The Future Submarine Project

Andrew Davies

This year's Defence White Paper reaffirmed most of the aspirations outlined for Australia's future submarine in the 2009 White Paper, with the notable exception of land attack cruise missiles. In doing so, it focussed on the two most capable options of the four that were hitherto under consideration—an evolved Collins class boat, or a new bespoke design. While media reporting said the government had ruled out the off-the shelf and modified off-the-shelf options, it has actually suspended work on those, thus allowing the possibility that they could be revived at some future time. Regardless of which of the two remaining options is chosen, maintaining continuity of submarine availability until the first of class is ready for service will require an extension of the planned life of the Collins fleet. The net result is that the evolved Collins is the option most likely to be pursued.

It's now almost *de rigueur* to refer to Australia's future submarine project as Australia's most expensive defence project ever. There's no reason to doubt that. While the lowest estimates are under A$10 billion[1] for the least expensive option of buying off-the-shelf submarines from an established production line, there's no real prospect of that happening, with both sides of politics vowing to have the boats built in Adelaide. Options that involve the design and build of a new class of submarine have been estimated to cost anywhere between A$20 billion[2] and $40 billion[3], with the upper figure more likely to accurately represent the total program cost with project overheads.

Less widely reported is that, barring a significant re-scoping at some point, the project is also likely to take the longest time in Australian defence project history. Even if we take 2012 as the starting point on the grounds that it's the first year in which a budget allowance for the project was made[4], the twelfth submarine isn't likely to move down the slipway before 2035—over two full decades from now. That's a very important observation, and is the key to understanding what's likely to happen next.

Background: From Oberon to Collins

Australia has operated a fleet of six submarines for much of the past 35 years, with six British-designed and built Oberon class boats being replaced over the period 1996–2003 by six Collins class. The Oberons proved their

[1] Sean Costello and Andrew Davies, *How to buy a submarine*, ASPI Strategic Insight, no. 48 (Canberra: Australian Strategic Policy Institute, 2009).
[2] Brice Pacey, *Sub judice: Australia's Future Submarine,* Kokoda Paper, no. 17 (Canberra: Kokoda Foundation, 2011). The figure quoted is a 'sail away' cost.
[3] Costello and Davies, *How to buy a submarine.*
[4] Prime Minister, Minister for Defence, Minister for Defence Materiel, *Next stage of future submarine project announced*, Joint Media Release, Canberra, 3 May 2012.

value as warfighting and intelligence gathering platforms. They are now known to have operated at great distances from Australia, including intelligence collection tasks in Soviet waters. And they produced some very good results in exercises, including against American carrier battle groups.

The Oberon was a large conventional boat, with a crew of almost 70. That's an important point for what follows—a large crew means that adequate rest periods can be accommodated even during operations. Their range, endurance and habitability meant that they were able to provide an independent Australian capability at a distance, as well as a useful complement to the US Navy's larger and all-nuclear fleet. These characteristics continue to form the basis for the requirements articulated in successive defence white papers.

When the Oberons reached life of type, it was therefore natural for Australia to retain a submarine capability. In the absence of a suitable Oberon-like replacement on the world market, the Collins was conceived as a boat that would build on the strengths of the class it would replace, being designed from the outset for long-range, high-endurance missions far from Australia. While reducing the complement to 42, the Collins still had a significantly larger crew than the smaller European boats that were the most likely alternative. (Of course, that was something of a mixed blessing, as the Navy found out when crew availability became a limiting factor for Collins availability in the 2000s.)

The transition from the Oberon to the Collins was poorly managed. Overly-optimistic delivery timeframes for the Collins meant that the Oberon life-of-type was reached before the replacement was ready for service. A crash program of extending the life of two of the Oberons meant that a continuous submarine capability was retained—at a lower rate of rate of effort than was desirable—but the resultant decline in submarine availability was a full twenty submarine years.[5] That shortfall had implications for not only for the management of submarine expertise, but also for the anti submarine warfare capability of the Australian Defence Force (ADF).

Even after the last of the Collins boats was accepted into service, the nation's submarine capability continued to fall well short. With a fleet of six, the Navy should be able to have two at sea, two at notice to move at periods of weeks to months and two in maintenance at any given time. The original aim was to have over submarine 1,500 days of availability annually from the fleet. That level has never been achieved, with a little over 1,000 days achieved in 2005–06 being the high point, followed by a steep decline to

[5] Andrew Davies and Mark Thomson, *The once and future submarine—raising and sustaining Australia's underwater capability*, ASPI Policy Analysis, no. 78 (Canberra: Australian Strategic Policy Institute, 2011).

under 400 days in 2009–10, before recovering slightly to 600 in the following two years.[6]

The future submarine project will face many of the same issues. Achieving a smooth transition between classes will be a significant challenge. Each Collins submarine has a nominal lifetime of three eight-year duty cycles, with a full cycle docking between each. On that basis, the first Collins will reach life of type in 2022 and the last in 2031.[7] That is an impossibly short timeframe in which to design and build a replacement. The Collins project was given the go-ahead in 1983; the first boat was commissioned in 1996 and the last in 2003.

If the future submarine project could deliver on the same timescale, the first of the new class would enter the water a full four years after the first of the Collins was retired. And it is likely worse than that—Defence Materiel Organisation (DMO) estimate for the in-service date of a new submarine is 17–22 years from commencing serious definition and design work.[8] Even an off-the-shelf purchase would be tight timing wise; Pakistan and Brazil have had to wait almost a decade for deliveries after signing contracts for French submarines. Insisting on licence building in Australia—seemingly a political inevitability—would be likely to extend the delivery period.

The net result of the time required to acquire a replacement for the Collins is a likely repeat of the capability gap at least as bad as that between the Oberon and Collins. If the DMO's upper estimate is accurate, it could result in no submarines being available at all in the late part of next decade.[9] As a result of this time pressure, the possibility of extending the life of the Collins for at least another duty cycle of eight years has been investigated. While no definitive statements regarding schedule, scope or cost have been made in the public domain, a recent review found that there is no fundamental reason precluding such an extension.[10]

It is not clear how much engineering work would be required to achieve an extra eight-year cycle for the Collins boats. A minimalist approach might result in the fleet retaining essentially its current systems. However, the low Collins availability makes a case for a more substantial overhaul, which might include replacement or a substantial reengineering of major systems.

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[6] Andrew Davies, 'Graph of the week: Collins (un)availability', *The Strategist*, 14 December 2012, <www.aspistrategist.org.au/graph-of-the-week-collins-unavailability-2/> [Accessed 3 June 2013].

[7] Andrew Davies and Mark Thomson, *Mind the Gap: getting serious about submarines*, ASPI Strategic Insight, no. 57 (Canberra: Australian Strategic Policy Institute, 2012).

[8] Presentation to the Seapower 2012 Conference by RADM Moffitt, Director Future Submarine Project, January 2012.

[9] Davies and Thomson, *Mind the Gap*, figure 8.

[10] John Coles, *Collins Class Sustainment Review Phase 1 Report* (Canberra: Department of Defence, 2012).

The most likely candidates for replacement are propulsion components—some or all of the diesel engines, generators, electric motors and batteries.

That is not a trivial work program, and substantial design and engineering work would be likely to be required, as well as significant time out of the water for each of the boats that were so upgraded. But, assuming the successful completion of the process, the gap between the Collins and the successor class could be essentially eliminated. That would require simultaneous work upgrading Collins boats and building the first few of the follow-on class, thus representing a demanding management task in the shipyards. But there would likely be some useful synergies as well—a point that will be returned to later.

2009 Defence White Paper: A Conventionally-Powered SSN

The 2009 Defence White Paper was a clear statement of the then government's view of a robust response to growing Chinese military power. That was obvious from the force structure detailed in the paper, with an emphasis on long-range maritime platforms with land strike capabilities and which, most importantly, would be able to work closely with US Navy forces in the western Pacific.[11]

As a result, the requirement for the future submarine was extremely ambitious, and would almost certainly result in a new design, there being no conventional submarine in the world that can meet the criteria:

> The Future Submarine will have greater range, longer endurance on patrol, and expanded capabilities compared to the current Collins class submarine. It will also be equipped with very secure real-time communications and be able to carry different mission payloads such as uninhabited underwater vehicles.[12]

> The boats need to be able to undertake prolonged covert patrols over the full distance of our strategic approaches and in operational areas. They require low signatures across all spectrums, including at higher speeds.[13]

Elsewhere, the 2009 White Paper stated that the new submarines would be able to undertake certain strategic missions where the stealth and other operating characteristics of highly capable advanced submarines would be crucial. Consistent with this, planned enhancements included air-independent propulsion and land attack cruise missiles.

[11] Andrew Davies, 'The Defence White Paper's Force 2030', in *Australian Defence Policy Assessment 2010*, ASPI Special Report, no. 30 (Canberra: Australian Strategic Policy Institute, 2010), pp. 8-12.
[12] Commonwealth of Australia, *Defending Australia in the Asia–Pacific Century: Force 2030* (Canberra: Department of Defence, 2009), para 9.3.
[13] Ibid., para 9.5.

That is a demanding set of requirements, and are beyond the ability of any conventional submarine currently on the world market. And given the explicit requirement for performance superior to the Collins plus a large payload, the future submarine thus defined was almost certain to emerge as a substantially larger boat

The 2009 White Paper also observed that "[t]he complex task of capability definition, design and construction must be undertaken without delay, given the long lead times and technical challenges involved."[14] While undoubtedly true given the timeframe analysis discussed above, it took three years for any funding to become available for that work (and another year before resourcing was reflected in the government's budget papers). And when resources did become available in 2012, the single-minded focus on big performance in the 2009 White Paper had apparently been tempered by some of the realities discussed above, with off-the-shelf and 'modified off-the-shelf' options being including in the scoping studies, along with studies for an evolved Collins class and a new bespoke design.[15]

The 2013 White Paper

The 2013 White Paper mostly preserved the force structure decisions of its predecessor, in keeping with the Defence Minister's insistence that 'core capabilities' would be retained.[16] However, there were some changes in the way the future submarine is described. Gone is the 'better than Collins' description. Instead, we are told only that

> the Government remains committed to replacing the existing Collins Class fleet with an expanded fleet of 12 conventional submarines that will meet Australia's future strategic requirements.[17]

Also, the future submarines (and frigates) are no long guaranteed to have land attack capability. Rather, that will be something a future government might choose to pursue, with the Air Force and Army having primary carriage of the ADF's strike capability:

> Australia's existing F/A-18A/B/F Hornet aircraft and future EA-18G Growler and F-35A Joint Strike Fighter aircraft will provide the principal ADF strike capability. Special Forces also provide covert strike options to Government, notably through the provision of targeting data, but also through kinetic strike. Australia's Air Warfare Destroyers, future submarines and future surface combatants will provide options for the Government to expand strategic strike capabilities if required.[18]

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[14] Ibid., para 9.6.
[15] Prime Minister, Minister for Defence, Minister for Defence Materiel, *Next stage of future submarine project announced.*
[16] Stephen Smith, Speech to the Australian Strategic Policy Institute, 1 August 2012.
[17] Commonwealth of Australia, *Defence White Paper 2013* (Canberra: Department of Defence, 2013), para 8.46.
[18] Ibid., para 8.15.

We are not told what the 'strategic requirements' for the future submarine are. This is consistent with the overall approach of the 2013 White Paper, which takes a much less confrontational tone than the 2009 version. But evidently long range and high endurance remain the key drivers of the capability goals, because work has ceased on the two options that would have resulted in shorter range submarines:

> The Government has also taken the important decision to suspend further investigation of the two Future Submarine options based on military-off-the-shelf designs in favour of focusing resources on progressing an 'evolved Collins' and new design options that are likely to best meet Australia's future strategic and capability requirements.[19]

By taking this step, the government has removed from the mix the two options with the least project cost and risk and the shortest delivery time—and the least capability, at least as far as off-the-shelf goes. A Collins life-of-type extension is now almost guaranteed. Indeed, we find in paragraph 8.51 a reprise of the Coles finding:

> In 2012, an evaluation of the service life of the Collins was completed, which found that the Collins Class operational service could be extended for one full operating cycle—some seven years excluding a period of formal deep maintenance.[20]

It is not entirely clear what that means in terms of the work or resources required. As will be explained later, there might be an opportunity to trial some systems for the future submarine in one or more of the Collins class boats.

The other significant step that has been taken since 2009, and which was re-announced in the 2013 White Paper, was the funding of a land based Submarine Propulsion Energy Support and Integration Facility, which will

> substantially reduce risk in the Future Submarine Program by providing the capability to research, integrate, assemble and test the propulsion, energy and drive train systems in all stages of the Future Submarine's design, build and through-life sustainment.[21]

The net result of all of these considerations is that the government remains committed to a large long-range submarine, but is perhaps not as wedded to the extremely demanding criteria of the 2009 ambition—although care should be taken when reading too deeply into the particular wording of White Papers. As well, the Collins class will receive whatever work is required for a further duty cycle and there will be research and development work on submarine propulsion systems in country. Collectively, these observations suggest the likely path of the future submarine project.

[19] Ibid., para 8.50.
[20] Ibid., para 8.51.
[21] Ibid., para 8.49.

The Way Ahead

There are two broad approaches to the development of military platforms. The first is a top-down, requirements driven approach, which involves finding technical solutions that meet the specified performance criteria. Extreme examples are the Apollo moon landing program and Manhattan project. The other is a bottom-up approach, which takes the technical solutions that either already exist in the market today, or which are currently well under development, and employs them to produce the best performance available with those systems that are likely to be mature and reliable.

In practice, most projects have characteristics of both, although the emphasis can vary significantly. In many ways, the two options remaining for the future submarine project fit into different categories. The new design option is likely to be more requirements driven and will necessarily involve a performance significantly beyond Collins (else why bother?). A likely outcome is a submarine designed to meet criteria similar to those described in the 2009 White Paper. It will therefore represent the most technically challenging of the competing approaches, as well as the most expensive. If successful, it will produce the most capable outcome of all of those considered. But it is also the one most likely to fail or, like the Collins project, to produce a submarine that fails to meet its performance goals.

The evolved Collins option is, by definition, a bottom up approach. The Collins already has sensor, combat and weapons systems that perform well. As noted earlier, the propulsion system has been its Achilles' heel. With the land based propulsion test system, much of the engineering risk in upgrading the drive train can be retired in an environment where experimentation is easier than at sea—although ultimately any solutions will of course have to be evaluated in an operational environment.

There is no suggestion in public comments that the now mandatory Collins life of type extension includes a reengineering of the propulsion system, although that would potentially allow the reliability of the class to be improved. It would be a matter of cost-benefit analysis as to whether a single extra duty cycle would make the effort worthwhile. But if so, that might provide an opportunity to prove technology applicable to the successor class as well. Once a potential solution is identified, one or more of the Collins class boats could be used as a test bed before the solution is migrated to the follow on design.

The evolved Collins therefore represents the more conservative of the two options in many ways. And there is a potential 'two birds with one stone' benefit. Under this approach, a 'Collins Mark 2' could begin with a full suite of systems that have already been proven to be successful. It also has benefits for management of the workflow and workforce in the shipyards—if there are significant overlaps in the systems and design philosophies of the

two classes simultaneously being worked on, it will be easier to move workers between jobs and there will be sharing of fixed cost overheads.

To see how this approach might work, a useful analogy from aerospace is the process that produced the F/A-18 E/F Super Hornet Block II aircraft. Its pedigree can be traced back to the F/A-18 A/B Hornet. A technological refresh saw the A/B systems substantially upgraded with much higher performance replacements in the same airframe to produce the C/D models. Many of those systems were migrated into the Super Hornet Block I—a superficially similar but larger airframe with more 'growth potential'. The proven airframe was then upgraded with a new generation of systems (especially the radar) to produce the much more capable Block II model. Through three major evolutions, the airframe and systems within it were progressively upgraded—but never at the same time. The result is an aircraft that has little commonality (other than a strong familial resemblance) with the original Hornet, but has better performance in almost all respects. The Super Hornet project is notable for being on time and closer to budget than most of its predecessors.[22]

To continue the aerospace analogy, the 'top down' approach that resulted in the 'fifth generation' F-22 Raptor and the F-35 Lightning II required the design of completely new airframes populated by a large number of new systems. The result is very high level of performance that is a quantum leap over their predecessors, but both projects were notable for substantial cost overruns and schedule slippages.

Conclusion

The future submarine project has come down to two options that vary significantly in terms of cost, risk and capability outcomes, although both aim to produce a submarine superior in performance and reliability to the Collins class. By suspending work on the (relatively) low risk options and focussing on the demanding capability requirements of a long-range strategic submarine fleet, the government has clearly shown its judgement of the value of submarines in the wider Asia–Pacific theatre. From here, the decision process will be informed by the trade-offs between cost, project risk and capability between two options that aim to produce a 'better than Collins' performance. Whether the outcome is the 'stretch goal' of a new design with a quantum leap in performance or a more modest evolutionary approach will be determined on the assessed costs and benefits of each.

Andrew Davies is the senior analyst for defence capability at the Australian Strategic Policy Institute. andrewdavies@aspi.org.au.

[22] 'The aircraft met all of its performance requirements on cost, on schedule and 400 pounds under weight', USN Fact file F/A-18 Hornet Strike Fighter, 6 May 2009, <www.navy.mil/navydata/fact_display.asp?cid=1100&tid=1200&ct=1> [Accessed 3 Jun 2013].