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Industry and Infrastructure for Future Submarines: An International Perspective

Speech presented at the Submarine Institute of Australia's 5th Biennial Conference in Perth, Australia, November 2010

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Published 2011 by the RAND Corporation
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Industry and Infrastructure for Future Submarines: An International Perspective[1]

Thank you for inviting me here today to discuss industry and infrastructure issues related to the Future Submarine.

Twenty years ago, Government and industry jointly participated in designing and building the *Collins* class, but today their roles have evolved to supporting submarines in the fleet. The challenge for Australia now is to revive and modernize a range of design, testing, production and oversight capabilities so that the Commonwealth has the ability and capacity to design and build the Future Submarine.

This is easier said than done. With the *Collins* program, Australia found that designing and building submarines is not easy, even with significant overseas input.

For almost two decades, we at the RAND Corporation have been exploring these issues in a number of studies for the U.S. Navy, UK Ministry of Defence (MOD), and most recently the Australian Department of Defence. Because of that experience, between November 2009 and February 2010, a team of researchers from RAND, working closely with Australian and U.S. consultants, conducted an independent, objective, and quantitative analysis that (1) describes the process to design a modern, conventional powered submarine; (2) describes existing design resources in Australia that could support a future submarine design progam; (3) identifies and analyzes gaps between design resources that Australia currently possesses and those that would be required by a new submarine design progam; and (4) identifies and evaluates options whereby Australian industry could achieve the desired submarine design capabilities.

This paper draws from RAND's considerable international submarine experience to discuss four important issues:

- The benefits of long-range planning
- Ways to achieve design and production efficiencies
- The need to sustain hard-to-replace resources
- The requirement for robust testing.

Although the environments in the United States, UK, and Australia are quite different, our work has identified some commonalities. So, in the next 20 minutes or so, I will review the benefits of long-range planning and what happens when you don't have it; canvass ways to improve design and production efficiencies in a notoriously inefficient sector; discuss the need to sustain hard-to-replace resources in the light of short-term economic pressures; and

[1] This paper was originally presented at the Submarine Institute of Australia's 5th Biennial Conference 2010, in Perth, WA, Australia, in November 2010.

talk about the importance of testing, often one of the first items to be curtailed when money has to be saved. I will try to place these in the Australian context and will conclude with some observations on what this means for the overall policy for designing and building submarines in Australia.

The Benefits of Long-Range Planning

One of the most important findings from our research is the importance of a comprehensive, long-term submarine-building strategy or plan. By a *strategic plan*, I mean one that would require the Australian Government to define its submarine building goals and future courses of action for the next several decades, establish a schedule or roadmap to achieve its plans, and identify future investments that would be needed—for example, in facilities and workforce skills.

A strategic plan would help eliminate the "boom and bust" cycle that has plagued ship and submarine production and design. It would allow Defence to make more efficient use of shipyard facilities and workforce skills and exploit the Government's "smart buyer" expertise. It would help Defence better understand the financial implications of its acquisition strategy and anticipate problems by allowing it to independently assess shipyard demand. It should also lead to reduced cost and schedule risk through greater program certainty.

Long-term planning would obviously have implications for how Defence manages the industrial base, and we have specific suggestions in that regard. First, we recommended that Defence attempt to smooth, or "level-load," the production and design demands it places on the industrial base, both over time at shipyards and across the vendor base. Several factors specific to the Future Submarine would affect the loading. These include the interval between boat starts, the time required to design the first of class and to build each boat, the fleet size desired, and the expected time in service. Among the benefits of level-loading would be better workforce and facilities use, more stable costs, and a greater ability of the industrial base to make long-term investment decisions.

Secondly, long-term planning might force Defence to reevaluate its competition policy. RAND research has shown that competition might not always be the appropriate option during every phase of a progam. In some cases, there may not be enough viable contractors to enable competition—or, perhaps more to the point, enough contractors to let one of them lose. For some situations, it might be in DMO's interest to explicitly allocate work. Competition would most likely remain a viable option in most cases, but the desire to maximize it should be only one factor in considering how best to achieve value for money over the long term. (I will have more to say about competition later.)

Third, to understand all the factors impinging on its plans, Defence would have to work more closely with industry than previously. That might require, for example, Defence to supply industry with more information regarding plans, budgets, and procurement options. At the same time, long-term planning might also encourage shipyards and the vendor base to work more closely together as they act to use complementary skills and facilities, promote skill synergies (such as for design), and give Defence procurement options which result in greater industrial efficiencies.

Finally, any long-term plan would have to be integrated across Defence's multiple ship acquisition efforts. We have often found that individual classes of ships are the purview of dis-

crete project teams, each making independent acquisition decisions. A plan that accounts for multiple ship types is necessary to better manage total demand on the design base, shipyards, and vendors over time.

Ways to Achieve Design and Production Efficiencies

Based on our research, we suggested that Defence consider a number of ways to improve its design and production efficiencies within the context of a long-term submarine acquisition strategy. We made six such recommendations.

First, Defence should continue the practice of entering into multiship contracts to provide industry with incentives for training and long-term facility investment. Such long-term contracts enable shipyards and vendors to justify major investments that permit greater efficiencies, which result in savings. As you know, firm pricing on such long-term contracts works better for mature designs and, therefore, may not always be appropriate for the first-of-class boat.

Second, Defence and industry should focus on training for skills that are readily employable outside the shipbuilding industry. To meet near-term peak workloads, the shipyard and vendors will have to hire and train new workers. However, after the peak, many workers will no longer be needed. If workers are trained now for widely employable skills, subsequent unemployment could be minimized. Vocational schools could be funded to train more students in such skills, at least over the short term.

Third, Defence should facilitate a discussion among the shipyards, their vendors, and related firms about whether the industry should adopt a common, interoperable set of design tools or develop industry standards that would allow design work to be easily interchanged. As Defence's shipbuilding program unfolds, shipyards and firms will probably need to share design resources. One difficulty in such sharing is that shipbuilders and design firms often have different computer-aided design and manufacturing tools. Thus, interchanging data and working cooperatively on a common design is difficult. Common design tools or standards for commonality would lead to common product models and databases and would also benefit life-cycle logistics support.

Fourth, Defence should work to mitigate peak demands that, in spite of careful planning, strain industrial capacity. Several mitigating options are available. Increasing the use of outsourcing would decrease the labor required to reside in a shipyard. Subcontracting peak demand work to others with excess capacity could ease the burden on yards operating at capacity. Also, Defence could consider performing peak workload outside the Commonwealth.

Fifth, DMO should try to reduce the high number of design and contract changes introduced after production has begun. These have been blamed for schedule slippage and cost increases in recent naval shipbuilding programs. Defence could help itself by ensuring that designs are mature before proceeding into production.

Sixth and finally, DMO should continue to encourage other best practices, to reduce cost and shorten build schedules. Our research confirmed the benefits of Australia's practice of using advanced outfitting in warship construction and of encouraging more outsourcing, where appropriate. Notably, both of these require a mature design prior to production, which by itself should reduce cost and schedule slippage. Additionally, commercially available equip-

ment may be less costly than equipment conforming to traditional military standards and thus could be preferable if operations or safety are not adversely affected.

Need to Sustain Hard-to-Replace Resources

The desire to realize efficiencies should not, however, take precedence over the need to sustain design and production resources and oversight responsibilities over the long term. The UK MOD is emerging from an experiment in transferring to the private sector responsibilities that the private sector had insufficient incentive to exercise. The idea was to shift as much risk as possible to the prime contractor and, at the same time, as much of the authority for design decisions as possible. Not coincidentally, the MOD was losing the resources necessary to maintain design skills and, to some extent, oversight skills in house.

In the case of the *Astute* submarine, the results of this experiment were unsatisfactory, because the terms of the prime contract for the first of class had to be dramatically revised after considerable cost escalation and schedule delays. The effect was to explicitly transfer the responsibility for the risk back to the MOD, where, as this turn of events demonstrated, it lay implicitly all the time anyway.

We drew two lessons from this experience. First, Defence must retain sufficient design and oversight expertise in house to see that its objectives are being met and to responsively engage the contractor. (We estimate that this is 15 percent of the design effort.) Defence must be able to make technical decisions on issues that arise concerning trade-offs between cost and performance or cost and safety. Defence cannot expect a contractor, in making such trade-offs, to arrive at the same results as the Government would. By the same token, Defence must have the expertise to estimate costs independently.

Second, Defence must support the retention of design skills not only in house but by industry during periods of low demand for such skills. The atrophy of design resources played some role in the problems encountered with the *Astute*. Design skills might be retained through "spiral development," that is, continuous design improvement, of a current class of ship, through continuous conceptual design of hypothetical future classes, or through development of prototypes. There might also be a role for collaboration with other countries facing peaks and troughs of design resource demand. Defence must have, as well, the in-house resources to support the R&D that will permit future advances in submarine design.

Requirement for Robust Testing

During the course of our research, we gathered considerable data on both the *Upholder* and *Collins* classes. Both vessels were designed by existing, experienced design organizations. Nevertheless, both progams experienced significant technical problems. In the case of the *Upholder*, production and operational difficulties stemmed from insufficient testing and a lack of system prototypes that could fully represent the propulsion plant, weapons system, and other equipment. This occurred because of a flawed assumption that experience with sub-systems previously fitted to *Oberon*-class boats negated the need for full testing and prototyping. The *Collins* class suffered from similar flawed assumptions.

The Future Submarine currently envisioned will be larger and more capable than either of these boats, requiring more design sophistication, integration, and robust testing.

The one critical gap that Australia will need to address, and address soon, entails a facility to test integrated propulsion and energy alternatives. While other facilities that do not currently exist in Australia can be accessed in the United States or United Kingdom, we concluded that a new integrated propulsion/energy test facility should be built in Australia. This would allow propulsion components to be tested in an integrated system and competed prior to installation. And subsequent testing of the operational duty cycle in a land-based facility will allow the test facility to stay ahead of the fleet, so that any problems that develop can be identified and resolved before the fleet experiences them, thus facilitating high levels of readiness and availability. This is a lesson the U.S. Navy, with extensive experience as a "parent navy," has learned and implemented with a number of ship classes.

Possible Actions for Australia

What does all this mean for Australia? As I said at the beginning, although there are many differences, there are important ways in which the Australian, UK, and U.S. submarine environments are similar. First, as I mentioned earlier, each country needs to deal with the issue of sustaining design resources during lulls between submarine classes. Second, none of the three countries builds large ships for the global commercial or warship export markets. Thus, Defence, MOD, and the U.S. Defense Department essentially set demand for naval shipbuilding. They decide the nature of the programs in terms of their number and size; the nature of the market, that is, whether it is run by competition or allocation; and, at least indirectly, the number of firms that will survive.

Considering these similarities, here are some tentative recommendations for the Australian submarine and, more broadly, warship industrial base. They are tentative because we have not made a thorough study of the shipbuilding industry, but on the basis of our current knowledge, these are some actions that Australia should consider implementing, pending further analysis:

- Smooth out demand peaks and troughs over the design and production cycle for each ship type by planning over the long term—that is, decades, not years. This should be done simultaneously for all ship types, so that the inevitable remaining peaks and lulls for one type can be balanced against lulls and peaks for another. Such planning must take into account the production intervals, build duration, desired fleet size, and platform life for each class. Plans should hedge against risk by recognizing gaps that may be caused by lower-than-expected funding and how to mitigate them.
- Resist any impulse to shift more responsibility for assurance of safety and performance to the private sector. Contracting arrangements notwithstanding, the Government is the ultimate risk-bearer and should remain responsible for cost-benefit tradeoffs.
- Make competition optional. Competition should not be the sole default method for obtaining value per dollar. It is desirable that shipyards specialize, and in a market with a limited number of yards, competition may not always be feasible. Competition is better achieved during the design phase or through subcontracting large segments of the production process.

- Protect and enhance the design and integration industrial base. With classes for some ship types following each other at longer intervals, design and integration skills may be lost. These skills may be difficult to reconstitute, particularly for such specialized capabilities submarines.
- Consider collaboration with key allies. It may be that, in a time of uncertain and variable demand, sharing industrial base resources with a trusted ally will, for certain ship types or equipment items, reduce costs with no security-related drawbacks.
- Standardize design tools across industry and Government. Using the same computer-aided design and manufacturing tools, or tools with compatible formats, could enable more rapid responsiveness on change requests and more seamless and economical collaboration across shipyards.
- Build a new integrated propulsion/energy test facility to test integrated propulsion and energy alternatives. In the light of the recent experiences with *Collins*, this is a no-brainer. Such a facility, if properly designed, can do long service, both for the *Collins* in the shorter term and for the Future Submarine in the longer term.

Our experience at RAND is that designing and building a new submarine class in Australia will be challenging. But it is an exciting challenge that will force change that will bring out the best in both industry and Government. I wish you well.

I would like to thank you again for the opportunity to address you today, and I will be happy to answer any questions you might have.