NAVAL SHIPBUILDING IN CANADA
WHY DOES IT TAKE SO LONG AND COST SO MUCH?

If you follow the news, and have read Briefing Note #6 about the National Shipbuilding Strategy (NSS), you'll know that Canada is in the midst of building new ships ('recapitalizing the fleet') for the Royal Canadian Navy and the Canadian Coast Guard. And you'll also know that it takes a long time from the announcement that a ship will be built to the actual operation of the ship – and the costs always go up. Why do the costs go up during the project? And why does it take so long? And before we begin, let us note that these two issues are not unique to Canada (or to the navy) – virtually every country will experience cost increases and delays in its procurement processes.

Let's talk about cost first, but the two questions are related. One of the main reasons for cost increases is that the initial number that the government announces is just an estimate. It seems like it should be easy to put a price on a ship and stick to it. But it isn't. Indeed, "[i]nitial cost estimates for a purpose-designed ship typically quote an error of □40%, so the risk of under- or over-predicting cost with early estimates is significant."[1] Getting good data to make an accurate estimate of cost is difficult. There is almost no Canadian data because no major warships have been built in Canada for more than 20 years.[2] And getting information from outside Canada can be problematic. For one thing not everyone wants to share information on their costs, and for another the ships won't be exactly the same so the costs will differ. As well, costs for labour, materials and technology will be different. Therefore the government makes an educated estimate of the cost at first. We should not be surprised that this cost changes over time.

As decisions are made about the ship, a more formal budget is developed. And this budget will include more than the cost of the ship itself. It will include things like long-term maintenance and/or service contracts for the ship which often represent significant costs. As well, factors that were used to come up with an estimate will change over time. For example, interest rates go up and down, steel prices vary, foreign exchange varies (i.e., the Canadian dollar goes up and down) and this is relevant because many components come from outside country. This means that the timing of purchases will affect the price.

There are a number of other considerations that affect the cost. The design and build of naval ships is extremely complicated, and involves many naval designers, engineers and technicians from a variety of manufacturers. So it's not just a matter of getting one quotation from one company – there are often many companies involved, and to ask all of them how much they would charge for theoretical equipment in a theoretical ship would be a long and painful process.

Weight is often seen as the easiest attribute upon which to base an initial design cost – you don't need to know the exact capabilities or characteristics at this point, just the size, and you can use other existing ships for this basic element. According to naval engineer, David Peer, "[h]istorical information from a known design and cost data for selected major systems and

[1] David Peer, "Estimating the Costs of Naval Ships," *Canadian Naval Review* (*CNR*), Vol. 8, No. 2 (2012), p. 5.
[2] This does not count the eight *Orca*-class patrol vessels built (on time and on budget!) for the RCN, 2005-2008. It also doesn't include the 12 *Kingston*-class Maritime Coastal Defence Vessels built in the 1990s. See David Peer, "The Orca Project: A Procurement Success," *CNR*, Vol. 9, No. 2 (2013), p. 29-31.

equipment can provide first approximations of ship cost for a series of concept designs that meet the capability requirement."[3] The problem with this method of determining costs is that the hull is often not the most expensive element of a ship. In the United Kingdom, for example, "systems represent the biggest percentage of the price of a warship – 70% compared to 30% for the hull."[4] The numbers may be somewhat different in other countries but the trend is similar. It's the technology inside the ship that has a major effect on the price and the government won't necessarily know what technology it will acquire at the beginning when it estimates cost.

Instead of trying to find existing *naval* ships to estimate costs, why not look at commercial cargo ships? Unfortunately, that's problematic. Commercial ships are very different – they function with small crews and their focus is to maximize cargo space. Naval ships have much larger crews (although that may change as technology relating to unmanned vessels is developed!). Furthermore, naval ships have much more complicated propulsion, communication and weapon systems. As well, warships are built to different standards of 'survivability' than commercial cargo ships – they're warships after all. This makes warships heavier and denser than cargo ships.[5]

Another possible consideration related to cost is where to build the ship. The government must decide if it wants to design and build a ship in Canada, or if it wants to buy a ship 'off-the-shelf' (i.e., an existing ship). The Canadian government no longer has the ability to design ships – the navy's design offices were closed years ago – so designs could come from industry inside or outside the country. Some people argue that because of labour costs and lack of efficiencies of scale, Canada could get ships faster and for less money if it bought them or had them built elsewhere. This has been a recurring debate but many would argue that it is a false debate.[6] Most states with mature navies build their own naval ships and have some sort of strategic alliance with domestic shipbuilders. Thus, France buys its ships from The Naval Group/DCNs, Germany gets its ships from B&V, the UK from BAE, and even in the United States, where the yards are private, there are specialties. The majority of Canada's allies believe that to protect their long-term national security interests, they must have the capability to construct, sustain, repair and upgrade their naval vessels. Thus they tend to sole source their naval and coast guard acquisitions to their national shipbuilding industry with no competition. In addition to these sovereignty concerns, governments want to promote local industry and create jobs.

Based on the advice of the navy (and coast guard) the government has to decide on the capabilities of the platform, and that will affect the cost. There is a tendency, of course, to want the latest and most impressive technology because the ships in the RCN (and CCG) are often used for up to 40 years and you want them to be as modern as possible right from the start. The technology choices affect the cost.

Delays and cost are related. Usually the costs go up if there are delays. This is because prices of raw materials and/or labour costs have increased. The original budget is also affected by inflation, which for the defence industry is higher than in society at large.[7] As the government

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[3] Peer, "Estimating the Costs of Naval Ships," p. 5.

[4] Timothy Choi, "The Costs of 21st Century Shipbuilding: Lessons for Canada from the Littoral Combat Ship Program," *CNR*, Vol. 8, No. 4 (2013), p. 25. He points out that the reverse is true for commercial ships – 80% of the cost for the hull, versus 20% for the systems.

[5] *Ibid*., p. 27.

[6] See, for example, Eric Lerhe, "Fleet-Replacement and the 'Build at Home' Premium: Is It Too Expensive to Build Warships in Canada?" Vimy Paper #32, Conference of Defence Associations Institute (CDAI), July 2016.

[7] See Mark V. Arena, Irving Blickstein, Obaid Younossi and Clifford A. Grammich, "Why has the Cost of Navy Ships Risen?" RAND Monograph 484 (Santa Fe, California: RAND Corporation, 2006).

makes decisions about design, builder and capabilities, the value of budget it has allocated to the project erodes. Unfortunately, "[t]he time value of money is often ignored in the discussion, but every year a project budget sits unused, it buys less."[8]

Now that you have a sense about why the costs increase, let us examine why building a ship takes so long. The procurement process in Canada is a slow one. To start, the government must be persuaded that there is a capability gap, or that ships are at/near the end of their useful life. Then the government must decide what capabilities it wants, put out a request for proposals for ship designs, carefully assess the bids, and then negotiate with the winning bidder to make sure all the ducks are in a row. There can be a design study, a feasibility study, a preliminary design, a contract design and finally a detailed design. Only after this can you start to build the ship.[9]

A slow procurement process isn't necessarily a bad thing – after all Canadians want to know that their tax dollars are being well-spent – but it means that there are many hoops to jump through before the government will select a design, a builder and the capabilities. We are talking about a lot of money, and the government is keen to make sure that opportunities for disputes and law suits from losing bids, for example, are reduced as much as possible. This slows everything down. And, as David Peer notes, getting a new ship is not like buying a car, "[u]nlike buying a car, the time it takes to buy a warship must include all design activities as well as construction. If you had to wait for your car to be designed and then built, car buying would also be a long process."[10]

In addition to building new ships for the navy and coast guard, one of the reasons for the National Shipbuilding Strategy – originally called the National Shipbuilding Procurement Strategy – was to end the boom-and-bust cycle that has characterized Canadian shipbuilding. This meant that the government would order a ship and the shipyards would be busy for a while, then there wouldn't be another ship ordered for years, sometimes decades, and the shipyards would lose workers and capability. Part of the idea behind the NSPS/NSS was to implement a project that ensured ships were continuously being built over a long period. But before that could be done, Canadian shipbuilders had to modernize their facilities. That took time. The shipyards are now modernized and henceforth the building process can proceed.

Another thing that has been problematic for the smooth unfolding of the NSS has been the shortage of personnel. As noted, Canada hasn't had a major naval shipbuilding project for 20 years so there were few people left who knew how to manage a project this big. It takes time to hire people, and they can only get experience over time. As well, the shipyards had to hire and train personnel to build the ships – this was a major concern at the start of the process.

Warships are extremely complicated entities. It requires meticulous work to get them right. A warship needs to be able to float, move and fight. Basic as they are, all these elements must be taken into account when building a ship. Floating involves consideration of hull strength, balance of the ship, and making sure that the hull is secure. To move a ship you need to think about the propulsion system – how will it move? And fighting, the *raison d'être* of a warship, involves incorporating a vast array of sensors, communication and weapon systems. On top of that, you have to consider the safety and comfort of the crew.

You may have heard talk about 'Canadianization' of ships. What does that mean? This is one of the reasons why some people object to buying naval ships 'off-the-shelf.' Canada has unique legislative rules and geographic and demographic circumstances that affect its warships. These

[8] Peer, "Estimating the Costs of Naval Ships," p. 7.
[9] David Peer, "Realistic Timeframes for Designing and Building Ships," *CNR*, Vol. 9, No. 1 (2013), p. 5.
[10] *Ibid*., p. 5.

include matters inside the ship as well as outside. For example, inside the ship, Canada has certain power supply standards and settings. Canada has rules about the space provided for crew members and policies about the accommodation of women on board ships, and these rules may differ from other countries. Canada has strict rules about the security of weapons on board ships, and this has to be accommodated. As well, there has to be both heat and air-conditioning in Canadian ships, something navies based in more temperate climates don't need to consider.

On the outside of the ship, Canadianization may mean adapting ships so they can operate in a cold, unforgiving climate. The waters around Canada can be rough, and there may be ice – if not in the water, then forming on a ship in cold weather. As well, Canada has rules about how waste water is to be handled and these rules may differ from other countries. These are the sorts of things that need to be considered when constructing/adopting a ship for Canadian use. Making sure that a design incorporates Canadian requirements lengthens the process.

Conclusions

This Briefing Note has illustrated why shipbuilding takes so long, and why it never seems to cost what was originally promised. Building ships takes time because they are extremely complicated entities. The costs increase because the original number is an estimate that gets adjusted as the process unfolds.

Let's end with two positive thoughts. First, as noted at the beginning of this Briefing Note, cost increases and delays are not unique to Canada – check the procurement process in other countries and you'll see the same trends. The second positive thought is that as the NSS proceeds, the personnel will gain experience, the government will get better at estimating costs, and the shipyards will get better at building ships.[11]

[11] The first ship of each class tends to take the longest and cost the most per unit. For a discussion of this see Howard Moyst and Biman Das, "Factors Affecting Ship Design and Construction Lead Time and Cost," *Journal of Ship Production*, Vol. 21, No. 3 (2005), pp. 186-194.