Making Waves

Maybe, Just Maybe, They're Serious

Cal Mofford

David Perry's observations in the last edition of *Canadian Naval Review* (Volume 12, No. 1) that there is simply not enough money in the defence budget to recapitalize the Canadian Armed Forces (CAF) is but the latest in a series of warnings raised by a number of defence analysts and authorities. The list would include the Parliamentary Budget Officer, the Office of the Auditor General of Canada, and Philippe Lagassé at the University of Ottawa, to name but a few. Therefore a review of Canadian defence policy could not have come at a better time.

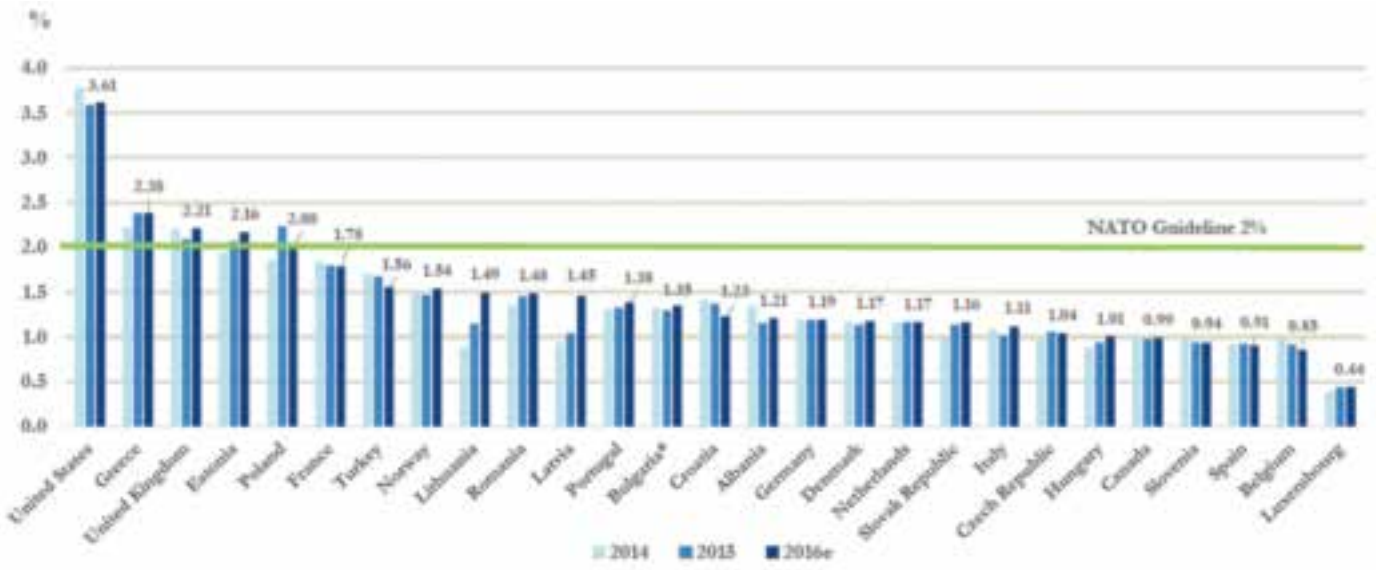
Should the current Defence Policy Review be like previous reviews, one anticipates some variation on the enduring themes of: defence of Canada; continental defence in partnership with the United States; and participation in international operations responding to world events. Like most policy documents, the final report will be short on details but will provide a broad context with perhaps some sense of the forces required to support it. However, to be useful to the Canadian Forces, it must be far more prescriptive in terms of force structure, with a view to ending up with capable forces that can be kept modern and effective. Absent this type of direction, the CAF will undoubtedly continue to pursue a force structure that is aspirational with unresolved competition amongst the services as they pursue equipment that they believe essential but is unaffordable, resulting in obsolescent military equipment as the government and its bureaucratic processes focus on affordability and sustainability.

A quick review of the relative expenditures by the Canadian government on the Department of National Defence (DND) is worthwhile inasmuch as it provides a benchmark of what successive Canadian governments are prepared to spend on defence.

Canada spends approximately 1% of Gross Domestic Product (GDP) on defence; well shy of the NATO goal of 2%. Over the last 30 years, this represented 18-22% of government direct program expenditures and 6.9% of total government spending.[1] The consistency (30 years) and relative ratio of these expenditures provide ample empirical evidence of what successive Canadian governments are prepared to spend on defence. We should expect no change given other demands on federal budgets, unless there is a significant change in the geopolitical environment that leaves Canadians worried about their security.

There have been changes over the last several years to the framework which the Canadian government uses to plan for the recapitalization of the CAF. Perry and others have written extensively on these process changes. Simply put, there is a fixed amount of funds available for recapitalization of major equipment with the costs amortized over the lifespan of the equipment. Budget 2016 provides a clear indication that the current government's goal is $84.4B

Figure 1: Defence Expenditure as a Share of Gross Domestic Product
(based on 2010 prices and exchange rates)



Credit: NATO Press Release 4 July 2016

(inflation included) to be provided over the next 30 years. If we assume that the average lifespan of most of Canada's major equipment fleets is 30 years, then this represents the totality of monies available to the army, navy and air force for all of their large-scale capital requirements. In essence, therefore, this represents all the money available for the CAF equipment force structure on a continuing and ongoing basis.

Most force planners will state that this is simply not enough to maintain the CAF structure as it currently exists. Retired senior military leaders have added their voices to this chorus. To illustrate, the Canadian Surface Combatant project originally forecast at $25B is now being re-assessed at a capital cost of somewhere in the mid-$30B (absent a draft design). The cost of the Arctic Offshore Patrol Ship (AOPS) fleet is in the order of order of $3.5B, and the Joint Support Ship replacement in the order of $3B. These numbers add up – and this is before the inclusion of a submarine replacement project which would cost billions of dollars, if recent Australian experience is an indicator. As well, these numbers are for navy fleets alone. Once the demands of the army, air force, special forces and intelligence agencies are added to this, it is difficult to understand how all of this will be affordable within the $84.4B envelope. Hence the necessity for the Canadian government to provide both policy and force structure direction.

Without this direction, we can expect continuing delays as the government bureaucracy obsesses over the affordability of the total major equipment renewal plan and stalls the process. Or delays could be caused by rejection of individual projects by the government as it becomes apparent that project costs exceed forecast costs. Regardless, these delays will result in gradual obsolescence, wholesale retirement of a given capability as it becomes unaffordable to support, or reduction in the future ability to acquire capability as inflation erodes purchasing power.

In a perfect world, a force structure review would start with a blank piece of paper working through an iterative series of force structure and defence policy models until an affordable defence policy and force structure is determined. However, the world is less than perfect. All of the services have their own beliefs based on their hard-fought experience about what is required to remain effective in meeting current defence operations and international agreements and with a weather eye to an uncertain future. Therefore, it is unrealistic to expect them to walk back from what they see as a minimum capability without a policy framework that forces them to do so.

However, the services are best placed to provide meaningful judgement and advice on capability tradeoffs and the mission sets that would be acceptable for these capabilities under various plausible scenarios. This is where a comprehensive Defence Policy Review would be most useful. For example, if the navy was directed to limit its upper end capability to providing local sea control within a coalition under the aegis of the US Navy against a moderately capable rather than a first order adversary then the resulting surface combatant would be less capable than one designed to fight independently against the best. The same would be true of the air force if its top mission was set as participating with the United States in continental air defence and expeditionary air superiority or supremacy roles alone, again under the aegis of a coalition of more capable air forces. The point here is that capability is the first order cost driver with the need for capability driven by what the government expects its military to do in meeting its domestic and international commitments.

Minister of National Defence Harjit Sajjan discusses NATO spending levels, spring 2016.

Since the underlying issue seems to be one of cost, this is the factor that needs the most attention. The Department of National Defence, for a myriad of reasons, seems unable to provide accurate indicative costs for major equipment purchases. Therefore, it would seem reasonable either to engage independent experts or engage defence industries directly, without prejudice, to provide better cost estimates for various levels of capabilities. This approach will undoubtedly incur its own set of issues, but would provide

more realistic benchmarks which DND can incorporate into its deliberations.

The current Defence Policy Review should as a minimum provide clarity to the mission sets in which it expects the CAF to participate and the level at which it expects this participation. The policy should be accurately costed with the resultant resources assigned to DND consistent with the force structure required to achieve the ambition. The only way to provide this coherence is through open and frank discussions among government, the defence industry, DND and the CAF as to what capability can be achieved at what price. To do otherwise will result in Canadian forces that will rapidly become obsolescent as major weapon systems age out while major replacement equipment projects are delayed.

Notes

1. Prepared by Peter Weltman, "Fiscal Sustainability of Canada's National Defence Program," Office of the Parliamentary Budget Officer, Ottawa, Canada, 26 March 2015.

Energy Use and Conservation in the Marine Sector

Peter T. Haydon

Environmentalists are making a lot of noise these days about 'getting off oil' in the next two to three decades. This might seem like a great idea until looked at carefully from a practical perspective. Sure, we could build more energy-efficient buildings and electrify the railroads, but what would happen to the rest of the transportation industry in Canada under such a concept? For instance, a complete or even partial lack of fossil fuels in the marine sector would cause absolute havoc. The inescapable fact is that the marine sector depends on the internal combustion engine. As I will explain, the extent of this dependence is sufficiently great to be a major factor in the national economy. Affordable alternatives to internal combustion engines at sea just do not exist at the moment. I suppose we could return to an era of sailing ships, but what would that do to a manufacturing industry structured on a 'just-in-time' logistics concept? Chaos! How would we maintain the export market for fish without refrigeration? And how would the essential network of ferries be sustained? Could we afford to rebuild the national fleets of ferries to run on nuclear energy or even fuel cells? These are all valid questions that should be included in any future proposal for getting off oil.

Policy-makers and their critics in central Canada have a nasty habit of ignoring the marine sector and its role in the national economy. This isn't new, it goes back well over 100 years despite the fact that the sea played and continues to play an essential role in the development of the country. Geographic and economic data should speak for themselves. One would think that by now the Canadian population would accept not only the magnitude of the ocean areas over which sovereignty is claimed but also that those waters are directly and indirectly the source of great wealth. Ignore the oceans at your peril!

Surprisingly, good statistics on Canadian ocean use are now hard to find. The government no longer collects and analyses the amount of marine data it did in the past, and the few analyses that are published are shallow in the extreme. But, by delving into some private sector reports and analyses, a pretty good picture of the Canadian marine sector can be found. It just takes a little effort.

The Canadian Marine Sector

We tend to speak of a *marine sector* in a unitary sense, whereas in reality it is multifaceted. I'll summarize five of the more obvious areas to provide an overview of the national economic and employment implications. Unfortunately, space does not permit mention of the very important R&D activities or the considerable ferry network connecting island and isolated communities with the rest of the country.

Also, I hope to make it clear that the common denominator throughout is the internal combustion engine, with some reliance on gas-turbines. That done, I'll talk a bit about realistic alternatives for marine propulsion systems and show that getting off oil at sea will be very expensive and will take a great deal longer to implement than the two to three decades being touted. In fact, taking such a step is more akin to initiating an industrial revolution than a simplistic environmental policy shift.

First, trade by sea, along the coast and international, is a key component of our economy. Somewhere in the vicinity of 315,000 tonnes of cargo, worth some $500 billion, are loaded and unloaded in Canadian ports every year. In turn, this generates nearly $200 million in operating income and leads to about a quarter of a million jobs. Most of the vessels engaged in seaborne trade are internationally owned and operated; the small Canadian merchant marine is almost entirely engaged in domestic trade and local transportation. Shipping adds $25 billion annually to the national Gross Domestic Product (GDP). An important and often overlooked point here is that many of the foreign merchant ships using Canadian ports, refuel and re-provision there. Getting off oil would almost certainly affect the freedom of use of those ports, with considerable economic consequences.

Second, resource exploitation, mainly the fishery and offshore oil and gas, employs some 83,000 people including

those in the shore-based support operations. Offshore oil and gas operations provide some $60 million annually to research and development (R&D) and pump over $2 billion in revenue to provincial governments. I could not find a figure for the number of vessels involved in the oil and gas industry, but over 18,000 vessels form the backbone of the inshore and deep ocean fisheries. The economic value to Canada of the fishery is $7.8 billion.

Third, the recreational use of the oceans and inland waters by Canadians is extensive. Here again, the data are scarce, but some 4.3 million small vessels are registered for recreational use. There is no easy way of telling how many of those vessels do not have an engine, but probably most do. With the support infrastructure, recreational use of Canadian waters is estimated to add about $5 billion to the economy every year.

Fourth, the shore-based infrastructure to support these marine activities is, as one would expect, very large and diverse; covering shipbuilding and repair, logistics, management and maintenance of ports and waterways, cargo handling, and the necessary administration to make it all function. Statistics covering the full economic value of this aspect of the Canadian marine sector are impossible to find, but several hundred thousand people are employed in all aspects of this activity. I could not find a figure to tell me just how many tugs, barges and small boats support this infrastructure, but anyone who has ever watched port or shipyard operations appreciate that they bustle with activity.

And, fifth, without a comprehensive system of regulations and the means of enforcement, any marine sector would be complete chaos. Although many of the related activities are shore-based, a significant number of ships and people carry out this work on the water. The Canadian Coast Guard, the primary law enforcement arm of government, for instance, maintains 119 vessels, 22 helicopters and employs over 4,500 people.

In summary, the marine sector in Canada employs thousands of people from coast to coast as well as in the North and on the inland waterways. The value to the economy is billions a year. In all, some 50,000 or so ships and smaller vessels use Canada's vast oceans and inland waters for many reasons and, with few exceptions, they all use some form of internal combustion engine for propulsion or to generate electricity. It is perfectly fair to claim that without the internal combustion engine and fossil fuel, the Canadian maritime sector would collapse and in the process do immeasurable damage to the economy.

Credit: Wikimedia Commons

The Port of Vancouver, Canada's busiest port, as seen from Harbour Centre Lookout, March 2007.

Credit: Wikimedia Commons

***U-32** (S182), the second **Type 212A** submarine of the German Navy, is powered by one diesel engine and an electric motor driven by two fuel cells. Photo 8 March 2010.*

Alternative Fuels and Means of Propulsion

At present, transportation accounts for roughly 39% of all Canadian energy consumption. This includes aviation, road and rail as well as the marine sector. Nearly all of that amount is fossil fuel. Assuming that somewhere between one-third and one-half of that energy is used by the internal combustion engines of the marine sector, ridding the economy of fossil fuels or even attempting to reduce consumption presents a huge challenge. Let's look at some options.

The first option, shifting to biomass-based fuels or cleaner variants of fossil fuels, is theoretically possible but those fuels still produce carbon emissions albeit at a lower level. Although biodiesel holds promise as an efficient fuel for transportation, with about 93% of the power derived from traditional diesel fuels, serious concerns exist over its sustainability as a major fuel because of the amount of biomass needed to create the fuel. Recent American studies for instance place the biomass requirements in thousands of acres. This is accompanied by calls for far larger crop yields per acre. Moreover, there is a not insignificant need for energy in its production, a fact which sometimes gets overlooked.

The second option is fuel cells. These are essentially chemical batteries and have been used for several purposes from driving buses to providing emergency electrical power. Iceland and the Netherlands are now using fuel cells to power small boats and Iceland has plans to shift its fishing fleet to this power source. Several submarines are using fuel cells to augment their diesel-electric propulsion to get greater underwater endurance. The cells are quite expensive and fairly bulky, but with some limitations can be retrofitted into existing hulls. Individual cells can be stacked to provide a larger power potential; an upper limit to which has not yet been established. Fuel cells are not easily refueled, and the production and storage of hydrogen, essential for the operation of the present generation of fuel cells, can be problematic.

For larger ships – naval and merchant – nuclear power offers a third option and the most logical solution to getting off oil especially as Canada already has a small nuclear industry. As with fuel cells, the key factor is to determine the amount of power needed. For instance, a modern, large container ship or the largest of the Marine Atlantic ferries have shaft horse power (SHP) ratings of 75,000 to 80,000. The electrical power needed to propel and provide domestic power for those vessels is about 70 megawatts (MW). The Russian nuclear-powered icebreaker, *Yamal*, has an SHP rating of 75,000 developed by two 56 MW reactors. (For cross-reference, a wind turbine develops 2-3 MW depending on wind strength, and one MW will supply power for about 200 homes.) A fourth generation Westinghouse reactor generates 550 MW; a modern aircraft carrier has two such reactors. Small commercial reactors developing 25 to 100 MW are being developed in many countries; these would produce enough power to drive medium-sized cargo ships and ferries. Once past the 'nuclear allergy,' the problem with nuclear power is cost and the need to develop a very large support infrastructure.

Conclusion

I have shown that 'getting off oil' in Canada's maritime sector would be a major undertaking that needs to be carefully planned in order not to disrupt the national economy. It would be, in fact, a national project that could take several decades to implement fully. There is no single solution to solving the perceived oil problem: a lot of new ships embodying new technologies will have to be built to replace existing hulls. It makes sense to use nuclear power for warships, submarines in particular, icebreakers, the large Coast Guard vessels, northern supply vessels, and probably most of the Marine Atlantic fleet. Fuel cell technology is certainly promising and could well offer a solution for the smaller commercial vessels, harbour tugs

and smaller ferries. Biofuels, once the sustainability issue is solved, could well become the primary fuel for small fishing vessels and the bulk of the recreational fleet, but there is a lot of preparatory work to be done before this can become a reality.

*The NYK Line ship **Auriga Leader** is the world's first commercial, solar-assisted cargo ship. However, its solar power capabilities produced only 0.05% of its propulsion power, and 1.0% of its electrical power in sea trials in 2009.*

The call to get off oil should be seen as an opportunity to move Canada to world-class status in the management of the marine sector. It will not be cheap, and will have to be accompanied by a significant public education initiative to overcome opposition to the new technologies. One has to wonder though if any government, present or future, will have the courage to embark on such a huge modernization initiative.

Canadian Wren Recalls Attachment to Bletchley Park

Drew Tapley

"Before the film came out, most people had never even heard of Bletchley Park, even those that were in the service," says Nancy Lynn, a Canadian with the Women's Royal Naval Service (known as Wrens) during the Second World War. She was drafted to Bletchley Park England in 1944 to help break the Enigma code. The film to which she is referring is the 2014 Oscar-winning film *The Imitation Game* which portrays the efforts at Bletchley Park to decrypt the German code that Adolph Hitler and his high command were broadcasting to their frontline generals.

The German military transmitted thousands of coded messages every day using cipher communication through an Enigma machine. This technology significantly enabled German U-boats to torpedo Allied supply ships in the North Atlantic Ocean to a point where British Prime Minister Winston Churchill considered Britain under serious threat of starvation.

Thanks to English cryptologist Alan Turing and code-breakers like Nancy Lynn at Bletchley Park, much of this information ended up in Allied hands within an hour or two of it being transmitted. This breakthrough is believed to have changed the course of the war, ending it years earlier and saving millions of lives.

In the spring of 1944, Lynn was stationed on the top floor of a huge Catholic boys' school building in Ottawa, secretly decrypting code aligned with the efforts of Bletchley Park. "The Royal Canadian Navy and Air Force occupied the whole top floor of the school," she said. "On one side was the Air Force, and I was on the other side with the Navy. They were still teaching in the school downstairs, and you could look out of the window and see the boys playing football in the playground. It was that secretive. No one knew we were there."

Nancy Lynn (born Baker) is pictured here in her home in Keswick, Ontario, holding her medal from Queen Elizabeth.

Born and raised in Toronto, Lynn joined the Wrens at the age of 19. She took basic training in Galt, Ontario (now a part of Cambridge), and was posted to Vancouver shortly afterwards. It was here that she began work helping to decrypt the Japanese code after Japan signed the Tripartite Pact in 1940 to form an alliance with Germany and Italy. "The movie *The Imitation Game* focused on the German part of Bletchley Park. I was in the Japanese part," she said.

After several months in Vancouver, five Wrens were chosen to go to Ottawa for more extensive work on breaking the code. Nancy Lynn was one of them. "I was picked from a large group. There were places for four Wrens, and the Admiral's niece was already on the list. The last place came down to me and one other girl, and they couldn't make up their mind, so they took both of us. I don't know how I was chosen. I was good at math, and scored very high at school. But I was terrible in English. I couldn't spell. Still can't."

The five Wrens traveled to Ottawa together, and didn't

Credit: Wikimedia Commons

Bletchley Park mansion. Bletchley Park was the place where Enigma messages were cracked during the Second World War.

know exactly what they would be doing there. Lynn worked more extensively on the Japanese code for several more months before being sent to Halifax, Nova Scotia, for specialist training. From there, she traveled to England on a boat: destination Bletchley Park.

She recalls the trip over rough sea. "One night the engines stopped, so there must have been submarines in the area. We were in a big convoy of boats, and I couldn't see outside as I was seasick, lying flat on my bunk. The food was terrible. We eventually arrived at the port in Liverpool, and took the train down to London."

It was November 1944. Lynn and the four other Canadian Wrens were billeted in London along with 40 British Wrens before being taken by bus to Bletchley Park. Lynn remained at Bletchley Park until the war ended, despite a rocky beginning when there was some confusion about what to do with people working on the Japanese project. According to Lynn, "They were not sure where to put us as the Japanese campaign we had been working on was fairly new. We had to explain what we did in Ottawa before they had any idea where we should go."

Bletchley Park in Buckinghamshire, England, is now famous as the Victorian mansion used by Alan Turing and his team of mathematicians. It became a national museum after the British government disclosed confidential details of Bletchley Park in 1974. But during the war, its purpose was, for obvious reasons, kept top secret. As Lynn recalls, "[w]e went with the officers to what looked like a country club on the property, and had to sign a pink slip of paper to declare that we would not breathe a word of what we did there. I was scared to death."

Lynn and the other Wrens worked shifts with the British and American military, as well as British civilians. The place was "big and broken up, with blocks of buildings and huts so nobody would be able to find out what we were doing. There was a room with a big table. I was given strips of paper with maps of Japanese ships, and part of my job was to put them together and compare them. I can remember this big map at the far end of that room where they plotted submarines."

She recently saw the film *The Imitation Game*. "The people doing that work were in the park too, but I never met them. All five of us Canadian Wrens were split up and sent to different places to work on different things. There was a man we worked for, a nice man. He was like Alan Turing but for the Japanese side of it."

Lynn now lives in Keswick, Ontario. She proudly wears a Canadian Bletchley Park medal that her son obtained for her by submitting paperwork about his mother's war service. She has never taken it off since he pinned it on four years ago, and also proudly displays a boxed medal that came directly from Queen Elizabeth.

"I always liked jigsaw puzzles, and that's what Bletchley Park was – an enormous jigsaw puzzle. I was really nothing but a speck in the system. But every speck was important because even the smallest piece of a puzzle brings the whole thing together."