter (JSF) program.[53] This platform alone, through its fifth-generation technology and the significant expense it represents, is both a driver of change and a representation of Australia's commitment to leveraging disruptive technologies. In fact, the RAAF is still trying to define how to best utilize and integrate this capability. As it is, the F-35 is leveraged beyond its stated role for its "superior sensor awareness," often "orchestrating the battlespace" and accelerating decision-making.[54] Investment in the JSF is also noteworthy as it guarantees "another 20-30 years of . . . human-in-the-loop"[55] despite some defence analysts viewing human-machine teaming as merely an intermediate step towards autonomy.

An even stronger expression of the RAAF's embrace of automation is the Loyal Wingman project. Unlike the JSF, it was launched specifically for the RAAF according to the vision expressed in Plan Jericho. The resulting MQ-28A Ghost Bat, an unmanned, modular and multi-role combat system teamed with a parent aircraft, successfully completed its first test flight in 2021, receiving an additional $115 million of funding in the process.[56] While not unique in its concept,[57] the project is currently the most advanced in terms of its development.

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[53] Australia, DoD, *2016 Defence White Paper*, 2016: 19, 95, https://www.defence.gov.au/sites/default/files/2021-08/2016-Defence-White-Paper.pdf.
[54] Australian Strategy Policy Institute, "RAAF Marrying Minds and Machines (Part 1)," published 26 February 2019, last accessed 27 March 2022, https://www.aspistrategist.org.au/raaf-marrying-minds-and-machines-part-1/.
[55] Australian Strategy Policy Institute, "RAAF Marrying Minds and Machines (Part 2)," published 27 February 2019, last accessed 27 March 2022, https://www.aspistrategist.org.au/raaf-marrying-minds-and-machines-part-2/.
[56] ADBR, "Loyal Wingman Makes Successful First Flight," published 2 March 2021, last accessed 27 March 2022, https://adbr.com.au/breaking-loyal-wingman-makes-successful-first-flight/.
[57] The Skyborg project by the United States Air Force has similar ambitions to deliver an unmanned combat system controlled by a crewed fighter aircraft.

Not merely content in investing in technologically advanced platforms, the RAAF is also visionary in terms of its infrastructure. Dr. Peter Layton's Future Automated Airbase[58] concept is particularly noteworthy for several reasons. First, far from depicting science fiction, Dr. Layton imagines the synergistic use of *already existing* technologies to reinvent airbases. Second, he goes to great depth to describe not only said technologies, but also the evolution of the duties and necessary competencies of the workforce. Third, Dr. Layton makes a compelling argument that, if implemented, the RPA-enabled concept would, in fact, achieve more according to various future strategic scenarios. This combination of realism, comprehensiveness, appeal, and modularity makes Dr. Layton's vision singular among other allied perspectives in describing the potential of RPA applied systematically.[59]

The Royal Australian Navy

For the Royal Australian Navy (RAN), the 2016 Defence White Paper committed to doubling the submarine fleet in "the largest defence procurement program in Australia's history,"[60] and promised a marked increase to the surface fleet, including three air warfare destroyers, nine frigates, twelve offshore patrol vessels, and upgrades to

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[58] Peter Layton, *Surfing the Digital Wave: Engineers, Logisticians and the Future Automated Base*, (Canberra: DoD, 2020), https://airpower.airforce.gov.au/sites/default/files/2021-03/AP46-Surfing-the-Digital-Wave.pdf.

[59] By means of comparison, the innovation arm of the United States Air Force–AFWERX–has recently issued six challenges to defence and security industry to transform Tyndall Air Force Base in the "Base of the Future". The very fact that the challenge has define six distinct challenges as opposed to an integrated concept necessarily makes this vision of the future airbase more modest. See United States, AFWERX, "Base of the Future," last accessed 27 March 2022, https://afwerxchallenge.com/botf.

[60] Australia, DoD, *2016 Defence White Paper* . . ., 92.

both "mine countermeasures and military hydrography."[61] While this monumental increase in capabilities was accompanied by a commitment to also grow the force,[62] the ADF has been struggling to meet its recruitment targets, causing a permanent force separation of 9.5% in 2021.[63] As a result, the RAN began investigating RPA not only as a means to maintain a maritime edge, but also as a practical way to address shortages in human workforce.[64] Realizing the importance of guiding, prioritizing, and coordinating initiatives, it published its own RAS-AI Strategy,[65] informed by RAND Australia.[66]

The RAN RAS-AI vision can be summarized in "five fundamental effects–Force Protection, Projection, Partnering, Potential and Control."[67] These effects will be achieved through the increased situational awareness, the mass and tempo of autonomous platforms, the workforce augmentation through human-machine teaming, and the protection of sovereign data by RAS.[68] Simply put, the RAN aims to have better coordinated forces that can project wider and deeper with a concern for data security, without requiring an increase to the human workforce.

Like the RAAF however, the RAN did not wait for the publication of its formal strategy to begin investing in automation. For instance, an automated *Rapid*

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[61] *Ibid*., 93.
[62] *Ibid*., 146.
[63] Australia, DoD, *Annual Report 20-21*, 2021: 113, https://www.defence.gov.au/sites/default/files/2021-10/AR-2020-21.pdf.
[64] Deloitte, "Case Studies: AI reports for Duty in the Australian Military," last accessed 29 March 2022, https://www2.deloitte.com/global/en/pages/human-capital/articles/AI-reports-for-duty-in-the-australian-military.html.
[65] Australia, RAN, *RAS-AI Strategy 2040: Warfare Innovation Navy*, https://www.navy.gov.au/sites/default/files/documents/RAN_WIN_RASAI_Strategy_2040f2_hi.pdf.
[66] RAND Australia, *Supporting the Royal Australian Navy's Strategy for Robotics and Autonomous Systems: Building an Evidence Base*, (Canberra: RAND Australia, 2021), https://www.rand.org/content/dam/rand/pubs/research_reports/RRA900/RRA929-1/RAND_RRA929-1.pdf.
[67] Australia, RAN, *RAS-AI Strategy 2040: Warfare Innovation Navy* . . ., 14.
[68] *Ibid*.

Environmental Assessment[69] and *Deployable Mine Counter-Measures*[70] capabilities were both initiated well before the launch of the RAS-AI Strategy, and are now entering service.[71] A more recent project, *Maritime Mine Countermeasures and Military Survey* (Figure 1) will further integrate the aforementioned capabilities with *Situational Awareness* and *Strategic Military Survey* capabilities into a "toolbox of scalable & versatile [RAS] to be deployed as mission packages."[72] A critical element of this project is its evergreen approach,[73] which was deemed necessary to ensure the systems evolve with both the threat and technological advances.

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[69] Australia, DoD, "Rapid Environment Assessment," last accessed 2 April 2022, https://www.defence.gov.au/project/rapid-environment-assessment.

[70] Marine Link, "For the Royal Australian Navy, Technological Leap Starts Small," published 25 June 2020, last accessed 2 April 2022, https://www.marinelink.com/news/royal-australian-navy-technological-leap-479672#:~:text=The%20Royal%20Australian%20Navy%E2%80%99s%20%28RAN%29%20SEA%201778%20deployable,ships%20%28MHCs%29%20with%20a%20new%20deployable%20MCM%20capability.

[71] Australia, RAN, "Navy Vision for Autonomous Systems," presented at the Land Forces: Australia Indo Asia Pacific Exposition 1-3 June 2021, last accessed 2 April 2022, https://aaus.org.au/wp-content/uploads/2021/06/02-Andrew-Kirby.pdf.

[72] *Ibid*.

[73] The concept of evergreening, prevalent in the world of information technology management, recognizes that systems and the elements they contain must evolve iteratively to ensure they remain relevant, competitive, and interoperable in light of rapid technological advances. The concept stands in opposition to traditional capability acquisition, which often cuts the capability's life cycle needlessly short.

Figure 1 – SEA 1905-1 Maritime Mine Countermeasures and Military Survey

Source: Australia, RAN, "Navy Vision for Autonomous Systems," presented at the Land Forces: Australia Indo Asia Pacific Exposition 1-3 June 2021, last accessed 2 April 2022, https://aaus.org.au/wp-content/uploads/ 2021/06/02-Andrew-Kirby.pdf.

New capabilities aside, the RAN RAS-AI Strategy envisions a greater, more permeant transformation still. Acknowledging the Defence Transformation Strategy's call for adapted business processes and the focussing of the human workforce towards greater efficiency,[74] the RAN partnered with Deloitte–a multinational professional services firm–to make the organization more agile. The resulting joint venture into RPA is noteworthy for its approach, which identified the *human worker* as only one of four types of workers, alongside *automated assistants*, *cognitive assistants*, and *AI advisors*:[75]

> To create a [Collective Intelligence] workforce with optimal capabilities, a cross-functional Deloitte team was embedded in the Directorate of Navy Continuous Innovation. . . . Working collaboratively within immersion labs, the team worked to identify and classify all current and anticipated

[74] Australia, DoD, *Lead the Way: Defence Transformation Strategy* . . ., 44.
[75] Deloitte, "Case Studies: AI reports for Duty . . .

> work types, then map them according to the level of strategic importance of the work, and the cognitive power required to do it. Using the map, assessments can be made as to which work can be augmented with AI, to what extent and in what sequence. The work types to be assigned to AI assistants are selected based on high return, rapid realization, and low risk. Use cases are developed for each type of prospective AI assistant.[76]

The Australian Army

The Australian Army's venture into RPA is similar to that of the other services: it published an Army-specific RAS strategy[77] ahead of the ADF concept, and also focusses RPA research on human-machine teaming applications. To this end, it stood up the Robotic and Autonomous Systems Implementation Coordination Office (RICO).[78] A 2020 update regarding ongoing initiatives included robotic search dogs ("quadrupeds"), optionally crewed combat vehicles and other autonomous leader-follower applications.[79] Moreover, the RICO's inaugural Director, Col Robin Smith, described the numerous opportunities and risks that automation presents to land logistics. His vision, which includes "significantly enhanced logistic situation awareness"[80] and a heavy-lift unmanned aerial system, has much in common with Dr. Layton's Future Automated Airbase concept, and could revolutionize the echeloning system prevalent among land forces.[81] This convergence in the RAS visions between services is arguably a critical element to enable efficiency in the pursuit of automation.

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[76] *Ibid*.
[77] Australia, Army, *Robotics & Autonomous Systems Strategy* . . .
[78] Australia, Australian Army Research Centre, "RICO," last updated 29 April 2021, last accessed 3 April 2022, https://researchcentre.army.gov.au/rico.
[79] Australia, Australian Army Research Centre, "Robotics and Autonomous Systems Experimentation (RICO Update)," published 20 March 2020, last accessed 3 April 2022, https://researchcentre.army.gov.au/library/land-power-forum/robotics-and-autonomous-systems-experimentation-rico-update.
[80] Australia, Australian Army Research Centre, "Future Land Warfare Collection 2021: Joint Logistics Through Robotic and Autonomous Systems . . .
[81] *Ibid*.

Perhaps the most ground-breaking work conducted by the Army concerns the impact of automation and augmentation on the human workforce. As previously indicated, the ultimate aim of RPA is to focus human capital on creative work, away from repetitive tasks. Beyond the introduction of autonomous capabilities, and as initiated by Deloitte for the RAN, a critical aspect in introducing RPA is to reconsider current structures, roles, and responsibilities of the human workforce. An initial analysis is provided in the Australian Army's Workforce Digital Potential Impact Assessment.[82]

In studying the various jobs across the land forces, the assessment established that "the core function of tasks is quite similar to industry generic roles, [and that] the impact of digital disruption in the next fifteen years is far more relevant to a Clerk or Logistics trade then [sic] that of an Infantryman . . . ."[83] This is welcome news as there is now a significant body of research emanating from civilian industry to inform the transformation, and it facilitates integration of civilian technologies. Overall, the research points to the possibility of achieving significant gains from augmentation over the next 15 years, with almost 50% of the human workforce being affected, resulting in at least 30% in capacity gain and upwards of 16% in personnel reduction (Figure 2).[84]

Within the Arms Corps, all trades were determined to be at least 25% augmentable,[85] with aircrew roles being 19% automatable. Numbers are even more significant for combat support trades, particularly logisticians and clerks (each approximately 60% automatable). In the clerks' case, for example, this includes the

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[82] Australia, Army, *Workforce Digital Potential Impact Assessment*.
[83] *Ibid*., 1.
[84] *Ibid*., 2, 4. Note that numbers were not stated explicitely by the assessment, and that percentages listed had to be approximated from the figures provided in the document.
[85] *Ibid*., 5. Numbers are significantly greater for intelligence trades, armoured soldiers, infantry soldiers, and special forces operators–each having roles that are augmentable in excess of 39%.

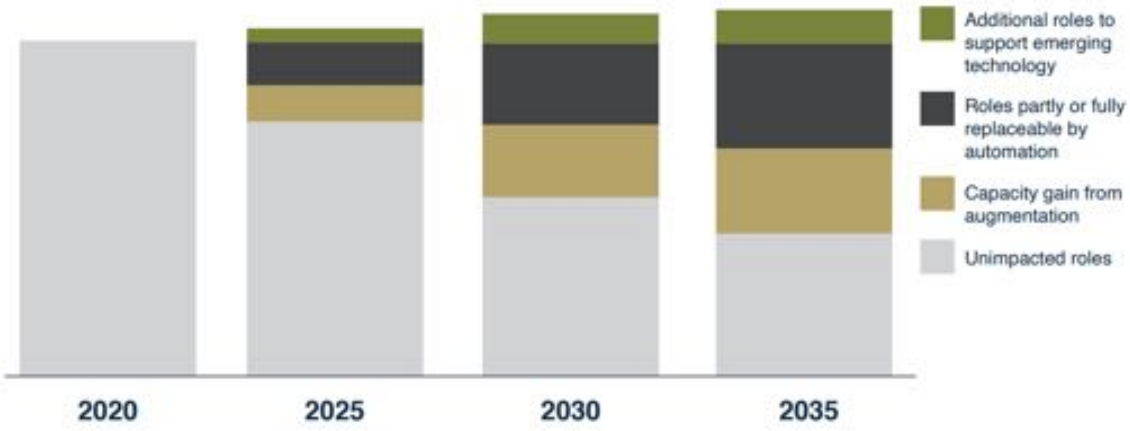

Figure 2 – Predicted Impact of Automation and Augmentation on the Australian Army

Source: Australia, Army, *Workforce Digital Potential Impact Assessment*.

repetitive yet time-consuming work of answering and directing phone calls, maintaining records, sorting incoming correspondence, preparing invoices, or even greeting visitors– all of which are tasks that are already automated by many civilian companies. To enable this transformation, the report recommends that research be pursued in select areas, process automation and predictive analysis specifically,[86] as well as quantifying those new technological skills and evolving occupation concepts.

OPPORTUNITIES FOR A CANADIAN IMPLEMENTATION

Canada's Need for Automation

While the ADF offers an interesting case study for any defence enterprise considering RPA, it is particularly relevant to the DND/CAF because of the many parallels between Australia and Canada. Geographically, both are large, sparsely

[86] *Ibid*., 3.

populated countries with exceptionally long coastlines. Though Australia's population is comparatively smaller,[87] both are of similar order and inconsistently spread across the territory. The two countries are federal parliamentary constitutional monarchies sharing an attachment to liberal democracy, facilitating trade, and upholding the international rule of law. Furthermore, they are both members of the British Commonwealth and of the Five Eyes intelligence-sharing community. Contextually, both Canada and Australia recognize the same mega-trends, each seeking to prepare its armed forces for renewed great power competition by addressing cultural issues, maintaining a technological edge, and reinforcing interoperability with allied nations. Finally, both the CAF and the ADF are experiencing recruitment and retention challenges, as well as funding pressures in achieving the requisite capabilities and readiness. That is not to say that the countries are identical–they differ noticeably in their geographical proximity to the United States[88]–but the Australian context is sufficiently similar for Canada to seek inspiration from the ADF towards its own digital transformation.

Given these striking parallels, concerns resulting from China's self-identification as a "Near-Arctic State",[89] and ongoing Russian expansionism, a critical conclusion is that the *need* for the ADF to invest in automation applies equally to the CAF. This is true

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[87] The Australian Bureau of Statistics (ABS) reports the population of Australia as 25.7M as of 30 September 2021; see Australia, ABS, "Population," last accessed 4 April 2022, https://www.abs.gov.au/statistics/people/population. By comparison, Canada's population is approximately 38M; see Canada, Statistics Canada, "Canada's Population, July 1, 2020," published 29 September 2020, last accessed 4 April 2022, https://www150.statcan.gc.ca/n1/pub/11-627-m/11-627-m2020062-eng.htm.

[88] This fact is significant, as it has arguably driven Australian investment in defence while enabling Canadian complacency, particularly in terms of continental defence. Facing the continuing rise of China, Australia has sought ways to become ever-closer to the United States, most visibly by becoming a signatory of AUKUS, a trilateral security partnership seeking to "deepen diplomatic, security, and defense cooperation in the Indo-Pacific region;" see United States, The White House, "Joint Leaders Statement on AUKUS," published 15 September 2021, last accessed 4 April 2022, https://www.whitehouse.gov/briefing-room/statements-releases/2021/09/15/joint-leaders-statement-on-aukus/.

[89] China, "China's Arctic Policy," last updated 26 January 2018, last accessed 14 April 2022, http://english.www.gov.cn/archive/white_paper/2018/01/26/content_281476026660336.htm.

on multiple levels, as well-implemented RPA will not only bolster Canada's national defence, but also enable the interoperability upon which alliances depend to achieve deterrence. Consequently, Canada needs to move beyond the generalities of SSE and adopt a deliberate, specific, and coordinated approach towards RPA. In other words, the CAF necessitates a vision nested within a strategy that expresses the desired AI workforce ratio, and a campaign plan detailing the approach towards automation. Ideally, these would be nested in, and resourced by the greater pan-governmental initiative towards digital transformation, which so far only addresses automation broadly.[90] Whether the CAF should adopt precisely the same approach as the ADF–a service-centric strategy with a stated focus on human-machine teaming at both the institutional and tactical levels–warrants further research. A less ambitious approach could stage implementation by focusing on institutional automation first and fostering the cultural embrace of automation, before shifting to service-initiated tactical applications and the integration of platforms currently under development by our allies.

Culture Shift: the Biggest Challenge to Successful RPA

A cultural shift *will* be required. In fact, Col Robin Smith contends that generating cultural inertia is likely the biggest challenge in implementing RPA. Quoting Theo Farrell, he reminds readers that "military organizations, as socially conservative and

[90] See Canada, "Digital Operations Strategic Plan: 2021–2024," last modified 2 July 2021, last accessed 14 April 2022, https://www.canada.ca/en/government/system/digital-government/government-canada-digital-operations-strategic-plans/digital-operations-strategic-plan-2021-2024.html. While the document refers to automation multiple times in various contexts, it does not mention it as one of its priorities, and remains altogether too generic. Furthermore, research has not yielded any evidence of a call by the Canadian government to invest in RPA, as was made by the Office of the President of the United States; see United States, Director - Executive Office of the President, M-18-23 *Memorandum for Heads of Executive Departments and Agencies: Shifting from Low-Value to High-Value Work . . .*

closed communities . . . are especially disinclined to innovate."[91] The CAF's strategy-to-be must therefore not only lead with a vision, but also communicate in a transparent manner what it is seeking to achieve, account for the human component of the transformation, and invest in its human workforce to both contextualize the changes and prepare personnel for new responsibilities.[92] That is because embracing automation successfully is not as simple as introducing a robotic workforce in today's structures.[93] The ongoing CAF experience with culture change, as unfortunate as its circumstances may be, provides the institution with a significant body of knowledge to leverage here. Since culture change takes time, effort, and consistence, transformation of the human workforce must begin soonest to enable it as it evolves from a *digitally aware* force to a *digitally transformed* one.

Focussing the CAF Investment in RPA

The logical entry point into automation is for the CAF to leverage existing technologies before considering developing its own, and maximize return on investment by seeking those opportunities that closely align with RPA suitability criteria. As a reminder, processes suitable for RPA are rule-based, repeated frequently, they include pre-defined triggers, they have defined inputs/outputs, and they yield sufficient volume.[94] Two ways to visualize the results is by considering common processes across the institution and individual military occupations; these are displayed at Tables 1 and 2, respectively. Importantly, the ratings provided therein are qualitative rather than

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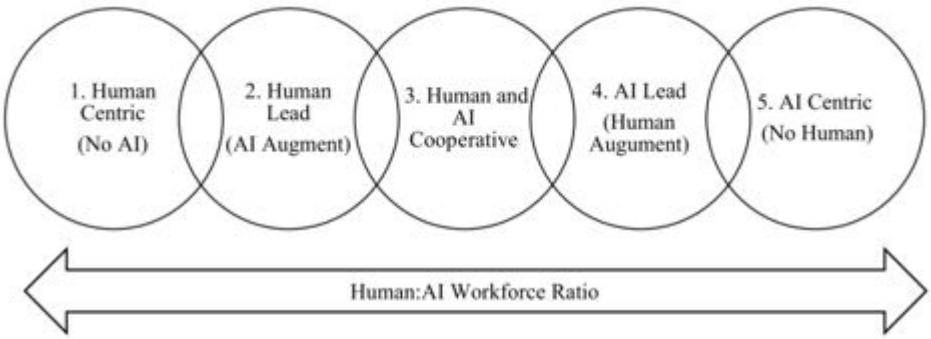
[91] Australia, Australian Army Research Centre, "Future Land Warfare Collection 2021: Joint Logistics Through Robotic and Autonomous Systems . . .
[92] This is consistent with and heavily influenced by recommendations for the implementation of RPA formulated in KPMG, "The Augmented Workforce . . .
[93] Australia, Australian Army Research Centre, "Future Land Warfare Collection 2021: Joint Logistics Through Robotic and Autonomous Systems . . .
[94] The Enterprisers Project, "How to Explain Robotic Process Automation (RPA) in Plain English . . .

quantitative, as they have been aggregated from sources that differ in their academic rigour. Furthermore, the analysis does not account for the financial cost associated with the implementation due to lack of data. Their purpose is thus primarily to expose opportunities while orienting future research into the automation of the CAF. The model described by Elissa Farrow was selected to express desired AI workforce ratios for the breadth of its continuum and its simplicity (Figure 3).[95]



Human Centric (No AI) - Humans offer a unique value add that machines cannot or "will not" provide due to boundary decisions made by humans. This operating model could be seen as human boutique, niche or an individualized personal service offering (a human would provide a deeply personalized or unique human service).

Human Led (AI Augment) - Humans lead and set direction for the organization and work priorities. AI is the equivalent to the "transactional worker" or subservient to the human leader. AI is considered a tool, a machine that has no form of agency. Humans have the legal authority and make the decisions on the AI architecture, including evolution or archive. Lower skilled or former process human staff are either upskilled in other functions or let go from the organisation.

Human and AI Cooperative - A cooperative organizational structure with both human and AI recognized equally for their agency. Both recognize one another's importance and worth. There are times in work where either AI or Human take the lead on decisions and process elements when they are best suited. Mutual respect exists and this is the primary difference to [Human Led and AI Led scenarios].

AI Led (Human Augment) - AI provides the organization strategy and the leadership and direction/vetoing of ideas to human teams who fulfil defined functions. Humans may support AI to fulfil the AI purpose and function. "The human becomes the laptop" or the human is the programmer/mechanic with AI establishing the design and control parameters.

AI Centric (No Human) - AI lead and run operating models providing service without human intervention. AI has legal agency and is considered to have rights. AI could be the organizational owner and self-managing and self-rejuvenating. AI may have a hierarchy of sentient evolved AI over more functional basic AI. Humans' role will shift outside the organizational setting to activities more philosophical, creative, ecological or of spiritual importance. Different models of income support and economy exchange for humans and community resources would be in place to keep community peace and order.

Figure 3 – AI Workforce Ratio Continuum

[95] This model delineates five high-level organizational scenarios that are termed (a) human centric, (b) human lead, (c) human and AI cooperative, (d) AI lead, and (e) AI centric. Falling back on the ADF case study, it is apparent that Australia generally envisions a "human and AI cooperative" model, but that need not necessarily be the case for Canada. Attitudes towards AI and levels of funding must be taken into account when expressing the vision to ensure it is both realistic and actually desired. See Elissa Farrow, "Determining the Human to AI Workforce Ratio – Exploring Future Organisational Scenarios and the Implications for Anticipatory Workforce Planning," *Technology in Society* 68 (2022): 4, https://www.sciencedirect.com/science/article/abs/pii/S0160791X22000203.

Source: Elissa Farrow, "Determining the Human to AI Workforce Ratio – Exploring Future Organisational Scenarios and the Implications for Anticipatory Workforce Planning," Technology in Society 68 (2022)

Table 1 – Perceived Return on Investment across Select CAF Functions

	RPA Suitability Criteria*									
Function	**Governed by Strict Rules**	**Applied Frequently**	**Has Specific Trigger(s)**	**Considers Defined Inputs**	**Yields Defined Outputs**	**Volume of Process**	**Σ**	**Safety and/or Security Considerations**	**State of Technology**	**Recommended AI Workforce Ratio**
Travel Arrangements	5	5	5	5	5	5	**30**	—	Widespread civilian application.	**Cooperative**
Financial Claims	5	5	5	5	5	5	**30**	Low risk acceptance with respect to finances; human-in-the-loop required.	Widespread civilian application.	**Cooperative**
Supply Chain Distribution	4	5	5	5	5	5	**29**	Specific considerations for Dangerous Goods.	Widespread civilian application.	**Cooperative**
Human Resourcing	4	5	4	5	5	5	**28**	Automation can assist in the protection of sensitive data.	Widespread civilian application.	**Cooperative**
Postal Services	5	5	4	5	5	3	**27**	—	Widespread civilian application.	**Cooperative**
Contracting	5	4	5	4	3	5	**26**	Automation must account for contractor vetting process.	Predictive/creative writing technologies exist. Use in contracting unknown.	**Human Led**
Career Management	4	3	4	4	4	5	**24**	Automation can assist in the protection of sensitive data.	Existing technology for talent management can be leveraged.	**Human Led**
Transport Dispatch	3	5	4	4	4	4	**24**	—	Widespread civilian application.	**Human Led**
Garrison Transport	3	5	4	3	4	4	**23**	Unfounded low-level of trust in the self-driving ability of vehicles must be addressed.	Technologies exist, though refinements are needed for mass application.	**Human Led**
Warehousing/ Inventory	3	5	3	4	3	5	**23**	—	Widespread civilian application.	**Cooperative**
CBRN Decon	2	1	5	2	4	1	**15**	Automation significantly reduces risk of human exposure.	Unknown.	**Cooperative**
Military Recce & Survey	1	2**	2	3	3	2	**13**	Automation significantly reduces risk of human exposure.	Technologies exist, though not for military application. Under development by allies.	**Cooperative**

PERCEIVED RETURN ON INVESTMENT

Notes

* Adapted from Landreman in The Enterprisers Project, "How to Explain Robotic Process Automation (RPA) in Plain English," published 30 July 2020, last accessed 18 March 2022.

** While the CAF conducts reconnaissance and surveying more frequently than what this figure indicates, individual applications are varied and have arguably little in common from a technical standpoint, in that they are applied in different environments, have different objectives and require different technologies. Thus, what is noted here is not the frequency of reconnaissance and surveys as a whole, but the lower frequency of individual applications.

*** Notably absent from this analysis is a decision-making function, as it was deemed too broad and would necessitate a wide variety of context-specific technologies.

Qualitative Scale

Process aligns poorly with RPA suitability criterion

Process aligns well with RPA suitability criterion.

Generally, the findings echo those of Australian studies: in terms of institutional RPA, the greatest return on investment would be achieved by focusing automation on

logistic processes. These include travel arrangements, financial claims, human resourcing, postal services, contracting, transport, and supply processes. Based on the

Table 2 – Perceived Return on Investment across CAF Occupations

Occupation		Preferred Manning Level (PML)	Over/ Under (%)	Relative Trade Size	Incentive to Automate as Personnel-saving Measure	Opportunities to Automate	Recommended Target AI Workforce Ratio	Prominent Foci of Automation
Title	MOSID							
Aerospace Control Officer	00184	518	-7.9%	Medium	Low	High	Cooperative	Information management, communication.
Aerospace Control Operator	00337	547	-1.8%	Medium	Low	High	Cooperative	Radar signal analysis, automated reporting.
Aerospace Engineering Officer	00185	697	-12.5%	Medium	Medium	Medium	Human Led	Information management.
Aerospace Telecom/Info Systems Tech	00109	907	-10.7%	Large	Medium	Medium	Human Led	Diagnostics.
Air Combat Systems Officer	00182	582	-23.2%	Medium	High	High	Cooperative	Mission management.
Air Weapons Systems Technician	00261	447	-3.1%	Medium	Low	High	Cooperative	Self-diagnosing air platforms, servicing, exoskeletons.
Airborne Electronic Sensor Operator	00019	233	-16.3%	Small	Medium	High	Cooperative	Radar signal analysis, report generation.
Aircraft Structures Technician	00138	867	-4.8%	Medium	Low	Medium	Human Led	Diagnostics, additive manufacturing.
Ammunition Technician	00169	213	-2.3%	Small	Low	Medium	Human Led	Automated warehousing, autonomous EOD, exoskeletons.
Armour Officer	00178	493	-15.6%	Medium	Medium	Medium	Human Led	Tactical decision-making, reconnaissance.
Armoured Soldier	00005	1812	-25.6%	Large	High	High	Cooperative	Autonomous tanks, human-machine pairing.
Artillery Officer	00179	554	-16.1%	Medium	Medium	Medium	Human Led	Tactical decision-making, mission planning.
Aviation Systems Technician	00135	1948	-3.9%	Large	Low	High	Cooperative	Self-diagnosing air platforms, servicing, exoskeletons.
Avionics Systems Technician	00136	1269	-2.4%	Large	Low	Medium	Human Led	Self-diagnosing air platforms, automated reporting.
Biomedical Electronics Technologist	00155	22	0.0%	Small	Low	Medium	Human Led	Diagnostics.
Bioscience Officer	00197	35	-8.6%	Small	Low	Low	Human Centric	N/A
Boatswain	00105	634	-15.6%	Medium	Medium	Medium	Human Led	Autonomous watercrafts, automated launch/recovery.
Chaplain	00149	213	-18.3%	Small	Medium	Low	Human Centric	N/A
Combat Engineer	00339	1748	-11.6%	Large	Medium	Medium	Human Led	Autonomous reconnaissance and EOD, project management.
Communication Electronics Engr Officer	00340	403	-8.7%	Medium	Low	Medium	Cooperative	Data administration, self-healing networks.
Construction Engineering Officer	00189	211	-17.1%	Small	Medium	Low	Human Led	Information management, camp design.
Construction Engineering Superintendent	00307	167	-7.3%	Small	Low	Low	Human Led	Project management.
Construction Technician	00306	159	9.4%	Small	Low	Low	Human Led	Management of building supplies, project management.
Cook	00164	779	2.7%	Medium	Low	Low	Human Led	Management of food supplies, food safety.
Court Reporter	00337	8	50.0%	Small	High	Low	Human Led	Speech-to-text technology.
Cyber Operator	00378	67	-76.1%	Small	High	High	Cooperative	Automated network diagnostics, data analysis.
Dental Officer	00191	136	-14.7%	Small	Medium	Low	Human Led	Data administration, chart interpretation.
Dental Technician	00335	211	-19.0%	Small	Medium	Low	Human Centric	N/A
Drafting and Survey Technician	00370	25	-20.0%	Small	Medium	High	Cooperative	Automatated surveying, enhanced CAD, materials accounting.
Electrical/Mechanical Engr Officer	00187	400	-17.8%	Medium	Medium	Low	Human Led	Information management.
Electrical Distribution Technician	00302	115	-11.3%	Small	Medium	Low	Human Led	Diagnostics.
Electrical Generating Systems Technician	00303	133	-7.5%	Small	Low	Low	Human Led	Diagnostics.
Electronic-Optronic Technician (Land)	00327	417	-13.4%	Medium	Medium	Medium	Human Led	Diagnostics.
Engineer Officer	00181	470	-20.4%	Medium	High	Low	Human Led	Tactical decision-making, reconnaissance.
Financial Services Administrator	00376	1040	-26.0%	Large	High	High	Cooperative	Automated financial processes, finance management.
Fire Fighter	00149	372	-16.7%	Medium	Medium	Low	Human Led	Automated entry/recovery platforms.
Geomatics Technician	00238	203	-10.8%	Small	Medium	High	Cooperative	Automated survey/topography services. Self-serve production.
Gunner	00368	1623	-4.4%	Large	Low	High	Cooperative	Autonomous artillery.
Health Care Administration Officer	00192	144	0.0%	Small	Low	Low	Human Led	Information management.
Human Resources Administrator	00375	2072	-17.4%	Large	Medium	High	Cooperative	Automated human resources processes, data management.
Imagery Technician	00137	236	-8.5%	Small	Low	Medium	Human Led	Imagery drones, AI photography generation/enhancement.
Infantry Officer	00180	1100	-15.3%	Large	Medium	Medium	Human Led	Tactical decision-making, reconnaissance.
Infantry Soldier	00010	5178	-13.2%	Large	Medium	Medium	Human Led	Automated load carriage.
Information Systems Technician	00362	3270	-28.3%	Large	High	High	Cooperative	Diagnostics, self-healing networks.
Intelligence Officer	00213	500	-16.4%	Medium	Medium	High	Cooperative	Information management, data interpretation, pattern analysis.
Intelligence Operator	00099	646	-23.4%	Medium	High	High	Cooperative	Information management, data interpretation, pattern analysis.
Legal Officer	00204	165	-6.7%	Small	Low	Low	Human Centric	N/A
Logistics Officer	00128	1707	-15.1%	Large	Medium	Medium	Cooperative	Tactical decision-making, information management.
Marine Systems Engineering Officer	00345	252	-9.9%	Small	Low	High	Cooperative	Systems operations, diagnostics, maintenance.
Marine Technician	00379	1864	-26.9%	Large	High	Medium	Human Led	Self-diagnosing ships, additive manufacturing.
Materials Technician	00134	271	7.0%	Small	Low	Medium	Human Led	Additive manufacturing.
Materiel Management Technician	00168	2708	-22.9%	Large	High	High	Cooperative	Automated warehousing, stock monitoring, exoskeletons.
Medical Laboratory Technologist	00152	27	-3.7%	Small	Low	Low	Human Centric	N/A
Medical Officer	00196	266	-28.9%	Small	High	Low	Human Led	Triage, chart interpretation.
Medical Radiation Technologist	00153	30	-6.7%	Small	Low	Low	Human Centric	N/A
Medical Technician	00334	1270	-14.4%	Large	Medium	Low	Human Led	Triage, chart interpretation.
Meteorological Technician	00100	246	-29.3%	Small	High	High	Cooperative	Automated meteorological survey.
Military Police	00161	1266	-18.7%	Large	Medium	Low	Human Centric	N/A
Military Police Officer	00214	182	-2.7%	Small	Low	Low	Human Led	Information management.
Mobile Support Equipment Operator	00171	1558	-16.5%	Large	Medium	High	Cooperative	Self-driving vehicle, leader-follower technology.
Music Officer	00210	14	-42.9%	Small	High	Low	Human Centric	N/A
Musician	00166	217	-23.0%	Small	High	Low	Human Centric	N/A

(Table continues on next page.)

Naval Combat Information Operator	00114	451	-29.7%	Medium	High	High	Cooperative	Diagnostics, information management, data interpretation.
Naval Combat Systems Officer	00344	263	-13.3%	Small	Medium	Low	Cooperative	Systems operations, diagnostics, maintenance.
Naval Communicator	00290	738	-23.8%	Medium	High	High	Cooperative	Speech-to-text, text-to-speech technology.
Naval Electronic Sensor Operator	00115	366	-21.9%	Medium	High	High	Cooperative	Signal analysis, data collation, automated reporting.
Naval Warfare Officer	00207	973	-13.1%	Large	Medium	Medium	Human Led	Tactical decision-making, mission planning.
Nursing Officer	00195	237	-13.1%	Small	Medium	Low	Human Led	Triage, chart interpretation.
Operating Room Technician	00372	78	-28.6%	Small	High	Low	Human Centric	N/A
Personnel Selection Officer	00208	145	-13.8%	Small	Medium	Medium	Human Led	Information management.
Pharmacy Officer	00194	49	-22.4%	Small	High	Medium	Human Led	Distribution of medication, assisted medical advice.
Physician Assistant	00374	115	-13.9%	Small	Medium	Low	Human Led	Triage, chart interpretation.
Physiotherapy Officer	00190	37	-13.5%	Small	Medium	Low	Human Led	Ergonomics assessments, injury prevention.
Pilot	00183	1592	-20.6%	Large	High	High	Cooperative	Tactical decision-making, airframe manoeuvres.
Pipes and Drums	00377	14	-14.3%	Small	Medium	Low	Human Centric	N/A
Plumbing Heat Technician	00304	113	-1.8%	Small	Low	Low	Human Led	Diagnostics.
Port Inspection Diver	00342	128	-12.5%	Small	Medium	High	Cooperative	Autonomous submersibles.
Postal Clerk	00167	120	-25.0%	Small	High	High	Cooperative	Automated warehousing, parcel tracking.
Preventive Medicine Technician	00371	99	-15.2%	Small	Medium	Medium	Human Led	Automated collection, sample analysis, hazard reporting.
Public Affairs Officer	00203	178	-10.1%	Small	Medium	Medium	Cooperative	Information management, narrative writing.
Refrigeration/Mechanical Systems Tech	00301	112	-12.5%	Small	Medium	Low	Human Led	Diagnostics.
Search and Rescue Technician	00101	149	-6.7%	Small	Low	Medium	Human Led	Detection, automated recovery.
Signals Officer	00341	606	-23.8%	Medium	High	Medium	Cooperative	Data administration, self-repairing networks.
Social Work Officer	00198	37	-29.7%	Small	High	Low	Human Led	Triage, information management.
Sonar Operator	00324	413	-28.6%	Medium	High	High	Cooperative	Acoustic signal analysis, automated reporting.
Special Operations Assaulter	00380	507	-28.6%	Medium	High	Medium	Human Led	Reconnaissance, range of semi-autonomous capabilities.
Steward	00165	259	-12.0%	Small	Medium	Low	Human Centric	N/A
Traffic Technician	00170	718	-16.7%	Medium	Medium	High	Cooperative	Autonomous material handling, automated documentation.
Training Development Officer	00211	186	-6.5%	Small	Low	Medium	Human Led	Curriculum development.
Vehicle Technician	00129	2245	-11.7%	Large	Medium	Medium	Human Led	Diagnostics, additive manufacturing.
Water, Fuels, Environmental Technician	00305	95	-3.2%	Small	Low	Medium	Human Led	Automated sample collection/analysis. Diagnostics.
Weapons Engineering Technician	00366	1162	-18.5%	Large	Medium	Medium	Human Led	Self-diagnosing ships, automated reporting.
Weapons Technician - Land	00130	423	1.4%	Medium	Low	Low	Human Led	Additive manufacturing.

Source. Director Personnel Generation Requirements (DPGR) Projected Status Reports.

Notes

(1) Occupations highlighted are assessed as providing the highest potential for automation. The darker the colour, the higher the perceived return on investment.
(2) Automation does not equate the replacement of the human workforce. Refer to Recommended Target AI Ratios for the desirable long-term level of automation.
(3) Some occupation titles have changed since the release of the reports used as reference. Where possible, updated occupation titles have been used.
(4) While this analysis is based on the current CAF occupation structure, further analyses must consider changing said structure to achieve better efficiency. This includes the creation of new occupation related to the introduction of automation.

current occupation structure, financial services administrators, human resources administrators, material management technicians, mobile support equipment (MSE) operators, and postal clerks should be targeted specifically based on the nature of their work, the size of the occupations and their low staffing levels.

From the standpoint of tactical automation, it is not surprising that those occupations that already work closely with technology would offer the best return on investment. Hence, pilots, air combat systems officers, armoured soldiers, gunners, MSE

operators, but also various sensor operators offer significant potential for further automation through new capability acquisition and life-cycle management. For the CAF, the recently announced intention to procure the F-35[96] should be welcome as a significant step towards strengthening interoperability with allies, and as a showcase of automation effects on the battlefield. More is required however, especially as the delivery timeline for the F-35 is uncertain, and Canada already lags behind partners and competitors. Human-machine pairing for airplanes, armoured vehicles, artillery, and logistical convoys is already under development by other militaries, and AI has the potential to accelerate sensor operations and reporting across all elements. In terms of tactical processes, decontamination and reconnaissance should be considered specifically as they align with RPA suitability criteria well, they expose soldiers to significant risk, and they are often secondary tasks that take away from an already limited workforce. In fact, automating combat engineer reconnaissance tasks is the currently subject of a UK Defence Science and Technology Laboratory competition,[97] and the RAN already implements autonomous marine surveying (recall Figure 1).

Enabling the Transformation: Calling for Future Research

Transforming the CAF to embrace automation is no small feat. The major challenges of articulating a vision, defining the transformation parameters, building cultural inertia, and focussing change have already been discussed. In turn, success in any one of these ventures requires the coordination of a number of enabling activities, each

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[96] The Defense Post, "Canada to Buy 88 F-35 Fighter Jets From Lockheed Martin," published 28 March 2022, last accessed 22 April 2022, https://www.thedefensepost.com/2022/03/28/canada-f35-fighter-jets/.
[97] Army Technology, "Map the Gap: DSTL's Competition to help the British Army cross Water," published 10 November 2021, last accessed 22 April 2022, https://www.army-technology.com/analysis/dstl-map-the-gap-uk-british-army-water-robot-automation-ai-artificial-intelligence/.

based on questions that are as yet unresolved. The following questions must guide future research to inform the institutional approach to automation:

1. *What is Canada's position regarding the ethics of automating defence activities?* Discussions at the international level surrounding the use of lethal autonomous weapon systems (LAWS) began in 2013.[98] While Canada has yet to formulate an official policy in that regard nearly a decade later, the discussion must be broadened still to encompass the ethics of autonomy in defence beyond LAWS. For instance, should Canada restrict the use of black box AI?[99] These discussions must begin now to shape capability development soonest.
2. *What AI workforce ratio should the CAF aim for?* The tables above recommend different ratios for various functions and occupations, up to a human/AI cooperative partnership. This self-imposed limitation was assumed because the human character of warfare is stressed repeatedly by Canadian military doctrine, such that AI led and AI centric functions and occupations were deemed unpalatable. But is that actually the case? A decision is necessary to inform the option space for a reimagined CAF structure.

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[98] RAdm J.B. Zwick, *Briefing Note for CCSI/CFD DND/CAF Endorsement of Policy on Autonomy in Weapons Systems*, 5 November 2021.

[99] The term "black box" denotes a closed system where inputs and outputs are visible to the user, but internal processes are not. To restrict the use of black box AI would foster transparency and trust, as well as enabling investigations in the case of incidents involving the AI workforce. However, this would largely restrict the number of suppliers, as many resort to black boxes as a way to protect proprietary software. The result could be greater cost, lower AI performance, and fewer bids by industry.

3. *What new human roles must be created as a result of automation?* While the US DoD calls for department staff to create and embed AI,[100] it is unclear that the CAF has the ability to generate its own AI in support of automation. Even if these tasks are outsourced, the CAF will at least be required to supervise, assess, and maintain its autonomous workforce. Are these new tasks to be absorbed by supervisors and existing technician occupations? Are new occupations required? Again, the answers to these questions must inform the reimagined CAF structure.

4. *What structure should the transformed CAF adopt?* Since implementing RPA is more than replacing human workers with robots, existing structures must be reconsidered to allow the successful juxtaposition of the various workforces.[101] Considering that the implementation of RPA will necessitate time, it is appropriate for structures to evolve in stages.

5. *How can the CAF achieve evergreening in capability development?* Canadian military procurement is slow and cumbersome, and was described by an independent review panel as "increasingly ill-suited to a world of quickly evolving/complex technologies."[102] In fact, one national policy think tank descries it as "the worst military procurement system in

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[100] United States, JAIC, DoD, "2020 Department of Defence Artificial Intelligence Education Strategy . . .
[101] Recall the model proposed by Deloitte for the RAN, which differentiates four workforces: *the human workforce*, *automated assistants*, *cognitive assistants*, and *AI advisors. See* Deloitte, "Case Studies: AI reports for Duty . . .
[102] Canada, DND, "March 2020 - Independent Review Panel for Defence Acquisition (IRPDA)," last modified 30 September 2021, last accessed 25 April 2022, https://www.canada.ca/en/department-national-defence/corporate/reports-publications/transition-materials/defence-101/2020/03/defence-101/irpda.html.

the Western World."[103] Allies have turned to evergreening to address the issue of military capability development, recognizing that platforms are not separate from the software that underpins them. How can the CAF optimize procurement and address issues with the current system?

6. *How should the CAF incentivize adoption of RPA?* If culture change is indeed the greatest challenge to implementing RPA, fostering change must be incentivized. Considering that automation can alleviate personnel shortages, services could receive the guarantee that human positions rendered superfluous by automation would remain within that service, for reassignment. Furthermore, programs such as the Royal Canadian Air Force's *Qulliq Plan* or the US Air Force's *Robot 4 Every Airman* competition[104] should be instituted for the various services, with winning entries being recognized and distributed widely.[105] Other solutions may exist however.

7. *How should the CAF prepare its human workforce?* While the CAF Professional Development Council has recently recognized digital literacy as a core competency, this is but a starting point. Complementary training on basic AI concepts, the ethics of automation, and working alongside an

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[103] Macdonald Laurier Institute, "Canada has the Worst Military Procurement System in the Western World: Richard Shimooka in the Hill Times," published 21 January 2019, last accessed 25 April 2022, https://macdonaldlaurier.ca/canada-worst-military-procurement-system-shimooka-the-hill-times/.
[104] United States, USAF, "R4EA: Robot 4 Every Airman," last accessed 22 April 2022, https://robot4everyairman.net/.
[105] The approach used by the R4EA competition is predicated on USAF personnel having access to UiPath, the leading self-contained automation platform used by the US government. The competition allows USAF personnel to create automated solutions to everyday work challenges. This not only allows for the dissemination of grassroots solutions with the potential to improve efficiency across the organization, it also fosters the ability of service personnel to recognize opportunities for automation and appreciate their merits.

AI workforce are also required. Furthermore, specific training addressing the additional tasks resulting from the implementation of RPA will be necessary in addition to platform-specific operator training. Significant occupation reassignment could result over time, requiring current service personnel to be retrained according to personnel needs. Most importantly, CAF personnel must learn to respect automated workforces and appreciate them for the edge they can provide, without being made to feel like the human workforce has become irrelevant or undervalued. The ways and means to achieve these critical objectives must be researched further and accounted for in campaign planning.

CONCLUSION

This paper highlighted the need for the CAF to implement RPA while shedding light on both the associated opportunities and challenges. From this research, it is clear that opportunities abound for the CAF to pursue automation, but that lack of vision, an overly conservative culture, and systemic obstacles have so far hampered meaningful progress.

In arguing so, the paper introduced relevant aspects of the strategic context and provided evidence that, because of current macro-trends and the exacerbation of a reduced workforce, the CAF should consider how the civilian industry and defense partners are already pursuing RPA to gain a competitive edge, and what it would mean for Canada not to do so. Following the introduction of RPA as a concept, the paper considered the gradual adoption of automation by the ADF. It showed that what began as

a series of independent initiatives as of 2015 was eventually coordinated by national policy and a strategy aiming to transform the ADF in a military force where humans and machine cooperate towards shared defence goals. Their envisioned transformation is total, in that automation is pursued at both the institutional and tactical levels, in close cooperation with industry, and without undue restraint from existing structures.

With inspiration from the Australian experience and with consideration for RPA suitability criteria, this paper then considered opportunities for automation across the CAF by function and occupation. In both cases, it became clear that the best return on investment rests in the institutional automation of logistics, particularly finances, human resources, supply, and transport, and the tactical automation of operators, such as pilots, armoured crewmembers, MSE operators, and sensor operators. Importantly, the research differentiated between levels of automation for each by using a consistent AI workforce ratio continuum. A different way to perceive the value of automation is by considering the resulting reduction in risk to the human workforce; with this in mind, the paper also identified decontamination and reconnaissance as tactical processes worthy of automation.

While the potential gains from RPA are significant, the CAF has many challenges to overcome if it is to be successful in its automation venture. Research pointed to the lack of a unified organizational vision, an under-appreciation of innovation within the CAF culture, and an ill-suited procurement system as being particularly problematic. The paper also raised important questions that must be considered now to shape the institutional vision and the resulting strategy. These concern the stance of Canada regarding the ethics of automation in defence, the desired AI workforce ratio, the need for

evergreening technologies, the incentivization of RPA, and the preparation of the human workforce for the transformation.

Automation is no longer a matter of choice. Avoiding it implies reduced capabilities in the face of rapidly growing threats, diminished interoperability, and eventually, the inability to be strong at home, secure in North America, and engaged in the world. While the direction that the CAF will take in the matter is as yet uncertain, opportunities do abound, and further research building upon this paper will inform the way. As the organization pursues its digital transformation further, it is expected that the adoption of RPA will rapidly offer a fresh waypoint for culture change and herald the embrace of our AI workforce.

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