Developing Australia's Independent Surface Combatant Design Capability – Challenges and Options

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ABSTRACT

The Government's 2017 Naval Shipbuilding Plan indicates that over the next decade or more, Australia intends to develop significant new naval industrial capabilities. In particular, the plan states a policy requirement for… *"future Australian Governments being able to plan and execute: the design, construction and sustainment of future fleets of major surface combatants … in Australia."* This objective has subsequently been emphasised through various ministerial statements.

Nations that maintain a warship design capability do so for strategic national security and military-economic reasons. The ability to design a competitive warship takes multiple decades to develop and must be proactively managed. A variety of measures and significant investments in skilling and technology are necessary to achieve a credible capability. In the context of this policy objective, this paper addresses some important questions relating to how the RAN will be supported in its exploration of the future of the Australian surface combatant fleet. These include:

a. Can Australia reasonably achieve an independent ability to develop globally competitive warship designs?
b. What are the benefits of such a capability?
c. How can such an ability be developed?
d. How can Australia's naval sector gain the skills and experience needed to establish, execute and assure such an undertaking?

These questions are central to how an independent sovereign warship development capability, and the operational capability of the RAN, will be developed in a manner which responds to long-term strategic uncertainty.

INTRODUCTION

In 2017 Government released the Naval Shipbuilding Plan (NSP), which outlined a structured approach to developing a sustainable naval sector (Commonwealth, 2017). Government's plans for investment in the naval sector indicate a then-year approx. $0.5 trillion enterprise over acquisition and sustainment of the currently planned naval programs. This context establishes, for the first time in Australia, conditions in which the pursuit of a sovereign, sustainable, end-to-end surface combatant design capability is a credible goal.

The Hunter Class Frigate Program (HCFP) represents a major portion of the investment under which the objective of sovereign combatant design is intended to be developed. In June 2018, Defence Minister Marise Payne said *"by the conclusion of the frigate build, ASC Shipbuilding will be a strategic national asset capable of independently designing, developing and leading the construction of complex, large naval warships"* (Commonwealth, 2018a). Under the

SEA5000-1 Head Contract, Government has formed an agreement with ASC Shipbuilding to develop a design capability to an extent that will be defined later in the program.

The Defence Industry Capability Plan states that *"… a motivated, innovative, cost-competitive and sustainable Australian industrial base, underpinned by experienced ship designers and builders who translate these attributes to Australian industry"* is a *"key enabler"* for delivering Australia's maritime and ASW capabilities (Commonwealth, 2018b).

The Government's objective of sovereign combatant design presents a range of significant opportunities, challenges, and necessities for the Australian naval, marine, technology, manufacturing and education sectors. This paper outlines some of those opportunities and challenges, and provides some concepts around how a plan for a truly sovereign combatant design capability might be developed.

MAINTAINING OPTION SPACE

At the cornerstone of a design capability is the Navy's place as the end user, with CASG as its acquisition agent, and the need to maintain a clearly understood option space enabling strong decision making throughout the capability development process. To achieve this, Australia needs the ability to explore the relationships between user need, system capability, industry capability and investment. Design is the activity which mediates these key program considerations. Without the ability to conduct advanced early design and cost analysis, the ability to respond to the decision space across these considerations is limited, and acquisition decisions are forced into accepting compromises.

As the program progresses, Government will seek evidence that the large investment it is making in the naval sector will be maximised for the benefit of Australia's naval capability, industry, knowledge capital, and strategic independence. In future assessment, reporting and decision making, it is important that Navy, CASG and Government have access to advice that is not linked to the commercial exigencies of a specific program or entity.

CAN AUSTRALIA SUSTAIN A CREDIBLE WARSHIP DESIGN CAPABILITY?

Figure 1 indicates the relationship of GDP to Defence budget for naval designing nations, not including the US (c. USD$649 Billion 2018 spend) and China (c. USD$250 Billion 2018 spend). Annex A provides further details related to the GDP and defence spend of naval designing nations. Figure 1 indicates that, above a basic threshold, maintenance of a naval design capability is not strongly correlated to GDP or total defence budget, with credible frigate design capabilities being maintained across two orders of magnitude of defence spending between $4 Billion and $650 Billion. Figure 1 shows that in terms of real defence spending, Australia is placed centrally amongst middle powers, with resourcing comparable to some important naval design centres including the Netherlands, Spain, Italy and South Korea.

By comparison with the case of Spain, we can conclude that independent combatant design, including integration of key US systems such as AEGIS, can reasonably be sustained within current Australian naval spending. In this comparison, the higher cost of operation in Australia is offset by the 50% greater defence budget applied by Australia.

Ultimately, the sustainment of a design capability depends not on defence spending level, but on how well the domestic naval sector is managed in terms of consistency and design cycle times. For instance, South Korea, Turkey, Spain and Japan have all taken a progressive system

program approach to their naval development programs, which provides the consistency of design scope to sustain and evolve their naval design capabilities.

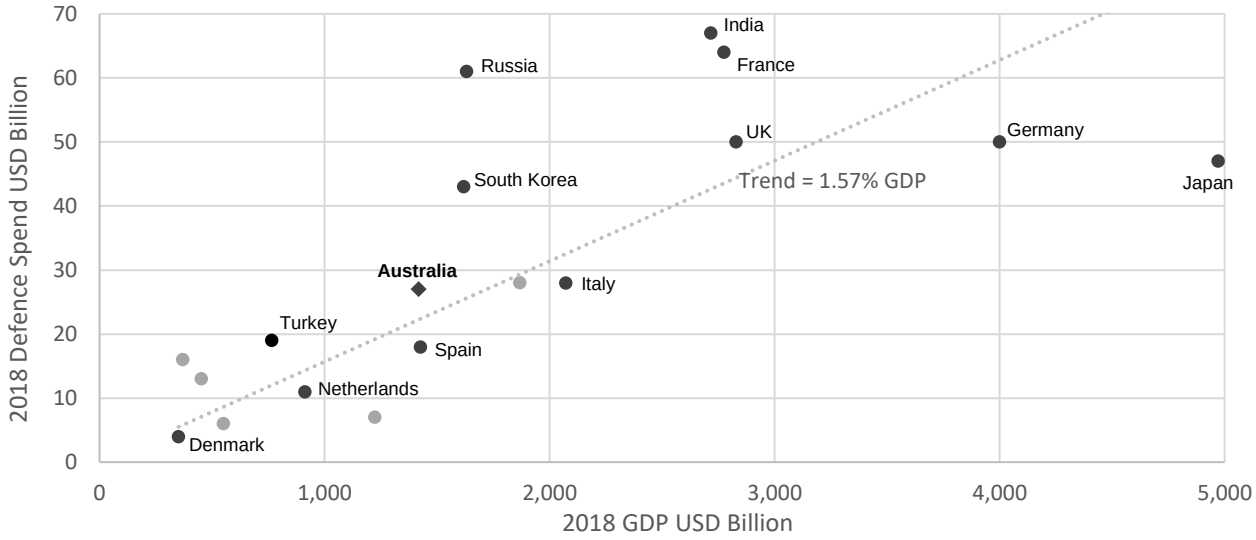

Figure 1 – Relationship of GDP to Defence budget, for nations with a credible naval combatant design capability, not including US and China. *Nations with a high-level combatant design capability are labelled against a black point, while nations with a lower-level design capability are shown as grey points. See also Annex A.*

Although most seafaring European nations have held a naval design capability over the long term, the Spanish capability was substantially re-vitalised based on US design technology transfer during the 1980's. The South Korean capability was also substantially established based on US design technology transfer during the 1990's. In both of these cases, the capability was established or re-established based on a long-term strategic objective of the national government to achieve an independent modern naval design capability, and in both cases the effort has been substantially successful. Nearly every country that has maintained or established a naval design capability has realised some export opportunities; with some countries, such as Spain, France and Germany, establishing significant industrial capacity and revenue on the basis of naval exports.

The broader Australian naval sector is unlikely to be cost competitive in the foreseeable future due to the cost of operation in Australia, but can achieve a competitive advantage through technology and capability leadership.

WHY PURSUE INDEPENDENT SOVEREIGN COMBATANT DESIGN?

The benefits of sovereign naval design fall into four broad areas. These are: strategic independence; technological and economic benefits; capability alignment; and sustainment benefits. These four areas of benefits are mutually reinforcing.

Addressing Strategic Uncertainty

Sovereign design provides Australia with an increased level of self-sufficiency in naval capability generation and sustainment, although combat system development is likely to continue to rely on foreign, in particular US, programs and participation. Removing reliance on foreign support for the provision of platform design markedly improves optionality for

Government and increases the long-term security of Australia's capacity to generate and sustain a competitive naval force.

The development pathways in combat systems are complex and demanding, and becoming more so with the advent of hypersonics, lasers, etc. These systems all have to be integrated in a survivable platform with a long service life, during which time every warfare technology we know and use now will change multiple times. This requires a level of capacity in the platform system to support future warfare systems development. Design provides Navy with the ability to define and realise the types and amounts of growth capacity that is needed to address the capability uncertainty that Navy faces in the longer term.

Related to this issue is the need to build naval ships in smaller design batches, allowing for a more progressive development of capability through the build program. Australia's capability margins are narrow, and require regular technology updates to sustain. Smaller build batches with larger capability development steps between design updates allows major technology changes to be incorporated in a timely way, providing a framework to consistently maintain Australia's capability margins.

Realising Technological and Economic Benefits

The economic impact of Australian industry content in a future Australian-designed naval ship can be expected to be greater than on previous and current programs, due to the large proportion of equipment and parts from foreign supply chains under those programs. Designing Australia's future combatant fleet in Australia will provide significantly greater opportunities for Australian industry to participate in the supply chain. Furthermore, a local design will be optimised for sustainment using the Australian supply chain and industry resources. This would be a ground-breaking step forward in the Australian naval sector, which has historically subsisted in the context of substantial foreign involvement in the acquisition and sustainment supply chain.

By providing a clearer understanding of the trade-offs between user need, system capability, industry capability and investment, an early design capability will help Government and Defence to set priorities and give guidance to other parts of the naval sector about where they should invest and develop.

A local design capability supports local development of naval systems. Combatant design demands a broad range of specialist technical skills, and represents a significant technological capacity, which has spin-off effects on participating and adjacent sectors. Australia already has some world-leading naval technology development programs and such development will be strengthened by the existence of a system program approach to platform design, which will align with and help support current combat system development programs. This will ultimately lead to more competitive capability outcomes.

Alignment to Australian End-User Needs

An Australian design is able to comprehensively address the end user capability requirements within the available investment envelope. Cole (2017) addressed the question of the relative value presented by an off-the-shelf approach to naval acquisition. While a developmental acquisition approach typically requires a higher up-front cost and schedule investment, it also delivers long-term offsets in total cost of ownership through better alignment to the support system, and increased value through better alignment of the capability to the end user need. For these reasons, full design development generally provides a stronger response to longer-

term interests. An off-the-shelf approach is clearly indicated in cases where a schedule imperative is driving the acquisition, and the typically longer development cycle of a more developmental design is impractical, such as in the current case of the HCFP.

An Australian design capability supports Defence's role as an informed customer. Sovereign design will enable the Navy to make well-informed choices and compromises on what is required, within the level of resourcing Government is prepared to provide.

Alignment to Australian Sustainment Context

Some of the most significant advantages of sovereign design come in sustainment. Naval ship designs are generally designed to be sustained using the industrial resources of the parent country. By fully aligning a design with the Australian supply chain and the local sustainment ecology, significant savings in cost of ownership can be achieved. A smaller batch approach with more regular design updates also provides for opportunities to improve the supportability characteristics of the design by incorporating support lessons from early hulls into follow-on design updates.

TOWARDS AN INDEPENDENT SOVEREIGN CAPABILITY

A Short-Term Need for a Long-Term Strategy

The long-term horizon associated with naval development requires steps to be taken sooner than later to have confidence that they will reach maturation at the appropriate time. There are a range of examples past and present where failure to adopt a long-term view has prevented the most satisfactory solution from being undertaken. Although HCFP will be delivered over a long period of time, the ability to design a competitive warship also takes multiple decades to develop and requires early and proactive management to provide a reasonable assurance of success. Having established a plan, it requires long-term commitment to develop the capability.

The Critical Link Between Capability Requirements, Cost and Design

Costing is a critical and complementary part of design. The capability analysis and decision support aspects of early design are not meaningful without reliable cost information, and later-stage design activities must be conducted in the context of ongoing affordability assurance. The link between design and costing activities is critical to program cost control and must be foundational to the design approach. This is link is significantly stronger in a responsive local design capability.

Related to this is the need to manage affordability against user need, and control the cost and scope of requirements. A common cause of program problems is the growth of requirements and cost past an authorised baseline. The solution to this problem is the use of smaller build batches with larger capability development steps between design updates. This allows capability and requirements to be developed more progressively, with requirements, cost and design baselines aggressively protected after they are approved. This approach provides improved cost assurance, and protects cost performance in later stage design and production activities.

International Partnering Considerations

BAE Systems has previously outlined an approach to designing a future Australian surface combatant via collaboration with a future UK program to replace the Royal Navy's Type 45

(Stewart, 2019). This approach inherently limits the level of sovereign, independent warship design capability that BAE Systems can be expected to pursue in Australia, because building such a capability would create a competitor to the sovereign warship design capability of the UK and impact the future export opportunities of the UK Naval Ships business. The proposed partnering arrangement falls short of the truly sovereign approach sought by Government.

The vast majority of attempted international collaborations in warship design have failed when the necessary compromises on requirements, participation and supply chain could not be achieved. Of the many attempts, there is one known successfully executed multilateral design program in the history of NATO surface combatant design; the French / Italian Horizon frigate – which itself went through a major program split, with the UK retiring to develop T45. It is instructive to note that one of the key reasons that the UK retired from the Horizon program was because of their insistence that UK primes take the lead in the development effort on Horizon.

Finally, previous experiences such as Collins indicate that major program issues are hard to export back to international contractors, and ultimately are most likely to be resolved by the sovereign nation that owns the problem.

Approach Alternatives

There are a few typical high-level approaches to distributing scope across a naval ship design activity. Three approaches relevant to the current Australian context are suggested below. Other possible options do not adequately take account of the current agreement in place with ASC Shipbuilding for the development of a design capability, or are fundamentally variations of the options indicated.

Approach 1 – Extend current ASC Shipbuilding intentions beyond development of a design modification / design support capability, to develop an end-to-end sovereign design capability, independent of other programs. Examples of this model include the UK Type 45 and Type 26 programs.

Approach 2 – Establish an independent design partner to provide concept, preliminary and functional design capabilities, which collectively with the design capability to be developed in ASC Shipbuilding, provides a sovereign design capability. An analogue of this model is the Canadian Arctic Offshore Patrol Ship (AOPS) project, although in that case not all of the participating designers were Canadian.

Approach 3 – Establish a national collaborative design capability, incorporating existing and foreshadowed elements of design capability in Australia including the future ASC Shipbuilding design capability, and developing the additional capabilities necessary through design partners (such as but not limited to Gibbs & Cox) in a teaming arrangement. This model is comparable to the approach to combat systems development through CMPS, or the Naval Design Partnering teams in the UK.

A COLLABORATIVE MULTI-PARTICIPANT APPROACH

A credible Australian design capability must involve a range of participants. We envisage the formation of a naval design centre based on collaborative involvement of key qualified government and industry participants, including Navy Capability, Navy Engineering, CASG, DSTG, ASC Shipbuilding, and specialist design partners.

An Australian Naval Design Centre would be established based on a commercial management model, possibly under the management of a lead contractor, and reporting into CASG, probably under FAS Ships. Personnel from the various participants would be assigned, posted, or contracted into the organisation as applicable, to support the required labour profile.

The mission of the Australian Naval Design Centre (ANDC) would be to provide naval surface ship design solutions to Defence through the collaboration of Defence, industry and academia.

The ANDC would be funded mainly by the CASG project offices for whom the ANDC is providing design services. It's likely that some Defence and ADF positions within the ANDC could be supported directly by secondment from participating branches and groups, such as HNC, HNE, CASG and DSTG. Commercial participants such as ASC Shipbuilding and other specialist design partners would be funded through appropriately structured strategic contracts with CASG, managed under FAS Ships. The ANDC would likely have two physical centres, in Canberra and Adelaide, with whole-ship design work likely experiencing a transition from Canberra-centric in requirements and concept design development, to Adelaide-centric from functional design through to productionisation.

IP management would be a key issue requiring early attention. It is expected that foreground IP developed by the ANDC would be owned by the Commonwealth. However, there are complicating factors associated with how commercial participants bring background IP to their participation in the design work. In relation to the Commonwealth this can be handled through the development of appropriate licensing agreements, however, there will be concerns around distribution of proprietary background IP across participants. This will need further examination. A reasonable level of compromise might be required from commercial participants in relation to background IP, in order to enable them to participate efficiently in the ANDC. This could represent an important test of an entity's willingness to bring the necessary collaborative behaviours to the work.

Significant benefits are available through the implementation of a collaborative approach, and these are outlined in Table 1.

Key Benefit	**Characteristics supporting realisation of benefit**
Best practices applied	• Various participants with diverse experiences bring their key strengths to the enterprise • Establishes an internal marketplace of design and engineering practices and solutions, from which the best practices and solutions are more likely to arise • Collaboration of ASC Shipbuilding and other design partners across design phases drives design for production interests into early design, and maintains functional design intent through detail design • Brings Systems Engineering processes that are aligned with the Commonwealth's approach to acquisition
Increased protections and optionality for Defence	• The Commonwealth is not locked in to a single supplier, and retains enduring flexibility in how scope is allocated across participants • Provides an inherent challenge function between parties that helps regulate inappropriate behaviours, and reduces risk of any one party's commercial motivations negatively influencing the program • Reduces the risk of any one party holding too much freedom to interpret the Commonwealth's requirements in a manner most beneficial to itself • Substantially frees design work from commercial influence of the construction scope, but objectively considers production cost impacts

Key Benefit	Characteristics supporting realisation of benefit
Broadens impact of technological and economic benefits	• Builds on existing sovereign capability by integrating and building up existing niche contributors in the Australian naval engineering community • Distribution of the design capability across a range of organizations makes the technological benefits more impactful across the sector
Best alignment with policy direction	• Reflects Defence and Navy Industry policy by strengthening collaboration • Mirrors the approach to sovereign combat systems development capability • Incorporating existing Commonwealth capabilities such as DSTG leverages existing investments

Table 1 – Some benefits of a collaborative multi-participant approach to naval design

Parallels with UK MOD's Naval Design Partnering Teams

The ANDC concept is comparable to the UK MOD's Submarine and Surface Ship Naval Design Partnering (NDP) teams, which are Defence and Industry consortia. These constructs arose due to a shortage of qualified and experienced personnel within the MOD. In response, NDP teams were formed to support the MOD in retaining its informed customer status and maintaining sovereign capabilities. The NDP teams have involved parallel participation from multiple first and second tier naval sector suppliers.

The teams have been involved in activities such as pre-concept and concept phase whole boat/ship design and technical studies; developing the embodiment of new technology into existing platforms; supporting the MOD in undertaking through-life technology management studies; technical support to Technology Demonstration Programmes (TDPs); and dealing with emerging technical issues in current platforms (UK Ministry of Defence, 2016).

The NDP construct shows that a participative approach can be constructed which provides Defence with the necessary expertise and support to fulfil its objectives, by drawing together the expertise which exists across competitor parties within the national naval sector.

A System Program Approach to Platform Design and Integration

The HCFP CS development effort is being directed by the Combat Management and Payload Systems (CMPS) branch of CASG. The recent formation of CMPS represents the introduction of a system program approach to naval combat systems in Australia. This will continue to evolve towards an integrated warfare systems approach as sovereign capability develops.

The need for a collaborative approach was recognised in structuring the development program for the HCF CS, acknowledging that the scope of functions was likely beyond the extant capabilities of any one business, and would have created unhealthy competition in the marketplace. Therefore, for CS development, lead participants deliberately took a partnering approach, to build on existing strengths in the sector, share risk, and establish sovereign capability across a range of government and commercial entities.

Having established a system program approach to Combat Systems development, Australia should consider the implementation of a system program approach to platform design and ship integration. Nearly all naval designing countries that have established or re-established their design capability in the post WWII era have done so via a system program approach, which sets out a progressive development of increasingly sophisticated combatants. Some specific examples include:

- The South Korean KDX program, consisting of 3 KDX-I frigates, 6 KDX-II frigates, 6 KDX-III AEGIS Destroyers, and a planned 6 KDX-IIA AEGIS frigates
- The Turkish MILGEM program, consisting of 4 corvettes, followed by 4 frigates, then a planned further 4 hulls to a more advanced frigate design
- The Spanish F100 program, which produced three hulls to the F100 design, made progressive design updates to hulls F104 and F105, then commenced development of the significantly updated and modernized F110 design, with a planned 5 hulls
- The Japanese Kongo-Atago-Maya class progression (4, 2, and 2 hulls respectively), which demonstrates a consistent development pathway for Japan's AEGIS destroyer fleet

Each of these programs commenced with an introductory combatant design, and made step changes in capability and technology across relatively small build batches, typically representing around a third of the combatant fleet size. In the context of Australia's planned combatant fleet of 12 hulls, such an approach would indicate significant design updates at every 3-4 hulls. This aligns with the proposed build of approximately 3-hull batches in the HCFP. Under the system program approach to platform design taken in comparable naval designing nations, each of these design updates would be used to drive an increasing level of ship capability and Australian design capability, with the full design capability being realised and matured through the design of an AEGIS DDG-equivalent ship for the Hobart class replacement program.

RESOURCING AND SKILLING THE DESIGN ENTERPRISE

Developing the necessary qualified and experienced personnel is the central challenge to Australia's development of a competitive naval enterprise. In response to this challenge, Government recently released the Naval Shipbuilding Strategic Workforce Discussion Paper (Commonwealth, 2019).

In development of a design capability, the time horizons are long. Full maturity is only achieved across an entire class lifecycle, by incorporating the design, supply chain, operational and support experiences from the previous class. Patience is needed in this strategic endeavour.

Australia is an unforgiving environment when criticism can be levelled at shortcomings in major government programs. Key to preventing such circumstances is to have expert staff on the government team who understand the implications of taking decisions now, and on outcomes which do need to emerge over a decade hence. This means that APS and Naval officers must be appropriately capable and experienced, and the necessary advisory staff established to provide such expertise.

Australia has made long-term commitments to some major US combat system elements. Therefore, it is in Australia's interest to further develop our technical engagement with these key US combat system elements and the US naval sector generally. Additionally, development of the workforce necessary to sustain a competitive naval sector in Australia will be enhanced by deliberate engagement and cooperation with the naval sectors in both the US and UK. One avenue that could support this is to progress the 4 EYES Defence free trade zone.

SUSTAINING THE DESIGN ENTERPRISE

One of the next steps in developing Australia's design capability is to design the work profile. As stated earlier, the sustainment of a design capability depends but on how well domestic naval work is managed in terms of consistency and design cycle times. Sovereign design can be developed and sustained by correctly phasing naval ship design tasking over the next 25 years, in the same way that Australia's naval production capacity will be sustained by appropriately phasing the ship construction scope under the NSP. There is sufficient design work available in the current naval investment program to achieve this, if it is structured appropriately. Figure 2 indicates the scope of design work available to sustain combatant design. Some guiding constraints arise through the contractual arrangements established for current programs.

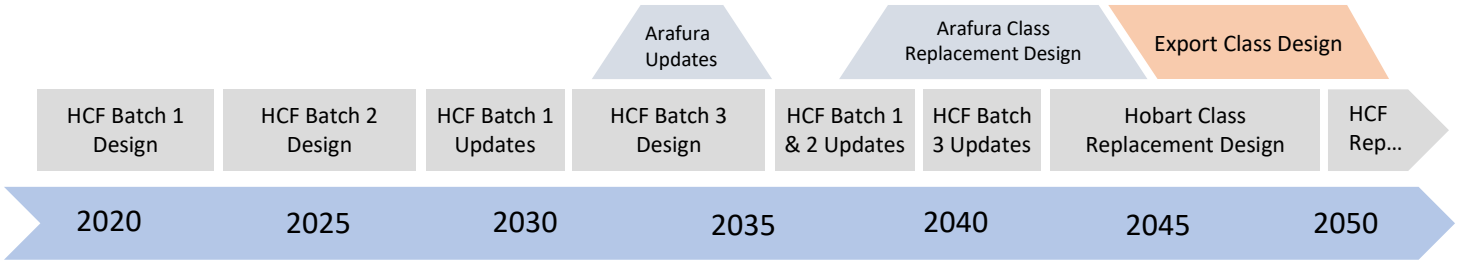

Figure 2 - Notional timeline of future naval surface ship design scope

AREAS FOR FURTHER DISCUSSION

This paper outlines a broad case and presents some basic concepts for consideration. There are a range of important questions that need to be examined as the suitability of a collaborative design capability is assessed. These questions include:

- Who are the wider stakeholders and how do they need to be engaged?
- What are the necessary elements of a sovereign warship design capability?
- What elements currently exist in Australia?
- What elements will be provided through the HCFP Head Contract?
- What elements need to be supplemented?
- Who are the participants, and what are their roles across the design enterprise?
- How are these participants best integrated through contracts and agreements?
- What is the appropriate management structure to maintain a strong focus on cost effective and timely delivery of design products, while appropriately integrating Defence and Industry personnel across a range of participants?
- What are the key risks that exist, and what backstops have to be established?
- How do we define the roadmap to a mature sovereign design capability and how will progress be measured along the way?

CONCLUSIONS

A long-term continuous naval ship production program in Australia allows, for the first time, credible pursuit of a combatant design capability. Establishing an independent combatant design capability is a Government policy, and an important response to increasing strategic uncertainty. It is a long-term objective which will require patient development.

Most other middle power nations which rely on seaborne trade for economic security have maintained, established or are establishing a naval design capability. Compared with other

nations, including high labour cost nations, Australia's current naval spending is sufficient to sustain an advanced combatant design capability. Sustainment of naval design is enabled by two key conditions: firstly a willingness to accept some program risk in order to reap the benefits of a sovereign capability, and secondly an appropriate phasing of design work scope.

Most naval designing nations, including other high labour cost nations, have realised some level of export success, including both ship designs, technology transfer, and built ships. The international OPV and frigate market will continue to grow over the next 2-3 decades. Australia will be able to compete in this market in the future through technology and capability leadership.

The Government has stated an objective for Australia to develop a sovereign, independent design capability, but the specific approach to achieve this objective has not yet been clearly defined. There is a stated expectation that BAE Systems will develop this capability in its subsidiary ASC Shipbuilding over the course of the Hunter Class Frigate program. However, previous statements about their preferred approach to future warship design in Australia, and potentially competing commercial interests, are somewhat in conflict with this goal.

A national collaborative design capability may be the most beneficial approach to establishing Australia's naval design capability. An Australian Naval Design Centre would incorporate existing and foreshadowed elements of design capability in Australia, and develop the additional capabilities necessary through design partners in a teaming arrangement. Key benefits of this approach include the application of best practices, increased protections and optionality for Defence, and broader impact of technological and economic benefits across the naval sector. A comparable approach has been demonstrated in the UK naval sector.

Australia should consider the implementation of a progressive system program approach to platform design and ship integration, as has been done by most other nations that have recently established or re-established a naval design capability, and as has been done for combat system development in Australia.

Development of the workforce capabilities necessary to grow and sustain a competitive naval design capability and broader naval sector in Australia will be greatly enhanced by strong links and cooperation with the well-established and experienced naval sectors in the US and UK.

This paper has discussed some concepts around the establishment of Australia's naval design capability. In further assessing the suitability of a collaborative design capability, there are some key questions that need to be examined by stakeholders. Defence has an opportunity to lead a more open and inclusive debate about what Australia's future naval design capability looks like.

Australia faces a major strategic opportunity to develop a truly sovereign naval design capability, and realise greater strategic independence; broad technological and economic benefits; an increasingly competitive naval capability; and improvement of the sustainment system and cost of ownership. We are now at the inflexion point between planning and implementing Australia's future naval enterprise, and the course we establish for sovereign design in the next few years will substantially define the extent to which we reap these benefits over the next 50 years.

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ANNEX A

Comparison of GDP and Defence Budgets of Naval Designing Nations

Table A1 provides a list of countries that maintain a credible independent naval design capability, ranked by 2018 Gross Domestic Product (GDP). Capability is indicated at two broad levels; the higher level (noted by a green indicator) being the ability to design an internationally competitive multi-role heavy frigate / destroyer sized combatant, and the lower level (noted by an amber indicator) being the ability to design a regionally competitive corvette / light frigate sized combatant. The table also gives the respective 2018 defence budgets for context, and some representative examples of programs that demonstrate the design capability.

Country	GDP Rank	2018 GDP USD BB	2018 Defence Spend USD BB	G20 Member	Combatant Design Capability	Representative Programs	Exports
United States	1	20,494	649	Yes	✅	DDG1000, DDG51, LCS	Yes
China	2	13,407	About 250	Yes	✅	Type 052D, Type 054A, Type 055	Yes
Japan	3	4,972	47	Yes	✅	Atago, Maya	No
Germany	4	4,000	50	Yes	✅	F124, F125	Yes
United Kingdom	5	2,829	50	Yes	✅	Type 45, Type 26, Type 31	Yes
France	6	2,775	64	Yes	✅	Horizon, Aquitaine	Yes
India	7	2,717	67	Yes	✅	Shivalik, Kolkata, Visakhapatnam	Yes
Italy	8	2,072	28	Yes	✅	Horizon, Bergamini	Yes
Brazil	9	1,868	28	Yes	🟡	Barroso (Corvette)	No
Russia	11	1,631	61	Yes	✅	Admiral Gorshkov	Yes
South Korea	12	1,619	43	Yes	✅	Daegu, KDX-III Sejong the Great	Yes
Spain	13	1,426	18	Via EU	✅	F100, F110	Yes
Australia	14	1,418	27	Yes	⊗	N/A	N/A
Mexico	15	1,223	7	Yes	🟡	Durango (Corvette)	No
Netherlands	17	913	11	Via EU	✅	De Zeven Provinciën, Holland	Yes
Turkey	19	766	19	Yes	✅	Istanbul, Ada	Bid
Sweden	22	551	6	Via EU	🟡	Visby (Corvette)	No
Iran	27	452	13	No	🟡	Moudge (Light Frigate)	No?
Israel	32	370	16	No	🟡	Sa'ar 5-6 (Corv., shared designs)	Yes
Denmark	36	351	4	Via EU	✅	Iver Huitfeldt, Absalon	Bid

Table A1 – List of countries with a credible naval design capability, ranked by 2018 GDP

ANNEX B

Summary Characteristics of Representative Levels of Design Capability

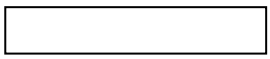
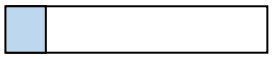
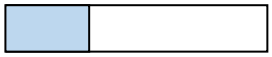
Design Capability	Relative risk and technological benefit	Significant Outcomes
No design capability - build to print		• Reduced programmatic risk in design activity • International supply chain
Develop production design drawings		• Productionisation capability • Aligns production documentation with build yard administrative processes
Develop production design		• As above, plus: • Detailed design capability • Increased alignment of production design with build yard production processes • Substantially international supply chain • Some opportunity for Australian supplier inclusion for minor parts and stock materials
Design modifications & updates		• As above, plus: • Limited functional design capability
Early design and cost analysis		• Requirements analysis and decision support capability • Concept design capability • Preliminary design capability • Cost analysis capability
Participate in multilateral project to evolve design		• Detailed design and productionisation capabilities • Limited concept, preliminary and functional design capabilities; the extent depends on cooperation structure and differences in partner programs • Opportunity to negotiate inclusion of Australian suppliers in the bilateral design, but Australian suppliers would compete with partner nation suppliers • Cost-sharing benefits arising from collaboration • Challenges and constraints arising from design, programmatic and supply chain collaboration
Independent major design evolution		• Detailed design and productionisation capabilities • Substantial concept, preliminary and functional design capabilities; extent depends on design change scope • Opportunity to include additional Australian suppliers at the cost of design change
Sovereign naval ship design capability		• Establishes end-to-end design capability • Maximum opportunity for Australian suppliers • Maximum alignment to RAN user need • Higher cost and technical risk profile • Maximum technological benefits in supporting sectors • Sovereign IP and ownership of export opportunities

Table B1 – Relative risk/benefit and significant outcomes associated with a notional set of tiered design capability levels