

**Maximising Strategic Options in Constrained Strategic Circumstances:
The Future Underwater Warfare Capability**

Australia's Strategic Sting

Executive Summary

Top Level Conclusions

To avoid a capability gap and retain an effective undersea warfare capability the future submarine must commence sea trials in 2022.

Planning and initiation of long lead activities such as R&D are now on the critical path to inform decisions to be taken in 2010 on technologies likely to be available when the contract is let in 2016.

To mitigate development risk, the Collins combat and ship control systems need to be developed, evolved and migrated into the future SM.

The design, development and construction of the future underwater warfare capability will be a uniquely Australian enterprise, a developmental project based on the Collins pedigree, with strong support from the USN and European submarine designers.

Immediate Actions Required

The future underwater warfare capability project should be listed in the DCP in 2008.

An extension of the Australia/US agreement on submarine cooperation to cover future underwater warfare capability is urgently required noting that the extent of access to USN submarine technology and associated USN sensitivities will be a critical factor the acquisition strategy.

Bilateral government to government agreements with selected Western European conventional submarine design partners should also be negotiated urgently.

Supporting studies and R&D projects with DSTO, industry and capability partners should be initiated as an early priority.

A project team with the capacity to scope the issues, initiate the studies, contribute to the Defence White Paper and other key Canberra based processes is the most urgent requirement.

- External assistance will be required to achieve this in a timely fashion.

The Defence White Paper process should facilitate agreement on the top level capability, acquisition strategy and timescales for the future underwater warfare capability.

- The process should not be used to delay initiating the immediate essential actions identified above.

ASC should not be sold until the conditions necessary to access the critical submarine technologies are known and factored into the pre conditions for sale.

Introduction

For the past 4 years the Submarine Institute of Australia Inc (the Institute) Project SM 2020 has been considering the requirements for a future underwater warfare capability for Australia. Deliberations have included 2 international conferences, the most recent in November 2006 and a number of workshops.

In December 2006 the Institute's SM 2020 team ¹ completed a study for the Chief of Capability Development, Department of Defence, into the strategic setting; capability and roles required of a future underwater warfare capability; lessons learnt from the Collins project; and the industrial and political aspects arising from the project to acquire this capability.

This paper summarises the major findings and conclusions from these various considerations; it remains a team effort.

At the centre of this capability is a future (manned) submarine, supported by:

- An indigenous submarine design and R&D capability,
- A variety of other systems, including unmanned underwater, unmanned aerial vehicles, and
- A dynamic command, control and intelligence system.

We will use the terms 'future submarine' and 'future underwater warfare capability' to distinguish between the submarine component and the overall capability.

We will approach it in a top down fashion to consider:

- The Strategic Setting facing Australia in the period to 2050.
- Capability and Roles - What Is It That ONLY Submarines Can Do?
- Force Structure Considerations
- Design Issues
- Collins Lessons learnt in the context of the future underwater warfare capability.
- Industry Issues
- Personnel Issues

¹ Oscar Hughes, Terry Roach, Paul Greenfield, Allan Behm, Frank Owen and Peter Briggs

The Strategic Setting

Forces Shaping The Future

Without attempting to predict the precise shape of Australia's strategic environment in the period 2020-2050, it is already clear that there are powerful forces at work that will determine both the strategic settings within which Australia will need to make its strategic choices and the boundaries within which Australia will seek to exercise its policy freedoms.

The rise of both India and China, the re-emergence of Japan as a strategic actor, and the uncertain future role of the United States, are all shifting the ground beneath our feet.²

Overall, the prospects for global peace and stability are gloomy: the convergence of ideological extremism driven by fundamentalist Islam and significant changes in global power balances indicate major strategic discontinuities. In the Asia-Pacific region, continuing adjustments in the great power balance, together with continuing political, social and economic dislocation in the Pacific Island countries indicate ongoing instability.

The Key Strategic Drivers

Radicalised Islam will continue to mount a fundamental and violent challenge to the value system of liberal democratic societies, and the threat of the use of asymmetric force – particularly terrorism – will continue, sponsored by both radical non-state groups such as al-Qaida and by fundamentalist states such as Iran and Syria. Australia and western interests in South East Asia will continue to be targets for such acts of violence as is evidenced in the Philippines and Indonesia. From the perspective of Australia's defence strategy, it is important to recognize that terrorism operates at the interface between the clash of values (that is, the clash between the absolutist values of radicalized Islam and the values of democratic liberalism) and the antagonism that traditionally defines relations between states pursuing opposing political and strategic objectives. States, particularly those that subscribe to political principles opposed to democracy and individual rights, will continue to exploit opportunistically the potential that always exists for destabilizing the security of their opponents by supporting instability on their opponents' borders. This may extend to support for groups that espouse terrorism.

For Australia, the political, economic and institutional fragility that characterizes most of the states in its immediate neighbourhood raises the double-headed spectre of large-scale domestic violence fomented by external interference.

² Defence Challenges for The Next Government, Dr Mark Thomson, ASPI 12 November 2007

China and India will emerge as major global and regional strategic players, exercising political, economic and strategic power in pursuit of their national objectives while at the same time constraining others in the pursuit of theirs. The centre of gravity of global economic power will continue in an easterly direction in the period of the strategic outlook so that by 2050 it sits largely on the Indo China border.

A fierce global competition for resources will become an increasingly important strategic factor; particularly energy (both hydrocarbon and nuclear), key strategic minerals and water. China and India will compete in this domain with the industrialised nations – the USA, Japan and the members of the European Union – as well as the emerging industrialised nations such as the members of ASEAN, key South American nations such as Argentina, Brazil and Mexico, the emerging powers of the Middle East (particularly Iran) and Russia.

Whilst Australia is well endowed with energy sources the trend is heading from a sensitivity to energy interruption to one of vulnerability:³

- 97% of our transport sector relies on petroleum products of which 76% is imported, most from the Asia Pacific region.
- This trend is increasing.
- Geosciences Australia predicts that Australia's net self-sufficiency in oil will decrease from 84% to 20% over the next 20 years.
- Indigenous refining capacity is declining and being replaced by offshore refineries.
- The developing countries in our region are experiencing huge increases in their own energy requirements.

We have a growing dependence therefore on imported oil and petroleum imports, refined in countries that are themselves increasingly vulnerable to an interruption in supplies.

Water will be an emerging issue for many in the region:

"The consequences for humanity are grave. Water scarcity threatens economic and social gains and is a potent fuel for wars and conflict."⁴

This will also translate into increased demand for energy, to provide water by desalination.

The political, economic and strategic reach of the USA will, in relative terms, reduce. While it will remain the wealthiest nation in *per capita* GDP terms, the balance of power between the USA and its competitors will shift, and the USA will no longer enjoy the freedom of action that accompanied its status as the sole superpower.

The message is clear: based on current trends, by the middle of this century, the world will see a Chinese economy that is significantly bigger than that of

³ Power Plays – Energy and Australia's Security, Michael Wesley, ASPI October 2007

⁴ UN Secretary-General Ban Ki-moon, The Australian, 5 December 2007

the USA in purchasing power parity terms, and an Indian economy that is approximately the same size as that of the USA. There are significant assumptions underpinning these predictions, one significant proviso is China's ability to maintain social cohesion and stability. Ross Terrill is optimistic in this regard:

".. the future is always more open than we prognosticators of China's future judge. China repeatedly eludes the limits set ... transcends the categories offered by past and present foreign mythmakers." ⁵

This means that, with China, India, and Indonesia having economies approximately 30, 20 and 3 times bigger respectively than that of Australia, our global strategic environment will be fundamentally different from that of 2007. ⁶

Climate change is likely to impose major stresses on the region: a number of small Pacific states may disappear, the impact of changing sea levels is likely to be felt throughout the Indonesian and Philippine archipelagos, and the inundation of large low-lying areas such as the Ganges delta is likely to initiate major population pressures on the Indian subcontinent. The impact of this on our security environment is by no means clear, but the possibility a significant impact on the global economy and strategic discontinuities can not be ignored. I note that Professor Paul Dibb is more optimistic in this regard. ⁷

Increased Importance of the Maritime Environment

Against this uncertain future strategic outlook, the maritime environment will become more significant in both economic and strategic terms. Sea Lines of Communication, increasingly more critical for the economic and energy sinews of the global economy will become more heavily populated and hence, the vulnerability to commercial shipping will increase.

The value of international trade flowing through this region will more than double by 2020, and possibly triple by 2030 the number of ships sailings in this region will more than double ⁸

The maritime security environment will also become more demanding. The investment being made in maritime capability throughout the region will give nations the capability to assert their maritime sovereignty rights, including in the undersea environment. The growing dependence on the sea for resources derived from it or carried on it will provide the stimulus to use this capability. Surface and sub-surface passage will be subject to legal and quasi-legal interference and constraint. In short, more countries will seek to practise undersea denial. There is also an increased probability that non state actors will use various forms of sea denial, such as mine laying.

⁵ The New Chinese Empire, Ross Terrill, UNSW Press,

⁶ Strategic Tides – Positioning Australia's Security Policy to 2050, Allan Behm, Kokoda Foundation

⁷ Defence Policy Can't Be Left to The Doomsayers, The Australian, Paul Dibb, 21 December 2007

⁸ Australia's Future Underwater Operations and Systems Requirements, p 9, Ross Babbage, Kokoda Papers April 2007

Access for surface warships or military aircraft may become constrained in many circumstances. It is not difficult to imagine a scenario in which a regional country finds the overt presence of an Australian ship or military aircraft an embarrassment in its relations with one of the regions recently emerged economic giants. Submarines on the other hand are able to exploit their stealth and will continue to provide Governments with an option in this scenario.

Regional Investment in Submarine Capability

Significant investment is underway by regional nations to acquire or improve their submarine capability. Modern, Western European technologies are being fielded in many of these capabilities. India and China are also acquiring European and Russian submarine technology of considerable sophistication. Indonesia's program to acquire 10 Soviet Kilo class submarines is the most recent example.⁹ By my reckoning, from publicly available figures indicates that by 2025, there will be in excess of 130 modern submarines in our region (in addition to those of Australia and the USA).

China is upgrading its nuclear powered submarines and India is also likely to acquire nuclear powered submarines; both will also field submarines with a nuclear strike capability.

These developments illustrate a near universal acknowledgement of the force multiplier effects of modern submarine forces and their ability to present a real threat to a potential aggressor that requires a disproportionate effort to neutralise.

Australia's Need For a Strategic Sting

Allan Behm has coined the term, **Decisive Lethality** to describe Australia's need for the ability to deliver a decisive blow in its defence:

*'Australia's strategic problem is unique: how to manage the defence of 20% of the earth's surface (including the EEZ) with 0.3% of the world's population? The answer lies in good policies that reduce the prospects of war – strategic diplomacy – working in tandem with defence capabilities that are decisively lethal should they be employed. Such capabilities are not premised on weapons of mass destruction. But neither can they be premised on massive conventional capabilities, because Australia has neither the resources nor the people to develop and maintain them. Rather, decisive lethality is premised on tailor-made capabilities that Australia is uniquely able to develop and deploy, for which effective counter-measures exceed the capacity of possible adversaries.'*¹⁰

This attribute becomes all the more important given the struggle to access the increasingly scarce and critical resources outlined above, **a significant portion of which reside under Australia's control.** For example:

⁹ Jitters As Indonesia Buys Russian Subs, SMH, 5 September 2007

¹⁰ Strategic Tides – Positioning Australia's Security Policy to 2050, Allan Behm, Kokoda Foundation

- Australia has the world's largest uranium reserves - 28 per cent of the planet's known supply. ¹¹
- Australia's economically demonstrated resources of zinc, lead, nickel, mineral sands (rutile and zircon), tantalum, uranium and brown coal remain the world's largest, while bauxite, black coal, copper, gold, iron ore, ilmenite, lithium, manganese ore, niobium, silver and industrial diamond rank in the top six worldwide. ¹²

A strategic sting is designed to make an aggressor avoid a military confrontation with Australia. Let me demonstrate why we believe Australia's future underwater warfare capability constitutes this critical strategic sting.

Submarines – 'The Special Forces of the Navy' ¹³ **What Is It That ONLY Submarines Can Do?**

Australia's Requirements of Its Submarine Force - The Strategic Sting of Choice?

Turning to Australia's requirements of its submarine force; the submarine's unique capabilities of stealth, long range and endurance that allow it access in key areas denied to other platforms will be critical in the scenario ahead of us. Other platforms can do parts these missions; none offers the covert combination of capabilities of the submarine.

The correct investment strategy in a future submarine force will confer a significant strategic deterrent capability for Australia, not only measured in Defence terms but also contributing to the security of energy supply.

A significant factor in the deterrent value is the exorbitant and disproportionate cost involved in trying to counter a capable submarine force and the degree of doubt that exists that, regardless of the investment, the ASW effort can succeed. Some commentators cite an investment ratio of greater than 100:1; every \$ spent on a submarine capability requires at least \$100 to counter and the desired outcome can by no means be guaranteed. This is a significant strategic return on investment.

Only the submarine offers this capability.

The strategic setting outlined above will result in a reinforcement of existing roles and an expanded range of strategic effects to be achieved by Australia's submarine force. These new or modified strategic effects expand the roles required of the future underwater warfare capability, beyond those currently expected of the Collins force. Let me discuss briefly the most critical.

¹¹ Australian Uranium Association, www.australianuranium.com.au

¹² Geoscience Australia, www.ga.gov.au

¹³ Australian Defence Association Director, Neil James

I should preface these points by emphasising the importance of good operational command, control and real time intelligence support to maximise the effect of submarine operations.

The Falklands War provides an example. The Argentinean Navy and Air Force demonstrated how not to do it – the one modern submarine available, the *San Luis* was deployed independently, without the benefit of coordination with the aircraft assets employed. Even with this limitation and a defective fire control system, *San Luis* conducted 3 attacks, all unsuccessful, possibly due to the failure to prepare the torpedoes correctly. Regardless of these realities, San Luis tied up a huge amount of the Royal Navy Task Force time and effort in defending against the threat and was never successfully attacked.¹⁴

Surveillance and Intelligence Gathering.

The ability to gain access to areas denied to other units, combined with its ability to concurrently observe activities underwater, on the surface, in the air and over the electromagnetic spectrum, are particular strengths. Combined with the ability to fuse and interpret the observations and react immediately to maximise the opportunities for further collection and understanding the activities makes a submarine a unique platform for this role.

Only the submarine offers this capability.

The information provided will contribute to Allied and Australian knowledge, enabling us to gauge intentions, deploy diplomatic and military preparations and, in the event of a contingency, position our limited military capability for maximum effect.

An example; during the Falklands War Royal Navy SSNs positioned off the major Argentinean airfields were able to alert the task force offshore to the departure and often, the composition of the departing waves of strike aircraft – critical information to enable the limited endurance Harriers defending the ships to be positioned.¹⁵

Land Strike.

A submarine fitted with land attack cruise missiles is able to position within launch range without alerting the adversary, withdraw quietly if not required, or launch on instruction and withdraw without provoking or offering an opportunity for a further engagement.

Only the submarine offers this capability.

While suitable land strike cruise missiles can be carried in combination with other weapons such as torpedoes, mines and anti ship missiles, this role requires a profile from the submarine that is incompatible with roles requiring a more proactive stance. Let me clarify this point:

¹⁴ Submarine Operations During The Falklands War, Lieutenant Commander Steven R Harper, USN, Naval War College, 17 June 1994, p 18.

¹⁵ Ibid, p6

- A submarine deployed on a land strike mission needs to find a quiet spot, at a suitable range from potential targets, keep well away from the adversaries ASW forces, avoid counter detection and await instructions.
- Compare this profile with a submarine required to gather intelligence or conduct more offensive operations – this submarine must go to where the action is and be much more proactive to be successful.
- Whilst a mix of weapons can be carried the two roles can not be easily mixed; a factor when force structure is being considered.

Battle Space Preparation.

The submarines' ability to covertly gain access to the denied areas, assess the environment and deployment of opposing forces, without alerting the opponent and relay this back in order to allow future task force operations in the area, make it a preferred option for effective battle space preparation.

Only a submarine offers this capability.

With suitable capabilities embarked, the submarine is able to identify and if permitted, neutralise threats prior to a coalition task force or shipping convoy moving into in the area. Once the task force operation is underway, the submarine is able to provide direct support, (noting that a conventional submarine lacks the mobility to support a rapidly moving task force - but is able to do so for short periods or in key geographical areas) – thus requiring more than one submarine deployed along the line of advance.

Another example from the Falklands War. HMS SPARTAN, a Royal Navy SSN was able to observe the mining of the approaches to Port Stanley and fix the position of the mines as they were laid - the Rules of Engagement did not allow the submarine to do a little offensive mine sweeping!¹⁶

Anti Submarine Warfare

The mirror image of this capability is the challenge posed by the growth in regional submarine capability.

*'In a contingency, submarines will be able to seriously threaten the operation of surface fleets and commercial trade.'*¹⁷

Australian submarines are a potent anti-submarine weapon; this is perhaps their most demanding role. This capability is enhanced by the optimised sensor suite possessed by a submarine compared with all other ASW platforms. Maintaining an edge across the spectrum of stealth, sensors, weapons, countermeasures and training is critical to success – an ongoing investment in R&D and programs to continually upgrade capabilities in **all** these areas is the price of a viable capability.

¹⁶ Ibid, p4

¹⁷ The Enemy Below: Anti-Submarine Warfare and the ADF, Andrew Davies, ASPI Special Report February 2007

Where practicable own submarines should operate as part of an ASW network. However, there are many scenarios, where we will lack sufficient sea and air control to permit the deployment of surface and air ASW assets.

Only a submarine offers this capability.

This is a very challenging role, it must be supported by the R&D effort to achieve a technology edge, current and accurate intelligence and executed by the most capable command and control support – these will be the difference between success and failure and all aspects of the underwater capability must be sustained and focussed to achieve this. Despite all these efforts to ensure a winning edge, the margin between success and failure is small and attrition of own forces must be anticipated. This reality and the relatively low mobility of conventional submarines are key issues for the force structure considerations.

A Network Contributor With Unique Abilities.

The submarines ability to gain access to critical, denied areas allows it to make it a unique contribution to the network. The technical challenge is to do so without compromising the submarine's covert stance, off-board vehicles and low probability of interception communications channels are some of the tools to achieve this.

Only a submarine offers this capability.

An Expanded Range of Special Forces Operations.

Given the strategic setting and trend for asymmetrical conflict, this is likely to be a growth area for the future underwater warfare capability. Exploiting the submarine's ability to covertly transport, launch and recover the Special Forces and their equipments, provide command and control and if necessary, a level of tactical fire support will be a significant design driver.

Only a submarine offers this capability.

It is also likely to require the fitting of additional weapons capabilities, such as short range, tactical land strike and AAW missiles.

Offensive Mining

Mining using sophisticated, discriminating mines or mobile mines where necessary will enable us to deny access to selected areas or ports not under our sea or air control. Depending on the situation, these can be declared, leaving the choice to the adversary whether he wishes to challenge the mine!

These can be laid in areas inaccessible to other units and activated on command, if necessary, by the submarine.

Only a submarine offers this capability.

The Role of Unmanned Vehicles In The Future Underwater Warfare Capability

Unmanned underwater vehicles and unmanned aerial vehicles are a force multiplier that will extend the manned submarines reach effectiveness and survivability. Remote sensors deployed or carried by an unmanned vehicle could offer a winning advantage to the larger submarine in an ASW encounter with the smaller submarines proliferating in the region.

These vehicles are a key component the future underwater warfare capability and should be considered an integral part, to be acquired as part of the overall project. It is a major area for R&D and a design driver for the future submarine.

Force Structure Considerations

Top Level Capability – What Australia Will Require of Its Future Submarine Force

In considering the strategic setting and our geographical area of interest, it is likely that Australia will wish to concurrently maintain submarines at very long ranges (>3,000 nm) in the critical roles of surveillance, intelligence gathering, indications and warning and in the event of a contingency, land strike. Concurrently Australia will also wish to provide submarines in support of Task Force operations or for special force missions closer to home (2- 2,500 nm).

The issue of concurrent roles and allowance for attrition of own submarines employed on offensive operations are additional factors to the calculation of the force structure required to achieve the strategic effects.

The Defence White Paper – An Opportunity, Not An Excuse

The proposed Defence White Paper provides an excellent opportunity to consider these issues and identified the top level requirement for the capability. However there is much to be done in the lead up to this project and limited time in which to do it – it could be a serious mistake to await the outcomes of the Defence White Paper before initiating the long lead activities.

What Our Alliance Partner Expects of Australia's Submarine Force

In view of the democratic and liberal values that both Australia and the USA share, the Australia - USA alliance will remain a core feature of our strategy. Arguably, the USA will place an increasingly high priority on Australia's capacity to provide a capable conventional submarine force as a contribution to that alliance. This is precisely the point that the then-Rear Admiral Al Konetzni made to the then-Minister for Defence John Moore in 2000, when, prior to its systems upgrade and noise reduction, Collins had already impressed at the annual RIMPAC exercise (news, by the way, that the then-Minister was not altogether impressed to hear!). "Mr Minister, the USN needs those boats!" It is reflected in the Agreement on Submarine Cooperation,

signed by the Australian Prime Minister at the Pentagon On 8 September 2001 – the day before the terrorist attack.

Conclusions on the Strategic Setting, Capability and Roles and Force Structure Considerations

The following conclusions are drawn from the first 3 sections of this paper:

- The likelihood of significant strategic discontinuities and major shifts in global power balance over the next four decades create a compelling case for the acquisition of a new and expanded undersea warfare capability to ensure there is no capability gap as the Collins class reach end of its capability and hull life in 2025.
- The strategic environment 2020 – 2050 demands an advanced underwater warfare capability, centred on a long-range, sophisticated submarine backed by a through life R&D based improvement program to achieve and maintain a qualitative edge.
- Compared with Collins, the future underwater warfare capability will be required to operate in a more demanding environment, at greater range and to achieve an expanded number of strategic effects.
- The underwater warfare capability will be a critical and unique asset in the nation's Defence capability; deterring 'would be' aggressors – providing the **strategic sting** and an increasing important contribution to the US alliance obligations.
- The strategic effects, consequent roles, the need for concurrency and an allowance for attrition should be factored into force structure considerations.
- The Defence White Paper offers an opportunity to set the top level capability, not an excuse for delay in initiating the long lead activities.

Design Issues

Submarine Design-- A Comparative Regional Advantage

Given the importance of a submarine capability as a core defence requirement for Australia beyond 2020, Australia's regional pre-eminence as a designer, builder and operator of submarines is a comparative regional advantage – it should be maintained as a matter of strategic priority.

'Australia is currently one of the few countries to have mastered advanced defence operations in the underwater environment cannot readily be matched or countered by most potential adversaries ...in many future defence contingencies, this competitive advantage would be extremely useful and in some is likely to prove decisive'.¹⁸

¹⁸ Australia's Future Underwater Operations and Systems Requirement, Ross Babbage, Kokoda Paper, April 2007, p 3.

A Unique Requirement

Because of Australia's geography and interests, the design and operational characteristics of the submarine capability will represent a unique combination of factors:

- Long transits from home bases in Australia to a distant patrol area, combined with the likelihood of short-notice contingencies will demand high levels of mobility and long endurance.
- The nature of the littoral operating areas, stretching from the Arabian Gulf to the North Pacific will demand both high agility and prolonged covert operations in littoral operating areas.
- And, as a result of the changes to the maritime operating environment noted above, Australia's submarine force will require a very low signature in all spectrums and at high speed, thereby imposing new demands on submarine design.

Acquisition Strategy

There are a number of options, after consideration of the various factors we have concluded that a submarine developed from the Collins experience and pedigree is the lowest risk path.

Happily this proposed acquisition strategy has received a degree of bi-partisan political endorsement that provides a useful starting point for the project; both political parties have agreed in the run up to the election that ASC is the clear choice to construct future submarine capability.¹⁹

In our opinion, it is unlikely that competition between two design proposals will be practicable in the timescales now available and given the limited number of experience personnel available to manage this project. The low-risk option is to develop from Collins. This development will entail substantial changes; the most visible will be the external hull shape, optimised for high-speed transit and a 'nose job' to streamline the critical first 5m – no row of torpedo tubes across a flat nose in future submarine! This can be expected to:

- Yield a 10% energy efficiency gain over Collins.
- Improved sonar performance compared with Collins, particularly when moving at high speed.
- Reduced self noise.²⁰

¹⁹ Government Matches Sub Deal, The Advertiser, 20 August 2007

²⁰ Some Aspects of Submarine Design Part 2, Shape of Submarine 2026, Professor Peter Joubert OAM

Internally, new technologies will be critical to achieving a capability edge; perhaps the most challenging areas are associated with acquiring, storing and using energy for both transit to a patrol area and covert patrol when on station. Few if any of the equipments used in Collins will be available or appropriate for the future submarine; developing and integrating new equipments is a substantial design and construction task.

There will be a number of new issues for the designers and operators to weigh up and consider in the trade off process, some examples include:

- Reconfigurability – the flexibility to adapt for the role of the day.
- Carrying capacity – the ability to accommodate and sustain the additional personnel and equipments associated with particular missions.
- The unmanned underwater and aerial vehicles pose a particular challenge in this regard.
- Achieving sufficient design margins, eg space, stability to allow for future growth.

There are many other issues for consideration during the early phases of the design trade offs, these examples are not exhaustive, simply intended to make the point that this will be a developmental project and should be appropriately managed and resourced. The lessons from Collins in this regard include the need to:

- Recognise and accept the developmental nature of the project – allow an appropriate contingency in time, funding and scientific support to cope with the unknowns that are bound to arise.
- Assign the risks so that they can be actively managed by those best able to do so. This approach points to a relationship style of contract, not a 'black letter law' performance specification contract.

In the high risk software based systems, the low risk path is to evolve from current weapons, combat system and C3I systems. When combined with the fitting of new land strike cruise missile this strategy reinforces the need to maintain access to US technology.

Air Independence

Given the threat environment arising from the strategic setting it will be critical that the future submarine is able to operate completely covertly whilst in a patrol area, without the need to snort to recharge batteries or refresh its atmosphere.

Current air independent propulsion technologies such as fuel cells or stirling engines incur a substantial space and weight penalty – the solution adopted in many smaller European submarines is to remove battery and generator capacity to offer up space and weight. This is not an appropriate solution for a submarine wishing to complete long transits, quickly and with minimum indiscretion. The air independent propulsion offers no assistance in this phase as its precious and limited quantity of fuel must be conserved for the patrol area.

We should be looking to second generation air independent propulsion technologies and alternatives such as the nuclear batteries ²¹ now under development in the laboratories. There is a major developmental project entailed in achieving an operational capability – an early candidate for DSTO and industry partnered R&D. The Russians appear to have solved this problem:

'Russia's Sevmash shipyard at the Arctic city of Severodvinsk has completed a hybrid submarine powered by a diesel-electric plant and a small nuclear reactor known to some engineers as a "teakettle" -- to keep a charge on the battery, providing essentially unlimited underwater endurance on relatively quiet electric propulsion. In effect, this is an Air-Independent Propulsion (AIP) system.' ²²

ASC's Design Capacity

ASC is the Design Authority for Collins. Provided its ownership is appropriate, it is uniquely placed to be able to access the critical, sensitive technology from both US and European suppliers and combine this with its real world experience on the Collins class. No other potential designer offers this opportunity.

ASC's capacity to act as the Design Authority for a new submarine will depend on continuing efforts to build its internal capacity by judicious hiring of experienced personnel, suitable design development tasks in Collins through life development, a continuing relationship with Electric Boat and support of a European design house to provide the technology unique to a conventional submarine.

Given the correct investment in fostering this capability ASC is indeed the low risk option. What can be done using Collins?

Future Submarine Capability Prototyping in Collins

COLLINS Class technology refresh/spiral development programs could serve to reduce the risk of design development work and prototype testing associated with the future submarine capability.

To be effective this program must not only maintain the capability of Collins, but also provide a test bed to push the technology boundaries where appropriate, e.g. emerging battery technologies, second generation Air Independent Propulsion systems and propulsion motor technology.

²¹ Nuclear battery keeps going, and going , Live Science, 16 May 2005.

²² Russia Completes Hybrid Submarine, Norman Polmar, 20 December 2007

Research and Development Program

We should be seeking a technology 'leap' to counter the regional growth in maritime technologies. By First Pass in 2010 we must have identified those technologies that offer this potential and then developed these to enable a contract to be placed in 2016 to incorporate these into the future underwater warfare capability.

A through life R&D program involving DSTO, ASC industry and technology partners will be essential to sustain the capability edge and is part of the parent navy obligation. The program should be used to deliberately foster and support small to medium enterprise companies in Australia, these companies have been the source of much of the leading edge innovation available in the Oberon and Collins programs.

Establishing the teams and relationships will take time. This work will provide a key input into the design trade offs to be considered in finalising the specifications and letting the contract in 2016.

The following areas are a sample of some of the areas likely to require indigenous R&D by DSTO and industry through all phases of the design, build and in service life of the capability:

- Hull materials
- Hull forms.
- Batteries.
- Air independent propulsion Systems.
- Propulsion arrangements including motors and propellers/propulsors.
- Life support systems for the extended period of dived operations.
- Unmanned vehicles, their interface with the submarine and measures to avoid compromising the covert stance of the parent submarine.
- Signature reduction measures, including coatings to reduce the submarines signature in all spectra, eg anechoic coatings v active sonar, radar absorbent material v radar, etc.
- Countermeasures operating in all spectra.
- Combat system, and sensors.
- C3I technologies, including those to support networking in a hostile environment.
- Ship control systems to reduce crew workload and numbers.

These programs also provide the essential entrée to our selected partners' R&D in these sensitive areas – part of the essential currency for a joint R&D project.

If the 'off the shelf' option is developed from Collins, what are the design drivers for this development?

The Key Design Drivers

The key design drivers for a future submarine capability are identified in priority order are:

- Stealth.
- Mobility.
- Range and endurance.
- Payload including weapons, countermeasures and unmanned vehicles.
- Sensors and connectivity.
- Manning.
- Handling characteristics.
- Through life supportability and growth potential.

Timescales

By 2025 HMAS COLLINS will be 30 years old and obsolete.²³ If we are to avoid a critical capability gap the future underwater warfare capability must be operational at this time.

Similar to the Oberon experience at this time of life, it will not be cost be effective to sustain or replace ageing systems, nor is it an option to extend Collins:

- Collins currently lacks the design margins (space, ship stability, power, cooling etc) to sustain significant capability enhancements to meet the increasingly demanding environment and new requirements.
- A life extension program is therefore likely to be a poor return on investment.
- The attraction of this option to the bureaucrat, as a means of delaying a difficult decision should be resisted – it is a distraction and will result in a serious capability gap.

We must therefore field a new underwater warfare capability in 2025
Assuming our recommendations on the acquisition strategy is followed the timescale counting back could be:

- 2022 – 2024 What Have We Got?

²³ Australia's Future Underwater Operations and Systems Requirement, Ross Babbage, Kokoda Paper, April 2007 page ii.

- Three years of pre acceptance trials – this is a critical part of the risk mitigation strategy and must not be regarded as a ‘just in case buffer’ or project float. During this period the submarine and its systems such as UUVs will undergo extensive trials to identify the inevitable, unexpected problems, resolve them and provide a submarine ready to commission and commence operational work up.

- 2016 – 2021 Build It.

Six years to finalise the design and construct the first submarine. The contract must be let in 2016, ie ‘Second Pass’ 2016.

- 2011 – 2015 Resolve Design and technology Issues and Finalise How You Intend to Acquire It.

Four years to complete the design studies/trade offs, develop the technologies to the point that they can safely be incorporated into the design and prepare the contract documentation for the design and build and supplier contracts.

- 2008 – 2010 What Capability Do We Need? Where Are the Technology & Knowledge Gaps? How Do We Fill Them?

Three years to establish the project teams, finalise the requirements and acquisition strategy, initiate the R&D teams, design teams, industry partnerships and Government to Government relationships whilst completing the initial studies to inform the design and trade off processes. By 2010 we must have identified those technologies likely to lead to the capability edge we seek.

‘First Pass’ 2010.

This process assumes an acquisition strategy of developing from Collins to the future submarine using ASC as the Design Authority and builder, supported by the USA and European designers and equipment suppliers. There are other models, but we submit, none that can achieve the end point with a lower risk profile in this time scale.

Nor can we afford to spend 2008 waiting for the Defence White Paper to tell us something we already know and have bi-partisan political endorsement for – there will be a future underwater warfare program, the long lead activities proposed in this paper will be relevant regardless of the implementation model decided following the strategic framework established in the Defence White Paper.

Nuclear Power

The requirements for long transits and covert operations and potential adversarial nuclear powered submarines could justify the introduction of nuclear powered submarines into the Australian Defence Force orbit. We submit that this is not a practical proposition in the timescales envisaged for the future submarine project. Apart from the significant political and public concerns to be overcome before implementing such a project, Australia lacks the critical regulatory regimes, industry capability and educational institutions to prepare appropriately qualified personnel. Unless and until we adopt nuclear power for electricity generation these essential criteria are unlikely to be economically achievable.

Development of this option would therefore be a distracting and time consuming debate and misuse of our very limited resources to manage this project. It has the potential to derail the timely acquisition of a future submarine capability, leading to a significant capability gap.

Accessing Submarine IP

Access to and control over IP is a key determinant of shipbuilding and repair capacity particularly in relation to vessel design and combat systems and their ongoing development and upgrades. Australia needs to be able to access the quote "best of breed" in submarine systems and design to achieve the capability. These will be drawn from Western European designers and our current submarine capability partner, the USN. All parties are particularly sensitive and wish to protect their submarine IP; Governments who fund much of the R&D are very sensitive to exposing their leading edge submarine technology to third parties. Australia must be able to demonstrate that it is able to protect this information from third parties. This has significant implications for the future ownership of ASC.

An open market approach is therefore **not** likely to lead to the most capable solution; instead, access to this technology will require specific agreements between Governments, the conditions attached may well limit the range of participants.

Selecting the right partners is therefore important; a critical test in this selection process is the depth and capability of their ongoing submarine R&D programs. This capability for original work is important in optimising the design, maintaining the leading technology edge in through life capability development and solving the inevitable 'unexpected' in service problems that are the lot of a parent navy. This team capacity will also be a major factor in identifying valid design options for future underwater warfare capability.

Access to US submarine technology will need early resolution and probably, an extension of the current government-to-government agreement on submarine cooperation on the Collins class. Similar government to government level agreements may be required to cover European involvement.

However, noting the unique features of Australia's requirements and difficulty of accessing submarine Intellectual Property (IP) there are a number of areas where Australia will have to develop its own solutions to the problems. Examples are provided in earlier consideration of the R&D issue.

The Defence Science and Technology Organisation working in conjunction with the USN and industry have demonstrated this capability in resolving many of the issues associated with the Collins program. Much of this Australian capability has now dissipated it will require time and incentives to re-establish an indigenous R&D capability in a number of key submarine technologies. Given the lead times for such activities, this is now an urgent requirement.

Conclusions On Design Issues

- Australia should build on the capacity established by the Collins project to design and build the future submarine.
- Collins can be used as a trials platform to reduce the risk of introducing new technologies for the future submarine.
- Time is tight, early agreement on the acquisition strategy and initiation of studies and R&D is now critical.
- Initiation of the long lead activities can not await the conclusion of the Defence White Paper process.

Collins Lessons Learnt in the Context of The Future Underwater Warfare Capability

Outcome

The principal aim of the COLLINS program was to acquire a new class of submarines suitable for operations in the mid-1990s and beyond. Compared to a 'build to print' program (eg, construction of, say, UPHOLDER Class submarines based on 1970s technology), the COLLINS program involved a number of innovations and acceptance of risk to ensure the capability sought was appropriate to the future strategic environment. It is now clear, despite its complexity and controversy, the aim was achieved and Australia acquired a world-class conventional submarine capability augmented by a strong industrial support base. In doing so the foundation necessary for the future submarine capability program has also been established.

Australia's Capability to Manage a Complex Developmental Project

The COLLINS program demonstrated that Australia has the capacity to manage a complex submarine construction program as well or better than a European or US supplier. Deficiencies in the build phase related more to design and contractual problems, including with overseas suppliers, than to shortcomings on the part of Australian industry. While a future program will also involve a number of innovations and acceptance of risk, there will also be initiatives based on COLLINS experience that will mitigate risk. These include migration of some equipment/systems evolved in the COLLINS class, access to USN and European submarine technology, adoption of more appropriate contract terms and conditions and improved transition planning.

Conclusions on the Lessons Learnt from the Collins Project

The Collins project, despite its complexity and controversy delivered an excellent strategic capability for Australia. A future submarine project will have a much stronger starting point as a result. The Government and Defence Department should have strong confidence in Australia's capacity to manage and deliver the capability.

Industry Issues

Global Marketplace

The global marketplace for submarine construction has undergone considerable consolidation in recent years particularly in the UK, Germany and US. While a number of countries construct submarines under licence, only Germany, Russia, France and most recently, Spain are active in the export market. None of the western suppliers are building a submarine that meets the capability required of the future submarine.

Australian Shipbuilding Skill Base

Commonwealth investment in the COLLINS Class has greatly boosted the skill base of naval shipbuilding in Australia. The base was further enhanced by the selection of ASC to construct the Air Warfare Destroyer (AWD).

Commitment To the Australian Shipbuilding Industry

Recognition and commitment by government of the strategic importance of the naval shipbuilding industry and relevant industry at large has given the industry greater confidence in its future and should encourage investment in its workforce, facilities and innovation.

Competitive Teaming for Efficiency

In addition to the design support provided by the US and European designers, competitive teaming through commercial alliances between overseas suppliers and local industry for the supply of systems and components offers the best prospect of ensuring efficient Australian construction.

Early selection of industry partners may be required where substantial development of the system is required in order to meet the requirement and to encourage mutual investment and sharing of risks.

Ownership of ASC

The future ownership of ASC must facilitate access to submarine IP in the complex and sensitive scenario outlined above. This is essential to maintain the new design through life, including the need for future modifications. To avoid future conflicts of interest and to demonstrate that Australia is able to protect 3rd parties sensitive technology, it is essential that the ownership of ASC be 'fully Australian' owned and controlled.

In our opinion we should not rush the sale process; it is important to 'get it right', the ground rules for accessing the critical IP should be fully understood and complied with as a pre condition of the sale.

- We would also get full value for ASC if it is sold with the future submarine project on the books.

Conclusions on Industry Issues

- The global market for conventional submarine design and construction has shrunk considerably since Collins was designed.
- Australia's industry base has grown significantly during the same period.
- ASC is the clear choice to design and build the future submarine; it will require design support from the USA and consultancy design support from leading European designers.
- The preconditions attached to ASC's access to these technology sources should be understood and complied with in the sale of ASC.

Personnel Issues

Submarine Personnel Skills Shortages

The availability of submariners to support the role of Defence as an 'informed buyer' with the skills and abilities to manage the future underwater warfare capability program will be a significant issue.

As was predicted at the time of the decision in 2000, disbanding the submarine policy capability in Canberra has left a significant gap in experienced submarine skills to mount and manage this project. It has also removed a career path for mid seniority submarine specialists and arguably, contributed to the significant loss rate of these personnel.

Currently the RAN has a severe shortage of senior submarine qualified engineers and operators. Very few of those in the service have the experience, networks and understanding to guide a complex project through the labyrinthine processes of Canberra. Given the time scales and shortage of personnel, lateral solutions will be essential.

The transition from COLLINS to future submarine capability will also pose significant personnel challenges for the operational submarine force. Manning the operational submarines and generating the surplus crews to transition to the new capability will be a demanding challenge. Against the backdrop of the current shortages, with insufficient crews to man the operational submarines, this will require priority allocation of scarce RAN manpower resources to achieve.

Non Uniform Expertise

The civilian submarine technical capability in Canberra has also been substantially reduced from that available to mount and conduct the Collins project. Filling these gaps in a timely fashion will require lateral solutions to make use of the skills available from industry and within the Defence Department to best effect.

Conclusions On Personnel Issues

- The shortages of skilled personnel in Defence and Navy to oversee the project are a significant limitation and must be factored into the acquisition strategy.
- A sustained priority allocation of the RAN's scarce manpower will be required to recover from the current shortfall, sustain the project and transition into the future submarine.

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