

Japan versus Europe

The quest to build Australia's future submarine

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Introduction

Andrew Davies

The building of Australia's fleet of future submarines is likely to be the largest defence program in this country's history. It will cost tens of billions of dollars and will run for decades. So it's little wonder that it's a recurring topic of interest on the pages of ASPI's blog *The Strategist*. Our contributors continue to examine the topic from all angles, and this *Strategic Insights* collects selected pieces from the past twelve months.

The Future Submarine Project is a wonderful case study of defence acquisition. Because of its scale and time frame, it spans every aspect of defence decision-making from long-term strategic crystal ball gazing, including the possible impact of future technologies, through military strategy development and force structuring, all the way to robust politics of shipyard jobs.



Collins class submarine. Photo courtesy Department of Defence.

This report is divided into four sections. In the first, the subject is the future strategic and technological environment. Benjamin Schreer surveys China's growing undersea warfare capability, and argues that the United States and its allies are going to have to rise to the challenge with sophisticated capabilities of their own. Andrew Davies investigates the prospect of submarines becoming obsolete due to emerging technologies, concluding that life underwater will get harder, but that submarines will continue to be an important part of the ADF's force structure.

There's also a nexus between the choice of acquisition strategy and geostrategic positioning. While a collaboration to build submarines between the Australian Government and a European supplier would be largely uncontroversial—as was the case with the Collins submarine program—entering into a relationship with Japan presents both threats and opportunities in terms of regional dynamics. Andrew Davies and Benjamin Schreer argue that the benefits outweigh the cost, while Hugh White's position is that such a move would unnecessarily link Australia to North Asian security issues. No matter which view prevails, the government will have to grapple with a geopolitical calculus, as Mark Thomson examines in the final piece in the strategy section.

Geopolitics will be one factor to be weighed in the Competitive Evaluation Process (CEP) launched by the Abbott government to choose a partner for the detailed design and subsequent build of the future submarine. The process is now coming towards the end, and all of the contenders bring relative strengths to the table. In a series of pieces reprinted here in the CEP section, Geoff Slocombe, Julian Kerr and Kym Bergmann take a look at the bids from Japan, Germany's TKMS and France's DCNS respectively. To round out the discussion, Andrew Davies and Mark Thomson ask whether the CEP will provide enough detail to be confident of a sole-source decision, and Kym Bergmann asks what will come next.

Arguments about the strategy driving the acquisition of submarines or the pros and cons of the various offerings of the bidders to the CEP are certainly robust, but arguably there's as much strong feeling about the industrial landscape as well. In the first piece in Section 3—Project management and industry—Hans Ohff, a key player in the delivery of the Collins class sounds a warning about the need to have an industry policy in place not just to support the build process, but also to provide a sound basis for through life support of the boats.

Where the future submarine will be built seems to have been largely settled by local politics, but Tony Shepherd reminds us that there are other reasons to favour a local build, a view shared by Peter Briggs, who also takes a look at the option of building the first boat overseas. As we have learned from the Air Warfare Destroyer project, a local build means that our shipyards will need to have mechanisms in place to identify and manage risks if we're to aspire to a best practice outcome. Terence Roach and Chris Mather explain what that means in terms of shipyard systems.

Finally, whichever partner Australia chooses, we will then enter into a process of making cost, risk and capability trade-offs as the final design emerges. Andrew Davies explains why air independent propulsion—once thought a 'must have' for modern diesel electric submarines—is now one such potential trade-off. Finally, Mark Thomson takes issue with some of the lower cost figures that have circulated of late, with a caution that, consistent with a long history of price escalation in defence projects, we should reasonably expect to pay more for each submarine than we did for the Collins.

1. STRATEGY

China's emerging undersea capability and the implications for Australia's future submarine

Benjamin Schreer, 24 April 2014

At [ASPI's recent Submarine Conference](#) the strategic rationale for Australia's Future Submarine (FSM) was only lightly discussed. Presenters stated that the FSM worked best as an 'offensive platform' and 'up threat'. But that issue deserves a more detailed debate: it's central to answering the question about what we want the submarines to do. A hidden assumption of the 2009 Defence White Paper, which provided the vision for 12 new and large diesel-electric submarines, was that the boats would be able to operate for extended periods as far away as Northeast Asia, including off the Chinese mainland. Some analysts, including [here](#) on *The Strategist*, support such a view.

But the future undersea environment off the Chinese coast will be markedly different from what it is today. A key reason for that is China's emerging submarine and anti-submarine (ASW) capability. To be sure, the current [undersea balance between the US and China is still very much in favour of our major ally](#). Beijing is catching up though, and by the time Australia's new generation of submarines goes to sea that balance might have shifted. As a [recent report](#) by the US Congressional Research Service points out, while China's current submarine force is now quantitatively smaller than it was in 1990, it has 'greater aggregate capability than it did in 1990, because larger numbers of older, obsolescent boats have been replaced by smaller numbers of more modern and more capable boats'.

A [staff report for the US–China Economic and Security Review Commission](#) puts the trend towards a more formidable Chinese submarine fleet by 2020 into a table:

China's Submarine Fleet, 1990–2020

Type	1990	1995	2000	2005	2010	2015	2020
Diesel Attack	88	43	60	51	54	57-62	59-64
Nuclear Attack (SSN)	4	5	5	6	6	6-8	6-9
Nuclear Ballistic (SSBN)	1	1	1	2	3	3-5	4-5
Total	93	49	66	59	63	66-75	69-78

The report also notes the ongoing modernisation of the fleet, defining 'modern' submarines as those able to launch ballistic missiles or anti-ship cruise missiles (ASCMs).

China's Submarine Fleet, 1990–2020, approximate percent 'modern'

Type	1990	1995	2000	2005	2010	2015	2020
Diesel Attack	0%	0%	7%	40%	50%	70%	75%
Nuclear Attack	0%	0%	0%	33%	33%	70%	100%

That assessment is underlined by recent [Congressional testimony from the US Navy's Office of Naval Intelligence \(ONI\)](#). The ONI also expects that by 2020 the 'vast majority' of China's submarine force will be armed with 'advanced, long-range ASCMs'. Moreover, apart from the possibility that a new Type 095 SSN could be equipped with a land-attack capability, the testimony reiterates the Pentagon's expectation that the JIN-class SSBN will become operational in 2014, marking 'China's first credible at-sea second-strike nuclear capability' against the continental US, Hawaii and Guam. Should the Chinese Navy (PLAN) increase its JIN-class boats from three to five it could sustain a continuous SSBN presence in the Western Pacific or the Indian Ocean. Finally, the PLAN has started to address more seriously its notorious shortfalls in ASW capability. For example, a recent [article](#) in the US Naval Institute's Proceedings Magazine (subscribers only) analyses China's deployment of a fixed ocean-floor acoustic network off its coast to monitor foreign submarine activities in its 'Near Seas'. While the authors note that it's not yet clear to what degree the 'generally weak' Chinese ASW capability will benefit from that network, they also stress that the PLAN is undoubtedly

putting more effort into strengthening its ASW capabilities. As my colleague Andrew Davies [points out](#), major advances in ASW could greatly complicate Australia's future submarine operations close to China's shore.

Of course, it'll take time for the PLAN to turn its new platforms into actual capabilities. For instance, as I've discussed [elsewhere](#), effective command and control in SSBN operations will be a major challenge. But two decades from now the PLAN will be more proficient in undersea warfare as well as ASW. This will not only increase the detection risk for Australian submarines. As well, the undersea land-attack options canvassed in the 2009 Defence White Paper will become even more questionable. And while [China's 'Near Seas'](#) will remain the primary operational focus of the PLAN for the time being, Chinese submarines will increasingly patrol in waters close to Australia—requiring attention of the ADF's ASW capabilities, including submarines.

We might be thus better off leaving the increasingly crowded undersea space off the Chinese mainland to our US ally whose nuclear submarines (like the USS Maryland) are faster and better armed. Moreover, expect non-nuclear submarines of partner nations like Japan, South Korea or Vietnam to also operate in this space given their geographic proximity to China. As [Peter Jennings](#) argued at our conference, Australia should consider adopting a more modest assessment as to how far 'up threat' our submarines should operate in the future. In my view, this implies a focus on operations in the Eastern Indian Ocean and maritime chokepoints in the Indonesian archipelago. While this could mean fewer and smaller boats, they would still make critical contributions to Australia's security and to allied operations by posing a credible threat to hostile surface and subsurface systems.

Option J—would you like strategic benefits with that?

Andrew Davies and Benjamin Schreer, 27 March 2015

There's a lot of talk about submarines again this week thanks to the [SubSummit](#) conference in Adelaide. Perhaps not surprisingly given the venue, much of the focus was on the local versus offshore build aspect. That's all fair enough—we're talking big dollars here, and the size of the program is such that all of the potential stakeholders have plenty of reasons to make their pitch. That's a good thing—the more the various options are explained the better informed the discussion can be.

Clearly the government wants to keep 'Option J'—a submarine sourced from Japan—open, which is why it settled on its 'competitive evaluation process' to allow for the possibility. Otherwise it would simply run a tender process similar to that for the Collins class for the Europeans to compete. The question then becomes how to weigh the positives and negatives of what are quite different options.

But one of the unfortunate downsides of this debate (in fact most debates) is the tendency to talk down the competition beyond what's objectively true, thus muddying the waters and detracting from the quality of the discussion. There's no shortage of criticism of varying quality of Option J out there—in fact it's hard to find much support. In [our new paper released today](#), we take a look at the case for Option J and find that there are indeed some real strategic positives as well as issues of concern.

Let's take a look at the critic's concerns. They fall into several distinct categories. The first are 'strategic concerns', with any [or all](#) of the following:

- Australia would be choosing sides in orth Asian security and thus would risk being drawn into a future conflict in that region
- a submarine deal would be to the detriment of Australia's important economic and security relationship with China
- Australia would effectively helping Japan to 'remilitarise'.

We don't buy any of those arguments. First, Australia would only find itself trapped into north Asian conflicts if it negotiated a submarine deal especially ineptly. If we get the support arrangements we need in place, Japan's leverage—even if it decided to use it—would be much reduced.

Second, China has shown no tendency to punish Australia for being a forthright critic of its security policies to date, and it's [far from clear that they could effectively punish Australia](#) in any case. Finally, Japan's moves towards a normalised security posture falls well short of a region threatening militarisation.

We think it's in Australia's interests for Japan to be more, not less, engaged in regional security. As American power declines in relative terms, having allies and partners around the region that can carry part of the burden of maintaining order will be increasingly important. That's probably why it's widely thought that the US is firmly supportive of a possible Australia–Japan submarine deal.

Because of these factors, Option J has positives that simply aren't there in the same way with France or Germany. Yes, they're both like-minded liberal democracies, but neither has the proximity, the inclination or the regional capability to make a lot of difference in our part of the world. On the other hand, the Europeans offer a wealth of experience in arms exports, and both have successfully exported submarine designs to be built in foreign yards. After our [experience with the AWDs](#), that's a very strong selling point.

The other broad class of criticism are 'industrial and economic concerns':

- a Japanese submarine would offer much less work in Australian shipyards than a deal with European suppliers
- the project management with Japan would be prohibitively difficult given [cultural factors and their lack of export experience](#)
- the [opportunity cost to Australia](#) of taking the work offshore would be too high.

We don't say a lot about that in this paper. (ASPI has commented [here](#), [here](#) and [here](#) on these in the past.) But it's almost certainly right to say that the 'Eurosub' option offers more local work.

Nor can we sensibly evaluate from publicly available information the capability issues that might arise, such as the [suitability of the Soryu-class for Australian mission](#) profiles and the difficulties that might be encountered in modifying the design for the RAN's use. That requires government—through Defence—to do its due diligence. Of course, that's also true of any European option.

Our paper shouldn't be interpreted as an endorsement of Option J. This isn't an 'apples versus apples' competitive evaluation and the two pathways have qualitatively different strengths. But it's not right to say that Option J offers little in the way of positives. Apart from anything else, it'd signal a further deepening of the Australia–Japan defence relationship and a further underpinning of the US alliance framework, at a time of shifting major power relations in the Asia–Pacific region.

The strategic risks of Option J

Hugh White, 7 April 2015

In their [paper supporting Option J](#), Andrew Davies and Benjamin Schreer don't just rebut some of the strategic arguments raised against it, but also provide their own argument on strategic grounds in its favour. Their rebuttals offer much to debate, but their positive argument is more important and more revealing, so let's focus on that.

The argument is essentially as follows. Australia's interests are best served by the creation of a strong coalition of democracies that would preserve the US-led order in Asia by resisting China's growing power and ambition. Creating this coalition requires a more strategically-active Japan and closer US-Japan-Australia strategic cooperation, both of which would be encouraged by Australia buying Japanese submarines.

Underlying this argument is an assumption that Australia's future security is best served by trying to perpetuate the US-led order which has kept Asia stable for 40 years. There's no doubt this would be the best outcome if it can be achieved, but for that to happen, China must be either convinced or compelled to abandon any ambitions to change that order and take a bigger leadership role for itself. The strategic policies of Washington, Tokyo and Canberra today all presuppose that Beijing will back off if they stand together and firmly refuse any concessions to these ambitions.

The more confident one is that this is right, the more credible the assumptions underlying Ben and Andrew's strategic argument for Option J becomes. But Ben and Andrew offer no support for their assumptions, and, as I have argued elsewhere, there are compelling reasons to suggest that they are wrong. If so, then the present policies will not preserve Asia's peace and Australia's security, but lead instead to an escalating rivalry and an increased danger of major war. And in that case, Option J would undermine Australia's security by deepening our support of US and Japanese policies which are not in our interests.

Moreover, if Andrew and Ben are wrong and China can't be forced to accept the old order, then we face a strategic future in Asia which, one way or the other, will be very different from what we have known. Whichever of the wide range of possible outcomes materialises, it's quite likely that the strategic interests of both Australia and Japan won't remain nearly as closely aligned as Andrew and Ben believe them to be today.

This matters to the submarine project to the extent that our future submarine capability under Option J would depend on maintaining a close strategic relationship with Japan. Andrew and Ben argue that it wouldn't, because we wouldn't depend on Japan's cooperation to support and operate our boats provided that we secured the technical information to allow us to do it ourselves.

But how confident can we be of that? As Ben and Andrew acknowledge, both Tokyo and Canberra seem to expect that despite the so-called 'competitive evaluation process', Option J, if it proceeds, would be based on a government-to-government deal. It's very clear that this would lead to the details of the deal being hammered out in a non-competitive, sole-source negotiation in which Australia would have a very weak bargaining position, with little leverage to press for the transfer of sensitive technical information.

And we can be sure the Japanese side would be determined to transfer as little of that information as possible, not just to protect the operational security of their own submarine capability, but also to maximise our dependence on Japanese submarine support.

After all, why is Tokyo so keen on Option J, when the commercial incentives are fairly modest and the potential risks of sharing its most sensitive military technology seem so high? The clearest reason is that Abe wants to use Option J to tie Australia as closely as possible to Japan strategically. He will therefore have strong incentives to keep Australia's submarine capability as dependent as possible on Japan, and hence, to share as little information with us as he can.

So there's a serious risk that Option J would leave our submarine capability vulnerable to future differences in Australian and Japanese strategic priorities. Moreover, that risk is highest in precisely those circumstances in which Australia's submarines would be most important to us. The bigger the shifts on the region's strategic order, the more we'll rely on our submarine capability, and the bigger the risk that strategic differences between us and Japan will undermine it.

There's no risk-free way to buy submarines, but Option J carries whole categories of strategic risk that the other options do not, and those are very likely indeed to outweigh the technical advantages, if any, that Option J offers.

Stuck in the middle of U

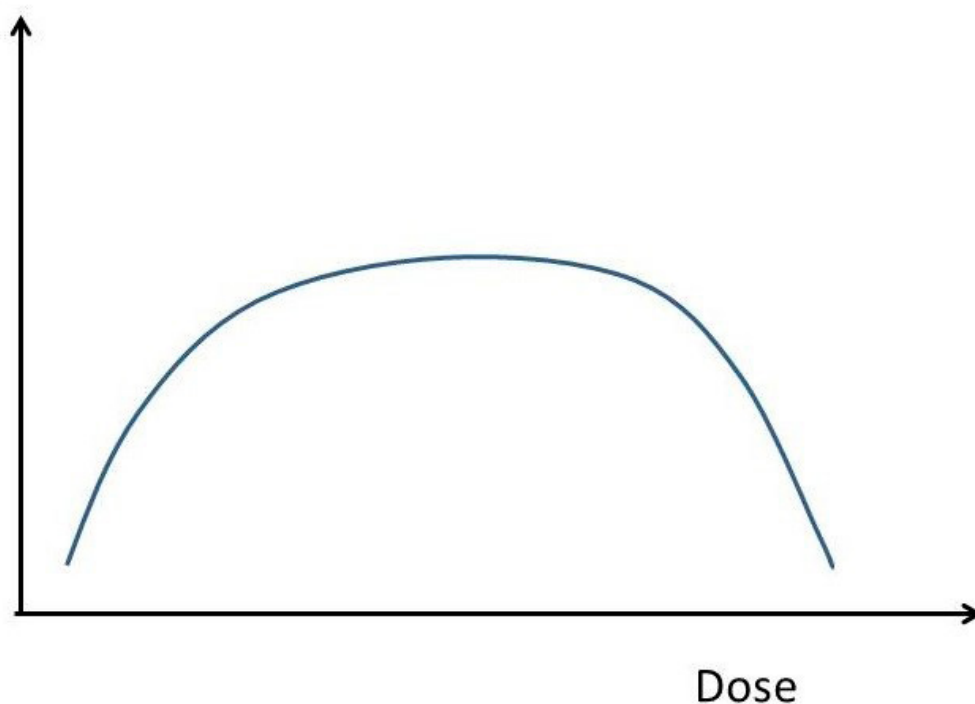
Andrew Davies and Benjamin Schreer, 9 April 2015

It's good to see that the '[Option J](#)' paper Ben Schreer and I wrote is generating responses. [Hugh White](#) and [Sam Bateman](#) raise concerns about a closer relationship with Japan: both of them argue that it's possible to get too close to Japan in a security sense, leading to unwanted outcomes, and that a submarine deal would do that. Both of them think there's more in a sub deal for Japan than for Australia. And both argue—Sam explicitly and Hugh implicitly—that we should be less active in trying to maintain a liberal democratic order in the Asia-Pacific.

We'll concede one point: of course it's possible for two countries to get too closely entangled, where one is inexorably drawn into the other's bad judgement and misadventure. (WW1 comes to mind.) But it's also possible to do too little, and the notion of an 'inverted U curve', is a useful tool for this discussion. Basically, it's a model of phenomena in which both small and large values of

an input parameter produces low outputs, but intermediate inputs produce a larger effect. Think about a therapeutic drug: at low doses it won't have much effect at all but at high doses it'll do more harm than good, or even be fatal. In between there's a dosage that produces the best clinical outcomes. Here's a schematic:

Therapeutic effect

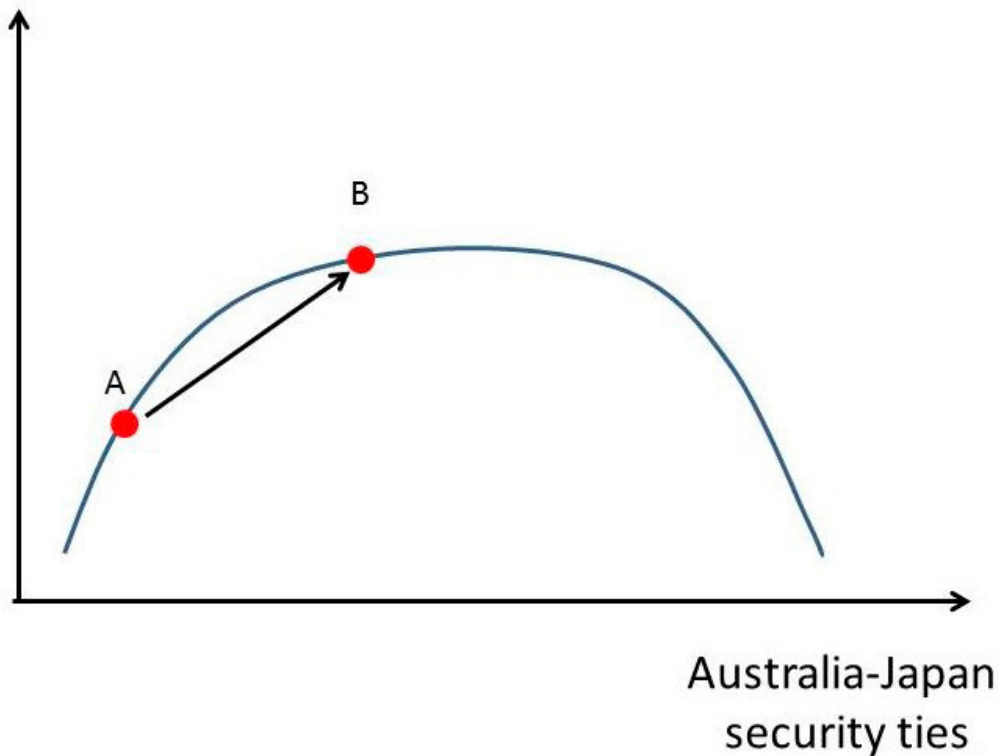


Inverted U curves also appear in [economic theory](#) and other applications—Malcolm Gladwell sees them at work in [school class sizes](#).

Applied to the Australia–Japan relationship, the 'low dose' part of the curve corresponds to the two countries doing little or nothing together in security terms, so missing out on benefits to be had by combining resources to meet common security threats. The 'high dose' regime is what Sam and Hugh worry about—getting in so deep that we'd be forced to follow when Japan pursues its interests even if the outcomes for us are worse. By 'worse', they mean getting embroiled in Sino-Japanese competition to our detriment, in a world where China is economically and militarily more powerful than today and the US less so.

As we said in our paper, we don't buy that. We argue that we're still on the upswing of the curve, and that a deeper security relationship will take us to a better, not worse, place. (A to B in the figure below.) That conclusion's based on two key judgements. First, that China's leverage over Australia is much weaker than is commonly supposed. Second, that it's too early to give up on the order that has provided security and prosperity for the entire region—China included. We thoroughly explain the point about Chinese leverage in the paper.

Strategic benefit to Australia



But even if those judgments are wrong—i.e. if China does hold significant coercive power over Australia and the liberal democratic order much valued by Australia and Japan is doomed by the rise of China—we're still not convinced that throwing up our hands and letting concerns about Chinese reactions effectively dictate Australia's security policy is the right approach. That's what we think the practical effect of Sam's prescribed 'even-handed neutrality' would be—even if Australia could affect neutrality given its long and dearly held alliance with the US.

Simply put, if we let China dictate the regional order, we'll get what China wants, and it's unlikely to be what we want. Even with American power in relative decline it's still formidable, especially when reinforced by like-minded allies. The downside risk is an escalation of tension, perhaps to the point of war. That's a risk that certainly has to be taken into account, and the outcome could be dire, though a mitigating factor is that American military power is backed up by nuclear weapons, which should put a brake on most adventurism.

The democratic states mightn't call all the shots any more (and shouldn't) but we'd certainly still have a vote. The resulting compromise is more likely to be acceptable if we negotiate with resolve from a position of solidarity. The future will probably have features we'd prefer not to have, but we should try to minimise those. Giving up now and eschewing partners like Japan could take us down into the left-hand part of the curve to a bad outcome.

Finally, Hugh and Sam argue that there's more in Option J for Japan than Australia. That's probably true, because Japan's circumstances are more fraught than ours. But that actually strengthens our argument, because it means that there's little incentive for Japan to withdraw support for Australia's subs. We're never going to be on the other side of a Sino-Japan conflict—at worst we'll be bystanders—but we'll always be potential partners, so why would Japan choose to undercut us? Like China, but for different reasons, Japan has little leverage over Australia.

Australia and Japan: the unknown unknowns

Mark Thomson, 18 November 2015

Australia and Japan have been moving closer on security matters since the mid 2000s. The first ministerial Trilateral Strategic Dialogue between the two countries and the United States was held in 2006, and a Joint Declaration on Security Cooperation was signed in 2007. Yet, security cooperation between Japan and Australia has—until recently—been limited to ‘nontraditional’ issues.

It was surprising therefore, when news broke in mid-2014 that Australia might buy submarines from Japan. The export of Japanese submarines or submarine technology to Australia would extend the bilateral relationship into the arena of hard-edged defence. Moreover, because submarines are among the most closely guarded of military technologies, it would also reflect a remarkable level of trust and co-dependence between Japan and Australia.

I wonder if Japan knew what it was getting into. Of all the possible areas of cooperation with Australia, submarines are probably the most fraught. We’ve grossly mismanaged our submarine capability over the past 20 years, and our initial steps to replace the current fleet have been tardy and haphazard.

The Abbott government’s plans for the future submarines were initially unclear, but by mid-2014 rumours were afoot that Australia’s next generation of submarines [would be built in Japan](#). Although it was never confirmed, many observers concluded that a deal had been reached behind closed doors between Abbott and Japanese Prime Minister Abe.

Whatever the understanding, domestic Australian politics soon threw things into disarray. Abbott’s waning popularity put his job on the line in February, and to head off a leadership challenge he was forced to open up the submarine project to broader competition. The reason: other potential suppliers were perceived to be more willing to build the vessels in Australia than Japan. The goal was to find work for the government-owned shipyard in South Australia. So it was that a three-way contest was initiated between France, Germany and Japan. Eventually, Japan also made clear that it was willing and able to build the vessels in Australia.

The resulting Competitive Evaluation Process (CEP) focuses on the credentials of the prospective suppliers with only ‘pre-concept’ designs and ‘rough order-of-magnitude’ costings requested—[effectively a beauty contest](#). In any case, the government isn’t bound by its findings—it will merely inform their decision. Rejecting a recommendation from Defence wouldn’t be unprecedented. The Howard government overturned a recommendation to purchase a German combat system for the Collins class submarines ‘on strategic grounds’ and went ahead instead with a US solution.

A decision was expected in early 2016, but that may now be delayed after Malcolm Turnbull took the leadership reins in September.

The challenge for Turnbull will be to balance the commercial and technical inputs gathered by the CEP with the strategic implications of the Japanese option. And make no mistake. A decision in favour of Japan would have tangible strategic implications. It would hasten Japan’s military normalisation, and it would also send an unambiguous message to both Beijing and Washington about the willingness of Australia and Japan to work together.

What happens if Japan loses the competition? Will the relationship return to where it was previously—friendly and sympathetic but with cooperation limited to nontraditional security issues? That might be too optimistic. Japan moved outside of its comfort zone to offer submarines to Australia, and a legislative change was required to make it feasible. In return, the Australian Government has been at best unpredictable (more like unreliable) as it contorted itself to accommodate the parochial demands of pork-barrel politics.

The critical question is the extent to which the submarine deal was conceived as a strategic, as opposed to commercial, initiative from a Japanese perspective. If it’s a purely commercial matter, a loss would merely be disappointing. But my instinct is that the original deal had much more to do with strategy than money—and the integrated whole-of-government approach to the contest by Japan is consistent with such an assessment. If I’m right, a Japanese loss would amount to, or at least be perceived as, Australia rejecting a closer strategic relationship with Japan.

Conversely, if Japan is awarded the contract, it will be perceived by many as another move in the great game that's afoot in the Western Pacific; a 'pivot within the pivot' that strengthens the US position in the region through a strategic rapprochement between two key allies.

While I think the Japanese offer of submarines to Australia was underpinned by a desire for closer strategic ties, I'm less clear about Australia's current position. At one end of the spectrum is a purely commercial deal; at the other is a substantive strategic partnership in the context of a region increasingly under pressure from Chinese assertiveness.

The Turnbull government's perspective is unclear. Chances are it's yet to form a view, and it may not do so until it has to make a decision about the submarines.

There are two schools of thought on whether closer strategic relations with Japan would be in Australia's interest. The argument against was put succinctly by Kevin Rudd who argued that a formal defence pact with Japan would 'unnecessarily tie [Australia's] security interests to the vicissitudes of an unknown security policy future in North East Asia'. While a formal pact is not on the table, the desire to avoid even implicit understandings remains strong in some quarters of Australian defence thinking.

In fact, despite the US alliance, Rudd's cautious approach is consistent with Australian defence policy since the early 1970s. Under the guise of the defence-of-Australia doctrine, we've long rejected any pre-commitments beyond the explicit demands of the ANZUS treaty. If Turnbull embraces this mindset, a closer strategic relationship with Japan would be approached with trepidation. If it did not militate outright against a Japanese submarine deal, it would mean that any deal would be cast in largely commercial terms so as to limit any implicit strategic quid pro quo. Caution over a closer Japan–Australia strategic partnership would be heightened by the tendency of the Australian media and some analysts to warn against offending China for fear of economic retaliation.

Not everyone shares Rudd's fears. The argument for cosying up with Japan is that Australia cannot afford to sit on the sidelines as the balance of power in the Western Pacific shifts towards China at the expense of the United States. It can be argued, Australia needs to stand alongside the United States and its other allies and partners in the region [to guard against creeping Chinese hegemony](#). Of course, that assumes that a display of unity will moderate Chinese behaviour rather than harden its resolve not to be 'contained' by the United States and its allies.

At this point, it's impossible to predict where the Turnbull government will come down on the question of closer Japan–Australia strategic ties. If it can, it will probably try to get past the submarine decision while retaining as much ambiguity about its strategic relationship with Japan as it can—irrespective of what it decides to do about the submarines. Nonetheless, observers in Beijing, Washington and Tokyo will each draw their own conclusions about the decision. One way or another, there'll be some explaining to do.

Turning Japanese

Mark Thomson, 9 February 2016

[Andrew Shearer](#) was Tony Abbott's national security adviser. In an [article published in mid-January co-authored with US analyst Michael Green](#), he said that 'senior US officials and military officers are in no doubt both as to the superior capability of the Japanese Soryu class and to the long-term strategic benefits to the United States and the region of an interoperable fleet of Australian and Japanese conventional submarines'. A week later, Greg Sheridan wrote of a '[strong US preference for the Japanese option](#)', in the context of Prime Minister Turnbull's visit to Washington.

A different picture emerges if you talk to anyone close to the [Competitive Evaluation Process](#) (CEP) that's underway to select a design partner from among the competing French, German and Japanese bidders. By all accounts, the Americans are being scrupulously even handed with respect to the three options. So what's going on?

There's no paradox. Both statements can be, and I believe are, true at the same time. It's entirely possible for the US to have a strong preference but nonetheless remain non-committed publicly and perhaps even privately. And there are good reasons for adopting such a position.

From an American perspective, the strategic [argument in favour of the Japanese option](#) is simple; a closer relationship between its allies Australia and Japan would manifestly bolster the US position in the region vis-à-vis China. I'm pretty sure that's where it begins and ends. Arguments about interoperability and supposed difficulties with integrating a US combat system onto a European boat can be safely discounted. Though few would admit it ([here's an exception](#)), the name of the game is to hedge against China's increasing strategic assertiveness. While capable submarines are useful to that end, they're not as important to the US as generating solidarity and co-dependence among its allies in Asia. Viewed that way, Australia's next generation of submarines are most significant as geopolitical totems.

But while the US might have a strong preference, there are also good reasons for it to keep its own council. First, they don't need to tell us what we already know, and any attempt to pressure us would be inappropriate and counterproductive. Second, by remaining silent they don't have to bear responsibility if (or when) the project gets into trouble. Remember, they had to bail us out when the Collins stumbled. Finally, they want to avoid creating a security dilemma by reinforcing Beijing's fears of strategic containment.

The CEP won't take account of US preferences, or indeed of geopolitics. It will be cost, capability and schedule from start to finish. If geopolitics is to play a role, it'll be via a political intervention—just as it did back when the Howard government overturned a tender evaluation in favour of a US-sourced replacement combat system for Collins. And don't think for a minute that the government can simply announce the result and remain silent about what the CEP concluded; the result will quickly leak out.

The Turnbull government will be remiss if they fail to consider the geopolitics of the submarine choice, and they'll be confronted with uncomfortable issues if they do. Setting aside the difficulty of balancing the technical and financial aspects of the project with geopolitics—which will be hard enough—the geopolitics are fiendish.

If the government picks Japan against the recommendation of the CEP (and, to an extent, even if it accepts a recommendation in favour of Japan), it will face criticism on two fronts. First, from those who are either concerned about a security dilemma or want Australia to forge a more independent strategic role beyond the US alliance. Second, there will be pushback from those who rely upon Chinese patronage for their business or professional livelihood. Yes Virginia, there is a China Lobby.

For those who want to counter rather than accommodate China's rise, a submarine deal between Australia and Japan would be a welcome turning point in regional geopolitics—an opportunity not to be missed. Apart from strengthening the US position in the region, it would be a (rare) demonstration to the US of allies willing to shoulder risks rather than free-ride. With the US struggling to deal with massive debt, anaemic growth and political dysfunction, it's in our interest to encourage their continued involvement in our part of the world.

There's a further geopolitical factor to take into account; the relative strength of our potential long-term strategic relations with Japan on the one hand and with France and Germany on the other. I'm not suggesting for a moment that either Paris or Berlin would sell us out in favour of their growing economic partnerships with China—Beijing will never have that sort of leverage. And we share many important interests with Europe, for example, countering violent extremism and cyber security. But Japan has, and will continue to have, a clear imperative to support us to the absolute limit of their ability. Japan's commitment to Asian security is existential, Europe's isn't. So, whatever the promises of undying fidelity the French and Germans might make, they will never have anything approaching as strong an incentive as the Japanese to support us and our submarines. To quote Lord Palmerston, 'nations have no permanent friends or allies, they only have permanent interests'.

Sometime later this year, the Turnbull government will pick a design partner for the future submarine. Whether they like it or not, it'll also be making a seminal strategic call on Australia's role in Asia. It's time we started talking about it.

2. COMPETITIVE EVALUATION PROCESS

The SEA 1000 contenders: the Japanese (part 1)

Geoff Slocombe, 25 August 2015

If Australia is to choose the Japanese contender for their future submarine then it should be because it's the best fit for our ongoing strategic requirements, fully meets project criteria, and is the most economically viable from now until the end of the 2060's. This decision shouldn't be a 'captain's pick.'

The Soryu-class ('Blue Dragon') submarine provides the capability the Japanese Maritime Self-Defence Force needs. But the current Soryu-class won't meet Australia's requirements. We will need Soryu Mark Two (Goryu? 'Australian Dragon') as a completely new design, which will have cost, performance and schedule risks. It won't be a Military off-the-Shelf (MOTS) acquisition as some seem to think. Similarly, the hull can't be built in Japan and fully fitted out in Australia.

The Soryu fleet includes six commissioned vessels which have a surface displacement of 3,480 tonnes (compared with the Collins-class 3,100 tonnes) and are 84 metres long. A further five are in various stages of construction. There's a continuous build program, with both Mitsubishi Heavy Industries (MHI) and Kawasaki Heavy Industries (KHI) involved and alternating the start of each new vessel.

There are a number of major changes required for Mark Two in evolving a design to meet RAN's requirements. This is no simple matter and presumably the CEP will establish how this could be accomplished.

The Soryu-class are currently operated and maintained for a service life of 20 years. Australia will want 30 years. Welding techniques, the steel used, corrosion control and number of compression/decompression cycles from deep dives all affect service life. So too do the maintenance and upgrade arrangements—Japan will need to create a new upkeep plan for Mark Two.

Australia needs a greater range than the current Soryu. The Collins-class has a range of 11,500 nautical miles at 10 knots surfaced and 9,000 nautical miles snorkelling just sub-surface at the same speed. Fully submerged it has a range of 480 nautical miles at 4 knots, when running on lead-acid batteries. Soryu has a surface range of 6,100 nautical miles at 6.5 knots, faster underwater. This will need to be increased in Mark Two by more fuel efficient engines and extra bulk fuel storage—perhaps by filling some water ballast space with fuel, to get longer range.

Remaining silently at depth for periods of up to 35 days, while travelling slowly for approximately 4,000 nautical miles in the patrol area, will be important for Australia's next submarines. Although not specified explicitly in the CEP criteria, Australia needs an excellent Air Independent Propulsion (AIP) system and specialist batteries to give the required endurance.

The Japanese have obviously made significant progress with Lithium ion batteries (LiBs) to the point where they are proposing that the final two Soryus being constructed in Japan about 2020 abandon their Stirling AIP engines and have only LiBs. LiBs are much more energy dense, providing up to four times as much power in the same space as occupied by classic lead accumulators. If this happens, this is a major technology advance as currently no commissioned diesel-electric submarine in the world has gone to sea with LiBs.

Diesel engine-driven battery charging technology needs to adapt to the new requirements—the need for much more electrical power for faster charging possible with LiBs. Currently, Soryus have two chargers, while Collins-class have three. This has significant implications for detectable snorkel depth battery charging time, which means that Soryus currently may have the higher indiscretion ratio. Mark Two must do much better.

Soryu Mark Two will be offered with a permanent magnet synchronous electric motor, with the advantage that brings of high torque at low revolutions, keeping propeller noise to a minimum and avoiding the need for a gearbox.

The Soryu-class have a Hitachi command and control system, while Australia wants the US AN-BYG-1 installed, a first for Japan. In terms of weaponry, the Soryus can launch Type 89 torpedoes, Harpoon missiles, and mines. Australia wants Mark 48 Mod 7 CBASS torpedoes, mines and probably the same UGM-84C Sub-Harpoon missiles as fitted in Collins Class. There will also be issues over which type of sonars should be fitted.

Cultural differences between the Japanese and Australian defence industries will be challenging. If they're lining up an Australian-based partner to help them deal with the serious issues ahead, there's been no public disclosure as yet.

The best chance for a successful Mark Two design and construction program with MHI and KHI, as Australia's international partners, appears to be a hybrid build. The first one or two submarines would be built completely in Kobe, with heavy involvement by Australian designers and shipyard workers there, before construction shifts to Adelaide for the remaining vessels in the project.

In the political arena, given that China is Australia's number one trading partner, what would be the impact of teaming with Japan and the US in what will be seen by China as a strategic coalition to contain their naval expansion? Neither French nor German CEP contenders have this problem.

The SEA 1000 contenders: the Germans (part 2)

Julian Kerr, 8 September 2015

Germany's bid for the SEA 1000 Future Submarine project could reasonably be described as coming from a safe pair of hands.

Since 1960, ThyssenKrupp Marine Systems (TKMS) through its Howaldtswerke-Deutsche Werft (HDW) subsidiary has delivered 161 diesel-electric submarines to 20 navies. Of this total, 123 have been built for international customers—including six NATO navies—51 of them in South Korea, Turkey, Greece and Brazil.

All have been built to fixed price contracts, a model which clearly works otherwise, as noted by TKMS Board member Torsten Konker 'we'd be broke'.

Notwithstanding the company's experience, TKMS has yet to construct a submarine in the 4,000 tonne range that's generally regarded as the size needed to meet Australia's requirements.

That isn't seen as a problem by TKMS, whose designs have steadily grown in size and capability to meet customers' specifications.

Such an evolutionary approach, based on the consistent use of the same design philosophy, is apparent in the Type 216 reference design on which the company's SEA 1000 proposal is based.

Predicated on a 4,345 tonne (submerged displacement) platform but designed to be scaled up or down, the Type 216 is 89 metres long with a hull diameter of 8.1 metres, two pressure-tight compartments, and a two-deck layout.

At the heart of the boat is a propulsion system that employs a methanol reformer air independent propulsion (AIP) system to achieve a submerged range without snorkelling of 2,600 nautical miles (4,815 km) at four knots, assisted by lithium ion batteries as a supplementary energy source.

Snorkelling under diesel electric power at 10 knots adds a further 10,400 nautical miles (19,260 km), during which the indiscretion rate—the percentage of time during which the snorkel is raised—is less than 20%.

Overall endurance is about 80 days during which, according to unofficial but informed sources, a submerged AIP period could, if required, exceed more than 20 days. By contrast, Collins boats have no AIP and their endurance without snorkelling is understood to be about three days.

While a 33-strong crew would be sufficient to man and operate the Type 216, 60 bunks will be provided to meet Navy's requirements that presumably include accommodation for embarked special forces; a gym area can be included for crew wellbeing.

The Type 216 design provides space for up to 18 heavyweight torpedoes or a mix of weapons that could include missiles and mines, fired through six bow tubes.

The design also provides an option for an innovative vertical multi-purpose lock just aft of the sail for cruise missiles, unmanned systems or divers, together with pressure-tight containers inside the aft and forward casing for torpedo countermeasures systems and garaging of unmanned aerial vehicles.

An intercept detection, ranging sonar and a new conformal array sonar in the bow are included in the sensor suite, as are an expanded flank array incorporating passive ranging, an aft sonar array, a towed array and underwater cameras.

The 2,200 tonne Dolphin II class now in service with Israel—and reputedly nuclear-armed—is the largest submarine yet produced by TKMS. Two variants known as the Type 218SG are reliably reported to have been ordered by Singapore with delivery expected in 2020.

Scaling up a pressure hull is assessed as low risk, entailing as it does the same hull material, the same calculation systematics and engineering tools, the same stealth calculations and design, the same underlying layout parameters, and the same degree of quality assurance and documentation.

The design risk is therefore in the reliability and integration of systems and subsystems, of which TKMS says more than 80% are already at sea in the company's Type 214.

Obviously these don't include the AN/BYG-1(V) combat management system and the Mk48 Mod 7 CBASS heavyweight torpedo that equip the Collins-class and are mandated for its successor. Nor are they likely to include several RAN-specified underwater and surface sensors.

Yet capabilities even within a given class can vary widely depending on the requirements, skills and presumably the pockets of the operators, and TKMS says that the integration of diverse systems and the handling of sensitive information is a well-established part of its normal business.

Close engagement with the Israeli Navy on a variety of systems had seen the Dolphin II—arguably the company's most capable type to date—'emerge as a unique submarine that precisely meets their needs'.

A \$20 billion offer by the parent company to deliver 12 Type 216-based submarines built in Germany, Australia or a mix of both, had been based on RAN's anticipated top-level requirements, Dr John White, chairman of the Melbourne-based subsidiary TKMS Australia (TKMSA), clarified to the Senate Economics References Committee in July.

Although the actual requirements had since been made available, the comparative evaluation process (CEP) involving all three SEA 1000 contenders wouldn't be long enough to produce a revised figure.

Both Defence Minister Kevin Andrews and Navy chief Tim Barrett have visited the sprawling TKMS shipyard in Kiel, where Andrews saw nine submarines either under construction, refit or repair.

A subsequent paper was prepared at Andrews' request predicting the additional facilities and expertise required at ASC should the Type 216 be constructed there under TKMS management. This paper was also copied to and discussed with Finance Minister Mathias Cormann.

Dr White, head of the successful 1990s ANZAC frigate programme, told the Senate committee that as with all complex infrastructure projects, including SEA 1000, when done properly the most efficient, lowest cost option was to engineer and plan from the very beginning for building all boats in Australia.

TKMS would also provide options for building all or some boats in Germany as requested in the CEP. If selected, the company would follow the ANZAC model and utilise multiple sites to make best use of the skilled labour located around Australia.

Perhaps surprisingly, Dr White disclosed that TKMS would find it difficult to achieve a continuous build from eight submarines—the number on which current speculation is centred—even if planned refits and potential upgrades were included in the time frame.

Since time is money, it wouldn't be prudent to achieve a continuous build process simply by extending the build schedule.

The SEA 1000 contenders: the French (part 3)

Kym Bergmann, 25 September 2015

It's often said that in terms of range, what Australia is looking for in replacing the Collins-class is a nuclear submarine, but with conventional propulsion. If this assessment were taken too literally it would favor the French bid from DCNS because that company is the only one of the three contenders that builds both types of submarines. Indeed, in their approach to the SEA 1000 Competitive Evaluation Process (CEP) the French have chosen to base their proposal on a slightly smaller version of a nuclear powered 'Barracuda' SSN than on a much larger version of their diesel-electric 'Scorpene' design.

How RAN has again managed to get itself in the position of asking for a product that doesn't exist is another story entirely—but if we are again going to go down such a risky path then the most important task is to contract with a company that can not only design such a submarine but effectively manage a contract of this huge size and complexity in Australia. DCNS stacks up well in both domains.

Looking first at the design, a nuclear-powered 'Barracuda' has a surfaced displacement of 4,750 tonnes that increases to 5,300 tonnes when submerged; has a length of 99.4 metres; and a crew of 60. While DCNS is rather guarded about many aspects of its design for SEA 1000, it has confirmed that the Australian conventionally powered version—known as the 'Shortfin Barracuda Block1A'—is 4,500 tonnes on the surface and 97 metres in length, also with a crew of 60. We can infer that the submerged displacement of the 'Shortfin'—so named after a sub-species that lives in waters around the Great Barrier Reef—will be a hefty 5,000 tonnes.

However, life isn't so simple as to replace a nuclear power plant with diesel electric propulsion. Submarines are exceptionally complicated beasts to design because they have to function in demanding and unforgiving environments; matters of weight and balance need to be precisely calculated; everything needs to fit exactly within a strictly confined space; and on top of that must be added requirements of a low noise signature, shock resistance, electrical efficiency, sufficient weapon load, habitability—and so on.

A conventional submarine needs to have a number of large diesel fuel tanks distributed throughout the submarine and many hundreds of tonnes of lead acid batteries that sit along the keel and are crucial to overall balance and stability. Nuclear submarines have a substantial reactor aft with a lot of protective shielding and an assembly of pumps and pipes to keep the whole thing working.

So the question then becomes one of design credibility and project management experience. DCNS has successfully designed and constructed submarines ranging from 1,500 tonne diesel-electric boats for export customers all the way through to French ballistic nuclear submarines in excess of 14,000 tonnes in the shape of the 'Triomphant' class. The company itself is owned 64% by the French Government, 35% by defence electronics giant Thales and the 1% balance in employee shares. DCNS has enormous technical and intellectual resources to draw down on, so designing the 'Shortfin' is clearly within its capabilities—a *sine qua non* of its selection for the CEP.

DCNS can trace its origins back to the seventeenth century and currently has 13,600 employees—though the majority of those work on naval surface ships for both the domestic and export markets. To look only at recent history, the company has sold conventional submarines to Chile, Malaysia, India and Brazil. The latter deal is particularly interesting because Brazil wants to use the local construction of four 'Scorpenes' as a bridge to building nuclear powered submarines—and France is assisting that process with a civil as well as military technology transfer package. This model is something that Australia might wish to consider if at some cosmically distant time we wanted to develop a nuclear industry.

Turning to how DCNS will approach building submarines for SEA 1000, the company is in favor of a hybrid approach to the program. This will involve building all of the first submarine in France and training Australians on its construction; building some of the second submarine in the parent yard—and all of the remaining six of the series in Australia. Analysis done by the company apparently shows that there are just as many Australian jobs involved in the hybrid model as there would be building all of them in Adelaide. It's worth pointing out even though the Collins-class was sold as an 'all Australian' build, the reality was that the complex fore and aft sections of the first of class were actually manufactured in Sweden as part of a technology transfer effort.

DCNS is holding many performance and design details of what it's offering until after the CEP bids have been lodged for competitive reasons. However, the company has nominated two areas of submarine technology where it believes it has something unique to offer. The first is the extensive use of 'soft patches' in the hull—which aren't soft at all—but are integral panels that can be opened as required to gain access to machinery and equipment spaces without the need to cut the hull, but which don't compromise the submarine's watertight integrity.

Another even more sensitive area is the propulsion system. Conventional submarines use propellers, usually of the seven-bladed skew-back variety. However, for their nuclear submarines France has moved to a pump-jet system, about which DCNS Australia Sean Costello says:

'The pump jet propulsion offered by DCNS will replace the current obsolete propeller technology. In adopting this technology, Australia will join an elite club, which includes only the United Kingdom, the United States of America and France.'

Other than the US, France is the only western country to produce almost the full range of military hardware from within its own national resources—everything from aircraft carriers, to satellites, main battle tanks, fighter aircraft, ballistic missiles, radars and command and control systems. Its excellence in submarine systems is demonstrated in part by the amount of French equipment that is on the Collins-class: the Thales 'Scylla' sonar suite; a world leading Sagem inertial navigation system and Jeumont Schneider electric motors. Collins was designed to be a 'best of breed' solution for RAN—and this quantity of French involvement is testimony to that nation's engineering standards and high quality output.

A final point about France: it has a greater permanent military presence in our part of the world than any other allied nation, with the exception of the US. With ongoing interests in places such as Noumea and Tahiti—legally considered as part of metropolitan France—as well as Reunion Island in the Indian Ocean, policy-makers in Paris are more interested in our part of the world than most Australians realize. If DCNS is successful in SEA 1000, it could act as an important catalyst for bringing two countries with similar interests and cultures much closer together.

The future submarine project: one step, two step

Andrew Davies and Mark Thomson, 8 October 2015

We've been at the [PAC2015](#) maritime expo and conference this week. There's only really been two topics of conversation on the trade floor: the future submarine and the future frigates. Admittedly those two projects amount to \$60 billion in total, give or take, so it's hardly surprising that they're centre of attention.

As usual in defence matters, there's a range of views about the strategic case for either or both, as has been reflected here on *The Strategist*. ([Ships](#) and [submarines](#).) But we found near universal agreement on two fronts, which was pretty striking—when people talk defence, consensus is unusual and diametrically opposed views are common. The first was that the Abbott government's August announcement about bringing the frigate and minor warship building projects forward would add unnecessary risk to the project. We've written a lot about that [recently](#) (and [here](#)), so we'll only note that there's no pressing need to hurry, with Anzac frigates being newly upgraded and the DDGs (air warfare destroyers) yet to be commissioned.

The second point of near unanimity was that the Competitive Evaluation Process (CEP) for the future submarine project is woefully inadequate as a vehicle for collecting data, and that it won't produce sufficiently detailed information for a well-informed value for

money decision. The agreement on that point is so strong across the board—we note ex-DMO head Warren King today [calling for an extra year in the CEP](#)—that we thought we should explore the alternatives.

We find ourselves torn on the subject—perhaps for a surprising reason. As analysts who've spent years worrying about acquisition projects and good governance in the expenditure of public money, we agree about the CEP's limitations. We'd prefer a systems engineering approach that systematically identifies risks and formulates strategies to avoid, manage or—if we must—accept them. Collecting information progressively, winnowing the possibilities and making trades between capability aspirations and engineering realities are the key elements of the Kinnaird two pass process.

One way of moving from the CEP to a more systematic approach would be to use the CEP as an ersatz Kinnaird first pass that eliminates only one of the competitors, leaving two in a second stage. At that point they'd be asked to produce detailed submarine designs, allowing for a more systematic evaluation of risks and more realistic cost and schedule estimates that could be used as a firmer basis for contracting.

That'd require time and money. But detailed design work has to happen after the CEP regardless, so the only extra time would be in evaluating two options rather than moving immediately to implementing a single concept. The extra cost might run to a few hundred million dollars, since it takes about a million engineering hours to design a submarine. Even so, that's just 1.5% of a \$20 billion project and it might be money well spent. Recall that Kinnaird and Mortimer recommended spending 10–15% of the project cost before contract signature as a prudent way of retiring risk early. Hurrying now could cause delays later, when they'll be much more expensive to fix.

Pulling us in the other direction, towards a single step process, is the recognition that the future submarine is as much a strategic decision as it is an engineering one. After all, Australia's in the market for a submarine design and build partner to help us build an enduring Australian submarine capability. But in the case of Japan, the deal would mean a lot more; it would represent a [substantial strengthening of strategic ties between the two countries](#). Critically, it would send a strong signal to both Washington and Beijing that the two countries are willing to work together to bolster a favourable strategic balance in the region. That was probably a strong factor in the Abbott government's original thinking.

From that perspective, there arguably isn't much to gain from a two step process. If the name of the game is geopolitics, and if the government judges that a closer strategic relationship with Japan is in Australia's interests, we should get on with the task of developing the submarine and the relationship.

Of course, that's predicated on the domestic political aspects of the project being equal, and they've played a significant role in the evolution of the project to date. That's pretty much why we have a CEP; the Japanese option seemed to offer less to Australian industry—enter the politics of jobs. Recent Japanese statements about their [willingness to build locally](#) should now have allayed that particular concern.

So when the government sits down to contemplate the CEP submissions, it needs to decide what's more important: the fidelity of technical information, or making a decision about Australia's strategic relations within Asia. Do we want an industrial partner or a strategic partner? If it's the latter we should just get on with it.

Australia's next generation submarine: where to now?

Kym Bergmann, 14 December 2015

With the Government confirming that it has received three proposals under the future submarine competitive evaluation process (CEP) it's worth considering where we're headed. There's a consensus emerging among analysts and commentators that the CEP might be a useful vehicle for selecting a strategic partner, but it isn't a process for making a well-informed commercial selection. In fact it's neither, but the Government nevertheless seems to be rushing ahead.

A big problem is that sooner or later everything has to be reduced to a contract. It's been a long time since the Department of Defence has had to negotiate anything really large and complex—once the messy Air Warfare Destroyer alliance is removed from the mix—and it could be that memories are fading about why it's essential to get that part of the procurement process correct. It's obviously important for the ADF and the Australian taxpayer to have a high level of confidence that what they'll be getting in exchange for a great deal of money is a product or system that largely approximates to what's required. But it's equally important for the supplier to also have the clearest possible understanding of what needs to be delivered.

Even a developmental program such as the F-35 is run as a series of annual contracts that specifically define what will be built in what numbers, what needs to be tested, and what needs to be modified—all for a precise dollar value. On the other hand, the CEP seems to be about a methodology rather than a product, and lacks a budget. At least when we attach ourselves to the US procurement system via the frequent use of FMS purchases, we mightn't always know what the exact price will be—but we can at least be certain that it will be for the same amount of money that the Pentagon itself is paying (with an administrative overhead).

Unfortunately much of the CEP is secret and we only have some general information about what is being sought, such as data on construction location choices and the knowledge that a lot of work is being undertaken on pre-concept designs. It's amazing to think that six years after the last White Paper announced Australia would be getting 12 new submarines and hundreds of millions of dollars spent on consultancies, Navy hasn't even been able to get itself to the starting point of a conceptual design.

If Defence plans to sign a production contract three years after selecting a preferred designer, they leave themselves open to enormous risks. Put simply, without commercial leverage the Commonwealth will either have to pay whatever the designer wants—or start the entire process again. The Department argues that the CEP allows them to understand how the bidders formulate their prices—but this doesn't guarantee price control at the end of the day. Far from it.

There don't seem to be any safeguards that can be built into a source selection decision at this early stage that will prevent future price hikes occurring. The only way to protect against those sorts of possibilities is to have at least two bidders to choose from and maintain competitive pressure for as long as possible.

The Commonwealth also seems to believe that having a close relationship with the three parent navies and their Governments will mean that it isn't ultimately ripped off. There are credible reports that the Government of Japan is already leaning on Mitsubishi not to add in too much profit. But Japanese companies are just as determined as their counterparts in Europe and the US to make money and pay shareholders. Presumably the management and board of Mitsubishi will be asking why they should build submarines for Australia any less profitably than they build them for the Government of Japan.

Australia developed a good relationship with Sweden on the back of the Collins program and for a while the two countries seemed quite close with the exchange of operational information and technical knowledge. Then Australia blew it. It all started to unravel in 1996 when a RAN officer leaked highly classified noise trials data to the *Daily Telegraph* specifically designed to damage the Collins program—which senior Swedish naval staff and politicians took to be a deliberate smear.

That was soon followed by other unfortunate developments such as RAN sending submarine propellers to the US for testing without even telling the Swedes what was happening. The final insult was kicking the submarine designer Kockums/Celsius out as an ASC shareholder in the year 2000. And some of our brightest bureaucrats were subsequently offended when Stockholm didn't fall all over itself in the rush to give Australia extraordinarily sensitive Swedish submarine IP.

If you get the contract right, the strategic relationship will follow because Australia will automatically have the opportunity to link up with the parent navy of whatever country is chosen and will also be developing substantial industry linkages into the bargain. The problem with the CEP is that it's designed to make a choice of supplier now, thus eliminating competitive pressure even before a design has been developed, let alone finalised.

At least with Malcolm Turnbull at the helm there's some hope that a sane, rational decision will be taken. What should happen is that the CEP offers now be used as the basis of a submission to Cabinet for First Pass Approval to acquire new submarines. Once

that box has been ticked the Department should issue a Request For Tender document to two or three bidders—and make them compete for a contract.

The only way that the current methodology makes any sense is that if Defence plans to end the competitive selection process for naval projects and enters into a series of long-term sole source contracts, as takes place in a number of countries including Britain, Sweden, Spain, Germany, Japan and the US.

This would constitute a radical overhaul of the entire procurement system and is dependent on an extremely strong local industry base that Australia unfortunately doesn't have. In all of these cases, governments are contracting with their own industry—Britain with BAE Systems, Sweden with Saab, the US with Electric Boat and so on. This means that both parties—government and local industry—have a mutual interest in negotiating reasonable contracts because they're interdependent.

The same logic won't apply if Australia sought to enter into such an arrangement with an overseas company, which could simply pull out of Australia if conditions weren't sufficiently favorable. But if the Government is going in this direction they should make it really commercially attractive and add SEA 5000 plus SEA 1180 to the mix. Both the French and German bidders make excellent surface ships; the Japanese only slightly less so. Just think of the package deal that could be done if Defence competed not only the future submarine but most of the surface fleet as well.

3. PROJECT MANAGEMENT AND INDUSTRY

The destruction of the Australian Submarine Corporation

Hans J Ohff, 10 June 2015

One can only conclude that the Commonwealth Government is actively facilitating the demise of the Australian Submarine Corporation (ASC). The government-owned shipyard has been singled out as responsible for a \$3 billion blow-out in cost, and a 24-month delay in schedule on the Air Warfare Destroyer (AWD) program that's currently underway at Outer Harbour in Port Adelaide.

These increases in cost and duration are taking place under a contract that includes an unusually high profit margin as well as providing a significant premium reflecting the costs of local construction. The inability to perform to such a contract is a manifestation of gross incompetence.

Ministers have openly declared their lack of confidence in ASC but the Abbott government remains wholly responsible for the performance of the company. ASC's sole shareholder is the Department of Finance, which reportedly has no intention to privatise the company.

Adding to the uncertainties dogging ASC is an apparent agreement between Prime Ministers Tony Abbott and Shinzo Abe to design and build the next generation of Australian submarines in Japan. The US has expressed strong support for increased military cooperation between Australia and Japan. Referring to Japan's undersea capabilities, RADM Stuart Munsch USN—who's in charge of all USN submarines between the International Date Line and the Red Sea—[claims](#) that 'the Japanese have got the (technological) lead right now'. Then-Minister for Defence David Johnston chipped in with [his assessment](#) of the Soryu-class: 'There's no other diesel electric sub of that size and dimension, it's extremely impressive that they can get a boat of that size—4,200 tonnes—through the water with diesel electric power.'

The traditional European submarine yards of France, Germany and Sweden, together with Russia and also South Korea, would differ from the assessments of both the US Admiral and the former Australian defence minister. Experienced Australian submarine experts, including Rear Admiral Peter Briggs RAN, have dismissed the statements of both Munsch and Johnston as plainly incorrect.

Treasurer Joe Hockey has also contributed to the debate [declaring](#) that we have 'run out of time' to contemplate a local build. Hockey claims that the failure of the previous ALP government to make any decisions on the Future Submarine Project (FSP) has left the Abbott Government with no option but an overseas build.

On the other side of the debate, South Australia's Premier Jay Weatherill and the State's Independent Senator Nick Xenophon point to the breaking of a cast-iron promise to have the Future Submarine build in SA.

While the bickering between the Government and the proponents of an Australian build strategy plays out before the Senate Economic References Committee; DCNS of France, TKMS of Germany and Kawasaki Shipbuilding/Mitsubishi Heavy Industries of Japan are working feverishly on their bid strategies for the multi-billion dollar contract.

The Germans and the French have proven track records in the design and build of naval submarines for foreign powers around the globe. The Japanese, with no post-war experience in exporting naval submarines, claim geo-political and geo-economic advantages over their European rivals. Japan also makes the bold claim the Soryu-class is peerless. 'It's the best conventional, non-nuclear submarine and we have the best technology to build them' [stated](#) CAP Hisayuki Tamura of the Japan Ministry of Defence.

While the Germans and the French say they would welcome the opportunity to work with ASC and other Australian suppliers to complete the bulk of the Future Submarine Project (FSP) in Australia, the Japanese are firm in their preference to build the boats in Japan—from both a security and capability perspective.

The confidence displayed by the Japanese may well be based on their belief that the Abe government has a firm agreement with Australia to build the FSP in Japan. But for retired VADM Masao Kobayashi to [suggest](#) that ASC 'don't have enough skilled workers to fashion the high tension steel', which even the Japanese find challenging, is an assertion without foundation. ASC and other Australian companies have demonstrable experience in working with exotic high tensile steels. If the naval shipyards of Japan can replicate the dimensional accuracy and weld quality attained by ASC during the construction of the six Collins-class boats, then both they and the Japanese Maritime Self-Defence Force should be well pleased with themselves.

Notwithstanding the past performance of ASC, it's doubtful whether the company has retained the technical skills that it built in the 1990s. While the AWD debacle and the poor operational availability of the Collins is not the sole responsibility of the company, the ASC of today is but a shadow of the submarine builder that it was 15 years ago. ASC's shareholder, its board and its senior management have much to answer for in reducing ASC to its current state.

ASC's decline began at the point that the Collins boats were completed in 2002. The RAN wanted a different, less commercial relationship with the company. The strict contractual terms between ASC and the DMO that were administered under a lump sum engineering and procurement contract, were replaced by a cosier relationship. The Department of Defence had convinced the Government to nationalise ASC and by releasing the designer (Kockums), the combat systems supplier (Boeing), and the constructor (ASC) from their respective contractual obligations, responsibility for latent defects, maintenance and operational improvements all fell to the Department.

As the shareholder of ASC, the Department of Finance appoints the Board, who while well-endowed with commercial, legal and political experience, completely lack expertise in naval design and shipbuilding. The Board has appointed four Managing Directors and six interim CEOs following the Commonwealth assumption of ownership in 2001. More recently, CEO and Managing Director Steve Ludlam cut short his five year contract, reportedly on the basis of a lack of support from the board. Alex Walsh, who replaced ASC's veteran Engineering Manager, Jack Atkinson, some eighteen months ago, has also returned to the UK. Thus the two most senior roles in ASC are temporary appointees. And it's the Commonwealth, not the ASC Board that has now commissioned an executive search firm to recruit a new 'General Manager – Submarines'. Meanwhile, ASC has initiated a manpower reduction program in its submarine division, and the AWD management team is being replaced with people from the US, the UK, Spain and elsewhere.

Will the current malaise lead to the demise of ASC? It should not and it must not. A world-class shipbuilding facility with dedicated staff and a skilled workforce—one that's capable of welding any steel that the Japanese mills can produce—is the foundation for the Future Submarine Project and the key component of its success.

Whether it is Japanese, German or French expertise that is selected by the Commonwealth, there's one fundamental strategic imperative that must accompany that decision. Australia must insist that the successful company transfers its design, engineering and ship-building capacities in a way that is integral to the build and though-life support program. Strategic, economic and defence considerations all dictate this requirement. The successful delivery of the Anzac-class frigates and the Collins-class submarines fully vindicate the capacity of Australian industry and ASC in particular to fulfil it.

The case for building submarines in Australia

Tony Shepherd, 15 June 2015

If there's one thing we've learned in the last 25 years, it's that government can't successfully run naval dockyards in Australia. This is why the National Commission of Audit recommended the immediate privatisation of ASC.

There are three other important lessons that we must heed if we are to create an efficient, enduring naval construction industry in Australia. The first is the requirement for a single highly competent prime contractor responsible for the delivery of the whole vessel, including systems integration.

Second, we must ensure that the chosen platform is subject to tight capability and configuration control and the use of the most advanced existing systems and equipment. Avoid R and D type solutions at all costs, and go with proven performers.

Finally, we should have confidence that we can successfully build complex warships here, adding to our high technology base and giving us the intellectual property and local capability to maintain, modify, and update naval vessels over a 30-year operating life.

Local construction gives us a much larger degree of independence than a build in an overseas dockyard. This is particularly important for a country at the end of a long maritime supply chain. The savage reality of this lesson was learnt early in WW2 when we struggled to defend ourselves.

The best recent example is the Anzac Warship Project, where 10 ships were delivered on time and on budget with full operational capability. They were designed by Blohm and Voss (now ThyssenKrupp Marine Systems TKMS) to suit Australian and New Zealand requirements, and built and integrated by a single prime contractor—Transfield Defence Systems—at the privatised Williamstown Naval Dockyard. With a new, vastly more productive workforce, ten Anzac frigates were built under fixed price contracts.

The combat system for the Anzac frigates was supplied by Sweden and developed in Adelaide. The cost penalty over a full ship build in Germany was negligible and more than offset by the long-term local industry support network. Local content in the project amounted to 80%.

These hard-learned lessons should be applied to the acquisition of our next generation submarines. The RAN has unique requirements: quiet, conventionally powered vessels able to operate in littoral waters and undertake extended, long-range patrols far from Australia. An 'off-the-shelf' solution to replace the Collins class isn't an option.

We should build on the lessons learned from the Collins-class submarines which, despite the well-known problems with systems integration and overseas suppliers, were successfully built in Adelaide. Both the Anzac frigate project and the Collins submarines' construction reached international benchmarks of productivity and quality as well as helping sustain more than a thousand SMEs across Australia.

We also need to learn from the difficulties and cost overruns experienced by the Air Warfare Destroyer (AWD) project. It isn't fair to use the AWDs as the key criterion to make decisions about the capability of local defence industry to undertake future naval

construction in Australia. The AWD alliance structure was flawed from the start, with the ship's designer left out of the alliance, and without a single experienced naval shipbuilder in charge.

The construction of the Anzac frigates and the Collins class submarines followed a series of well-established procedures in Defence procurement, starting with a careful identification of the RAN's top-level requirements for each platform. After the selection of a short-list of experienced offshore designers, funded project definition studies led to the submission of fixed price tenders for a local build which maximised the involvement of Australian industry. The Abbott government should follow this well-proven, risk-reduction path.

Our successful naval shipbuilding experience in Australia in the 1990's showed that we could build surface warships and submarines simultaneously. The Abbott government should have confidence that, with the right defence procurement procedures and contractual arrangements in place, and with construction in privately-operated dockyards, the future submarines and the future frigates can be built successfully in Australia.

Our next generation submarines should be built in Adelaide in a privatised dockyard with a single prime contractor using a proven, suitable design from a proven designer. This isn't for xenophobic reasons. It's for sound strategic and economic reasons.

Future Submarine Project—reduction of taxpayers' risk

Terence Roach and Chris Mather, 7 July 2015

Recent postings on *The Strategist* by Mark Thomson (AWD Program) and by Charles Carnegie (Leadership Risk) cast a bright light on the present record of program management failure in Australian Naval Shipbuilding, and on the possibilities for a repeat performance. Carnegie's paper asserts that, with the Future Submarine Project, 'Australia will soon be exposed to a 'leadership risk' of approximately \$15 billion'.

A survey by independent consultants [Caravel](#) for Infrastructure Australia (2013) found that 48% of projects failed to meet their baseline time, cost and quality objectives.

The report concluded: 'It appears that the delivery of Project Governance in Australia is generally highly dysfunctional'.

[Edward Morrow](#) was with RAND Corporation before he established Independent Project Analysis, Inc. in 1987. Morrow's book [Industrial Megaprojects](#) (2011) cites the failure of 65% of global projects with value over \$1 billion, from analysis of over 300 megaprojects. He found that about 30% of megaprojects fail due to errors in basic data, including engineering design, adding that projects derail long before contractors are engaged.

Although Morrow's area of analysis is industrial, his experience and much of his work are directly relevant to the FSM megaproject.

In Morrow's area of commercial developments, failure means financial loss that damages the sponsor company severely or lethally—for the FSM Project, economic failure means that Australian taxpayers must bear the unexpected additional cost. There's an ethical as well as legal responsibility on Government to put in place all feasible systems to manage the risk of failure of the FSM Project.

Large and complex projects are fragile, requiring the most careful direction and management. They must be closely monitored and tightly integrated to achieve success, with a stable foundation for the best prospect of managing turbulence in the complex project environment. According to Morrow:

One essential element of planning how to control the project is to establish the project management Information Technology (IT) system and approach that will be used. Of highest importance is to plan for as much interoperability of IT systems as humanly possible. The IT systems requirements should be incorporated into the invitation to bid for the main design/construction contract and into the requests for quotation from all of the key vendors of equipment.

This is routinely done now in the global offshore oil and mining industries, including for megaprojects in Western Australia.

DMO's approach to information management systems has failed to comprehend the criticality of this issue. It appears to see that topic as solely the responsibility of the selected shipbuilder, and does not seem to appreciate that it would be prudent and wise to be an informed customer, and to insist on a modern information management system. In this context, the AWD saga is a sorry tale of information management failure from the beginning.

The recent briefing by the outgoing General Manager Submarines listed ten criteria for the FSM Competitive Evaluation Process. Information management was omitted from the list, despite being a critical foundation needed for the Future Submarine Project—as a lesson to be learned from the AWD Project, to avoid repetition.

At project start, it's critical that the information strategy is clearly defined. This strategy is essential for the execution of the project over its entire life. Access to the digital resource is vital from the start to ensure that transparency is available to track actual progress achieved. For optimal results, the design house and the construction shipyard should use the same engineering software solution.

Many Australians (including DMO personnel) concerned with shipbuilding are unaware that Heavy Engineering IT software has changed enormously in the 15 years of this century—as our individual experiences with personal computing and mobile phones have shown.

What began with design office solutions to produce engineering drawings have now become Enterprise solutions covering all best-practice shipyard processes from concept to delivery, using a unified database that can then be readily used for ship operation and sustainment—unlike the AWD Project.

Engineering IT has now become a critical foundation for risk management of cost and schedule, including double figure percentage reductions in labour costs. Proven worldwide—notably in Korea—the world's most successful shipbuilding country, at DSME including in its collaborations with BMT UK and NASSCO San Diego.

Intense attention is given to increased project control, capital discipline, eliminating project overruns, and delivering improved efficiency in operations.

Australia's new naval shipbuilding industry should be established on a premium IT system foundation for best prospects of success and for maximum future-proofing. This should be a matter of considered direction by the Commonwealth, rather than simple acceptance of the choice of the design house and/or the shipbuilder.

The pros and cons of building the first submarine overseas

Peter Briggs, 9 October 2015

In two posts for *The Strategist*, [Why Australia Should Build Its Own Submarines](#) (part 2 [here](#)), I discussed the benefits of building all submarines in Australia, including better management of the cost of ownership through an Australian design environment and avoiding the manpower and facility overheads of establishing production and test facilities overseas.

What about building the first one or two submarines at the overseas designer's yard? This is described in the Competitive Evaluation Process as a 'hybrid' build program. Possible advantages cited by advocates include an earlier delivery from the parent yard's more experienced workforce and an opportunity to iron out any bugs while there, and the capacity to train the Australian workforce for the submarines to be built in Australia.

This approach risks establishing different supply chains; one in the overseas yard and a second in Australia for the remainder of the submarines built here. Alternatively, to avoid the additional cost of the two supply chain approach, one supply chain delivering to the overseas or Australian building yard.

This is a more complex arrangement and one where a more significant overseas supply chain is likely to remain throughout the life of the submarine. This increased supply chain complexity will result in a reduction in Australian Industry Involvement (All) and an increase in the cost of ownership.

A return to the days of dependence on an overseas supply chain would revive Australia's unhappy experience of this in the past; remember the Oberon submarine spare parts drought during the Falklands War.

The way to avoid this situation is to undertake the design phase when key components are defined in Australia, with the intent of achieving a given level of All. This was done for Collins and ANZAC projects; both exceeded the 70% target. These vessels were engineered, planned and procured from the beginning of the concept studies to be built most efficiently in Australia.

This also avoids a clash between overseas and Australian construction standards governing everything from cabling to lifting rules, etc. Non-conformance can necessitate expensive and time consuming re-work to meet Australian regulations—a problem for the AWD.

An Australian supply chain is important. Supply of components comprises the vast majority of the platform contract value and hull fabrication the remainder, of which the trades' workforce component is less than half.

As proof of success, today, more than 90% of Collins ASC's supply chain purchases are spent in Australia. This is a significant lesson to be learned from the Collins project and one that a hybrid option can't match.

As a result, Australia has a [world-class submarine sustainment industry and capability](#); we should ensure that it's used to the full for FSM. This opportunity will be denied if we fail to undertake the design definition here or build any of the submarines overseas.

Can we develop the workforce in time? ASC today has a workforce of over 2,600 professional engineers and skilled tradespeople, supported by [an active apprenticeship and professional training program](#). This includes ASC's nucleus of pressure hull welders used for the recently successful full circumferential hull cut and rejoin of HMAS Farncombe's pressure hull during the current Full Cycle Docking.

Expanding the workforce and developing the skills and production line facilities for hull forming and welding is a task to be undertaken in parallel with the design process.

Will the overseas build be quicker? Assuming hull diameter and scantlings are the same, the Japanese and French will offer the benefit of an existing production line. However, it's likely that any overseas build will require some new production/test facilities and workforce.

The manpower bill for an overseas build will be larger; both in cost and dislocation to place engineers, tradesmen, crewmembers and their families in an overseas facility to standby the building and sea acceptance trials of the first one or two submarines. At the same time we would need to set up similar capability in Australia for the follow on submarines. The duplication will compound the cost and risks of this critical phase.

The possibility of firing US ADCAP torpedoes on an overseas test range seems unlikely, delaying problem resolution and acceptance until the submarine returns to Australia.

Will the hybrid allow the inevitable design issues to be resolved more quickly? Often the problems only emerge after the follow on submarine has substantially progressed. At this point in a hybrid build we face the complication of two building sites in action. Finally, modern communications and common CAD/CAM system should allow the full capability of Australian and overseas design houses to be effective.

There were many early design 'fine tunings' during the early build stages on HMAS Collins, rectified on the spot, by Kockums working inside ASC, supervising the ASC's production design. This ensured the smooth transition from design to build, which hasn't been the case for the AWD project.

The later Collins design shortcomings were only uncovered after extensive sea trials. These were resolved by a team effort involving Defence, DSTO, the USN and Australian industry. Most of the changes fitted were designed and implemented by ASC, and certified by the designer, Kockums. I can't imagine this would have been possible had the first submarine been built in Sweden.

The Collins and ANZAC projects have demonstrated the value of planning, designing and engineering from the very beginning for procurement, construction and sustainment in Australia—to achieve the best overall value for money and strategic capability, with cost-effective and reliable sustainment in times of peace or conflict.

To avoid duplication exacerbating the manpower load and costs during the critical start up phase of the build, ensure first of class lessons are efficiently incorporated into the Australian build and to minimise the cost of ownership we should initiate the PDS phase with firm direction that all submarines are to be built in Australia, with a specified All target.

4. COST AND CAPABILITY

Cheaper by the dozen

Mark Thomson, 12 January 2016

According to the newspapers, the government's Competitive Evaluation Process (CEP) for the Collins replacement yielded bids of [between \\$10 and \\$12 billion](#) for eight boats, with the price for 12 boats [below \\$15 billion](#). Delighted by the news, the South Australian Government has [renewed its call](#) for (the originally planned) 12 submarines to be built in South Australia. Who cares if we need them or not, they're cheaper by the dozen.

I like a bargain as much as the next guy, but something doesn't seem quite right. The Collins project spent \$9.3 billion in today's dollars to deliver six boats*. But the vessels had a problem or two, and extensive work had to be done to rectify what the [SEA1000 website](#) calls 'legacy defects'. That included \$301 million to achieve an 'interim minimum operating capability', \$361 million 'to improve reliability, sustainability, safety and capability' aboard the vessels, and \$553 million to fit a combat system that actually worked. All up, the taxpayer was slugged \$10.5 billion for six boats.

For the sake of comparison, let's round the Collins price down to \$10 billion—just in case some of the follow-on work included enhancements as well as remediation. Even then, \$10–\$12 billion for eight boats looks like a great deal compared with the \$10 billion we paid for six. It means that the new boats will be cheaper than the old ones. And it's not because we are seeking a less capable vessel; the Competitive Evaluation Process seeks a submarine with 'range and endurance similar to the Collins' and 'sensor performance and stealth characteristics that are superior to the Collins'. Moreover, most observers anticipate that the new vessels will be larger than their predecessors. So why does it appear to be cheaper to build boats in the 2020s than it was in the 1990s?

Some of the apparent difference could come from the combat system being excluded from the future submarine cost estimate but included in the Collins cost. But we know from the Collins combat-system replacement program that an installed combat system costs only around \$100 million per vessel, which is a small fraction of the overall picture.

Perhaps the foreign exchange rate has delivered savings on the import-dependent share of the project? Although figures of 70% local content are routinely bandied about, the import-dependent share will be much higher because many locally sourced components will depend on imported inputs and capital goods. A favourable shift in the exchange rate could, in theory at least, reduce the cost of the imported share. Alas no. The average [A\\$/US\\$ exchange rate](#) over the life of the Collins program (weighted by annual spending) was 73.6 cents—better than today's 72 cents. As things stand, we're actually more than 2% worse off.

The changing price of labour further deepens the puzzle. There's no estimate available for the labour share of the Collins or future submarine projects, but it will be substantial—especially if the labour input to locally sourced components is included. For example, an indicative labour-share figure for a major warship is 50% [according to Defence](#). The ABS only began its present wage statistics series in late 1994 and the median spend on the Collins occurred in 1991–92, but extrapolating the average real

annual growth (1.4%) in the reported data (1994 to 2015) yields a cumulative rise of just below 40% for the period 1992 to 2015. But the median spend on the new boats won't occur until 2025 at the earliest, there's another decade of wage growth to be added. Assuming (conservatively) that real wage growth moderates to 1% per annum, that still yields a 54% increase in unit labour costs between the Collins and future submarine projects.

In principle, it's possible that the unit labour cost growth has been offset by productivity gains in manufacturing technology. Indeed, the automobile industry has managed to do so through mechanisation and supply chain refinement. But submarine yards don't lend themselves to intensive mechanisation in the same way as automobiles; the production runs are too small to justify the investment. In any case, the government's 2013 Future Submarine Industry Skills Plan envisaged a workforce of between 1,000 and 2,000 for the future submarine (excluding design, combat and platform system engineering staff), whereas the ASC workforce averaged only 821 between 1990 to 2000. So it appears that we'll actually need additional rather than fewer people—so much for productivity gains.

Setting aside the details of labour demands and wages, the long-term historical trend in successive generations of military equipment has been for [real unit costs to increase](#). To the extent there are productivity gains, they are invisible in the data. Indicative rates of growth for advanced defence platforms typically run at [3-4% or more above inflation](#).

We are left with a paradox. Australian-built submarines are falling in price at the same time as they improve in quality and grow in size—despite a greater than 50% real growth in unit labour costs and countervailing historical trends in the cost of defence platforms. A cynic might observe that a non-binding beauty contest such as the CEP allows bidders to promise low prices and ratchet up the figure when the competition has left the field. Oops, I guess I'm a cynic.

*Unless otherwise stated, all historical figures have been converted to 2015-16 dollars using the CPI.

Future submarine: coming up for air?

Andrew Davies, 5 February 2016

The future submarine project is heating up, with the government due to choose from the three competing bidders in a few months' time. All of the current press attention seems to be focused on the politics of the build, such as [whether the Americans have a preference for the Japanese option](#), or [the local industrial angle](#).

Perhaps it's not too surprising that there hasn't been a lot of discussion about some of the design aspects of the future boats. After all, submarine design is a pretty arcane topic for the mainstream press. But getting the design parameters right is critical for a deliverable project, and it's worth understanding the key issues, even if that requires some 'techie talk'.

One of the drivers of the design is the required range and endurance of the boats, which in turn impacts on choices for the propulsion system. Detailed Collins specifications are classified, but missions can last 60 days or more. At an average transit speed of eight knots (typical of a large diesel-electric boat), a boat can patrol for about 30 days at 3,000nm from base. The 2009 White Paper talked of extending the Collins range and endurance but there's since been a [scaling back of ambition](#), to a submarine with similar speed and endurance to the Collins, but with better stealth, weapons and sensors.

That's going to be challenging enough. None of the three competitors has a boat that meets our needs 'out of the box'. Japan's [Soryu class](#) is designed for a submarine concept of operations of relatively short patrols at modest distances from base. The two European firms are offering new designs. Germany's TKMS has concept designs for a 'large ocean going submarine' and a [Type 216](#), both of which draw on experience with the smaller Types 212 and 214. But both new concepts are significantly larger, which has implications for engine capacity and energy generation and storage. France's DCNS has proposed a [scaled-down version of the Barracuda SSN](#), with its nuclear propulsion replaced by a diesel-electric system.

For a boat that'll be among the largest conventional submarines, the propulsion system will be critical. The Germans have the same challenge the Swedes faced in designing the Collins—scaling up a successful design and providing it with adequate power.

The French have to give up the essentially unlimited power of a nuclear reactor and compensate with diesels and batteries (and have also suggested [replacing the propeller with a pump-jet](#)). The Japanese seem to have about the right sized solution already, but it's not clear whether they can meet the range and endurance requirements.

Going a step further into the detail, two related points of interest will be whether the chosen solution has an air-independent propulsion (AIP) system and which type of battery is chosen. It once seemed a no-brainer that the [future submarine would have AIP](#), as an [increasingly challenging ASW environment](#) puts a premium on sustained quiet operations. AIP reduces the need to run the diesels to charge the batteries ('snorting'), which produces acoustic and thermal signatures that risk compromising the position of the boat.

To give an example of the possible advantage of AIP, a Type 214 submarine can run at 4 kts on batteries for about 60 hours before it needs to snort. With AIP, the endurance can be over a month at the same speed (see [Figure 2 here](#)). Again, there's a trade-off, as the endurance falls off quickly with speed (see [Figure 3 of the previous link](#)), and AIP isn't suitable for a high-speed dash should circumstances require it. Nor is AIP a free good for the designer. It allows extended periods of quiet operation, but it's also hungry for space, having a relatively low energy density (4.5 MJ/L for fuel cells, for example) compared to diesel fuel (35 MJ/L). For a given submarine size, the incorporation of AIP *reduces* overall range and endurance.

Modern battery technology might provide an alternative solution. In the past, the only practical energy storage solution in conventional submarines was banks of lead acid batteries. They're well-understood and reliable, but they're also heavy and have a low energy density (typically around 0.4 MJ/L). With AIP systems up to a factor of ten more efficient in storage, the tactical advantages of AIP outweighed the penalty of reduced diesel storage. But modern lithium ion batteries can achieve much better energy densities than their lead acid predecessors (up to [2.4 MJ/L \(PDF\)](#), though probably less in a submarine for safety reasons, at least for now), as well as being much lighter for a given volume.

While lithium ion batteries can't (yet?) match AIP for energy storage efficiency, the difference is much less than with older battery technology. Provided that we're convinced of their reliability and [safety](#), it'll be tempting to leave out AIP, and use the space and weight freed up to carry more diesel, extra mission payload, or both.

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