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CHANGING THE RELATIONSHIP BETWEEN THE OPERATOR AND THE COMBAT SYTEM TO ACHIEVE EXELLENCE IN OPERATIONS

Lieutenant-Commander James LeClair

JCSP 48	PCEMI 48
Service Paper	**Étude Militaire**
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CANADIAN FORCES COLLEGE – COLLÈGE DES FORCES CANADIENNES

JCSP 48 – PCEMI 48
2021 – 2022

Service Paper – Étude militaire

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AIM

1. The aim of this paper is address how the Royal Canadian Navy (RCN) can best enable both human and machine learning to achieve required military outcomes. As naval technology continues to modernize, there are ways to leverage these tools to improve how a human operator interacts with a ship's Combat Management System (CMS). Modern radars, and other active and passive sensors of the electromagnetic spectrum, are capable of processing information that improve a user's understanding of threats to a ship. A predictive and learning CMS takes a historically manually-intensive task of manipulating the combat system, and associated sensors, away from the operator. Instead, the CMS presents a clear assessment of threats, and proposes solutions for ships to defend themselves and others in a task group. The challenge for the RCN is to train human operators to move from their traditionally manually-intensive tasks to focusing on more strategic planning and thinking. In order for this to be successful, improvements must be made to the CMS to ensure the humans who interact with it trust its efficacy and outcomes.

INTRODUCTION

2. In naval operations, the operator and combat system relationship is complex. At a macro level, the tasks of a combat system are to present the operator the Recognized Maritime Picture (RMP), assess threats, present the operator with solutions, and execute the proposed solutions. Prior to Halifax Class Modernization (HCM), the combat system in the Halifax Class and the Iroquois Class was referred to as the Combat and Control System (CCS). These systems were advanced for their time, but required constant and significant configuration for success at sea. The modernized Halifax Class has introduced Combat Management System (CMS) 330 to the fleet as the CMS of the present, and future fleet. CMS 330 will be the baseline software for the future Canadian Surface Combatant (CSC)[1], and Joint Support Ship. With that in mind, this service paper will aim to address where the RCN should focus its efforts in improving the human and machine learning in today's fleet, and the fleet of tomorrow.

3. Canadian Joint Operational Command's (CJOC) draft copy of its Pan-Domain Force Employment Concept (PFEC) specifically identifies that automation, and human-machine teaming, are areas that the CAF must rapidly adopt and integrate[2]. According PFEC, Artificial Intelligence (AI) is "becoming a major source of military power on the world stage"[3]. The RCN is expected to perform in domestic and expeditionary

[1] Staff, Naval News. 'Lockheed Martin Canada's CMS 330 Selected for RCN Joint Support Ships'. *Naval News* (blog), 7 February 2019. https://www.navalnews.com/naval-news/2019/02/lockheed-martin-canadas-cms-330-selected-for-rcn-joint-support-ships/.

[2] Canada. Department of National Defence. Pan-Domain Force Employment Concept: Prevailing in an Uncertain World. Ottawa: CJOC, 2020. 22

[3] Canada. Department of National Defence. Pan-Domain Force Employment Concept: Prevailing in an Uncertain World. Ottawa: CJOC, 2020.22

environments as employed by CJOC, and will be expected to deploy independently, and also in a Canadian Task Group[4]. By identifying the mission sets expected in areas of tension, up to and including combat, the scope of machine learning in naval warfare must have, in almost every condition, a human in the decision loop when there is a kinetic release of weapons that will harm another combatant.

DISCUSSION

4. In naval operations, the first combat challenge for a ship is awareness of all contacts in the operating environment. These contacts are in the air, on the surface, and beneath the surface. Operators work to build and maintain this combat picture - commonly referred to as the Recognized Maritime Picture (RMP). Combat information from passive and active sensors, and observations based on human interaction, such as radio communication, help build the RMP. The maintenance of the RMP supports a CMS in determining threats to a ship or task group. Digital processing of normally laborious tasks, such as message transcription, are an example of how the CMS can increase an operator's efficiency. The Air Tasking Order (ATO) is a prime example of how automation can change the human task from digitizing to comprehending the tactical picture. In multi-national missions in North Atlantic Treaty Organization (NATO) theatres of operations, there are hundreds of daily flights of friendly forces. The standard method of communicating these flights is via the ATO. If a CMS had a digital version of an ATO uploaded, it could use that information in the tasking order (i.e. flight times, International Friend Foe (IFF), mission type, etc.) as reference information when an air track is finally detected by a ship in the task force via IFF interrogator and radar. By having early awareness of the track information, the CMS can cross reference this information and inform the operator of the friendly contact. This enables to operator to prioritize efforts on contacts of interest.

5. In order for a CMS to understand what a specific threat is to a ship, and provide valid combat solutions, there needs to be a threat database. The machine (CMS) must have a central reference to make a threat analysis in operations. The CMS could then match observations of tracks using data gathered from sensors to make appropriate assessment of a track's command classification (Friend, Neutral, Hostile, Unknown, Suspect), and what type of platform it is. There should be an RCN organization responsible for this database, and members must have access to technical and tactical intelligence products the CMS uses as a library. In addition to a threat database, it is equally important for the CMS to have information on performance of friendly sensors and effectors. With this knowledge, the CMS can concurrently calculate optimal defence solutions in all areas of warfare such as air, surface, and sub-surface at the task group level.

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4 Canada. Department of National Defence. Strong, Secure, Engaged: Defence Policy. Ottawa: DND, 2017. https://www.canada.ca/en/department-national-defence/corporate/reports-publications/canada-defence-policy.html. 35.

6. Defending a ship from attack in naval warfare is extremely complex. Machine learning can best aid an operator in complex multi-ship, or task group defense, scenarios. Observations by the Canadian Forces Maritime Warfare Centre indicate that multi-ship defence in a task group is extremely difficult to coordinate. However, a properly programmed CMS that communicates with other units in a task group can constantly process track and threat information. With this threat information, it always presents the operator with a defensive plan in case of an attack. For example, in Air Defence, the CMS presents a pre-planned response to each ship in the task group in case of an attack from air launched, anti-ship missiles from a known contact. This pre-planned response would use the CMS calculation of the highest probability of surviving the attack. This could mean one ship is responsible for defence of the task group, or it could mean that each ship is expected to contribute to the overall defence of the task group. This would all depend on the direction of attack, weather, other warfare priorities, task group composition, and the displacement of ships. Defence Research and Development Canada (DRDC) has created a Battle Management System that has demonstrated a capability to fill this deficient capability. This system, called Combat Resource Allocation Support (CORALS)[5], has the potential to integrate some of its processing into the Halifax Class CMS to augment task group defence. Consequently, the human operator would be pre-emptively presented with options for the best defence based on the threat evaluation of CORALS. This concept of pre-planned options affords the operator time and space to make better decisions than in the past. The clear advantage of CORALS in task group defence is that a CORALS in one ship communicates with the CORALS in a consort. Some of the essential combat information such as ammunition inventory status for weapons or countermeasures, and engagement status during attacks, are some of the data fields that CORALS can communicate to other task group units.[6] The clear benefit from a task group defense concept is that CORALS can calculate the best solution in an attack, based on available ammunition in each ship, without operators wasting time confirming ammunition states over tactical radio circuits.

7. Although a CMS in lab-based testing or simulation demonstrates effectiveness in ship defence, it must be acknowledged that warfare in any environment is complicated when human lives are at risk. It is important for the CMS to conducts threat assessments of contacts and also identify if the contact is occupied by a human being. This could be an aircraft, surface ship, or submarine. In conditions of tension below that of open conflict, the decision to engage any contact with a human should have the operator as part of the decision loop for authorizing the engagement to occur. This situation is most likely to occur for assessment of air contacts. Modern radars and combat systems can measure kinematic data from tracks such as radar cross section, IFF, aspect, speed, pattern of movement, and track history to assess the most likely identity of an air track. With an updated threat library as described earlier, the CMS can match track information with the threat library to assess track identity. Once the identity of the track is known, the

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5 Benaskeur, Abder, and Hengameh Irandoust. 'A Conceptual Framework for System-Mediated Collaboration in the Context of Naval Force Battle Management'. Valcartier Research Centre: Defence Research and Development Canada, December 2015. https://cradpdf.drdc-rddc.gc.ca/PDFS/unc214/p803153_A1b.pdf. 15.

6 Ibid, 22

operator can leverage the speed of the CMS to execute the defense of the ship in case of an attack. For defenses against drones, missiles, or other unmanned objects, the CMS should be configured for the operator to permit automatic engagements of hostile tracks. For human-occupied objects, the decision to engage should rest with the operator. The operator always has the option to use traditional measures, such as warnings via radio, to determine hostile intent. This configuration of user participation best enables the Commanding Officer to make decisions based on hostile intent, ROE, or political direction. Therefore, as advancement in automation and system integration promote the speed of response against a threat, there must be the option to keep engagement authority with the operator.

8. Collective Training (CT) ashore with land-based combat simulators, such as the operations room trainer found at CFB Halifax, is the next step of proving the viability of a CMS in ships. Finally, testing CMS compatibility during training supervised by Sea Training Group, followed by Operations Team Training Two (OTT2), which is the final CT milestone in Force Generation (FG) to prepare operations teams for expeditionary operations. Normally, the ship will participate in major multi-ship exercises at sea. The conditions of these exercises can have a blue force and red force, and contained in Special Instructions (SPINS) are IFF codes for exercise hostile and friendly aircraft to squawk. Therefore, proving some aspects of an improved and intelligent threat evaluating system in a weapons safe environment is the next logical step in practical training at sea that tests a CMS. Observations from operators can help to improve system functionality. The training environment provides opportunities for operators and system programmers to improve the stability and interoperability with the operator. Naval training institutions have a responsibility to maintain modern course content and teaching objectives. Synchronization between instructors, CMS programmers, and tactics experts is essential in supporting the training institutions to shape learning outcomes for new operators.

CONCLUSION

9. CMS 330 is vastly superior to previous systems, paving a new path forward – one that allows automation of decision making and ability to respond to defensive threats, while allowing the human operator to operate more effectively. Concentration of effort should be placed to create a ‘learning’ machine that supports the operator at sea by coordinating defence of a unit and defence of a task group. By calculating effective defensive measures prior to attack based on the Recognized Maritime Picture, CMS can inform the operator can maximize the limited time available to defend the ship.

10. In addition to the CMS being integrated into the system, combat operators must change their functions at sea. The operator should focus on less on ‘doing’ and more on verifying the presented RMP and accepting plan proposals from the machine. The future Canadian Surface Combatant will have less accommodation spaces, and therefore a reduced ship’s company. It stands to reason that there will be less combat operators, which means the traditional complement of combat operators that were embarked in the Iroquois Class, and the Halifax Class, will need be reduced, while still fulfilling the core

maritime tasks at sea[7] as specified in Leadmark 2050. As discussed, there can be more automation in defensive responses that involve defeating unoccupied threats such as missiles and torpedoes. However, when any response involves the release of weapons against a human occupied object, the operator, needs to accept any decisions. This could be against an aircraft such as a fighter jet, a fast Attack Craft, a large surface combatant, or a submarine. This means the operator has authority to permit, delay, or cancel an engagement based on Rules of Engagement, political direction, or change in behavior. Combat modeling and simulation can demonstrate the effectiveness of a CMS, but the challenge is to integrate the human into its decision loop in an operational theatre.

RECOMMENDATIONS

11. It is recommended that the RCN focuses efforts on exploiting CMS 330's features to promote human and machine learning. CMS 330 will be the baseline for the future fleet[8], and therefore efforts to build a robust, resilient, and stable support system are recommended. The threats to HMC Ships in the international theatre continue to change, and because of this a team dedicated to supporting this change management and creating a threat database is recommended. The RCN should develop these threat updates in a manner that can be electronically distributed to deployed ships via secure data transfer and import to the CMS.

12. It is recommended that that the RCN increases the collaborative combat capability of HMCS ships so that the Canadian Task Group has the highest chance of survivability of an attack in a multi-threat environment. The CMS must be aware of consort combat capability by means of constant connectivity between units. As stated in Strong Secure Engaged, the RCN aims to reconstitute the Canadian Naval Task Group. Although CORALS is a DRDC project and not necessarily an industry peer compared to Lockheed Martin and its CMS 330, there are some groundbreaking concepts in CORALS that should be incorporated into CMS 330 threat evaluation at the task group level.

13. It is recommended that automation efforts continue to find efficiencies in RMP management by digitizing the processing of operational messages for the purpose of visualizing friendly assets, operating areas, water space management, and tasking orders. Traditionally these messages need to be transcribed from text to drawing geographical lines, circles, and arcs. A standardized digital message reader should eliminate this laborious task and refocus efforts on awareness of CMS system status, and the tactical situation.

14. It is recommended that levels of operator interaction and automation continue to be respected when the release of weapons on human occupied targets is proposed as a track of automation. Deployed HMC Ships should never find themselves in a situation in

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7 Canada. Department of National Defence. Canada in a New Maritime World: Leadmark 2050. Ottawa: Commander, Royal Canadian Navy, 2016. 28.

8 Staff, Naval News. 'Lockheed Martin Canada's CMS 330 Selected for RCN Joint Support Ships'. *Naval News* (blog), 7 February 2019. https://www.navalnews.com/naval-news/2019/02/lockheed-martin-canadas-cms-330-selected-for-rcn-joint-support-ships/

which the CMS has unilaterally engaged a human occupied contact without the operator giving authorization.

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