National Defence Défense nationale

Canadian Forces College

Collège des Forces Canadiennes

ARTIFICIAL INTELLIGENCES INCORPORATION INTO THE JOINT OPERATIONAL PLANNING PROCESS

Major Michael Miller

JCSP 45

Exercise *Solo Flight*

Disclaimer

Opinions expressed remain those of the author and do not represent Department of National Defence or Canadian Forces policy. This paper may not be used without written permission.

PCEMI 45

Exercice *Solo Flight*

Avertissement

Les opinons exprimées n'engagent que leurs auteurs et ne reflètent aucunement des politiques du Ministère de la Défense nationale ou des Forces canadiennes. Ce papier ne peut être reproduit sans autorisation écrite.

Canada

CANADIAN FORCES COLLEGE – COLLÈGE DES FORCES CANADIENNES

JCSP 45 – PCEMI 45
MAY 2019 – MAI 2019

EXERCISE *SOLO FLIGHT* – EXERCICE *SOLO FLIGHT*

ARTIFICIAL INTELLIGENCES INCORPORATION INTO THE JOINT OPERATIONAL PLANNING PROCESS

Major Michael Miller

Some people call this artificial intelligence, but the reality is this technology will enhance us. So instead of artificial intelligence, I think we'll augment our intelligence.

— Ginni Rometty*, CEO of IBM*

INTRODUCTION

Over the last half-century, there has been a significant expenditure of resources directed towards expanding the scope and scale to which Artificial Intelligence (AI) can be used. Social networking writ large has generated a vast amount of information, and from a military perspective has been an impetus for the expansion of AI within the defence. AI at its inception was devised to assist academic fields of disciplines, as AI was programmed with algorithms capable of solving complex equations, specifically to test hypotheses about the very nature of AI and the system's ability to demonstrate an ability to learn.[1] Research and development (R&D) within the AI realm by institutes like Defense Advanced Research Projects Agency (DARPA), MIT or Tesla has led to an exponential increase in the competency and use of 21st century AI. Ray Kurzweil, director of engineering at Google predicts that AI systems will be capable of outperforming even the smartest humans by 2029.[2] If this is indeed the proposed reality, then an understanding of the requirements needed to program these autonomous systems is needed within the decade. Furthermore, the battlefields of the future can see an increased use of sensors from a military perspective, generating vast sums of information where assistance with sorting the endless streams of data will outpace human's capacity to monitor.

Stating that AI could potentially outperform even the smartest humans is not an easy feat. It would require specific algorithms defined within a precise framework or environment, to allow the system to perform the task it has been given. Establishing a continuous feedback loop to

[1] Bruce G Buchanan, "A (very) Brief History of Artificial Intelligence." *AI Magazine* 26, no. 4 (Winter 2005). 53.

[2] Ray Kurzweil, Stephen Hawkins, and Elon Musk, interview by Michael Warren. The Dark Side of Artificial Intelligence Toronto Star, (March 2019).

enable comparison and adaptive changes to situations permits AI to evolve and learn from experience, becoming aware of its surroundings. Combining the term *militarization* and AI, people send out an instantaneous fear, albeit leveraged by Hollywood to develop futuristic movies. The fear stems from the development of autonomous robots similar to the film "Kill Command" where killer robots targeted humans for practice whilst not bound by any moral or ethical parameters.[3] While still a long way off, there is value in integrating an AI system within the military in a non-kinetic manner. AI systems are capable of monitoring multiple informational nodes concurrently. This provides a persistent presence within the geospatial realm. Therefore the militarization of AI within a nation's strategic and operational planning process could offer another tool to planning staff for understanding the continually evolving complex environment.

Within the Canadian Armed Forces (CAF) there is a disproportional development of military operational planning process (OPP) across all environments. The lack of formal training offered across all environments throughout the developmental periods (DP), hinders the requirement to be capable of planning at a joint level. For a force that seeks to be *Joint,* The CAF doctrine is heavily influenced by the Army with a focus on land operations. Senior officers are not exposed to the Joint Operational Planning Process until their attendance if selected on the Joint Command and Staff Program (JCSP). Current career progression within the CAF is trending at a normal 1-2 year cycle in a position. Positions that take time to develop individuals, mainly those bound to work within a headquarters planning shop or more commonly known as the *5 cell,* a term established by the Prussian's to identify the office responsible for plans and strategy. Old adages of learning from a fire hose worked well from a heuristic approach,

[3] Stephen Chen, "Artificial intelligence, immune to fear or favour, is helping to make China's foreign policy." *South China Morning Post.* (Hong Kong: South China Morning Post Publishers, 2018). 3.

however, with the complex environment and requirement to retain a persistent finger on the pulse across all domains, has identified a need to augment planning staff. Additionally, human beings are creatures of habit and comfort and are resistant to change. Along these lines, individual experience and biases will appear within planning, which cannot be discounted, still, all these factors grouped could impact the development of well thought-out and resourced plans. The militarization of AI does not seek to omit the human connection with regards to plan development but, merely deepening the understanding of complex problems.

PLANNING WITHIN THE COMPLEX ENVIRONMENT

The CAF OPP is described within joint doctrine as a process used to prepare plans and orders for CAF operations.[4] The commander of an operation is vested with the authority to conduct planning and they are supported by staff that turns their direction and guidance into operational plans. The procedure that the staff uses is a logical and stepped process to aid the generation of a plan, by providing the commander with decision-making information on the situation. As the battlespace continues to evolve in complexity, military planners may develop operational plans for areas where previous conflicts have little similarities or relevance. Telecommunication network hubs of the 21st century have created an operational landscape which connects all domains together providing mass dissemination and collection of data.[5] [6] This immense amount of data has become a requirement now for militaries to collect and filter on a continuous base.

[4] Canada. Department of National Defence. BGJ-005-500/FO-000, the Canadian Forces Operational Planning Process (OPP). (Ottawa: DND Canada, 2008). 1-8.

[5] Division, Modernization and Strategic Planning. Future Land Warfare Report. Conceptual Development, Canberra: Australian Army Directorate of Future Land Warfare, (2014). 6.

[6] Domains refer to the Land, Air, Sea, Cyber and Space.

Planning for military operations is a multifaceted, knowledge-intensive, and collaborative endeavor.[7] It seeks to leverage the intrinsic experience of staff level planners. Within the joint environment, specific needs and capabilities exist. There is not a one size fits all application for AI, at every level of service; requirements based on desired inputs or outputs are needed to be tailored.[8] Rear Admiral Scott Bishop who is the head of Canadian Forces Intelligence Command stated, "You can put artificial intelligence in any decision-support tool or any combat tool. I think it's going to be ubiquitous on the battlefield and ubiquitous in our support for operations."[9] To negate the inclusion of AI within the military creates a blind spot that hinders our employment and provides the adversary with an area to potentially exploit.

Merging the OPP with AI within this context is aimed at Stage 2 and 3,[10] as the output is geared towards taking a broad understanding, identifying the overall objective and probability of success and the ideal solution space that can be achieved. Data processing is a critical element of military operations: the side that makes the best and quickest use of the information it acquires generally prevails on the battlefield.[11] Human initiation and experience have proven capable over the decades of achieving success through the application of the OPP, as seen by the victories of nations during the great wars. With each passing war, nations seek to gain a competitive advantage over their adversaries through advancements in technology.

Technology's expansion and mainstream have leveled the playing fields for many nations, as well as non-state actors leveraging social media to conduct nefarious activities. With

---

[7] Jitu Patel, Michael Dorneich, David Mott, Ali Bahrami, and Cheryl Giammanco, "Improving Coalition Planning by Making Plans Alive." IEEE Intelligent System 28, no. 1 (2013). 17.

[8] Jitu Patel, Michael Dorneich, David Mott, Ali Bahrami, and Cheryl Giammanco. "Improving Coalition Planning by Making Plans Alive." IEEE Intelligent System 28, no. 1 (2013). 18.

[9] Stephen J Thorne,. "Artificial Intelligence: Transforming the battlefield." *Defence Today.* Legion Magazine, October 17, 2018. https://legionmagazine.com/en/2018/10/artificial-intelligence-transforming-the-battlefield/

[10] CFJP 5.0: Stages of the Operational Planning Process: Stage 1 – Initiation, Stage 2 – Orientation, Stage 3 – Courses of Action Development, Stage 4 – Plan Development and Stage 5 – Plan Review.

[11] Stephen J Thorne, "Artificial Intelligence: Transforming the battlefield."

the continuous amount of social media data being streamed across the informational domain, it generates a continuous bombardment of information. Analysis cannot be left to humans to sort through as noted by Rear Admiral Bishop, "Trying to make sense of all the information and all the data that's out there is well past the point where we can just throw more human beings at it."[12] Timely analysis of this information is critical to completing a thorough evaluation of factors that provide real-time inputs on emerging threats. Continuous updates allow planners to determine the impact on the proposed mission or validate assumptions throughout the process.

Deliberate planning at the operational level is predicated on horizon scanning to identify emerging threats or, identified areas of opportunity either branch or sequel plans based on current operations. Though timely analysis is required of the information, AI enabled sensors can function quickly, yet there is still a requirement to build a historical database to create patterns or trends. Artificial intelligence is the most effective way to prioritize, identify patterns and process the volume of information—"that ocean of data" as referred to by Rear Admiral Bishop—that constantly flows from satellites, drones, troops on the ground and other military and intelligence assets.[13] The sheer volume of this information is only useful if planners are apt at turning this information into relevant plans. Particularly breaking away from the status quo of conceptual ideas, that are still in line with doctrine but seek to address areas that were foreign to military operations of the past global conflicts.

THE CYNEFIN FRAMEWORK

21st-century planners must be open and willing to diverge at times away from the status quo and breaking away from their comfort zone. As within the military, private sector as well aims to gain a competitive advantage over their competition. Models have been developed in the

[12]Stephen J Thorne,. "Artificial Intelligence: Transforming the battlefield."
[13]Ibid.

private sector to assist leaders and executives with decision making. One model is known as the Cynefin model (figure 1). It possesses quadrants that represent the different actions that occur within environments: Simple, Complex, Complicated and Chaotic contexts.[14] In a simplistic way, these different quadrants look at decision making from the analysis of known and unknown factors, evaluating them and then deriving a solution to the problem, mirroring some facets of the OPP steps. But within the model, there are pitfalls that can occur based on the human variable from practitioner's to experts when moving across quadrants within the Cynefin Model.

(Figure 1: Cynefin Framework from Cognitive Edge.com)

Examining the S*imple* quadrant, which at its rudimentary form it predicated on complacency, which tends to be were planners end up. A majority of the time within the military, a planner is considered an expert within their trade and assumed that they are equally apt planners at the operational level. To non-Army officers, OPP is seldom used, and frankly often

[14] David J Snowden, and Mary E Boone. "A Leader's Framework for Decision Making." https://hbr.org. November 2007. https://hbr.org/2007/11/a-leaders-framework-for-decision-making.

modified within the CAF,[15] however, what it does create is an atmosphere of integration and information sharing based on experience and training. By working in unfamiliar environments leaders and experts are capable of approaching decision making more creatively.[16]

During periods of unfamiliar exposure, people tend to be creative and exploratory as complacency is absent and will remain absent until their actions become routine. If we view JOPP for what it is, a process that follows a logical path, then humans are naturally inclined to lessen their cognitive processes and engagement through conducting repetitive tasks.[17] Though each planning session has a different problem to solve, the stages and the steps remain the same. The net result from this complacency is poor analysis and no creativity in plan development.[18] To mitigate this effect from routine tasks, AI would provide alternative analysis and considerations to planning teams. Incorporating AI as a system within the planning and enabling the machine to operate results in different decisions from those the human would make.[19]

To think that by moving into the complex and complicated quadrants may solve this complacency mindset is true, but it creates another issue. Another potential obstacle is "analysis paralysis," where a group of experts hit a stalemate, unable to agree on any answers because of each individual's entrained thinking—or ego.[20] Though the Cynefin model views these experts in the complicated quadrant, it still displays slight complacency grounded in their specific fields of expertise. Transition to the complex is challenging to overcome individual egos, however

---

[15] CJOC mentor teams provided to CFC during a two-week cycle of JOPP (March 2019) provided valuable insight into the different methods of planning that is conducted within the operational headquarters. It was a modified approach that streamlined some processes and was usually required due to time constraints.

[16] Snowden, David J, and Mary E Boone. "A Leader's Framework for Decision Making." https://hbr.org. November 2007. https://hbr.org/2007/11/a-leaders-framework-for-decision-making (accessed April 23, 2019)

[17] Raja H Parasuraman, and Dietrich H Manzey. "Complacency and Bias in Human Use of Automation: An Attentional Integration ." Human Factors 52, no. 3 (June 2010). 381

[18] Ibid., 381.

[19] Stuart Russell presentation in 2015 meeting of Experts on Lethal Autonomous Weapon Systems (LAWS), at the United Nations in Geneva.

[20] David J Snowden, and Mary E Boone. "A Leader's Framework for Decision Making." https://hbr.org. November 2007. https://hbr.org/2007/11/a-leaders-framework-for-decision-making.

necessary to adapt to the current environment facing militaries. AI provides the unbiased insight, and when used can provide additional solutions to potentially myopic looking views that plague planners looking to calculate an exponential number of variables. The computations conducted by AI when validating potential outcomes has the potential to help planners develop strategies that are more synchronized, addressing the required resources and probability outcomes of multiple solutions.

WARGAMING

A part of childhood that could be viewed as a staple in our daily interaction and socialization with the world, is our ability to play games. A game provides children the venue to explore new worlds and let their imaginations develop new concepts. Similarly, within JOPP, wargaming is used as the process to assist staff in systematically stepping through a course of action (COA), to identify potential shortfalls in capability or ill-defined effects.[21] The outputs of the war game provide the commander with the salient information with regards to the recommended COA. This however, is subjective to the experience and overall level of participation of those involved in the war game and at times could lack the intellectual rigor applied to fully ascertain the viability of the course of action.[22] The reality is that wargaming will remain a subjective process; nonetheless, the incorporation of AI can build accurate models with relative accuracy and probability.

Humans possess the cognitive ability to understand and comprehend situations or environments they operate in. The skills are developed over time and drawn from their experience and exposure throughout their training and professional military education (PME).

---

[21] Eikmeier, Dale. "Waffles or Pancakes? Operational- Versus Tactical- Level Wargaming." Joint Force Quarterly JFQ, no. 78 (Third 2015). 51

[22]John Thomas Hanley Jr, "On Wargaming: A Critique of Strategic Operational Gaming." Order No. 9221337. (Yale University, 1991). 268

Having this depth of knowledge, humans can aptly apply assumptions to areas that are unfamiliar to them.[23] Nevertheless, when faced with multiple problems, or having to evaluate a number of variables applicable to a wargame can become a laborious task that is extremely time-consuming. A unique feature of AI is based on the speed for which systems are able to produce recommendations. Within the complex environment, AI systems can provide a range of options with recommendations for the best move, sometimes in the blink of an eye.[24] The limiting factor is the processing power and amount of historical data the system can access to derive its findings.[25] This historical database does require significant human capital upfront, nevertheless the time expended building this baseline may possibly allow the AI to mature in its development of solutions using previous data as comparison criteria.

While AI systems at their early inception could pose a slightly daunting task, the overall functionality will provide users, specifically during a wargame with behavior and understanding of the operating environment.[26] Once fully functional, AI systems which are integrated into the wargaming process can produce a number of key operational outputs. The outputs are focused on what Dale Eikmeier has stated as "the Big W for what, and little h for how."[27] Through the proper algorithms, AI can conduct rapid testing of an entire range of weapon systems characteristics, logistical needs, tactics and strategies for the purpose of identifying the *What* would be needed to derive the optimal combination as well as the probability of occurrence.[28]

---

[23] Denise Garcia, "Lethal Artificial Intelligence and Change: the Future of International Peace and Security." (2018). 335.

[24] Stephen Chen, "Artificial intelligence, immune to fear or favour, is helping to make China's foreign policy." *South China Morning Post.* (Hong Kong: South China Morning Post Publishers, 2018). 3.

[25] Bruce G Buchanan, "A (very) Brief History of Artificial Intelligence." AI Magazine 26, no. 4 (Winter 2005). 54.

[26] Ibid., 54.

[27] Dale Eikmeier, "Waffles or Pancakes? Operational- Versus Tactical- Level Wargaming." *Joint Force Quarterly* JFQ, no. 78 (Third 2015). 51.

[28] Anotine Bousquet, The Scientific Way of Warfare. New York, Chichester: (Columbia University Press, 2009). 147.

Commanders thus can be reassured that during the war game, unique requirements, specifically, technical data, has been considered and staff has addressed the issues, theoretically mitigating personal biases or lack of experience within joint operations on a modern battlefield.

Participation in a war game is not limited to just military personnel. Operational level planning requires the inputs of all stakeholders as it bridges the gap between Strategic objectives and Tactical level *how.* Eikmier referred to this grouping as "unified action partners,"[29] a consortium that includes military, government and coalition partners. The grouping creates similarities as well as divergent requirements. These additional limitations or desired outcomes add to the complexity of wargaming generating additional variables that need to be calculated. During a traditional wargame, these enablers provide relevant insight to legal, political or national caveats. AI systems, which have these inputs, can apply them in their computations, specifically to moral, which machines are tasked not only to promote well-being and minimize harm, but also to distribute the wellbeing they create.[30] This potential delegation of wargaming duties to an AI system results in different decisions from those the human would make. The decisions are drawn on by captured data from previous operations that have similar characteristics and not influenced by emotional traits inherent within humans.[31]

On a daily basis, humans are constantly displaying emotions often tied to a requirement to make a decision. Emotion is influenced heavily by our culture and familiarities, and when applied to a military context, it is often a negative response. Christopher Coker noted that "we humans have a tenancy in a war to act with emotion; particularly post-conflict events/scenarios

---

[29] Dale Eikmeier, "Waffles or Pancakes? Operational- Versus Tactical- Level Wargaming." *Joint Force Quarterly* JFQ, no. 78 (Third 2015). 52.

[30] Edmond Awad, et al. "the Moral Machine Experiment." Nature,(2018). 59.

[31] Stuart Russell presentation in 2015 meeting of Experts on Lethal Autonomous Weapon Systems (LAWS), at the United Nations in Geneva. https://www.unog.ch/80256EE600585943/%28httpPages%29/6CE049BE22EC75A2C1257C8D00513E26?OpenDocument

where we have witnessed a peer become injured or killed."[32] This is specific to a wartime scenario that links a personal connection; nevertheless, individuals will continue to draw on this familiarity. There is the potential of it to blur their focus, or inadvertently influence those around them to access the situation during the war game. On the other hand, this emotional attachment is non-existent within an AI system. It does not get *wed* to a plan or a course of action and uses logical and predictable outcomes to facilitate the output of products from the war game.[33] Stated previously the war game is to draw out the critical *big* muscle moves at the operational level with little emphasis on the tactical.

Operational Functionality

When war gaming or *Kriegsspiel* was first introduced by the Prussians in the 19th century it was an attempt to realistically represent warfare.[34] At the time of its inception into military planning, it was novel. Kriegsspiel broke the template for how militaries plans were developed by adding a representative ground for where the battle will be fought and brought the mindset of the players into a much more persuasive simulation.[35] Viewed as almost a chess game, the overall conduct of the early war game was not grounded in rules and was very basic.[36] Unknown at the time was that chess itself was complex. Even for chess, the human cannot provide, in advance, an individual response for each of 10 exp 55 scenarios.[37] Omitting this approach to modern planning where the battlefield has moved from a two-dimensional view to a multi-domain would result in missed opportunities.

---

[32] Chritopher Coker, *Future War.* (Cambridge: Polity Press, 2015). 118.

[33] Ibid.,118.

[34] CFC/JCSP 45 briefing provided by lead Directing Staff LCol Gundermann (German Air Force) during DS 520 Operational Planning during winter 2019.

[35] Jason Begy, "Playing at the World: A History of Simulating Wars, People, and Fantastic Adventures: From Chess to Role-Playing Games." *American Journal of Play*, (Spring 2013). 392.

[36] Ibid., 391.

[37] Stuart Russell presentation in 2015 meeting of Experts on Lethal Autonomous Weapon Systems (LAWS), at the United Nations in Geneva.

Within the emerging multi-domain environment commanders ought to understand the complicated and intertwined relationships that exist within this fast-paced setting. Focusing on the incorporation of AI within a deployed operational headquarters is theoretically where AI's speed, which is inconceivable for humans, will have a positive impact.[38] The accessibility and filtering of information is the lifeline of any military plan. Operations conducted on the battlefield of the 21st century employ a myriad of sensors in an attempt to understand the Joint Operational Area (JOA) to inform commanders and staff at all levels. This extreme saturation of the JOA provides critical information in real-time to planners and addresses information requirements identified by commanders and staff.[39] This information permits planners to continually access their course of action and information requirements against the real-time perspective on the factors influencing the JOA and what future efforts will be needed to mitigate them, all with a view of guiding the war game.

The planning process creates many outputs during the stages. The outputs are aimed at offering the commander the information needed to make decisions or control the tempo.[40] A wargame seeks to flesh out a number of supporting documents that will assist the commander in the orchestration of effects across domains to exploit or mitigate critical vulnerabilities.[41] The NATO Science and Technology board has further highlighted the benefits on AI within the planning process as both an enabler and driver for new possibilities. As an enabler, AI follows the operational requirements and provides the commander with better means to conduct his operation. As a driver, the commander is provided (new) means to conduct his operation

[38] Kurzweil, Ray, Stephen Hawkins, and Elon Musk, interview by Michael Warren. The Dark Side of Artificial Intelligence Toronto Star, (March 2019).

[39] Hans-Georg Ehrhart, "Postmodern Warfare And The Blurred Boundaries Between War And Peace." *Defense & Security Analysis*, (n.d.). 365.

[40] Canada. Department of National Defence. *BGJ-005-500/FO-000 The Canadian Forces Operational Planning Process (OPP).* Ottawa: DND Canada, 2008. 4-8.

[41] Antoine Smallegange, Harrie Bastiaansen, Auke Venema, and Adelbert Bronkhorst, "Big Data And Artificial Intelligence For Decision Making." *NATO Science and Technology Board.* NATO, (Q2 2018). 5.

differently.[42] Assisting in the identification of new options facilitates operations to be resourced correctly in terms of force structure, or aid nations in developing future capabilities.

Decision making lies within the authority granted to commanders and for the time will rest there. As AI becomes more mainstream within the militaries around the globe, those that avoid its inception will be left at a disadvantage. Dr. Feng Shuai, a senior fellow with the Shanghai Institutes for International Studies stated that, "lacking the assistance of AI will be at an absolute disadvantage in many aspects such as risk judgment, strategy selection, decision making and execution efficiency, and decision-making reliability."[43] In line with this statement many superpowers, like the United States have significantly increased their defense spending in the field of AI. Programs like Project Maven, that uses AI to categorize drone imagery saw a 580% increase in funding.[44] This program is not geared towards autonomous *killer robots* but as an enabler to aid in the development of plans.

The modernization of our planning process combining human intuition with the speed of AI will accelerate the commander's ability to wage war. An AI system can be generated to perform a number of applications. These applications are unique to military planning, supporting considerations or details that humans may have overlooked.[45] Acknowledging that nothing is perfect, the combined efforts of human and AI deliver a more comprehensive overview of the situation both for the area of influence and interest.

There are three AI applications that are currently available to military planners. These applications are diverse in their outputs but complementary when seeking to solve a large

---

[42] Antoine Smallegange, Harrie Bastiaansen, Auke Venema, and Adelbert Bronkhorst, "Big Data And Artificial Intelligence For Decision Making." NATO Science and Technology Board. NATO, (Q2 2018). 7.

[43] Stephen Chen, "Artificial intelligence, immune to fear or favour, is helping to make China's foreign policy." *South China Morning Post.* (Hong Kong: South China Morning Post Publishers, 2018). 3.

[44] Jay Cassano, "Pentagon's Artificial Intelligence Programs Get Huge Boost In Defense Budget." *Fast Company*. (August 15, 2018).

[45] Sputnik. South Korean Army to Use Artificial Intelligence to assist Military Commanders. General Interest Periodicals, (Moscow: Rossiya Segodnya, 2017).

objective. *Neural Network* applications are applications that provide planning teams with decisive points along various lines of effort in the operational design.[46] The downfall to this application is the initial human capital to create the parameters for the AI to function is tedious, but once built the application is efficient and applies rules based query-and-response to recognize patterns.

More in line with wargaming, the remaining two applications are related to generating solutions, based on the adaptation of variables within the battlespace. These applications seek to find the optimal solution grounded in probability. *Genetic Algorithms* is a fast and transparent application that lends itself to the discovery of multiple options, derived from altering variables over several generations, ceasing only when solutions display no apparent benefits.[47] During the conduct of a war game, solutions are provided with incremental adjustments to both friendly and adversary forces. The overall output of this application could be useful in establishing a credible and validated Joint Statement of Requirements (JSOR).

Similarly to the JSOR application is the requirement for commanders and staff to understand the flow of the battle. The flow of the battle allows planners to validate their own data entry comparing inputs to desired outputs. *Fuzzy Logic* attempts to draw a correlation between inputs and outputs. Although the term ‘fuzzy' could be interpreted with a negative undertone, it provides planners with crisp values that look at maneuver planning and force allocation.[48] Applying this application alongside Genetic Algorithms could ensure that forces available are capable of achieving the task, but more importantly to highlight short-falls or requirements to strategic level planners and force development cells.

---

[46] Gabriela Prelipcean, Mircea Boscoianu, and Florin Moisescu, "New Ideas on the Artificial Intelligence Support in Military." In Proceedings of the 9th WSEAS international conference on Artificial Intelligence, knowledge engineering and data bases. World Scientific and Engineering Academy and Society (WSEAS), (2010). 35.

[47] Ibid., 36.

[48] Ibid., 36.

A defining aspect in the use of AI in a military application is predicated on trust. Change within an organization brings heavy resistance. The acceptance of AI in any form is not immune to this phenomenon. In general, people resist change for a number of factors ranging from loss of credibility due to a lack of initial understanding of the dreaded requirement to learn a new way of doing business.[49] Applying the aforementioned applications of AI into wargaming brings about a stigma. The loss of control of the process and the emotional detachment of planners created as a result of allowing a computer to conducted war gaming creates a negative perspective. Philip Sabin a military historian and professor of Strategic Studies at King's College noted this stigma stating that "it seems especially inappropriate to reduce the tragic sacrifices of armed conflict to a mere 'game."[50] However, war gaming theoretically possesses the opportunity to mitigate threats and provide an optimal recommended plan, in line with the criteria entered by humans.

The fear that AI has the potential to become self-aware is contained thru human interface with the systems. Authors of doomsday articles like Denise Grace cast a dark shadow claiming, "an AI weapons global race will imperil everyone, Nuclear weapons serve as a historic model, alerting us to what can result: an imbalanced system of haves and have not's and a fragile balance of security."[51] The probability of this outcome is unpredictable; however as technology advances developers and programmers must remain alert, robots will self-improve faster than we slow evolving humans. That means outstripping us intellectually with unpredictable outcomes;[52] could equate to a doomsday scenario or rogue development of courses of action.

---

[49] Rosabeth Moss Kanter, "Ten Reasons People Resist Change." Harvard Business Review, 2012.

[50] Philip Sabin, "Wargaming In Higher Education: Contributions And Challenges." *Arts and Humanities in Higher Education*, (2015). 342.

[51] Denise Garcia, "Lethal Artificial Intelligence and Change: the Future of International Peace and Security." (2018). 339

[52] Kurzweil, Ray, Stephen Hawkins, and Elon Musk, interview by Michael Warren. The Dark Side of Artificial Intelligence Toronto Star, (March 2019).

THE ROAD AHEAD

Within any institution, organizational change is needed to keep pace with emerging trends. Change management is key to transitioning our current way of thinking and evolving it to better addressing future threats. As part of the curriculum at the Joint Command and Staff Program (JCSP) at the Canadian Force College (CFC), lectures have educated senior officers on some best practices and models that welcome and enable change within an organization.[53] However, during the OPP serial, basic and fictional scenarios where provided to students. To ensure that graduates are capable of understanding the future demands, planning tools and access to CAF systems should be provided to better mimic reality. As future leaders within the CAF, the introduction of emerging technology is paramount in order to socialize and obtain stakeholder buy-in. In doing this, future leaders will be afforded the exposure and application of new tools, aimed at breaking the stigma of resistance by being exposed outside of a real-life situation.

Design Thinking

In an exploratory effort to evolve the operational level planning process CFC has taken a proactive approach, along with many other nations like the United Kingdom and Australia, to breaking the traditionalist mold of a rigid process that drives planning. A number of key guests lectures from national and international areas were brought in to provide an understanding and conceptual approach to operational planning. Aaron Jackson, a specialist in defence and military studies creatively outlined design thinking as a method that focuses on innovation and creativity breaking away from the stepped and structured approach to OPP.[54] Design thinking is aimed at solving complex problems. Complex environments as depicted by the systems analysis generated

[53] JCSP 45 Roto 1 curriculum DS 556 Command/TOC/LE-4 – Change Management. Teaching points: Applying methods to minimize resistance and influence stakeholders and Identifying organizational design impediments and enablers to change and influence organizational culture.

[54] Aaron Jackson Brief to JCSP 45 on Design Thinking - DS 548/DES/LE-1 Principles of Design Thinking in the Military Context, 10 April 2019.

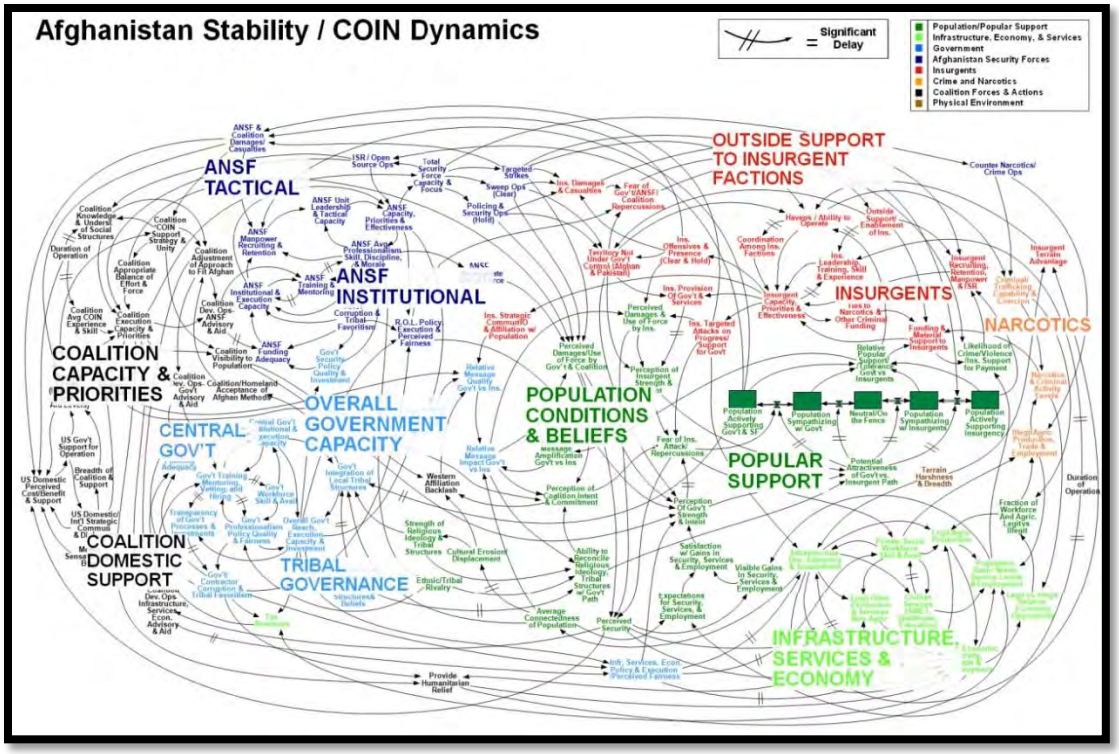
for stability operations in Afghanistan (figure 2).[55] The intricacy of this diagram brought to light for military and government leaders the true complexity of the environment. Stability operations in this environment take time and require large amounts of data to find trends and patterns. This system is ideal for AI that could be married up with a known framework like John Boyd's OODA (Observe, Orientate, Decide and Act) Loop.

OODA loop comparison and the further exploration of mitigation and false/positive from the positive feedback loop where humans tend to make conclusions about the information being provided that is in line with their biases. Similarly to an echo chamber where you and those around you are of like mind and tend to believe what you want to be true. Creating this type of environment is detrimental to the planning process and does not create novel and new ways to solve address emerging threats. Boyd who was a USAF pilot explained that "people are taking to be too literal."[56] The designation of a loop was to allow for the convenience of explanation, it is an iterative process that takes into consideration a number of factors within the environment and compares them against each other.[57]

[55] Aaron Jackson Brief to JCSP 45 on Design Thinking - DS 548/DES/LE-1 Principles of Design Thinking in the Military Context, 10 April 2019.

[56] Anotine Bousquet, The Scientific Way of Warfare. New York Chichester: (Columbia University Press. 2009). 189.

[57] Ibid., 189.



(Figure 2 – systems analysis - http://www.umsl.edu/~sauterv/analysis/analysis_links.html)

A comprehensive factor comparison within a complex environment could require a large amount of analysis. Analysis that would take a significant amount of time to compute, which when using the OODA loop model defeats the purpose as speed is a key characteristic to allow your force to get ahead of the adversaries decision cycle. To ensure speed of action, AI systems can be programmed with defined parameters that seek to compare the difference between the internal framework and the external world.[58] This loop is capable of proposing both positive and negative feedbacks which are non-linear. While there is still human control factor nested within the development of the internal framework, the AI's capability of pulling data from multiple domains and fusing them into a representative picture is outside the scope of a human.[59] Therefore the AI's capability of providing a clear picture supports the 'observe' stage of the

[58] Anotine Bousquet, The Scientific Way of Warfare. New York Chichester: (Columbia University Press, 2009). 193.

[59] Antoine Smallegange, Harrie Bastiaansen, Auke Venema, and Adelbert Bronkhorst, "Big Data And Artificial Intelligence For Decision Making." *NATO Science and Technology Board.* NATO, (Q2 2018). 6.

OODA Loop and thus enables planners to focus on the changing situation during OPP, and aptly respond to it, specifically during COA development or war game.

CONCLUSION

Artificial Intelligence is still a theoretical system; however, the appetite of many private and public sector entities will continue to push the envelope in creating more sophisticated applications. An application that is able to work on non-linear problems, understand the environments and develop recommendations from a planning perspective on how to best solve a problem. Within the JOPP, AI which is capable of achieving this level of analysis through learning and connected networks will allow it to predict future requirements within a high degree of certainty. Commanders and staff may be capable of adopting a more proactive approach to planning operations in terms of either a branch or sequel planning within the operational design stage. Failure to encompass AI could degrade a militaries situational awareness, hampering a commander's power to orchestrate a battle, conversely exposing a flank from which an adversary can have a marked advantage. [60]

Vice Admiral Lloyd Commander of the Royal Canadian Navy (RCN) referred to the increased incorporation of AI within the CAF as a whole, noting that he was concerned with conducting operations on, in or above the battlefield of the 21st century without AI, viewing it as a requirement to be effective within the forecasted complex domain.[61] Although he was not explicit on the application of AI, its utility should be viewed in broad employment. Employment that commences with the execution of a JOPP during JCSP firstly to garner stakeholder buy-in but to validate AIs ability to determine the operational requirements and forces needed to achieve success within a simulated environment. Omitting the positive feedback loop inherent within

[60] Antoine Smallegange, Harrie Bastiaansen, Auke Venema, and Adelbert Bronkhorst, "Big Data And Artificial Intelligence For Decision Making." *NATO Science and Technology Board.* NATO, (Q2 2018). 4.

[61] CRCN visit to CFC/JCSP45 11 April 2019.

human planning encourages militaries to not fight the war they want but the war they are in. Throughout JCSP 45, senior leaders have insisted on finding new and creative ways to solve problems and often reminded students that they will be charged with this task following the course. AI's creativity and modeling can provide leaders with this creativity as well as leveraging a design thinking mindset. Planners that are able to provide their commanders with products aided by AI that showcase probability as well as optimal solutions with the justification and requirements can only prove beneficial for breaking the motto of *rinse and repeat*. Inclusion of AI now is key to the longevity of the CAF. Operations will continue to be complex and as new generations of recruits enter the force, AI will be a staple in their way of life and a necessity in their ability to lead the institution.

> The reality is there's so much data coming off those [intelligence, surveillance, and reconnaissance] platforms that only a small fraction is actually analyzed by human beings. So we're going to have to think about where we can use technology to analyze more of the information that we have at our disposal.[62]

This paper did not discuss ideas surrounding moral and ethical considerations as the author believed that the use of AI within a planning environment would not have the ability to act or have the authority of command. To minimize a potential planning conflict that may contravene moral or ethical boundaries, AI programs designed for planning would require an internal framework modeled after Rules of Engagement (ROE) or International Humanitarian Law (IHL) to name a few and would be a potential follow on a research topic to understand the variances within the outputs. However as noted by Barack Obama, where does the responsibility lie, with the engineers, the programmer's, or the commanders who use AI to support decision-making. [63]

---

[62] Stephen J Thorne, "Artificial Intelligence: Transforming the battlefield." Defence Today. Legion Magazine, October 17, 2018https://legionmagazine.com/en/2018/10/artificial-intelligence-transforming-the-battlefield/

[63] Edmond Awad, et al. "the Moral Machine Experiment." Nature,(2018). 59.

Bibliography

Awad, Edmond, et al. "the Moral Machine Experiment." *Nature*, 2018: 59-64.

Begy, Jason. "Playing at the World: A History of Simulating Wars, People, and Fantastic Adventures: From Chess to Role-Playing Games." *American Journal of Play*, Spring 2013: 391-393.

Bousquet, Anotine. *The Scientific Way of Warfare.* New York Chichester: Columbia University Press, 2009.

Buchanan, Bruce G. "A (very) Brief History of Artificial Intelligence." *AI Magazine* 26, no. 4 (Winter 2005): 53-60.

Canada. Department of National Defence. *B0GJ-005-500/FO-000 The Canadian Forces Operational Planning Process (OPP).* Ottawa: DND Canada, 2008.

Canadian Defence Academy. "Leadership in the Canadian Forces - Conceptual Foundations." By Canadian Defence Academy, 164. Canadian Defence Academy - Canadian Forces Leadership Institute, 2004.

Cassano, Jay. "Pentagon's artificial Intelligence programs get huge boost in defense budget." *Fast Company.* August 15, 2018.

Chen, Stephen. "Artificial intelligence, immune to fear or favour, is helping to make China's foreign policy." *South China Morning Post.* Hong Kong: South China Morning Post Publishers, July 30, 2018.

Coker, Chritopher. *Future War.* Cambridge: Polity Press, 2015.

Division, Modernisation and Strategic Planning. *Future Land Warfare Report.* Conceptual Development, Canberra: Australian Army Directorate of Future Land Warfare, 2014, 1-26.

Droid, Curious. *Rise of the Terminators - Military AI, Weapons that think for themselves.* November 23, 2016.

Ehrhart, Hans-Georg. "Postmodern warfare and the blurred boundaries between war and peace." *Defense & Security Analysis*, n.d.: 263-275.

Eikmeier, Dale. "Waffles or Pancakes? Operational- Versus Tactical- Level Wargaming." *Joint Force Quarterly* JFQ, no. 78 (Thrid 2015): 50-53.

Garcia, Denise. "Lethal Artificial Intelligence and Change: the Future of International Peace and Security." 2018: 334-341.

Geist, Edward Moore. "(Automated) planning for tomorrow: Will artificial intelligence get smarter?" *Bulletin of the Atomic Scientists.* Routledge, Feb 17, 2017. 80-85.

Gunning, David, and Peter Z Yeh. "Innovative Applications of Artificial Intelligence 2015." *AI Magazine*, Summer 2016: 5-6.

Jr, John Thomas Hanley. "On Wargaming: A Critique of Strategic Operational Gaming." *Order No. 9221337.* Yale University, 1991.

Kahneman, Daniel. *Thinking, Fast and Slow.* Anchor Canada, 2011.

Kanter, Rosabeth Moss. "Ten Reaseons People Resist Change." *Harvard Business Review*, 2012.

Kurzweil, Ray, Stephen Hawkins, and Elon Musk, interview by Michael Warren. *The Dark Side of Artificial Intelligence* Toronto Star, (March 2019).

Meiser, Jeffrey W. "Are Our Strategic Models Flawed?" *Ends+Ways+Means=(Bad) Strategy.* Parameters, Winter 2017. 81-91.

Parasuraman, Raja, and Dietrich H Manzey. "Complacency and Bias in Human Use of Automation: An Attentional Integration ." *Human Factors* 52, no. 3 (June 2010): 381-410.

Patel, Jitu, Michael Dorneich, David Mott, Ali Bahrami, and Cheryl Giammanco. "Improving Coalition Planning by Making Plans Alive." *IEEE Intelligent System* 28, no. 1 (2013): 17-25.

Prelipcean, Gabriela, Mircea Boscoianu, and Florin Moisescu. "New Ideas on the Artificial Intelligence Support in Military." *In Proceedings of the 9th WSEAS international conference on Artificial intelligence, knowledge engineering and data bases.* World Scientific and Engineering Academy and Society (WSEAS), 2010. 34-39.

Price, Mathew, Stephen Walker, and Will Wiley. "The Machine Beneath: Implications of Artificial Intelligence in Strategic Decisionmaking." *PRISIM* 7, no. 4 (2018): 93-105.

Russell, Stuart, Sabine Hauert, Russ Altman, and Manuela Veloso. "Ethics of artificial intelligence." *Nature* (Nature Publishing Group), May 2015: 415-418.

Sabin, Philip. "Wargaming in higher education: Contributions and challenges." *Arts and Humanities in Higher Education*, 2015: 329-348.

Smallegange, Antoine, Harrie Bastiaansen, Auke Venema, and Adelbert Bronkhorst. "big data and artificial intelligence for decision making." *NATO Science and Technology Board.* NATO, Q2 2018. 1-11.

Snowden, David J, and Mary E Boone. "A Leader's Framework for Decision Making." *https://hbr.org.* November 2007. https://hbr.org/2007/11/a-leaders-framework-for-decision-making (accessed April 23, 2019).

Sputnik. *South Korean Army to Use Artificial Intelligence to assist Military Commanders.* General Intersest Periodicals, Moscow: Rossiya Segodnya, 2017.

Thorne, Stephen J. "Artificial intelligence: Transforming the battlefield." *Defence Today.* Legion Magazine, October 17, 2018.

TV, CNBC Intrenational. *AI is a means to an end, not an end in itself for markets.* December 15, 2018.