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A concept design of the Canadian Surface Combatant.

Off-the-Shelf or New Design? Considerations for the Canadian Surface Combatant Program[1]

by David Rudd

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Introduction

The costs associated with building a new generation of naval vessels is a matter of deep concern for the Government of Canada (GoC) and the Royal Canadian Navy (RCN). While the 2008 Canadian First Defence Strategy (CFDS) calls for the renewal of the RCN's surface fleet, concerns have been recently raised about the feasibility of these plans given expected resources.[2] In the case of the $26.2-billion Canadian Surface Combatant (CSC) – a program intended to replace the current fleet of destroyers and frigates – a once-in-a-generation procurement will put tremendous pressure on stakeholders to agree on an achievable list of operational requirements and deliver them on time and within strict budgetary parameters. The process is further complicated by the particular competitive environment created by the National Shipbuilding Procurement Strategy (NSPS), the need for re-industrialization of Canada's shipbuilding sector, and by the desire of the GoC to avoid the negative publicity of another defence mega-project that fails to deliver.

This CSC program demands a rigorous analysis of procurement options to determine how the RCN can best fulfil its requirements. Although this is not the decisive factor in how a ship should be procured (electoral politics and industrial policy are other drivers) it raises the question of whether an optimum balance between cost, capability, and risk is best achieved by purchasing existing ship designs – perhaps with some modifications – or pursuing a new design customized to the RCN's particular requirements. Although the new Liberal government has not pronounced on the CSC program, there are indications that the momentum is moving toward the adoption of an extant design – perhaps of European origin.

This article will contribute to a broader understanding of naval procurement by defining and discussing military-off-the-shelf (MOTS) as a procurement option for a major naval platform. A non-exhaustive list of advantages and disadvantages will be examined, along with a brief exploration of allied experiences, all with a view to enhancing the ability of decision-makers to assess the suitability of this option for the CSC program. It will be shown that despite the many attractions of extant designs for budget-minded navies, understanding MOTS is not a straightforward matter, and pursuing it is far from risk-free.

MOTS: Definition and Discussion

An 'off-the-shelf' solution refers to the implementation of readily available and mature technologies/systems for applications which have traditionally been handled by customer-unique or customized systems. A concise definition of the military variant of off-the-shelf – or MOTS – is somewhat elusive, although general characteristics of MOTS equipment include that which:

- is already established in-service with the armed forces of another country or [the buyer's]; it is not a new design;[3]
- is sourced from an established production facility;
- has minor modifications to deliver interoperability with existing [buyer's] and/or allied assets[4]

And yet, this definition may be too restrictive. In the world of naval platforms, MOTS can arguably encompass 'modular' designs whereby the on-board systems vary according to customer requirements, but the ship's size, shape and displacement are broadly similar to the vessel of origin. The German '*Merhzweck-Kombination*' (MEKO) 200 series of general-purpose frigates were originally built for Turkey as the *Yavuz* class, but were subsequently ordered by other allied navies with slightly different weapons/sensor packages. At the time of writing 25 of these units were in service. This attests to the soundness and longevity of the design, and speaks well to its affordability over the 15-year span of the build programs.

An even more expansive understanding of the MOTS approach can be found in the practice of acquiring vessels second-hand, rather than through new-build programs. Royal Navy Type 22/23 frigates, as well as ex-Royal Netherlands Navy M-class frigates have found second homes in the navies of Chile, Romania, and Belgium, to name but a few. These ships are delivered largely 'as-is,' and are ideal for countries looking for proven capability without the need for extensive modifications, albeit at the possible cost of long-term supportability and earlier capability obsolescence.

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MOTS does not encompass projects where a number of off-the-shelf components are integrated together for the first time. Thus, the Canadian Patrol Frigate program of the 1980s/1990s, employing an otherwise-proven suite of sensors and effectors, would not have qualified as MOTS, under even this expansive definition.

The Complexity of Ships

As noted by a RAND Corporation study, the acquisition of naval vessels is fundamentally different from land or air systems – particularly if the former are constructed for/by the buyer, rather than acquired second-hand.[5] Systems such as armoured vehicles or fighter aircraft may be built in their hundreds. By contrast, naval vessels are typically built at low production rates, ranging from a handful to a few dozen. Land and air systems are developed differently; both go through prototype phases. For navies, there are no pre-production or prototype ships; each hull is expected to enter service, and so, pressure to ensure that the lead vessel is perfect (or near-perfect) is particularly intense.

Military aircraft tend not to be offered *à la carte*, or in the modular format of some naval vessels such as the MEKO frigate design; they come with a more fixed architecture – a given size, a given powerplant, and a given sensor suite (if applicable). Beyond communications gear and minor alterations to satisfy national air worthiness requirements (known as 'non-discretionary modifications'), there may be rather little for a buyer to customize. Thus there is less chance of a buyer attempting to take the design in directions that may result in technical failure. (The speed and success of the air force's C-17 and C-130J acquisition programs attest to this.) Similarly, most land systems are also purchased largely 'as-is.' Even the most complex systems such as armoured vehicles may offer choice of armament or defensive aids, but little else. Ships, on the other hand, are more complex. With a much greater number of systems (and therefore system inter-dependency), they will typically take longer to design and to build.

This latter point – the degree of design complexity – is relevant in that a combatant ship is a true 'system of systems.' It boasts the widest variety of sensors, effectors, and command/platform management systems of any single military platform, sourced from a potentially wide variety of manufacturers.[6] Moreover, the complexity of any given design is not necessarily fixed. While a buyer may settle on a foreign design, he may also want certain modifications or system substitutions to satisfy his particular operational, regulatory, and industrial requirements.[7] The MOTS approach to naval construction thus represents an approximate, or 'best fit' solution to a naval capability deficiency. The approach yields, according to one study, "capabilities that are close to what is desired…they inevitably leave some desired requirements unfulfilled. To close this gap there is a need to modify the technology."[8]

In view of this, it is clear that the acquisition of a combatant vessel presents unique challenges. It is not a question of choosing either an off-the-shelf solution or an original design. Indeed, MOTS may be a matter of degree; a design may fall along a continuum in which it is tailored to customer needs, with the buyer requiring (due to operational, industrial, or environmental directives) certain systems in lieu of those on the original design. Depending on the degree of customization, the result may be a 'MOTS+' or 'MOTS++' design that is easily identified as a cousin of the original but may in fact incorporate significant internal or external design changes (the '+' or '++' referring to the degree of deviation from the parent design.) To illustrate this, a conceptual design continuum is found in Table 1.

'Basic' MOTS	MOTS+	MOTS++	'Clean Sheet'
Interior/exterior design identical to lead ship	Near-identical design/minor mods to external structure, internal systems, sensors and effectors	Similarity in design but with significant structural and/or systems changes for enhanced capability	Unique design and systems lay-out; next-generation technologies incorporated
High fidelity to parent navy's SOR	Overlap with parent navy's SOR	Minor fidelity to parent navy's SOR; different/expanded roles envisioned	Uniquely tailored to buyer's SOR
Likely built by OEM	Built by OEM or buyer, or co-operative build with some local content	Built by buyer, or co-operative build with significant local content	Built by OEM
Low program risk	Low/Medium program risk	Higher program risk	Higher program risk
Examples: Moroccan *Mohammed VI* (copy of French *Aquitaine* class); Portuguese *Bartolomeu Dias* class (acquired 2nd-hand from Netherlands)	Examples: RAN Adelaide class (derivative of US *Perry* class); Saudi *Al Riyadh* class (derivative of French *La Fayette* class); MEKO 200 series	Examples: Singapore *Formidable* class (derivative of French *La Fayette* class); Danish *Iver Huitfeldt* class (derivative of *Absalon* class)	Examples: *Halifax* class; UK *Daring* class

Table 1: General categories of surface combatant designs.

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The main challenge posed by customization is to *program risk* – defined as the likelihood of failing to achieve design functionality and manufacturability within given budgetary and time limits. Theoretically, adherence to an original design will minimize program risk, while introducing modifications will, again theoretically, heighten the chances that delays and/or cost overruns will occur. Having said this, Table 1 may not accurately illustrate the progression of risk in all cases. While the 'clean sheet' option is situated to the right of the continuum, seemingly to present the highest degree of risk by virtue of the originality of the design and the desire to push the technological threshold, it is possible that the MOTS++ option may in fact pose greater risk to budgets and schedule because an otherwise functional design is being significantly altered and the additional requirements may not be served by the original design.[9] If a cost/capability trade-off is improperly performed, if a buyer fixates on an established design but calculates that it can (and must) be changed to suit his particular requirements, the result may be a hybrid design that is more costly and/or complex than one that is developed from scratch.[10] Thus, potential buyers should not automatically conclude that an original design is the least palatable route to naval re-capitalization. It may depend upon the project at hand.

How far can a design be modified to accommodate buyer's capability requirements without exceeding cost/risk limits? To be sure, 'discretionary modifications' will increase tension between the need to deliver on time and the desire to squeeze the last drop of performance out of an existing solution. Altering a design creates numerous technical and operational challenges such as manufacturability, system performance, testing, operator workload, and mission accomplishment. These issues are almost certain to crop up in a ship-design/build program where a financially-constrained buyer concludes, perhaps too hastily, that an otherwise attractive extant design can be easily (and significantly) adapted for his own use. The implications of even a 'slightly' modified design are illustrated by a conceptual diagram developed by the Australian Defence Management Organization. Figure 1 shows how even a small amount of customization ('Australianisation') can push the cost and schedule of an acquisition to unexpected levels.

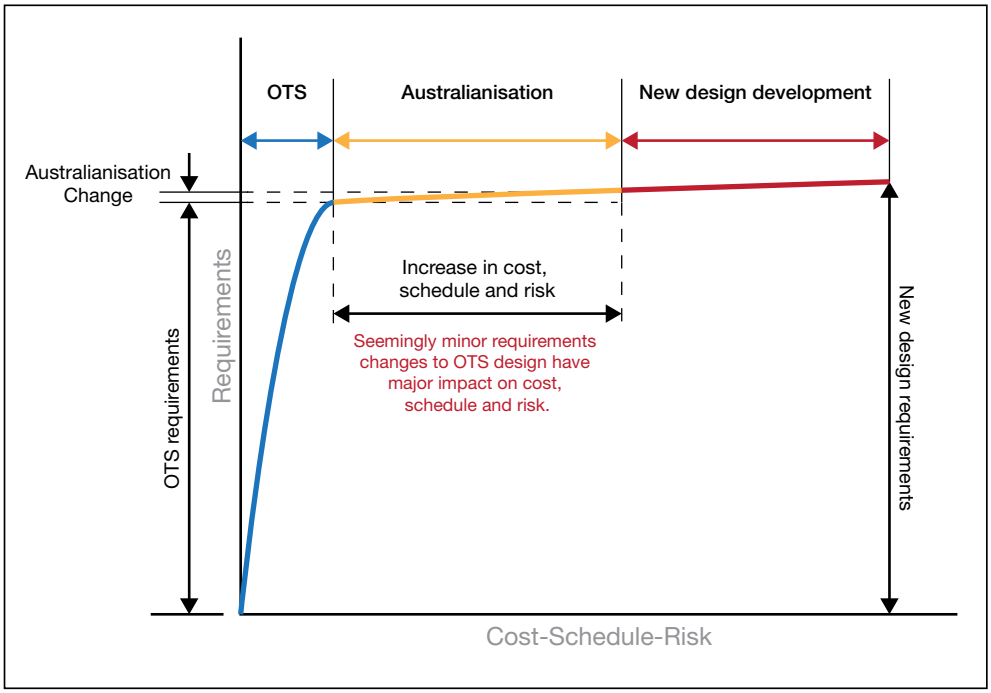

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Figure 1: Impact on cost, schedule, and risk of volume requirements.[11]

H. Franssen © THALES

HMDS *Absalon*, the first of the Flexible Support Ships of the Royal Danish Navy.

Thus, notwithstanding the point made earlier that *heavily* modified designs may exceed the complexity of 'clean sheet' designs, it is evident that modifications of whatever degree have the capacity to increase program risk.

To illustrate the point further, an analysis of the Royal Australian Navy's (RAN) future surface combatant requirements postulated that the *Hobart*-class air warfare destroyer (AWD) could act as the basis for an anti-submarine warfare (ASW) frigate. But according to Andrew Davies of the Australian Strategic Policy Institute, such a MOTS-based plan, while feasible, is fraught with difficulties:

> At the very least, the [*Hobart*'s] *Aegis* air defence system will be replaced, meaning that the ships will need a new radar and combat system. As well, they would greatly benefit from a second helicopter, requiring some redesign in their superstructure. The sonar systems fitted to the AWDs should be quite capable, but mightn't be the best solution for a dedicated ASW ship. All these changes are doable, but experience should teach us not to take any redesign and integration work for granted. There are also some engineering questions to be asked about the suitability of the AWD hull and propulsion systems for the ASW task, for which reduced radiated noise from heavy machinery and flow around the hull is required to reduce the detection range of the vessel by a hostile submarine. It might be the case that a modified AWD isn't as effective in the role as a different design and the level of compromise would have to be looked at carefully.[12]

Davies goes on to point out that Britain's Royal Navy (RN) also considered a MOTS-based solution for a successor to the Type 23 general-purpose frigate. Looking to adapt Type 45 *Daring*-class AWD to achieve economies of scale and reduced fleet running costs, the concept of an ASW variant of the *Daring* class was subsequently shelved as the costs and risks of the modifications required were found to outweigh the benefits.[13] The RN has now opted for a new general-purpose design – the Type 26 Global Combat Ship.

Both the Australian and British experiences may inform RCN attempts to reconcile AAW with ASW into an identical (or near-identical) class of surface combatant. This is not to say that the task is impossible. The Royal Danish Navy's *Iver Huitfeldt*-class air-defence frigates may be viewed as a MOTS+/++ derivative of the less costly *Absalon*-class patrol/command frigate (although the latter does not have a particularly strong ASW capability). The main differences include a more powerful radar suite, propulsion system, main gun and missile armament, and the deletion of the flexible deck in the air defence variant. However, the rarity of this approach to naval re-capitalization suggests that allied navies are wary of attempts to derive a 'family' of ships from a parent design. Were Canada to select an existing design as the basis for CSC, it would do so knowing that the design was meant for only either AAW or ASW – not both. It is noteworthy that the Danish program achieved the success that it did by opting for an original design solution!

MOTS Advantages and Disadvantages

A number of considerations need to be weighed before choosing whether to build to a new or established design, or a variation of the latter. These include initial development costs, the satisfaction of operational requirements, the ease of manufacture,[14] in-service date, and long-term sustainment/capability enhancement. Seen through this lens, buying a naval vessel off-the-shelf holds a number of potential benefits, including:

- more timely delivery resulting from a generally shorter acquisition schedule;[15]
- reduced development risk – all MOTS ships were once clean-sheet designs for the parent navy, so a high degree of (technical) risk mitigation has already taken place and the complex 'system of systems' has reached a level of maturity/functionality that should leave few surprises to potential buyers;
- if built concurrently or in tandem with parent navy, larger production quantity may result in savings;
- large user base may uncover design defects early and more readily identify upgrade opportunities;
- existing design may help the buyer gain a better understanding of initial project costs.[16]

On the surface, and excluding considerations relating to industrial development, MOTS potentially represents the most attractive procurement option for budget-conscious navies. The issue of timely delivery is perennial concern and has caused many in Canada's naval community to argue for selecting an extant design and building it before the current fleet obsolesces.[17]

MOTS may also be attractive for political decision-makers eager to avoid procurement 'debacles' characterized by slow delivery and/or cost overruns. Indeed, where there is low risk-tolerance, where the political ground is infertile for even the perception of mismanagement, choosing an extant design may provide a degree of psychological reassurance to stakeholders that an unproven design cannot. As MOTS does not exclude the possibility of domestic production, the government of the day may see it as the best of both worlds – a way to manage complexity, schedule and cost while generating significant employment.

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These considerations must be balanced by the many short- and long-term drawbacks of buying a mature design. The following represents non-exhaustive list of concerns:

- overall project cost may be difficult to discern due to differences in labour rates/efficiency between the OEM and domestic builder;
- if a build program is not large enough, the buyer may not have sufficient market power to negotiate the most favourable terms with the original equipment manufacturer (OEM) – more so if the design is idiosyncratically tailored to local needs (i.e., buyer's maritime geography, habitability/environmental/safety standards, or crewing concepts);[18]
- the buyer might have to pay a significant premium to secure the intellectual property required for in-service support and mid-life upgrades;
- even with an existing or modified design, the manufacturing process may need to be altered to suit local industrial capability, thereby adding time and cost;[19]
- possible incompatibility with other MOTS systems that are acquired concurrently;
- the MOTS design may not be backward-compatible with in-service equipment or supporting infrastructure, necessitating (costly) changes to the latter to ensure compatibility;
- the OEM might insist on retaining sole right to export to other nations, even if modifications resulted in a new sub-class of ship;
- (premature) retirement of MOTS ship by the parent navy may result in loss of economies of scale stemming from a narrower supply chain;
- if the buyer's defence industrial policy seeks technology or skills transfer, older MOTS solutions may have less to contribute than a new design;
- mature designs may bring forward the date of class obsolescence unless a clear margin for technological growth is evident.

Taken separately, none of these potential disadvantages are significant enough to exclude MOTS as an acquisition option. Since the majority of a ship's cost is not in its design and construction but in the following decades of operations and maintenance, initial industrial/manufacturing challenges may be of less importance to the buyer.[20] Indeed, they may be viewed as acceptable costs of moving the project along. And neither established nor custom designs are decisively advantageous in preventing change or disruption to a purchaser's training syllabus – particularly when the program seeks new-generation technologies. Whether a buyer chooses MOTS or an original design, he will need to adopt new tactics that will allow him to exploit more capable onboard systems. (Indeed, the new systems *must* be substantially more advanced else they will not provide the customer with a generation's worth of capability.) In some cases these changes may happen for reasons that have little to do with the ship itself. For example, the advent of ship-based unmanned air systems for intelligence, surveillance, and reconnaissance has opened up opportunities for virtually all fleets, regardless of the provenance of their designs.

The point here is that whichever route Canada takes to the re-capitalization of the RCN surface combatant fleet, it will have to confront a host of potential pitfalls – some technical, some operational, some industrial, others political. Many of these will befall DND/RCN, even if allegedly 'safer' existing designs are considered. But the challenges may deepen depending on the degree to which the RCN insists on altering a MOTS design to suit its particular operational, regulatory and industrial requirements (see Figure 1). Thus the choice of which procurement route to take is not as clear as some might suspect.

DND, CFJIC IHS89-4-3

HMCS *Halifax* under construction in St. John, New Brunswick.

MOTS for Canada: Non-operational considerations

Aside from cost, design longevity, marketability, etc., other high-level considerations stem from Canada's particular defence-industrial landscape and are summarized in Table 2. The GoC's National Shipbuilding Procurement Strategy has designated a builder for the CSC program. If a foreign design is chosen, who will be the all-important single point of accountability answerable to the Crown? Irving Shipbuilding has now been designated the prime contractor, but the ship design and combat systems integrator are still unknown. If a completely new design is chosen (presumably from an experienced design house), one may assume that the client-server arrangement that characterized the *Halifax*-class build will prevail – i.e., the builder will also be the prime contractor. This may be a more attractive model than one involving a foreign OEM offering a MOTS or MOTS+/++ design through its Canadian build partner and then having to deal with a local combat systems integrator who is unfamiliar the original design and may not offer systems to fit that particular ship configuration.

As the GoC's nascent Defence Procurement Strategy seeks to maximize the industrial and technological benefits of large procurements for the Canadian economy, is there any advantage to choosing one procurement option over another? Assuming that the RCN is not contemplating recycling existing all sensors and effectors from existing and retired vessels, these will be sourced externally, regardless of which path is chosen. The combat management and certain platform management systems may likewise be sourced from a foreign manufacturer, although the integration may be entrusted to a domestic firm. These transactions would likewise take place if either a MOTS(+/++) or designed-in-Canada solution was chosen. Steel and most fittings would be sourced locally to the greatest degree possible. Again, this would be the case irrespective of the final choice. If MOTS(+/++) is the preferred route, but policy demands that certain systems on the parent design may be replaced by Canadian-made products wherever possible, planners will have to determine what premium (if any) will be paid for import substitution.

If Canada's defence-industrial policy ever envisions the export of complete systems, it will likely have to negotiate terms with those who retain intellectual property rights over the original design (in the case of MOTS variations) or the various individual systems that go into a ship's hull (in the case of an indigenous design). There is no clear advantage here; either procurement option could result in a marketable product. However, if a MOTS-based approach is taken, the export laws in the country of origin could be a significant factor in whether the complete ship could be sold to third parties.

GoC Consideration	'Basic' MOTS	MOTS+/++	'Clean Sheet'
Defence-Industrial			
• Single point of accountability	less desirable	less desirable	optimal
• Benefits to Canadian designers	less desirable	desirable	optimal
• Benefits to Canadian suppliers	neutral	neutral	neutral
• Export Potential	less desirable	desirable[21]	optimal
Schedule			
• Design completion	optimal	less desirable	less desirable
• Workforce familiarity	neutral	neutral	neutral

Author

Table 2: Summary of Non-operational Considerations.

Note: The summary is for illustrative purposes only. Degrees of desirability should be treated with caution in that a finding of 'less desirable' does not necessarily denote an unacceptable degree of risk to defence-industrial priorities and schedule, while 'optimal' does not equate to nil risk.

If, on the other hand, a unique design is pursued, there will need to be at least one experienced private-sector design house in Canada or abroad. It would require time and money to come up with a new design, since a large engineering team would need to be assembled. But with a custom design, Canada might have more latitude over the choice of on-board systems and the method of their integration. Critically, the customer would own the intellectual property so critical to in-service support, mid-life upgrades, and possible foreign sales.

The other key part of the industrial base – the shipyard workforce – will have to ascend a steep learning curve regardless of which acquisition route is taken. Whether the ship design is indigenous or contracted from a foreign party, the challenge facing the yard will be to overcome initial unfamiliarity with the design and gradually increase the efficiency with which it assembles the new class. As there is no clear advantage, it might be premature to conclude that MOTS provides the path of least resistance.

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Operational Considerations

Without the benefit of a final statement of operational requirement (SOR), it is difficult to speculate what extant MOTS designs the RCN might choose for the CSC program. What is known is the CSC program must adhere to two broad parameters. First, the CSC will replace, not one vessel, but two within a single program – an anti-air warfare/task group command-and-control (AAW/TG C2) variant, and a general-purpose (GP)[22] variant. Second, the RCN will attempt to maximize commonality between the variants to achieve economies of scale during the build phase as well as operations/maintenance savings over the longer term.[23] If consistent with the SOR, similar hulls and hull systems (i.e., propulsion, shipboard management) will be acquired while procuring somewhat different combat systems, sensors, and effectors.[24] Are there extant designs which can possibly fulfil these requirements?

With the exception of the US Navy's formidable *Arleigh Burke*-class destroyer, most of Canada's allies separate AAW/TG C2 and GP functions into different ship classes. If Canada forges ahead with a MOTS(+/++)

PixelSquid, by ES3DStudios at https://www.pixelsquid.com/stock-images/arleigh-burke-destroyer

Artist rendering of a US *Arleigh Burke* Class destroyer.

Grégoire Chaumeil © Marine Nationale

FREMM *Aquitaine* during its first put out to sea off Lorient, 2011.

approach to the hull/system commonality challenge it will have a narrow field from which to choose. The only allied build program which has taken a 'family' approach in recent years is the aforementioned *Absalon-/Iver Huitfeldt*-class from Denmark. Taken together, the original design (*Absalon*) and the AAW/TG C2 sub-class may possess much of the capability sought by the CSC program – when deployed in a notional task group, they can prosecute targets in the air/surface/sub-surface domains and provide limited support to forces ashore. French shipbuilder DCNS has promised to roll out an air-defence variant of its FREMM/ *Aquitaine*-class frigate, but this remains only a concept. BAE Systems would undoubtedly welcome Canadian participation its Type 26 program. But since there is no dedicated air defence version being planned for the RN, a re-design to suit the RCN's AAW needs could throw up some of the same problems that caused the British to opt not to develop a general-purpose variant of the *Daring* class.

It is unclear whether the lack of extant candidates is a statement against a MOTS 'family' as a solution for the CSC program. On the one hand, it may reflect the engineering challenges associated with adapting a parent design for other roles – a challenge which Canada nevertheless took up in the 1990s when it married ASW with AAW/TG C2 in the heavily modified *Iroquois*-class destroyer.[25] On the other, the dearth of candidates may be a simple matter of timing in that many allies have not yet come around to the Canadian (or Danish) way of thinking (re: commonality). But for most navies, the replacement of ship classes is an incremental process in which different classes are retired at different times; countries with several classes of surface combatant do not typically replace their *entire* fleets in one large program. Those that have done so recently tend to have only one type of major combatant to begin with, and invariably choose a similar type of ship[26] to replace it rather than expand their capabilities by acquiring a 'family' of vessels. Thus the decision to combine the replacement of the RCN's two classes of surface combatant into a single program, while not unique, is certainly unusual and could present many challenges.

If two types of vessels are to be replaced within a single program that emphasizes commonality, adopting a MOTS design is arguably more problematic. In order to achieve commonality, a family approach is theoretically desirable. But since the only MOTS example currently in allied service has been built to satisfy The Royal Danish Navy's requirements, adopting both designs (AAW/TG C2 *and* GP) means the CSC program would be twice disadvantaged from a requirements standpoint. The RCN would either have to adapt its requirements to suit the vessels on offer, or would have to pursue two sets of design changes to bring the parent designs in line with its requirements. While the latter option may be technically possible, it raises serious questions as to whether the resulting MOTS+/++ solution is more operationally suitable than one designed from scratch. Indeed, if an original design can take advantage of the latest advances in scalable, flexible, and space/weight-saving technologies available mid-decade, this may confer a degree of commonality and 'future-proofing' on the CSC that may not be available from designs conceived ten or more years ago.

Conclusion

There is a theoretical and practical argument to be made for adopting off-the-shelf solutions to defence procurement in general and to naval re-capitalization in particular. Defence planners may favour MOTS to meet immediate needs in a timely fashion. They may also favour MOTS on the assumption that it provides greater cost predictability in fiscally-challenging times.

But while MOTS might seem to be the wave of the future, it is not necessarily the best solution. Over the course of a ship's lifespan, the user will demand an expanded capability range – something that the MOTS design may or may not be able to deliver. Those expecting an established design to address the full range of specific user requirements will likely be disappointed. If the prospective buyer feels tempted to seek more customized (MOTS+/MOTS++) designs he may inadvertently create engineering and construction challenges that are difficult to surmount. Such is the high level of system inter-dependency in modern warships that even a small change to a design built to another navy's specifications can have a ripple effect throughout that design, causing a degree of program risk out of all proportion to the change being sought. Australian and UK experience suggests that a rigorous cost-capability trade-off should be performed before a decision is made on whether to adapt an existing design or not.

It should be remembered that the construction of the next-generation fleet is not solely a matter of defence policy. Governments are expected to take a wider view – one encompassing industrial, technological, and skills development. Big projects seen through the lens of the broader national interest will often demand that decision-makers be willing to pay some sort of premium to meet these objectives. For a government intent on maximizing Canadian content in its broadest sense, there may be virtue in allowing for more time to contract for an original design and taking it through the build stage. For a navy aware that it has but one chance in a generation to more fully meet all its requirements, the in-house route may offer certain advantages over MOTS.

Suffice to say that despite the many arguments in favour of MOTS there may be fewer clear advantages to it than one might suspect. Accordingly, stakeholders in the GoC and the RCN will have to carefully weigh the pros and cons of sourcing the Canadian Surface Combatant off-the-shelf, knowing that the choice will have consequences far beyond the performance of the finished product.

NOTES

1. This is a condensed, updated version of an internal DRDC report published in July 2014.
2. Office of the Auditor-General of Canada, *Report of the Auditor General of Canada*, Chapter 3 – National Shipbuilding Procurement Strategy, Ottawa: Public Works and Government Services, Fall 2013, pp. 19-21.
3. For the purposes of this study, 'design' will refer to the complete ship encompassing the platform (hull and machinery), as well as the combat system.
4. David Mortimer, *Going to the Next Level: The report of the Defence Procurement and Sustainment Review*, Commonwealth of Australia (Defence Materiel Organization), 2008, p. 17.
5. Jeffrey Drezner, *et al*., *Are Ships Different? Policies and Procedures for the Acquisition of Ship Programs*, RAND National Defense Research Institute, 2011, pp. xi, xiii.
6. Commander David Peer, "Estimating the Cost of Naval Ships," in *Canadian Naval Review*, Vol. 8, No. 2 (Summer 2012), pp. 4-5.
7. Regulatory requirements may not enhance combat capability, but, in keeping with national or international laws, must be adhered to nevertheless. They might include improvements to environmental standards (i.e., on-board waste management), safety standards (i.e., reinforced fuel tanks) and habitability standards (i.e., crew accommodations).
8. Leo Hogan, "Good Enough? Off the Shelf Procurement in Defence," Raytheon Australia Occasional Paper, Undated, p. 5. Accessed 15 November 2013 at: http://www.raytheon.com.au/rtnwcm/groups/rau/documents/content/rau_ots_procurement_occ_paper.pdf.
9. For example, a study by the US Government Accountability Office concluded that the addition of a remote mine-hunting system to the 40th *Arleigh Burke*-class destroyer (DDG-91) would necessitate alteration of nearly 30 percent of the ship's design zones. See Government Accountability Office, *Defense Acquisitions – Improved Management Practices Could Help Minimize Cost Growth and Navy Shipbuilding Programs*, February 2005, 40. Accessed 28 November 2013 at: http://www.gao.gov/new.items/d05183.pdf.
10. Of the three options to satisfy the RCN's Joint Support Ship (Version 2) requirement – MOTS, MOTS+ and a new design – MOTS+ was considered to be the most risky. Interview with Directorate of Naval Program Support, Gatineau, 3 December 2013.
11. Warren King, General Manager Programs, Defence Management Organization. See Mortimer, p. 18.
12. Andrew Davies, "Trouble at the docks? Part II." Accessed 31 October 2013 at: http://www.aspistrategist.org.au/trouble-at-the-docks-part-ii/.
13. Navy Matters, "Medium sized Vessel Derivate (MVD)". Accessed 31 October 2013 at: http://navy-matters.beedall.com/mvd.htm.
14. This refers to the ability of the shipyard and combat systems integrator to perform their respective duties, but also to link their processes at the point where the combat systems are mated to the hull.
15. Andrew Davies and Peter Layton, "We'll have six of them and four of those – Off-the-shelf procurement and its strategic implications," ASPI Special Report, November 2009 (Issue 25), p. 4. The authors refer to a 2008 report by the Australian National Audit Office which found that the acquisition cycle could be considerably accelerated when the major defence articles are procured off the shelf. This 'general rule' may need to be re-considered if a shipyard builds an existing design with which it is unfamiliar.
16. Peer, 5. By contrast, initial cost estimates for purpose-design are harder to determine, varying at least 40 percent either way.
17. Peter Haydon, "Choosing the Right Fleet Mix: Lessons From the Canadian Patrol Frigate Selection Process," in *Canadian Naval Review*, Vol. 9, No. 1, p. 68.
18. Stefan Markowski *et al*, "Australian Naval Procurement Cycles: Lessons for Other Small Navies," Proceedings of the Fifth Annual Acquisition Research Symposium, Naval Postgraduate School, Monterey, CA, 14-15 May 2008, p. 359.
19. Interview with Directorate of Naval Program Support, Gatineau, QC, 3 December 2013. The choice of the *Berlin*-class support ship for the JSS requirement will require a revised set of blueprints and a different build schedule because the designated builder, Vancouver Shipyards, does not have the same construction capability as the OEM, Thyssen-Krupp Marine Systems.
20. Markowski *et al*, p. 382.
21. Theoretically, if Canada were to request (and pay for) more design changes, the intellectual property for the final design is more likely to accrue to Canada. Nevertheless, many on-board systems may still require re-export permission from the foreign supplier if the design is to be sold to third parties.
22. For the purposes of this study, 'general-purpose frigate' refers to a combatant ship with the ability to, at minimum, self-defend against surface, sub-surface, and short-range air threats and to prosecute targets in all three domains within short to medium distances from the ship. It does not have the ability to act as task group command ship or to assume responsibility for the air defence of such a group.
23. Government of Canada, *Defence Acquisition Guide 2014* – Naval Systems, Canadian Surface Combatant. Accessed 17 June 2014 at:http://www.forces.gc.ca/en/business-defence-acquisition-guide/naval-systems.page?
24. Discussions with senior RCN officers, 16 January 2014.
25. Admittedly, the modified *Iroquois*-class did not mount a dedicated anti-ship weapon, although the Standard surface-to-air missile could have been used, if necessary.
26. In Norway's case, the five ageing *Olso*-class frigates were replaced with an equal number of *Fridtjof Nansen*-class general-purpose frigates, beginning in 2006.