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THE NEW AND IMPROVED ROYAL CANADIAN NAVY: AN ANALYSIS OF CRITICAL CONCEPTS AND PHILOSOPHIES FOR CREW OPTIMIZATION

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Exercise Solo Flight

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As the Royal Canadian Navy (RCN) continues through the procurement process to develop the Navy of tomorrow, many factors are being investigated in order to reduce cost while attempting to get a ship capable of meeting the demands to support the government. Although cost is one of the main factors for investigating options that could be provided by crew optimization, costing is simply used as the catalyst of this discussion and will not be further investigated throughout this paper. As such, one of the main factors being put forth to decrease cost is the notion of reduced crews, or crew optimization, which is primarily aimed at the frigate replacement for the Canadian Surface Combatant (CSC) project.¹ Navies are inherently expensive to procure and operate, therefore governments and navies are searching for innovative ways to reduce cost while maximizing capabilities to still meet the desired mission sets when modernizing their fleets. This raises the question, what are the most significant factors being considered by the RCN prior to adopting a crew optimization strategy for the future CSC platforms? It would appear that the leadership of the RCN is very interested in exploring the feasibility of optimized crews for the CSC. However, various concepts must be explored prior to implementation in order to reduce unintended second and third order effects which would inadvertently cause undue stress and risk on command and crews.

The most significant factors of crew optimization that the RCN must consider are the challenges and philosophies associated to the concept on future operations which, if

¹ Ian D.H. Wood, *National Shipbuilding Procurement Strategy: Human Capital and the NSPS* (Halifax: Centre for Foreign Policy Studies Dalhousie University, 14 November 2014), 12-15; Renee Chow, "Decision Support for RCN crewing: Simulation for Crew Optimization and Risk Evaluation," (Presentation, Defence Research and Development Canada, 14 November 2014), 3 and 5; Renee Chow, Matthew Lamb, Ghislain Charest, and Daniel Labbé, "Evaluation of Current and Future Crew Sizes and Compositions: Two RCN Case Studies," *Naval Engineers Journal* 128, no. 4 (December 2016).

not properly investigated, would result in unintended and potentially catastrophic impacts on the future of the CSC and RCN. This paper will discuss the major challenges and philosophies associated to crew optimization with a specific focus on the RCN and the feasibility of option space for the future CSC platform.² The purpose of this paper is to discuss the concepts of crew optimization which must be considered, but not necessarily to produce developed solutions to address the concerns raised.

The challenges the RCN will face, while investigating crew optimization, will be broken down into sub categories of operational tempo and readiness, and key assumptions as they relate to future crewing requirements. The discussion for each of these sub-categories will focus on impacts that key decision makers must be aware of prior to implementing any form of crew optimization in an attempt to identify and avoid the second and third order effects on maintaining successful RCN at-sea operations. The two main philosophies identified within this paper will focus on the concepts of flexibility and training construct to maintain credibility and proficiency for future maritime operations within a crew optimization strategy. The discussion for both the challenges and philosophy sections of this paper will rely on the direction published in key documents, such as Leadmark 2050, to introduce concepts and provide context for reduced crewing. Furthermore, open source data will be used as the basis for analyzing lessons learned by other western navies, specifically the US Littoral Combat Ship (LCS), to add to the arguments of conceptual feasibility for the RCN.

² M.S. Shortridge and R. Antoniewicz, “CSC Accommodations & Crewing – RCN Investigation” (Presentation, Director Naval Major Capital Project, 2 December 2015).

Context

Although crew optimization is viewed as simply a reduction in crew, it would be more accurate to view it as a restructuring of capabilities or a reassignment of personnel within the context of a shore-support concept.³ This would mean that certain jobs and functions which were conducted within legacy platforms would be developed within a shore based construct or become automated on board the CSC. Both of these are not new concepts, however, crew optimization will create challenges and risks which if left unaddressed within RCN philosophy will be detrimental to implementing it on board the CSC and future maritime operations .

Challenges

The notion of crew optimization has been revitalized within the RCN as it appeared in Leadmark 2050, which created the interest for preliminary analysis and development of the Simulation for Crew Optimization and Risk Evaluation (SCORE) tool by the Defence Research and Development Canada (DRDC).⁴ The desired intent of this tool was to explore possible crew reductions³ by identifying and comparing individual crew functions on board with a series of evolutions expected of a RCN ship at sea.⁵ Noting this was a preliminary analysis for feasibility of crew optimization, there were significant flaws which would not fully identify the critical concepts required prior to implementing for the future CSC platform. Of most concern to be discussed further was

³ Michael A. Evans and Thomas M. Schwen, "Chasing a Fault across Ship and Shore: Explaining the Context of Troubleshooting in the U.S. Navy," *Performance Improvement Quarterly* 19, no. 2 (2006): 218-220.

⁴ Department of National Defence, *Canada in a New Maritime World – Leadmark 2050* (Ottawa: DND Canada, 2016), 49.

⁵ Renee Chow, "Decision Support for RCN crewing: Simulation for Crew Optimization and Risk Evaluation," (Presentation, Defence Research and Development Canada, 14 November 2014)

the information used to create the initial analysis and the level to which the analysis was conducted to date.

Firstly, the information generated for the initial analysis was based upon current Halifax Class watch and station billets.⁶ This poses a challenge from the start by already framing the mindset, and thus the results, around current practices, doctrine and philosophies which does not take into consideration future technical advancement for automation and other conceptual notions with how the CSC will be operated in the future environment. Secondly, the level of analysis did not fully consider the secondary duties required from the crew when conducting various at sea evolutions.⁷ While sailing, every crew member has secondary duties, traditionally more than one, which they are responsible to perform outside of their primary job. For example, every member in the engineering section is required during action stations to support the Damage Control (DC) organization by fighting fires, floods or conducting repairs created by combat damage. Within this example, it is important for the SCORE tool to account for the DC responsibilities (not just the crew's primary duties) prior to implementing or recommending a crew optimization strategy. Some of the DC functions may be able to be reduced with automation, such as fitted fire suppression systems, however, these systems must be further considered by the inputs into the SCORE tool. If this is not considered then a critical function for sailing a warship will cause undue, and potentially catastrophic, challenges once crews are optimized on board the CSC. These potential

⁶ Renee Chow, Matthew Lamb, Ghislain Charest, and Daniel Labbé, "Evaluation of Current and Future Crew Sizes and Compositions: Two RCN Case Studies," *Naval Engineers Journal* 128, no. 4 (December 2016).

⁷ *Ibid.*

issues starts the conversation surrounding second and third orders of affect that occur when not fully exploring the concepts linked to operational readiness and tempo.

Operational readiness deals with the services and systems required for a ship to float, move, and fight. More specifically, readiness addresses the maintenance of equipment and logistical needs to support a warship and enable it to sail on operations. Currently, the legacy platforms have an organic capacity to fulfill this function on board with minimal support from outside or non-organic services. On board the current Halifax Class Frigates, maintenance is built into the current crewing capacity and conducted within the normal watch and station bill (the rotational crewing bill established for daily work conducted).⁸ Furthermore, the crewing and parts to support level one maintenance and repairs also resides on board within the logistics section.⁹ These two sections have been identified as potential areas for reduction and reallocation to shore services.¹⁰ This reallocation would have a significant impact on the operational readiness of ships but could be a viable option to explore for crew optimization with the right shore support, organizational structure, and change in RCN philosophy to address the gaps created.

Firstly, if the engineer section were reduced on board then it is expected that there would be an increased capacity developed within shore maintenance facilities in order to address the need to maintain operational readiness of ships when they are in home port. Furthermore, when a ship is deployed they would require an increased capacity to conduct maintenance abroad to account for the lack of crewing on board to address the lack in capacity to conduct maintenance and repairs while underway by the crew. There

⁸ CFCD 129 – Royal Canadian Navy Readiness and Sustainment Policy. October 2009.

⁹ Royal Canadian Navy. Logistics Deployed Support. *Naval Logistics Publication – 4.00*, published 30 July, 2015, RDIMS # 356157.

¹⁰ Department of National Defence, *Canada in a New Maritime World – Leadmark 2050* (Ottawa: DND Canada, 2016), 49.

are several options available to the RCN to address this gap in organic capability, such as an increased responsiveness in home port maintenance teams and the establishment of Mobil Repair Parties (MRP) to support deployed ships.¹¹ Exactly how these two initiatives would be incorporated will require further investigation; however, what is certain is the RCN would require a fundamental change in philosophy to support these two options. The RCN could no longer rely on a ship's company to be responsible to conduct all routine maintenance while underway without additional support.¹² This departure in philosophy would also cause commands to potentially assume greater levels of risk due to the incomplete ability to affect at-sea-maintenance. Similar to the engineering section, there are certain reductions within the logistic section which has potential to be reduced onboard. However, the logistics capacity on board would have to be addressed by restructuring support ashore in order to address the gaps created by crew optimization.¹³ These two support sections (engineers and logistics department) would require a shift in RCN philosophy in operational readiness prior to implementing a crew optimization strategy for the CSC which would ensure risk and readiness remains at an acceptable level to support the expected government mission sets. One such concept which would assist with enabling engineering and logistical support within an optimized crew is to increase the capacity ashore to include a support cell available 24 hours a day while sailing to assist the reduced sections on board with diagnostics, maintenance monitoring, logistics and administration. This concept already exists for the combat

¹¹ Keith Lynn Marchbanks, "Ships Maintenance, Repair and Modernization Overseas: Requirement Concepts and Funding Issues in Maintaining Material Readiness of Deployed Forces" (Master's thesis, US Navy Naval Postgraduate School, 1992), 72-77.

¹² Michael A. Evans and Thomas M. Schwen, "Chasing a Fault across Ship and Shore: Explaining the Context of Troubleshooting in the U.S. Navy," *Performance Improvement Quarterly* 19, no. 2 (2006): 219-221.

¹³ Royal Canadian Navy. *Logistics Deployed Support*. Naval Logistics Publication – 4.00, published 30 July, 2015, RDIMS # 356157.

section to have 24 hour access to battle watches within higher Head Quarters (both MARLANT/MARPAC on domestic operations and CJOC on international deployments) which aid and enable in the communication of direction, orders and mission organization when sailing. The restructuring of these kinds of reach back Command organizations could be explored further to consolidate and incorporate the engineering and logistics gaps within an optimized crew construct.

With the formulation of these support sections being located ashore, this may introduce a second and third order effect challenge in the form of low bandwidth to support transfer of data from ship-to shore. To avoid the current challenges with data transfer, the future CSC would require an increased bandwidth capacity. This would decrease the risks associated with reduced capacity within the logistics and engineering sections and ensure the requisite support from shore support organizations. This would allow for ships to pass and receive larger data files and video conferencing with shore support units when troubleshooting engineering difficulties and processing administration. Additionally, the increased connectivity with shore support organizations would greatly assist without unnecessarily having to sail into port to receive support and thus have the potential to positively affect the degree of operations tempo more than originally expected within an optimized crew construct.

Operational tempo is the term used to describe the ratio of at sea time in comparison to time spent alongside in port. Traditionally, this ratio has been very high for RCN ships deployed with the average being for every 30 days deployed only 4 would be alongside in port. A challenge for the RCN, within an optimized crew construct, would be the ability to operate at sea without the traditional support sections for the

CSC.¹⁴ As described above when addressing the operational readiness concept, the RCN would have to revise their philosophy with respect to the ratio an optimized crewed ship could be away from port services capable of providing the maintenance, repairs and logistics required to operate future warships.¹⁵ The shore support required for domestic operations could be mitigated through exploring concepts for other means of support from continental partnerships with the US Navy and Canadian port services while away from home port.¹⁶ However, these concepts would not be restructured as simply for overseas deployments where delays or problems with foreign customs processes could render an optimized crewed ship mission ineffective. The concepts for crew optimization must consider and factor in the high potential issues foreign customs and policies would have on MRPs and Forward Logistics Services (FLS) when supporting deployed RCN ships.¹⁷ The RCN will have to acknowledge the risks associated with the shore services concept required for the implementation of crew optimization and therefore account for a decreased operational tempo this could produce. The second and third order effects of a reduced operational tempo would require the RCN leadership to adopt a philosophy which would understand and allow for missions to be interrupted by more alongside time than previous legacy platforms on similar missions. The philosophy adopted to account for the reduced operational tempo would have to be investigated for further impacts, but it would be important for the RCN to socialize this philosophy with maritime coalition

¹⁴ M.S. Shortridge and R. Antoniewicz, “CSC Accommodations & Crewing – RCN Investigation” (Presentation, Director Naval Major Capital Project, 2 December 2015).

¹⁵ Ibid.

¹⁶ Ian D.H. Wood, National Shipbuilding Procurement Strategy: Human Capital and the NSPS (Halifax: Centre for Foreign Policy Studies Dalhousie University, 14 November 2014), 12-15

¹⁷ Royal Canadian Navy. Logistics Deployed Support. Naval Logistics Publication – 4.00, published 30 July, 2015, RDIMS # 356157.

and allied partners in order to maintain a high degree of credibility and proficiency for future collaborative missions.

Key Factors

It is important to note the key factors which constrain options which have been considered by other western navies prior to developing further arguments for the RCN. The first key factor is the difficulties associated with balancing a small navy with the directed mission sets required of the RCN if a crew reduction was to be pursued. At the apex of this difficulty lies the linkage of the Government of Canada (GoC) mandates from the Canada's First Defence Strategy (CFDS) and the types of equipment and capabilities required to reside on board the CSC platforms.¹⁸ Although the CFDS is being revised under the current Government, it can be surmised that mission sets which require the RCN to support allied partners and contribute globally will remain consistent with present day. This analysis is based on the importance the current government has placed on RCN operations and continued presence within NATO's involvement in the Mediterranean and continued support for Coalition led operations in the Gulf of Oman and Arabian Gulf Areas of Operations (AOO) under CTF 150.¹⁹ Based on the importance being placed on supporting allies and maintaining a global presence, this now offers some stability to start the discussion on how this can be achieved. The RCN has worked with and supported many coalition and allied operations and has built a high level of credibility amongst our maritime partners, namely the US Navy. This credibility was developed through our participation on numerous exercises and missions which afforded

¹⁸ Department of National Defence "Canada First Defence Strategy." (2013), pg 10

¹⁹ Source: <https://www.canada.ca/en/department-national-defence/news/2016/12/hmcs-john-next-canadian-ship-deploy-operation-reassurance-support-standing-nato-maritime-group-2.html?=&wbdisable=true>

the RCN a high level of reliability at the operational and tactical level which can be best summarized as interoperability. The RCN has been able to achieve a high degree of interoperability with coalition partners through the flexibility and training of our manning philosophies.

Philosophies

A key factor which constrains the challenges for reducing crew size is one of flexibility. The leadership of the RCN has continued to stress that one of the Navy's strongest assets over its Army and Airforce counterparts is that the RCN offers the Government of Canada (GoC) a flexible response to global issues. The Navy can set sail on short notice, conduct mission planning on route, and maintain a constant presence anywhere in the maritime environment.²⁰ This level of flexible offers the GoC a quick and timely response to a variety of both combat and non-combat related mission sets. This flexibility is further demonstrated through the ability for the major RCN combatant platforms to be re-rolled from one theater of operation to another distinctly different theater of operation without having to return to Canada. However, this flexibility does come with an associated cost which is strongly intertwined within a highly trained and flexible crew capable of operating within a complex and uncertain maritime environment. In order for the RCN to maintain this level of flexibility, it must maintain the core capabilities which allow it to be a multi-role platform.²¹ If manning was to be reduced, then a critical component which allows the RCN ships to be flexible would be severely diminished unless alternative support and philosophy to mitigate these issues is developed.

²⁰ Ibid.

²¹ M.S. Shortridge and R. Antoniewicz, "CSC Accommodations & Crewing – RCN Investigation" (Presentation, Director Naval Major Capital Project, 2 December 2015).

As discussed within the operational readiness section, the RCN must consider the second and third order effects with crew optimization and develop the associated concepts and philosophies to support the reduced crew initiative. One such philosophy which is worth exploring further, is the concepts for future training of personnel. In other words, the RCN will need to address the training requirements to continue to produce highly trained and proficient sailors as they progress in rank, if that trade is affected by crew optimization. Maintaining a highly trained and experienced crew for the future CSC will be instrumental in maintaining the credibility amongst our coalition partnerships.

Within the current Halifax Class ships each trade and rank is represented on board in order to facilitate experience and on the job training (OJT) to progress in rank. Furthermore, there are established and assigned training billets on board the current Frigates which affords junior sailors the opportunity to progress through OJT training packages. This concept would be lacking within the affected sections under an optimized crew construct. Therefore it is vital for the RCN to consider and develop a training philosophy to address and mitigate the gap caused by crew optimization. Two such philosophies to consider are the concept of using a pan-fleet progression structure and the concept of a 'blue and gold' crew. Both of these concepts would provide the RCN with options to address the expected training gap with an optimized crew while still providing experience opportunities at each rank level.

By the time the first CSC platform is ready for sea trials there will be at least four different surface ships being operated within the RCN fleets. This would provide the RCN the opportunity and required platforms to investigate the concepts within a pan-

fleet training model. Basically, within this model, experience and training would be developed among all four types of ships at various rank levels. Meaning the lower ranks would predominately reside in the smaller, less operational driven, platforms and progress into the major combatants as they become promoted. This is a departure with how current RCN training philosophy is constructed within the Halifax Class frigate and would require more robust investigation prior to implementation. However, several western navies currently follow a similar philosophy which the RCN could leverage when investigating and developing the CSC training philosophy.

The second concept to discuss with respect to training options is the notion of a 'blue and gold' crew model. This concept would still require a range of ranks within each section to be included within a crew optimization strategy, but would increase the number of personnel receiving the required at sea experience and OJT. As demonstrated by the Sachsen Class frigates that employ the model of the 'blue and gold' crewing system, crews rotate every four months while deployed.²² Although this is a consideration to address some of the training gaps of the crew optimization for the future CSC, it may not be the best solution available. The primary reason this model could not simply be used for CSC is due to the increased personnel demand this model requires in order to have two crews per ship. However, the concepts that this model employs may have merit that could be investigated and developed further, such as conducting a crew exchange between a deployed ship's company with that of a crew from a ship in home port. The concept of rotating two crews, while the ship remains forward deployed, is not entirely new to the RCN as demonstrated when HMCS Toronto remained in the

²² Ian D.H. Wood, National Shipbuilding Procurement Strategy: Human Capital and the NSPS (Halifax: Centre for Foreign Policy Studies Dalhousie University, 14 November 2014), 76-78.

Mediterranean and conducted an entire ship's company swap.²³ However, if crew swaps are the sole means of addressing the training gap within the crew optimization strategy, then it may not fully address the intended requirement. Further development of these two concepts presented should be examined to garner a more complete understanding of the problem and solution space that will be required to avoid second and third order effects within the CSC.

The initial analysis for crew optimization conducted by DRDC and the SCORE tool are being further explored by the RCN on board HMCS Montreal, known as the X-ship initiative. This initiative is using the basis of the initial SCORE analysis to further explore areas to reduce crewing for the future fleet.²⁴ This initiative further proves the seriousness of the RCN's desire to implement crew optimization for the CSC, however, the pending results from the X-ship trials must be viewed and combined with specific CSC concepts in mind and not merely implemented based on legacy platform data.

The first key concept that the X-ship trials must incorporate in order to be applicable for the optimally crewed CSC is based on the notion that the platforms for the Frigate and CSC are different. Therefore, these platforms will have major differences that must be accounted for within the manning trials to better align to the future CSC platform. Although the RCN is awaiting announcement on which platform will be chosen as the basis of the CSC, the fact remains that every ship has different operating procedures and systems which must be considered prior to implementing an optimized

²³ Source : <https://www.thestar.com/news/canada/2015/01/18/hmcs-toronto-returns-home-to-canada-after-six-months-in-mediterranean-sea.html>

²⁴ Department of National Defence, "Experimental X-Ship Advancing Innovative Naval Concepts," *The Maple Leaf* 19, no.4 (April 2016): 3.

crew strategy.²⁵ These differences must drive key decisions and philosophies which, if not considered, could negate the innovation the RCN is striving for and cause undue stress on crews and acceptance of risks by Commands. The best example of this negative impact on a navy was the failure to align crewing necessities with platform requirements as experienced by the US Navy in the LCS project.²⁶ The US Navy wanted to develop a combat capable platform that implemented a crew optimization strategy. The main basis for reducing crews stemmed from a desire to reduce through life and operating cost while increasing the level of automation to maintain combat effectiveness.²⁷ Although conceptually this initiative seemed feasible, there were contributing factors which ultimately caused the US Navy to decrease the number of crew it originally proposed to reduce.²⁸ One of the main contributing factors was the US Navy's over reliance on Industry driven concepts towards automation to replace and reduce manning requirements.²⁹ Much of the analysis on automation was based off of commercial shipping standards with little consideration to requirements that are centric to operating a warship at sea. In these instances, the US Navy needed to develop and understand their own concepts to test against Industry's results to prove that the concepts were sound prior to using commercial standards to influence a reduction in crew. Additionally, the US Navy did not have a clear understanding of the concept of employment for the LCS

²⁵ Ian D.H. Wood, National Shipbuilding Procurement Strategy: Human Capital and the NSPS (Halifax: Centre for Foreign Policy Studies Dalhousie University, 14 November 2014), 76-78.

²⁶ Government Accountability Office, *Littoral Combat Ship – Deployment of USS Freedom Revealed Risks in Implementing Operational Concepts and Uncertain Costs*, Report No. GAO-14-447 (Washington, DC: U.S. Government Printing Office, July 2014).

²⁷ Source: <https://www.strategypage.com/dls/articles/LCS-Gets-A-Bigger-Crew-And-Lots-Of-Tweaks-2-12-2014.asp>

²⁸ United States. Littoral Combat Ship and Frigate – Congress Faced with Critical Acquisition Decisions, Report No. GAO-17-262T. Washington, DC: U.S. Government Printing Office, December 2016.

²⁹ Source: <https://www.strategypage.com/dls/articles/LCS-Gets-A-Bigger-Crew-And-Lots-Of-Tweaks-2-12-2014.asp>

which also contributed to the decision to reinstate 25 percent of the eliminated crewing billets.³⁰ Unfortunately for the US Navy, the realization that led to the reinstatement of eliminated billets was only realized once conducting trials with the first in-class LCS which greatly contributed to the USS Freedom being double the projected cost. This does not appear to have affected the way forward with the LCS project within the large US Navy, however, there is an important lesson the much smaller RCN needs to consider.

Due to the relatively small size of the RCN, the luxury to adjust the design of the CSC, especially after the first in-class is built, is extremely costly. Not only would the fiscal cost be a problem, but more importantly the cost in terms of acceptance of risk due to an improperly developed understanding of the concepts of employment and the impacts experienced on a smaller crew. During the sea trials for the USS Freedom, the crew logs were gathered and analyzed for crew employment and rest cycles. It was noted after the two month trials, that too much was being demanded on the reduced crew, which caused the US Navy to make the costly decision to reinstate 25% of the eliminated billets.³¹ In order for the RCN to avoid requesting additional funds to reinstate billets, or accepting risk associated to over worked crews, the RCN will need to ensure proper analysis of the optimization strategy prior to the build phase of CSC. This stresses the importance of the crew optimization work, on board the X-ship, and the necessity to develop trials and tests which incorporate the concepts learned from other western navies so as not to repeat them. The detriment of not fully developing concepts to support new philosophies, as it relates to CSC crew optimization, prior to implementation would cause

³⁰ Ibid.

³¹ Ibid.

undue stress on personnel and create the environment for second and third order effects to occur.

One such order of effect is the direct impact a reduction in sailing durations to account for the increased need for crew rest would have on operational tempo of future missions. It is also important to note that the down time for increased crew rest could compound the concepts discussed earlier on operational tempo which has already explored the increased requirement to be in port more frequently. Additionally, any further demand placed on the future CSC requiring it to be alongside more frequently would have a direct correlation to the subsequent RCN philosophy with respect to mission employment. More specifically, this would translate to a reduction in operational availability and range for the CSC. As experienced with the LCS, the USS Freedom has developed an operational tempo which requires it in port for a 5 day work and maintenance period every 25 days, and a 2 week period for every 120 days at sea.³² The concept developed for these work periods are a direct effect of the final crewing adopted by the LCS platforms, and would be a similar approach for the future CSC to develop and address the work to rest ratio gaps within the crew optimization strategy selected.

Conclusion

Historically, the RCN has enjoyed philosophies which allowed for a relatively self-sufficient ship capable of supporting and performing the mandate of the government. The past success achieved was rooted in the concepts that have been developed and tested on board well trained and crewed legacy frigates capable of integrating and operating with various coalition partners within the maritime environment. The Halifax Class frigate is now past the expected midlife milestone and the project to replace these

³² Ibid.

platforms is now underway. However, based on initial costing estimates for replacement, there is a strong desire to investigate innovative means to deliver a capable CSC ship at a more reasonable through life cost. The RCN is investigating the notion of crew optimization as one method to achieve this. Based on the preliminary analysis conducted by DRDC and the crewing studies being performed on board the X-ship, the notion of crew optimization is shifting from the realm of desire into an intended solution space.

This paper has presented critical concepts related to the major challenges and associated philosophies which must be understood prior to key decision makers implementing a crew optimization strategy. The major challenges of crew optimization for the RCN were identified and discussed by examining the concepts of operational tempo and readiness, and key assumptions as they relate to future crewing requirements. The link was made between reducing crews on board the CSC to an increase in shore support organizations to fill the functional gaps caused by crew optimization. This linkage will have a direct impact on how operational readiness will be conducted in the future based on the shore support concepts, especially during overseas deployments. Furthermore, based on the concept of increased alongside requirements to enable the requisite shore support, there will be a decrease in operational tempo and patrol durations. The philosophical considerations identified and discussed the concepts associated to flexibility with a specific focus on impacts of training structures. Credibility amongst maritime coalition partnerships, and lessons to be learned from other western navies' procurement follies and crewing concepts were identified to avoid costly oversights for the future CSC.

Flexibility is the key to sea power, and as such any new concepts that would affect it should be afforded in-depth analysis to fully understand the impact and new philosophies generated. Training philosophies are of particular importance as the implementation of a crew optimization strategy would prevent the current model for the Halifax Class frigate. Both the major challenges and philosophy sections of this paper developed arguments which addressed key factors that require further development to avoid or mitigate the risk of unintended second and third order effects. These effects, if not explored and developed in conjunction with the specific crew optimization strategy for the CSC, could create an environment leading to undue or catastrophic stresses being placed on crews and commands of the CSC.

As a relatively small navy, the RCN does not have the luxury of correcting or realigning major challenges and philosophies once a CSC design is agreed upon and construction has commenced. Therefore, the RCN leadership of today must strive to fully investigate and develop the concepts that will directly impact the successful implementation of crew optimization for the CSC fleet of tomorrow.

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