

The Costs of 21st Century Shipbuilding: Lessons for Canada from the Littoral Combat Ship Program

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Danish frigate *Iver Huitfeldt* during a port visit in Århus, Denmark, 20 January 2012.

As Canada embarks upon its first major naval revitalization since the end of the Cold War, its navy finds itself in a difficult position. Although the National Shipbuilding Procurement Strategy (NSPS) promised some \$33 billion for the purchase of the Royal Canadian Navy's (RCN) next-generation combatants and support ships, that funding is now on shaky ground.¹ It is highly unlikely that the sum will be augmented to accommodate any cost increases that occur in the course of the NSPS.

What factors contribute to ship cost growth and which of these can be controlled by decision-makers, thereby maximizing the effectiveness of NSPS funding? This article identifies and examines these factors. It will do this by utilizing the RAND Corporation's 2006 study "Why Has the Cost of Navy Ships Risen?"² and applying its findings to the US Littoral Combat Ship (LCS) program. There are several reasons behind choosing the LCS for the case study. First, at almost \$500 million per ship,³ the LCS has failed to meet the original conception of a low-cost small combatant. This is especially glaring because many foreign warships are available at that price (or less) and are much more capable in terms of combat power. One example is the Danish *Iver Huitfeldt* class, which costs as little as \$333 million per ship (including sensors and weapons!) despite displacing nearly twice as much as an LCS.⁴ Second, the LCS program is set in the 21st century and reflects the advances in the realm of computer-aided design and automated shipbuilding techniques that will

be used in any future RCN naval construction. Finally, the LCSs are equipped similarly to that of the RCN's Arctic Offshore Patrol Ships, the first ships of the new RCN fleet. Both share a basic weapons suite, low crew levels and relatively conservative sensor systems. These three elements make the LCS program a relevant and contemporary case study for the RCN modernization effort.

Applicability of the RAND Analysis to the LCS Program

The primary finding of the RAND study is that the main reason for increased ship costs is the increased complexity of ships, and in particular the insertion of more numerous combat and non-combat systems. This has resulted in the recommendation that perhaps ships should be built separate from their systems. The authors cite the LCS program and its approach of developing the mission packages separate from the hull, and suggest that this may be one way of reducing the cost of ships. The logic behind this proposal is that the US Navy would only have to buy enough mission packages for the ships that are operating in the package's role. For example, instead of buying 55 massive ships capable of holding the mine counter-measures (MCM), anti-submarine warfare (ASW) and anti-surface warfare mission packages all at the same time, and thus requiring 55 units of each of those packages, the navy could settle for 55 small LCSs and a reduced quantity of those packages. This would be done based on the operational vision that there would



The Littoral Combat Ship USS *Freedom* (LCS 1) arrives at Joint Base Pearl Harbor-Hickam to participate in the 2010 Rim of the Pacific exercise, June 2010.

never be 55 LCSs needing the same mission package type at any given time.

The logic is certainly sound. And although the LCSs and their mission packages are extremely expensive relative to traditional combat capability, this does not take away from the expected cost savings for the LCS program as a whole versus building the same number of multi-mission combatants. The one caveat here is that buying fewer mission packages may mean higher prices per unit.

In any case, the RAND report's suggestion for ship-systems separation rests upon the finding that systems do in fact contribute significantly to ship costs. Because there are no recent Canadian shipbuilding programs to examine, let's look at the validity of this by examining other shipbuilding industries around the world. In the United Kingdom, systems represent the biggest percentage of the price of a warship – 70% compared to 30% for the hull.⁵ This is in stark contrast to commercial vessels, where the reverse is true – 20% systems, 80% hull. Although the figures measure somewhat different elements, the same trend holds true in Australia where the costs are 33% for “platform design, hull, machinery, and equipment” versus 41% for combat systems.⁶ Logistical support and training and project management make up the remaining costs. The similarity between these two countries is strengthened if we shift the Australian machinery and equipment cost percentages into that for combat systems, more accurately reflecting the broad system-hull dichotomy of the British example. In sum, the RAND conclusion that systems are the most significant element of ship costs is valid, seemingly regardless of country.

Another factor in increased ship costs noted in the RAND study was the use of multiple shipyards for the same class of vessels. Thus, contrary to the theory that *increased* competition leads to reduced costs, the study argued that further consolidation of shipbuilding industries and eliminating competition between shipyards would result in cheaper ships. Certainly, historical practice appears to bear out the validity of this suggestion. Throughout the Cold War and since its end, the British shipbuilding industry has continually merged shipyards in ‘rationalization’ schemes.⁷ However, this suggestion is not helpful in the Canadian case as the shipbuilding industry is already as ‘rationalized’ as it can be. With only the Vancouver and Halifax shipyards as the major players in the NSPS, it would be more useful to examine how ship costs can be reduced in a situation where only two shipyards exist, but the absence of such a situation elsewhere makes comparison difficult.

Based on economic theories, competition amongst shipyards

should result in cost savings, but there is little evidence that this holds true in practice.⁸ Furthermore, competition amongst shipyards may well result in economic ruin, or at least hardship, for one or more of the yards. During Imperial Germany's Dreadnought construction program, for example, the extremely competitive climate resulted in major shipbuilders like Blohm & Voss losing significant sums of money for every ship they built.⁹ The LCS program provides us with a very interesting case study of the impact that competing shipyards may have on modern ship costs.

At least one US Navy official has publically stated that the decision to purchase both versions of the LCS, and thus buy from two separate shipyards and companies, has resulted in a \$600 million net savings over purchasing one design. The US Navy had originally wanted to make a decision about which of the two LCS builders would win the contract to build the first 10 ships. The LCS design of the winning bidder would from then on be the only design built, regardless of which shipyard won the contract to build after the first 10 ships.¹⁰

As it turned out, the navy decided in late 2010 to buy both the Lockheed Martin monohull and the General Dynamics trimaran designs, awarding each company 10 ships. The justification for this was the expectation it would save \$600 million in total procurement costs versus going with the strategy of picking one design.¹¹ This figure already accounts for the \$300 million in extra costs associated with maintaining two designs' worth of spare parts, simulators and differing components.¹² Information is scarce regarding how exactly buying and supporting two drastically different ship designs, each with their own different radars, engines and other hull-specific components,¹³ can end up being cheaper than going with just one design.



Here we see the Lockheed Martin monohull variant of the Littoral Combat Ship (top) and the General Dynamics trimaran variant (bottom).

One possible explanation for why there are cost savings involved in this particular scenario may rest, ironically, in the very distinct differences between the two LCS designs. The RAND report concluded that “multiple producers may not make it as far down the learning curve as a single one will during a constant production run.”¹⁴ That is, a single design spread over multiple yards means fewer hulls built by each, and consequently each yard may not have the opportunity to gain sufficient familiarity with the design to find areas where savings can be attained (i.e., ‘learning’). In contrast, a yard that is responsible for building all of the hulls can gain the experience necessary to benefit from that learning and still have new hulls on which to apply those cost-cutting lessons, resulting in lower total procurement costs. This is essentially an economies-of-scale argument, in which each shipyard is treated as a self-contained producer.

So why not go with the original strategy of building a single design of the LCS at one yard? Simply put, the \$600 million figure may well be a *potential* or *expected* rather than *actual*, cost savings – a relative savings dependent on a comparison with the possibility of awarding the second (and/or subsequent) batch of LCS builds to a company that did not have the experience of working on the initial 10 ships. In such an event, that second company would have had to be paid for retooling all of its construction equipment and facilities to conform to the winning design. As

well, this second company would have to ‘relearn’ areas in which cost savings had already been achieved by the first company. Finally, the second company may experience delays in restarting construction since it will have to rehire some of the workers that would leave while there was little or no work to be had during the construction of the first batch by the first company. This outcome runs the risk of costing the navy more money than the current option of both designs and both shipyards. In purchasing both designs for the first 20 ships, there is work stability in the likelihood of the navy continuing to award both shipyards a roughly equal distribution of the remainder of the 55 total hulls. This stability means that there is less potential risks of cost increases due to any switching back and forth between two shipyards to build a single design, as may have been the case under the initial procurement plan.

Of course, much of this could have been mitigated had the navy insisted on there only being one design to reach the physical stage. A more rigorous analysis of the two radically different designs could have avoided the problems involved in paying for the establishment and disestablishment of physical equipment and manpower to build both designs. In short, the \$600 million in relative savings, and probably more, would have already been covered had the



Credit: U.S. Navy

The Littoral Combat Ship pre-commissioning unit **Independence** (LCS 2) is the second ship in a new design of next-generation combat vessel for close-to-shore operations. It has a crew of less than 40 sailors, can reach a sustained speed of up to 40 knots and can accommodate two SH-60 Sea Hawk helicopters.

navy decided to build all 55 ships in one shipyard with the same design.

One final point made by the RAND report was that it would reduce ship costs to build ‘commercial-like’ ships.¹⁵ This would mean that naval vessels would be built to civilian survival standards. Navies other than the USN have already been doing so – RAND cites examples like HMS *Ocean* of the Royal Navy and the ships of the Royal Netherlands Navy. In theory, building ships towards a lower, civilian, standard should result in significant cost savings. However, the LCS does not follow this pattern.

Despite the word ‘combat’ in its name, the LCS was never conceived to be a combatant in the traditional sense. To the extent that a combat-capable warship is usually able to absorb some battle damage while continuing to fight, the LCS fails this criterion.¹⁶ The USN decided that the LCS should be built with only the minimal amount of durability – what it terms Level 1+. The lowest level of survivability is 1 and the highest is 3, therefore 1+ implies a Level 1 with additional sources of protection that fall short of a full Level 2 survivability. This puts the LCSs at a rank that is lower than the FFG 7 class frigates they are replacing. The additional bit of protection that the LCS has is meant to allow the ship to retreat from the area if it is damaged by hostile forces. Part of the reason behind this choice of lesser protection was that it would be cheaper, since Level 1 survivability is little more than what commercial ships have. Yet neither version of the LCS is cheaper. Indeed, the LCS was originally to cost \$220 million but the cost is now nearly half that of a Level 3 *Arleigh Burke* destroyer. This illustrates that this cost-saving measure suggested by RAND isn’t always effective.

Credit: Wikimedia Commons



HMS *Ocean* at the 2005 International Fleet Review, showing landing craft on davits and stern ramp deployed.

Conclusions and Lessons for the Royal Canadian Navy

What should the Royal Canadian Navy learn from this? First, the cost savings resulting from a mission package approach should be evident. In particular, the Arctic Offshore Patrol Ships (AOPs) will be able to benefit from this. For example, it is unlikely that Pacific fleet AOPs need to be equipped with Arctic gear, as it is a much further distance to Canada’s northern waters from Esquimalt than it is from Halifax – especially given the location of the prospective Nanisivik refueling station at the eastern end of the Northwest Passage. This may reduce the numbers needed for Arctic-specific items such as climate-controlled 25 mm gun copulas and fully-enclosed lifeboats.¹⁷ Obviously, these items are significantly less expensive than the remote vehicle, organic helicopter and heavy weapon technologies involved in the LCSs’ various mission packages, but the general principle still applies. The only caution here would be the increased per unit cost of each individual component due to the decrease in total number of orders.



Credit: U.S. Navy/Chief Journalist Alan J. Baribeau

USS *Arleigh Burke*, lead ship of this class of guided-missile destroyer, conducts underway operations in support of *Operation Iraqi Freedom*, March 2003.



The US Navy's newest Littoral Combat Ship USS *Independence* (LCS 2) arrives at Mole Pier at Naval Air Station Key West.

Finally, as we can see from the LCS experience, there is little to lose by building the future Canadian fleet to a high standard of survivability. The attempt to decrease construction costs of the LCS through the use of near-civilian level survivability failed. The RCN should not make the same mistake. Not only is it economically false, it would also expose Canadian sailors to unnecessary risks. Canadian waters can be cold and unforgiving, and Canada must ensure that the men and women who go off in ships to defend Canada receive the best protection available.

NSPS implementation and funding distribution have begun, but ship designs are yet to be finalized, and no hulls have yet been laid. It is not too late to examine the possibilities outlined in these conclusions. 🍷

Second, the RCN might find it worthwhile to look into possible cost savings that may result if it were to build the entire future Canadian Surface Combatant (CSC) class using a single design. Currently, the RCN is expected to build two types of CSCs – a few to replace the *Iroquois* air-defence destroyers and the majority to replace the *Halifax* general-purpose frigates. Even if the two were to utilize the same hull, the vastly different roles of the two ship types demand CSC replacements that are also drastically different in terms of equipment and capability. However, doing so may prevent the builder from capitalizing upon the benefits of economies-of-scale. Thus, while conventional wisdom would expect that building most of the CSCs to a less advanced standard would be cheaper, this should be weighed against potential savings from building the entire fleet to the same design. It may even be the case, though unlikely, that economies-of-scale would make building the entire fleet to a single advanced multi-mission design cheaper than a mix of air-defence and general-purpose designs.

The economy-of-scale argument could also be used to examine the government's indecision regarding whether to build six, seven, or eight AOPs. Building eight may result in a lower average cost per ship, but would likely cost more overall. The LCS experience would also suggest that even if Esquimalt-based AOPs will not require Arctic capabilities, it would be economically risky to build an expensive ice-capable version for Halifax and a cheaper ice-incapable version for Esquimalt, as this would eliminate any possibility of savings resulting from experiential learning in the building process.

Notes

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