Niobe Papers

Crewing the Canadian Surface Combatants

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Over the next 20 to 30 years Canada is scheduled to invest a significant amount of money into the multibillion-dollar National Shipbuilding Strategy (NSS).[1] For the Royal Canadian Navy (RCN) this means taking delivery of fifteen new frigates, six new patrol craft, and two new replenishment vessels, one of the most significant recapitalizations in the Navy's history. The cost of this building program is significant but often overlooked are the running costs of crewing this new fleet. Indeed, while the 2019 Parliamentary Budget Office cost estimate for a Canadian Surface Combatant (CSC) was $69.8 billion (over 26 years), the cost to operate these ships will be even more over the vessel's life span.[2] There are recent examples of this high cost to manage ships. One, the recently upgraded Halifax Class Frigates in-service support (ISS) contract is estimated to at $7.5 billion until the 2040s.[3] The second example is the Arctic/Offshore Patrol Ship (AOPV) and Joint Support Ship (JSS) ISS (AJISS) contracts – the other ship classes being built under NSS – are estimated to cost $5.2 billion over 35 years.[4] The AJISS contract accounts for half of the platforms that CSC will introduce and the AJISS contract is costed against far less technically advanced platforms. Building and ISS maintenance costs of the NSS are substantial; therefore, keeping these costs under control is essential to the RCN – as it is for any fleet – and the surest route to cost control is to reduce the crew size.

The most labour-intensive platform being delivered to the RCN will be the CSC and it is imperative to get its crewing system right. Doing so means addressing crewing from the earliest stages as a central component of the ship and not as an afterthought. It also means optimising crew size, not simply with an eye towards the number of sailors, but keeping in mind human performance, rest, safety, and training.[5] This holistic view of crewing involves the melding of logistics doctrine, training patterns, and all manner of crew activities so that they function as one, rather than as separate, siloed activities disconnected from a central policy and purpose.

Developing a holistic approach to crewing is more challenging than it sounds. Scheduling something as complex as a major warship is devilishly difficult and there have been serious failures in the recent past. The most dramatic example was the US Navy's (USN) long struggle to bring the Littoral Combat Ship (LCS) online and make it an effective warship. The LCS is a cautionary tale and an example of where early and broad attention to crew requirements was not emphasised – leading to a fatigued crew and higher maintenance and operational costs, resulting in a less effective platform. As Canada brings its next generation of warships online it has an opportunity to learn from past failures and to do it right with its new surface combatants.

Rebuilding the Fleet

As the RCN builds its future fleet, an increasing focus is being placed on total cost – rather than simply the sticker price of the ships themselves. At an estimated cost of $50-60 billion for a fleet of 15 ships, each CSC is being priced at about $3.9 billion.[6] These high costs are endemic across fleets. In 2000, the US Naval Research Advisory Committee found that 70% of a ship's total cost of ownership is tied to operations and support (personnel, maintenance, consumables, and support).[7] In addition, the USN concluded in 2003 that a crew reduction of 60-70% for its future DD(X) class of 32 ships would save $18 billion (2002 dollars) on personnel related costs amortized over the life expectancy of the ships.[8] Of this operational support cost, 51% is associated with personnel, meaning that a reduction in crew size could offer large savings to ship procurement.[9] The US General Accounting Office determined that decisions on requirements made early in a ship's design phase could lock in savings of up to 80-90% of the total ownership costs over he vessel's lifetime.[10] Given this finding, ship design and project teams are taking personnel costs into account more than ever before – and not only life cycle costs, but at the onset as a design driver.[11]

The attention to crewing cost reductions is easy to understand. The costs of warships are high, crewing is expensive and managing personnel costs is one of the most straightforward ways to reduce total life costs. Managing crew sizes is more complex than simply cutting however, if crew size is over-estimated in the design phase then build costs inflate owing to exorbitant accommodation costs.[12] If crew size is underestimated, then the platform may fall short in operational capability, leading to delays and cost increase, given that there will have to be additional design changes to correct it.[13] Therefore, it is imperative to get the crew size correct from day one of the ship design program.

The RCN has already demonstrated real attention to this issue. This is a trend that we have seen with the AOPV, as well as the JSS. Beginning in 2010, Defence Research and Development Canada (DRDC) – as tasked by Director Naval Personnel and Training (DNAV P&T) – worked to support crew reductions for AOPV and JSS. In this role, DRDC worked closely with the RCN to develop decision making tools to analyse the reduced crew numbers allotted for AOPV and JSS and, as a result, developed the Simulation for Crew Optimization for Risk Evaluation (SCORE) program to support this task for AOPV and JSS.[14]

A key factor in managing this balancing act and calculating correct crew size is what has been dubbed the human systems integration (HSI) approach. This framework offers the right approach to optimise ship crew size and reduce overall costs for new ship systems and is one that should be baked into the CSC.[15] SAE International defines HSI as simply "the management and technical discipline of planning, enabling, coordinating, and optimizing all human-related considerations during system design, development, test, production, use, and disposal of systems, subsystems, equipment and facilities."[16] In the US for example, the aim of HSI is "to optimize total system performance (hardware, software, and human), operational effectiveness, and suitability, survivability, safety, and affordability" for defence acquisitions.[17] Therefore, when applying a HSI framework, it is important to recognize that an optimised crew is not simply a reduction in crew members in favour of technology. Moreover, "optimised crewing for ships refers to the minimum crew size consistent with the ship's mission, affordability, risks, human performance, and safety requirements."[18] In order to optimise how a navy employs its personnel, HSI uses a system engineering approach to evaluate which functions should be performed by the crew versus technology. When used early and properly, HSI can minimize personnel requirements, along with workload while maximising gains from technology.[19] In a 2003 Congressional Report addressing the actions needed for the USN to reduce total ship ownership costs through crew reductions, the Assistant Secretary of the US Navy stated: "failure to incorporate HSI approaches can only lead to increasing manpower costs in the future what will threaten the ability of the Department to sustain the transformation, readiness, and investment priorities we have established."[20] Such a failure can be seen in the USN's LCS program.

Littoral Combat Ship (LCS) Project

The USN's view for its future fleet will be comprised of large surface combatants (destroyers and cruisers) and smaller surface combatants (frigates, mine warfare ships, and patrol craft).[21] In 2001, Admiral Vern Clark, the Chief of Naval Operations, announced that the new surface combatant fleet would include a large multi mission destroyer (DD(X)) and cruiser (CG(X)) as well as "a small focused mission ship called the Littoral Combat Ship (LCS)."[22] It is important to point out that the LCS program will replace all USN small surface combatants and will be the first recapitalisation platform delivered for the USN. To reduce overall cost of their ships, USN senior commanders wanted the LCS platform to the "maximum extent possible, [to] employ reduced/optimal manning concepts."[23] The DD(X) program has a "key performance parameter to cut the new crew size by 60-70%" compared to the old destroyers the program is replacing.[24] Similarly, reduced crewing became a key driver for the LCS program with Admiral Clark stating that he "expected LCS builders and designers to justify each person in the crew and push for the minimum manning possible."[25]

The LCS was the first ship delivered under the USN's recapitalisation plan and many of the US Navy's "key performance parameters," envisioned for their future fleet were employed on the LCS. One of these was the need to reduce total life costs; in doing this the USN wanted to employ a minimal "core," while bringing in module mission crews to maximise effectiveness.[26] Admiral Clark directed a core crew of 30 to 50 for LCS, which was largely based on his idea that innovation and technology would drive these numbers down from the traditional frigate crews of 170. The Preliminary Design Interim Requirements documents set the LCS crew at 75: a core crew of 40, an aviation crew of 20, and a 15 person mission module detachment.[27] The LCS project team's objective was to keep the crew at no more than 75 and Clark believed that this aggressive target would drive industry to use automation as much as possible in order to drive down core crew numbers and overall life cycle costs.

This initial minimalist crew concept set for LCS, the "supporting off-board for logistical, maintenance and training would be absolutely critical" to the success of such a reduced crew.[28] Therefore, LCS crews were to be fully trained ashore prior to joining the ships as there was no ability to conduct on-the-job training. The LCS would not have any logistical capabilities on board, "and a limited ability to conduct maintenance at sea; instead, it would rely heavily on shore-based support, including flyaway maintenance teams made up of contractors flown in to conduct scheduled maintenance."[29] To meet the maintenance requirements, the LCS was to follow a rigid schedule of five day preventative maintenance port visits every 25 days at sea as well as a two week intermediate maintenance period every 120 days.[30] Navy planners knew that these numbers were aggressive, and the project team was content to let LCS Flight 0 iron out the details and then make adjustments based on the experience operating those ships.[31]

From the experience of the first in class USS *Freedom* (LCS 1) deployment, the USN decided to increase the size of the core crew to 40 to 50 – owing to evidence of crew fatigue and poor crew readiness and performance levels.[32] Even with the additional 10 core crew members, on *Freedom*'s second deployment the crew depended heavily on the mission module detachment to stand watches and assist with training and maintenance.[33] Furthermore, the "core crew also relied heavily on the maintenance contractors embarked" to stand watches in the engineering spaces.[34] Even with the additional manning for the second deployment, the crew was only able to average six hours of sleep per day, two hours below the Navy standard.[35] Most alarmingly, key members of the engineering and operations departments averaged even less than the average six hours of sleep.[36]

The initial vision for the LCS was to leverage innovation and automation in order to reduce crew numbers, with an end state to lower total ship cost. As the Dean of the Center for Naval Warfare Studies stated, "perhaps the most serious objection to LCS is that the Navy charged into series production without having a clear idea of how the ship would be used."[37] The USN failed to apply HSI policy and direction from day one for LCS. By setting key performance parameters of a maximum 50 core crew and by using Flight 0 as its way to test its reduced crew assumptions, it did not allow for the flexibility needed to grow the core crew without having significant design change. The lessons identified from *Freedom*'s deployments have not solved the problem of operating with a reduced crew in a high tempo environment. In 2013, the USN decided to increase the LCS permanent crew from 75 to 98.[38] The cost to modify LCS 3 and 4 was estimated to be somewhere between $600,000 to $700,000. Changing the remaining LCS hulls from the initial bulk buy is estimated at $6 million, while funding for follow-on ships will be addressed in future budgets.[39] In 2014, the LCS life cycle cost estimate was $79 million which is comparable to the more crew intensive DDG-51 Flight IIA of $88 million.[40]

LCS Lessons Identified for Crew Reduction

The USN's failure in designing the LCS offers clear lessons for Canada as the RCN recapitalizes its fleet. In 2020 the AOPV and JSS are too far down the design path to modify, indeed there are already AOPV in the water. Focus must be placed on the CSC with an eye towards decreasing the life cycle costs over their thirty year lives.

Looking at the USN's failure with the LCS project, it becomes clear that two factors limited the its ability to optimize crewing. First was the failure of leadership to create the environment to apply HSI. It has become evident that HSI needs to be engrained in the project from the beginning of the design phase and throughout the build. If HSI experts were part of the project team, they would be positioned to support the Project Managers in leveraging labour-saving technology and holding down acquisition costs by using in-service systems without considering the through life costs.

Secondly, the sustainment framework required to support an optimised crew needs to be developed in conjunction with the delivery of the ship. The key component to managing crew workload and fatigue is to ensure that effective policies are in place to guide the required training, maintenance, and logistical support for reduced crews. As demonstrated with the LCS, an optimised ship (crew) will fail without a robust policy and organisational structure in place to meet the operational demands of the ship by taking those demands away from the crew and enabling them to focus on mission tasks.

Compared to the USN, the RCN has not embraced an HSI approach regarding its crew reduction plan for its future fleet. The initial crew concept for AOPV was of a small crew, similar to a Maritime Coastal Defence Vessel crew of 35. Once the AOPV platform was selected and crew manifests were being developed by DNAV P&T problems were quickly identified and the indication was that the AOPVs could not be operated with such a small crew. DNAV P&T contracted DRDC to support the RCN with crew optimisation for AOPV using their SCORE program and the crew numbers generated fell between 45 to 65 personnel, in the end the RCN endorsed the 65-person crew.[41] Similarly, JSS was given a core crew of 165, which was calculated by the two crews (500) of the two AORS divided by the three JSS that would be delivered by the project. Project Management Office JSS with DNAV P&T and DRDC used SCORE to generate a crew of 199 for JSS which would enable it to conduct its primary task of replenishing a task group at sea.[42] Both the SCORE validation of AOPV and JSS used current RCN doctrine, policy, regulations, Standard Operating Procedures (SOP's) and Tactics Techniques and Procedures (TTP's) to generate the respective crews. However, HSI was not incorporated in calculating AOPV and JSS crew size.

Since HSI was not implemented throughout the AOPV and JSS projects there is a risk that the training requirements for a reduced, or "optimized" crew have been underestimated and will not account for automation and technology, or the doctrine, SOP's and TTP's to support it. Smaller crews will inevitably increase the training demands on them, due to the fact that they will be required to be more cross-functional than today's crews. Meaning the future sailor will have added training requirements expected of them compared to their predecessors in today's fleet. Additionally, because this training will more than likely be specialized, the RCN could risk having more senior members on ships crews (higher ranks), which will drive up personnel costs, which ignores the goal of an optimized crew. In the end, similar to the USN LCS, it may simply become and game of trial and error for AOPV and JSS to get it good enough.

Reducing through life costs while maintaining operational effectiveness should be the mission of new ship delivery. Although AOPV and JSS took a step in the right direction using DRDC scientists to support crew studies, they did not use HSI experts to optimise crews by incorporating the use of technology and automation in the design of the ships.

For the CSC, the RCN can cut total ownership costs by taking a different path, optimising the platform with lessons taken from the LCS project. To do so, the RCN can apply the two main lessons identified from the LCS' procurement analysis for optimising crews. First, and most importantly, the CSC project should follow an HSI and a system engineering approach to reduce the crew numbers. An HSI policy should be ingrained in all project documents, specifically the Statement of Operational Requirements and the Project Charter, with the aim to empower the Project Manager (PM) and Project Director (PD). Furthermore, an HSI subject matter expert, with potentially a small detachment, should be part of the PD staff to coordinate with all RCN and Department of National Defence organisations to maximise resources and ensure all organisations are meeting the aim to optimise the crew of CSC.

Second, optimising ship's crew size has to be recognized as an exercise, not simply in reducing numbers of sailors, but in creating what a USN report to Congress defined as the "minimum crew size consistent with the ship's mission, affordability, risks, human performance, and safety requirements."[43] Therefore, the RCN should give direction to all RCN logistics, training, and maintenance organisations to commence the development of new RCN concepts, policy, doctrine, SOP's, and TTP's that will be required to sustain an optimised CSC at sea. This process will be resource intensive, however as noted by the LCS project, if these mechanisms are not in place, then any optimised ship will not succeed.

Conclusion

As Navies strive to recapitalise their fleets, they will continue face further pressures from governments to reduce the overall cost of ships, and that means reducing the total life costs. The easiest approach has been to reduce the size of a ship's crew, however, reducing crew levels is easier said than done. If HSI principles are not followed from the start of the design phase, through the build of the ship, then opportunities will be missed, opportunities which could have leveraged technology and automation to support crew optimisation. Furthermore, if Navies do not have a robust policy to effectively manage and sustain the logistical, maintenance, and training requirements that fall out of an optimised ship, then the crew will be over-tasked with additional responsibilities and this will hamper the operations of the ship.

Finally, evidence suggest that total life costs will go up if HSI, as well as operational support and sustainment concepts, are not put into place before the ship is delivered – primarily due to redesign work and additional crew numbers added afterwards. More important than rising costs are the impacts on the crew due to increased workload and lack of support. These factors will contribute to fatigue and lower readiness and preparedness levels during operations. Unlike the USN's use of Flight 0 ships to correct shortcomings, the RCN will not be afforded the luxury to test on the fly owing to the limited number of CSC ships being delivered. Consequently, the RCN needs to put the time and effort in at the beginning of the platform design phase in order to optimise the crew before the majority of the systems are locked down.

Notes

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[26] Report to Congress, "Littoral Combat Ship Manning Concepts," Department of Defense OPNAV – Surface Warfare, file: RefID: 4-7F8BB29 (July 2013), 2.
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