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READY TO LEAD IN THE 21ST CENTURY : THE RCN AND UNMANNED AND AUTONOMOUS INNOVATION

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JCSP 44

Exercise *Solo Flight*

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CANADIAN FORCES COLLEGE – COLLÈGE DES FORCES CANADIENNES

JCSP 44 – PCEMI 44
2017 – 2019

EXERCISE *SOLO FLIGHT* – EXERCICE *SOLO FLIGHT*

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By Commander Lucas Kenward

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> Remotely piloted systems can be used effectively for a wide range of military applications, from ground systems used as bomb disposal robots to undersea systems for conducting acoustic surveillance, mapping or the surveil-lance of 'choke-points', to naval mine countermeasures. Aerial systems can provide temporary communications relay during a disaster relief mission when regular networks have been damaged, enable long-range coastal and Northern surveillance, and provide a targeting and precision strike capability.
>
> -Strong, Secure, Engaged: Canada's Defence Policy, p78

The Royal Canadian Navy (RCN), since the implementation of Strong, Secure, Engaged, has reinvigorated its efforts to procure and introduce new systems that enhance its combat capability while concurrently leveraging new technologies. This paper will argue that the RCN is leading the Canadian Armed Forces (CAF) in the introduction, procurement and operationalization of unmanned and autonomous systems to enhance its core capabilities. The RCN continues to leverage industry to provide the latest in surveillance technology to enhance key combat capabilities that are either absent from certain classes of ship, or, introduce a significant cost and efficiency savings to existing capabilities.

The RCN's very motto, *Ready Aye Ready,* infers an institutional belief in innovation and preparedness. The RCN envisions itself as an innovator, *Ready to Lead* change and doctrinal innovation to maximize its ability to be *Ready to Fight.* While all

branches of the CAF are empowered by Strong, Secure, Engaged to innovate and push the envelope to bring to full operational capability a host of new systems, it is the RCN that is leading the charge. To provide example in these cases we will look into the history and current status of the RCN's very nascent Unmanned Aircraft System(s) (UAS) and its long-standing work in the Unmanned and Autonomous Underwater Vehicles (AUV) domain.

Background – How did we end up here?

> *No Navy can expect to be successful if it remains rigidly rooted in traditional methods and current practices – it must challenge itself constantly and have the organizational wherewithal to not merely accept change but to strive for it.*
>
> -RCN Strategic Plan 2017-2022

Innovation in the maritime domain is usually enabled by the identification of some sort of tactical shortcoming or the occurrence of an at sea mishap that drives rapid change. For the RCN, the latest push towards a new paradigm of innovation could be argued to have started during the "bathtub years" when the *Halifax* class frigates began their long mid-life refit programme. The RCN was left with a significant capability gap, the significant decline of available frigate sea days combined with the ageing out of the *Iroquois* destroyer fleet (a significant blow to the RCN's Anti-Air Warfare capability) and the RCAF's venerable Sea King Helicopters reaching the end of their useful utility (it seemed to matter less, however, when there were no ships to put to sea). Initially the culture of innovation, born out of this platform unavailability, manifested itself in new missions for the *Kingston* class patrol vessels, where they were tasked with operations that were not conceived of at the time of their construction – capacity building

deployments to Africa and counter-narcotics operations in the Caribbean Sea and Eastern Pacific Ocean. Accidents, of course, do happen and change was further driven with the catastrophic fire in HMCS *Protecteur* resulting in the eventual loss of the RCN's replenishment at sea capability and a collision at sea of *Algonquin* – indeed these "series of mishaps… highlighted some of the very serious challenges that the Navy is facing"[1]. These significant capability shortfalls in Anti-Submarine warfare and underway support were eventually mitigated through the introduction of the Cyclone helicopter and the procurement of the Interim AOR M/V *Asterix*, but the unexpected and un-forecasted leveraging of the *Kingston* class for Force Employment identified two capability gaps – one from a lack of organic capability, and the other, a product of a focus shift from core Naval Mine Warfare skills/capability to counter-narcotics and "out of hemisphere" partner nation capacity building. The RCN envisions unmanned systems as a critical part of solving these capability gaps, and has committed itself to reinvestment in MCM capabilities, "the commensurate nurturing of skills and competencies within the MCM community" and "options to extend the.. *Kingston* class.. [to retain] the fleet capacity that successive operational research studies have concluded is needed".[2]

The future of naval operations, particularly in the littorals, will be shaped by myriad technological advances - none with more "immediate impact in recent years than the development and deployment of autonomous vehicles"[3]. Recognizing the swift pace of change confronting it, the RCN established the office of the Director New Capability

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[1] Rob Heubert. "The Royal Canadian Navy: Facing Rough Seas" *Canadian Global Affairs Institute.* January 2016. https://www.cgai.ca/facing_rough_seas
[2] Canada. Department of National Defence. Canada in a New Maritime World: Leadmark 2050.Ottawa: DND Canada, 2017, 45.
[3] Ben Lombardi. "The Future Maritime Operating Environment and the Role of Naval Power". Ottawa: DRDC Canada, 2016, 83-84.

Introduction (DNCI) in 2012, charging it with being a "focal point for pan-naval coordination of activities associated with the introduction of new platforms and capabilities into fleet service…"[4]. While DNCI has largely left innovation and guidance of the Mine Warfare domain to the Canadian Forces Maritime Warfare Centre and to the Director Naval Requirements, it has taken a key guiding role in the implementation of the CAF Unmanned Aircraft System Provision of Services (CAF UPS) – a project sponsored by the Commander of the RCN.

Autonomous Mine Countermeasures

> *When you can't go where you want to, when you want to, you haven't got command of the sea. And command of the sea is a rock-bottom foundation of all our war plans. We've been plenty submarine-conscious and air-conscious. Now we are going to start getting mine-conscious – beginning last week.*
>
> -Admiral Forrest Sherman, USN, Wonsan, Korea

Sea mines are as useful and effective today at achieving sea denial as they were during the dawn of the US civil war and, as above, during the Korean War. Canada has maintained a small Naval Mine Countermeasures (MCM) capability since the Second World War, when sea mines wrought havoc on warships throughout the North Sea and the Baltic. The *Kingston* class were built as general mine countermeasures ships with typical MCM ship constraints and capabilities - slow speed, long on station endurance and large quarter-decks with a low freeboard that allowed room for expansive MCM mechanical sweeping gear. While the equipment was certainly old technology, the RCN

[4] Broadsides Discussion Forum, "Naval Transformation Announcement" *Naval Review* (blog), 22 May 2012, http://www.navalreview.ca/2012/05/naval-transformation-announcement/

continued to invest in critical staff officer and NCO training, with advanced Mine Warfare courses in Belgium and the United Kingdom being attended by Canadians so they could maintain skills needed to lead or participate in a Mine Countermeasures Tasking Authority as part of a maritime Task Force[5].

In the mid-nineties, in addition to bringing on-line the *Kingston* class and maintaining the intermediate and advanced training regimes for its sailors, the RCN also procured to systems that, at the time, were on the cutting edge of technology. The Deep Seabed Intervention System (DSIS) and Bottom Object Inspection Vehicle (BOIV) were fundamentally umbilical controlled remote systems, designed not as a MCM capability, but as tools to effect seabed intervention. The RCN also procured and brought into service route survey equipment, the AN/SQS 511 side-scan sonar – a towed system designed for use of the *Kingston* class – designed to take high resolution imagery of the seafloor as part change detection principles which supported MCM activities[6]. Unfortunately the 511 was rather unwieldy and never fully delivered on its promises, and was eventually scrapped in favour of smaller, commercial off the shelf variants still in use today[7]. In 1999, the RCN had the ability to conduct the full spectrum of MCM – detection, classification, localization, reacquisition, identification and disposal – using equipment procured for the *Kingston* Class and Clearance Divers but only to a depth of approximately 80 metres. By 2010, however, much of the original equipment procured

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[5] William Barter, "Executive Summary: Naval Mine Counter Measures (NMCM) Review" (Halifax, Maritime Operations Group Five, 2017)
[6] Change detection requires that you have a baseline sonar image of the objects on the seafloor so that if hostilities break out or you suspect enemy mining, you can re-survey the area and easily identify any new objects (changes) that have been introduced.
[7] Dan Beeby, "Technical troubles sink sonar defence system," *Globe and Mail,* 6 April 2007.

fell into dis-repair or were no longer technically supported – the BOIV, DSIS and 511 – were either shelved due to failure or part availability or so infrequently used that fewer and fewer sailors were capable of using them, leaving the RCN with only Clearance Divers as a bona-fide MCM capability[8].

As technologies matured, however, commercial and military off the shelf systems became capable of the full spectrum of MCM, including disposal, using tethered systems. Eventually, inertial navigation systems became sufficiently mature that unmanned and autonomous operations were now possible and a veritable explosion in AUV options occurred. The RCN, and DRDC, continued to work towards a made in Canada solution to remote MCM, eventually developing a Remote Mine hunting system technology demonstrator and the interim remote mine-hunting and disposal system (IRMDS). Though the IRMDS was never brought to FOC due to its size and relative complexity, and didn't actually develop a disposal capability, it did lay much of the groundwork for the eventual stand up/definition of the current Remote Mine hunting and Disposal System (RMDS) project[9]. The RMDS project is envisioned to provide the full spectrum of MCM capability from two 20 foot sea containers, which could be fitted to any of the RCNs current and future ships and, perhaps more importantly, could be operated from ashore or on another platform of opportunity[10].

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[8] J. Greenlaw, "Sea Mines and Naval Mine Countermeasures: Are Autonomous Underwater Vehicles the answer, and is the Royal Canadian Navy ready for the new paradigm?" (Masters of Defence Studies Paper, Canadian Forces College, 2013), 88-89.
[9] Ibid., 76.
[10] Government of Canada. "Remote Minehunting and Disposal System." Last modified 1 Jan 2019. http://dgpaapp.forces.gc.ca/en/defence-capabilities-blueprint/project-details.asp?id=1642

Figure 1 – HUGIN system being deployed from HMCS *Yellowknife,* July 2016

Source: Lookout Newspaper/DND

While the RMDS continued through the definition phase, the RCN continued to work with autonomous systems to maintain core staff planning skills with the assistance of our allies. During Exercise Rim of the Pacific (RIMPAC) 2016, HMCS *Yellowknife* embarked a Norwegian HUGIN team, and successfully operated the HUGIN for the first time from an RCN vessel[11]. A cutting edge military/civilian project spearheaded by *Sjøforsvaret* (the Royal Norwegian Navy) in cooperation with Norwegian tech giant Kongsberg, HUGIN AUV's are modular, containerized and capable of seabed intervention and object detection up to 6000 metres in depth[12]. While in its current form HUGIN doesn't deliver a disposal capability, thanks to its high speed and long

[11] Lookout News. "Yellowknife embarks Norwegian sailors and their mine-hunting technology HUGIN." Last modified 2 Aug 2016. https://www.lookoutnewspaper.com/yellowknife-embarks-norwegian-sailors-mine-hunting-technology-hugin/

[12] Kongsberg. "Autonomous Underwater Vehicle, HUGIN." Accessed 26 Apr 2019. https://www.kongsberg.com/maritime/products/marine-robotics/autonomous-underwater-vehicles/AUV-hugin/

endurance, it is among the most capable AUV's for detecting possible mines and is particularly adept at route survey, rapid environmental assessment and intelligence preparation of the battlespace in support of littoral forces.

The RCN also invested in the acquisition of four Remote Environmental Monitoring Units (REMUS) to assist with survey work in shallow water. Not only did the RCN procure the systems and training within both Fleet Diving Units, at RIMPAC 2018 the RCN deployed HMCS *Whitehorse* with a contingent of Royal Netherlands Navy marines who operated three REMUS systems from the ship in an effort to prove the deployability of the capability in *Kingston* class ships. This was followed by the deployment of the newly RCN acquired REMUS systems to Exercise Trident Juncture onboard *Glace Bay* in the fall of 2018[13]. REMUS systems are regularly operated by both Fleet Diving Units to maintain operator proficiency and conduct shallow water survey work inside and in the approaches to Halifax and Esquimalt harbours.

The RCN continues to push the envelope towards a future of AUV enabled and enhanced MCM by procuring state of the art systems, developing future projects to take advantage of the rapid pace of technological change and integrating training and sustainment into its Force Development cycle. The RCN also continues to leverage NATO partnerships and experience to ensure that the RCN sailors of tomorrow are

[13] Lookout Newspaper. "New REMUS 100 for the Royal Canadian Navy". Accessed 26 Apr 2019. https://www.lookoutnewspaper.com/new-remus-100-royal-canadian-navy/

familiar with the operational and tactical planning methodologies to take full advantage of future systems by participating in MCM exercises[14] and operations[15].

CAF UPS – Enhancing ISR at sea

> Given the unique value provided by remotely piloted systems, the Canadian Armed Forces will also invest in an extensive range of new capabilities for the RCN, the CA, and the RCAF. This will include remotely piloted aerial systems.
>
> -Strong, Secure, Engaged: Canada's Defence Policy, p15

The RCN has historically leveraged organic ships' sensors and maritime helicopters and tactical data links to provide ISR capabilities to its ships at sea. Maritime Patrol Aircraft, of course, became increasingly critical to expanding domain awareness, especially as their C4ISR suites were dramatically upgraded through the CP-140 Aurora modernization project[16]. Most seagoing nations have progressively identified the operational flexibility that can be provided to them through the procurement and use of unmanned systems to expand surveillance and reconnaissance ranges for ships at sea while reducing costs, considering constraints surrounding operational tempo/availability and risks associated with manned aircraft. The RCN, in cooperation with the Canadian Army, developed CAF UPS in mid-2017 to provide enhanced, near real time Intelligence,

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[14] Allied Maritime Command (NATO). "NATO Mine Countermeasures Warfare Exercise Begins in Belgium". Last modified 20 Mar 2018. https://mc.nato.int/media-centre/news/2018/nato-mine-countermeasures-warfare-exercise-begins-in-belgium.aspx

[15] Adminmaple, "HMCS Summerside Arrives in Latvia with SNMCMG1". *Maple Leaf Navy Magazine* (blog). 19 Nov 2018. http://mapleleafnavy.com/2018/11/19/hmcs-summerside-arrives-in-latvia-with-snmcmg1/

[16] Royal Canadian Air Force. "Canada's modernized CP-140 Aurora has 'James Bond' properties", last modified 6 July 2018. http://www.rcaf-arc.forces.gc.ca/en/news-template-standard.page?doc=canada-s-modernized-cp-140-aurora-has-james-bond-properties/hvexurrt

Surveillance, Target Acquisition, and Reconnaissance (ISTAR) to ships at sea and to land units.

The *Kingston* class, in particular, were limited in their ability to conduct surveillance beyond line of sight, as they didn't have facilities for helicopters and they lacked the tactical data link capability of larger ships and maritime patrol aircraft. With the class now committed to two-hundred days per year of counter-narcotics operations, where enhanced surveillance capability is crucial to the detection and monitoring phases of the CARIBBE mission, the RCN viewed a UAS capability as a potential capability upgrade to the patrol vessels to assist with support to their embarked United States Coast Guard Law Enforcement detachments.[17]

The RCN had previously experimented with UAS during Operation MOBILE in Libya but reaffirmed its commitment to integration and experimentation with Fleet units in October 2016 with the capability demonstration of the AeroVironment RQ-20 Puma UAS in HMCS *Summerside.* This capability demonstration eventually led to class one rotary wing trials in *Winnipeg* in November of 2017[18]. Once CAF UPS was approved and handed over largely to DNCI and DNR to initiate, it was decided that the initial steps would be the procurement of the Puma UAS, assignment of personnel to training courses and eventual sea trials in *Kingston* class ships on both coasts. In spring 2018, both coasts'

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[17] Canada. Department of National Defence. *Memorandum of Understanding between the Canadian Forces and the United States Coast Guard concerning the embarkation of United States Coast Guard Law Enforcement Detachments and Observers on Canadian Forces vessels and Aircraft to suppress illicit traffic in the Joint Interagency Task Force South Joint Operating Area.* Ottawa: 8 October 2010.

[18] Royal Canadian Navy. "RCN on track to acquire unmanned aircraft systems", last modified 6 July 2018. http://www.navy-marine.forces.gc.ca/en/news-operations/news-view.page?doc=rcn-on-track-to-acquire-unmanned-aircraft-systems/jbr1ekxx

UAS detachments were stood up (a total of six personnel), aircraft and control suites procured and training for operators was commenced in earnest.

Figure 2 – Image from Puma of HMCS *Edmonton* at sea , August 2018

Source: DND/CAF

HMCS *Edmonton* went to sea in August 2018 to conduct the sea acceptance trials of Puma off the west coast of Vancouver island. This achievement was notable as the CAF had only taken possession of the Puma systems a few months earlier and had only concluded the required operator training serials[19]. With the sea trials successful, the Puma control suite was re-assigned to *Whitehorse* who proceeded with Force Generation training of the system into the Fall of 2018 with a view to having her fly the system operationally during OP CARIBBE in early 2019. There were some challenges to this aim notably that the RCN didn't yet have a Special Purpose Flight Permit (SPFP) from the RCAF to operate Puma outside of a Force Generation model. While the team in *Whitehorse* and Patrol Vessel Sea Training (Pacific) continued to develop and refine

[19] Maple Leaf – Defence Stories. "Advanced unmanned aircraft to provide eye in the sky for Kingston-class ships", last modified 6 March 2019. https://ml-fd.caf-fac.ca/en/2019/03/25364

initial Puma SOPs at sea, the teams at DNCI, DNR and Coastal Forces (Pacific) worked closely with the RCAF to garner a Force Employment SPFP that would support operations on CARIBBE.

When *Whitehorse* transferred Operational Command Authority to the tactical control of Joint Interagency Task Force (South) in late March of 2019, she sailed with the Puma onboard a valid SPFP for Force Employment in hand. It took some time, familiarization and operational/airspace flexibility, but in early April the Puma was used for the first time in direct support of a law enforcement boarding activity[20].

The initial use of Puma for Force Employment is only one small step in the much larger and ambitious CAF UPS project, of course. Larger and more capable UAS will be deployed in *Halifax* class frigates to provide an over the horizon ISTAR capability. It is intended that any such UAS will have vertical take off and landing capability and be able to operate at least 50 nautical miles from the ship and be storable and launchable even if the ship has a maritime helicopter embarked. Initial implementation is expected in 2020 and if the Puma project is any indication, the RCN looks to be in a good position to achieve initial operating capability by 2022[21].

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[20] Maple Leaf – Defence Stories. "A futuristic first on Operation CARIBBE", accessed 15 Apr 2019. https://ml-fd.caf-fac.ca/en/2019/05/28921

[21] Government of Canada. "Royal Canadian Navy Intelligence, Surveillance, Target Acquisition and Reconnaissance Unmanned Aircraft System", last modified 10 Jan 2019. http://dgpaapp.forces.gc.ca/en/defence-capabilities-blueprint/project-details.asp?id=1297

Conclusion

> We have had to make some tough – and not universally supported – decisions, and more will continue to be made in the years to come. The need to retire four of our ships before their replacements had arrived no doubt hurt us, from both a capacity and a capability standpoint. This was out of necessity and certainly not by design or intent. This, therefore, cannot naively be misconstrued as some false dividend… It's important to keep in mind that the situation we had to manage was completely avoidable. It should act as a powerful reminder of what happens when we allow ourselves to continually manage risk by putting off tough decisions, in the interest of short-term expediency.
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> -Vice-Admiral Mark Norman, turning over Command of the RCN 21 July 2016

The RCN continues through a period of unprecedented transition. It is perhaps the very complexity of the RCN's past and future challenges that makes the organization so capable of rapid change and evolution. Indeed, it is uniquely the RCN that has endured, since unification, a "feast or famine" cycle of ship building and capability delivery where the RCN has needed to evolve tactics, doctrine and operating procedures to reflect a changing operational landscape with very old, or very new ships – innovate or face obsolescence or an inability to use, to their full potential, the new capabilities presented by new ships. The RCN today finds itself recovering from a period of incredible turmoil – the loss of critical classes of ship with unique capabilities needed to maintain a blue water force concurrent with a comprehensive major warship mid-life refit – and, entering a period of truly unprecedented renewal. In the next 20 years the RCN can expect delivery of at least two new supply ships, six Arctic and Offshore patrol ships, up to fifteen single class surface combatants and two critical enablers to the RCNs future operations – the RMDS and CAF UPS projects. It should be no surprise then that the

RCN remains focused on change and, as a small organization (relatively speaking), has already taken incredible strides forward in owning the unmanned and autonomous battlespace within the CAF. The RCN must be capable of rapid innovation to maintain its credibility and its ability to remain *Ready to Help, Ready to Lead, and Ready to Fight.*

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