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TESTIMONY

Trends in the United Kingdom's Naval Shipbuilding Industrial Base

Lessons for the United States

JOHN F. SCHANK

CT-259

April 2006

Testimony presented before the Senate Armed Services Committee, Subcommittee on Seapower on April 6, 2006.

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The RAND Corporation

**Trends in the United Kingdom's Naval Shipbuilding Industrial Base:
Lessons for the United States**

**Before the Armed Services Committee
Seapower Subcommittee
United States Senate**

April 6, 2006

Mr. Chairman and distinguished members of the Committee: Thank you for inviting me to appear before you today to discuss issues related to the future of the U.S. naval shipbuilding industrial base. For almost 15 years, we at the RAND Corporation have been exploring these issues in a number of studies funded by the U.S. Navy. Because of that experience, in 2001 we were asked by the United Kingdom's Ministry of Defence to aid in conceiving and evaluating acquisition options for a new class of destroyers, and we have since then completed several other studies for the MOD (see the appendix). Most of these projects have been directed either by myself or by my colleague John Birkler, who could not be here today, but I need to acknowledge the work of numerous RAND staff and other associates whose names I won't mention but who were responsible for the bulk of the research effort.

I am going to focus on the work we have done for the UK Ministry of Defence, because this work has particular relevance for decisions to be made at the strategic level about the future of the U.S. naval industrial base. Over the next decade and a half, the United Kingdom will embark upon its largest naval shipbuilding program in many years. This effort will be challenging, because it follows a period of reduced warship demand that has led to consolidation and reduction in the capacity of the UK shipbuilding industrial base and in the oversight resources

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available to the MOD. Demands on the U.S. naval shipbuilding industrial base have also been falling, resulting in concerns, for example, about the submarine design base. At the same time, the United States also faces a likely future increase in demand, as the Navy builds to a 313-ship fleet. Let me review some of the suggestions we made to the UK MOD in three respects—the need for long-range planning, ways to improve efficiency, and the need to sustain hard-to-replace resources—and then I will conclude with some possible implications for the United States.

The Need for Long-Term Planning

One of the most important findings that has consistently arisen from our research for the MOD was the importance of a comprehensive, long-term MOD shipbuilding strategy or plan. By a strategic plan, we mean one that would require that the MOD define its shipbuilding 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 or workforce skills.

A strategic plan would help eliminate the “boom and bust” cycle that has plagued ship production and design in the United Kingdom. It would allow the MOD to make more efficient use of shipyard facilities and workforce skills and exploit the government’s “smart buyer” expertise. It would help the MOD 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.

Implications of Long-Term Planning

Long-term planning would obviously have implications for how the MOD would manage the industrial base, and we have made some specific suggestions in that regard. First, we recommended that the MOD attempt to smooth, or “level-load,” the production and design demands it places on the industrial base. Several factors specific to each class of ship would

affect the loading. These include the interval between ship starts, the time required to design the first of class and to build each ship, 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.

Second, we observed that long-term planning might force the MOD to reevaluate its pro-competition policy. To best use the industrial base, competition might not always be the appropriate option. In some cases, there might not be enough viable contractors to enable competition—or, perhaps more to the point, enough contractors to let one of them lose. For some classes of ship, it might be in the MOD's interest to allocate work across shipyards. Competition would likely remain a viable option in most cases, but the desire to achieve 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, the MOD would have to work more closely with industry than previously. That might require the MOD to supply industry with more information regarding plans, budgets, and procurement options. But the result should be reduced risk in shipbuilding programs because the government would have more certain understanding of industrial capacity, as well as better progress indicators, such as earned-value metrics. At the same time, long-term planning might also encourage shipyards to work more closely together as they act to use complementary skills and facilities, promote skill synergies (such as for design), and give the MOD procurement options which result in greater industrial efficiencies.

Finally, any long-term plan would have to be integrated across the MOD's own ship-acquisition entities. Currently, each class of ships is the purview of its own integrated project team, which makes acquisition decisions independent of the actions of other teams. Because one yard may build ships of different classes, a plan that accounted for multiple classes would be necessary if the total demand load on a yard is to be leveled over time.

Ways to Achieve Design and Production Efficiencies

Based on our research, we have also suggested the MOD consider a number of ways to improve its design and production efficiencies, within the context of a long-term shipbuilding strategy. We made five such recommendations.

First, the MOD should sustain its practice of placing multiship contracts to provide industry with incentives for training and long-term facility investment. Because they have received only limited orders for new ships and have faced a highly competitive market in recent years, many UK naval shipyards have not modernized facilities. Only with long-term contracts and prospects will the shipyards be able to justify this type of major investment. Such investments should permit greater efficiencies, which should result in savings to the MOD. It should be kept in mind, however, that such long-term contracts work better for mature designs and, therefore, may not always be appropriate for the first-of-class ship.

Second, the MOD should facilitate a discussion among the shipyards 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 the MOD's shipbuilding program unfolds, UK 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 are difficult. Common design tools or standards for commonality would lead to common product models and databases and would benefit the MOD in life-cycle logistics support.

Third, the MOD should work to mitigate peak demands that, in spite of careful planning, arise to strain, if not exceed, industrial capacity. Several mitigating options are available. Increasing the

use of outsourcing would decrease the labor required to be resident in a shipyard.

Subcontracting peak demand work to smaller shipyards with excess capacity could ease the burden on yards operating at capacity. Also, the MOD could consider relaxing the current defense industrial policy to allow peak workload to be performed outside the United Kingdom.

Fourth, the MOD should recognize and 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. The MOD could help itself out by ensuring that designs are mature before proceeding into production. The MOD could also speed production by responding more quickly to changes proposed by the shipyard to save time or money.

Fifth and finally, the MOD could encourage other best practices to reduce cost and shorten build schedules. Our research has highlighted the potential benefits of increasing the use of advance outfitting in warship construction and encouraging the use of greater outsourcing, where appropriate. Notably, both of these require a mature design prior to production, which should by itself reduce cost and schedule slippage. Additionally, the use of commercially available equipment may be less costly than equipment conforming to traditional military standards and thus could be preferable if operations or safety are not adversely affected.

Sustaining 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 MOD is emerging from an experiment in transferring responsibilities to the private sector 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, as 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 three lessons from this experience. First, as desirable as fixed-price contracts may generally be, the MOD should not let such contracts for high-risk, first-of-class designs of technically demanding projects. On the contrary, the MOD should consider dividing the project into different segments (steel-working, outfitting, etc.) and putting these up for separate, competitive bids. This is one way to maintain competition in an industry subject to short production runs.

Second, the MOD must retain sufficient design and oversight expertise in house to see that its objectives are being met and to responsively engage the contractor. The MOD must be able to make technical decisions on issues that arise concerning tradeoffs between cost and performance or cost and safety. The MOD cannot expect a contractor, in making such tradeoffs, to arrive at the same results the MOD would. By the same token, the MOD must have the expertise to estimate costs independently.

Third, the MOD 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 in the attack submarine case 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. The MOD must have, as well, the in-house resources to support the R&D that will permit future advances in ship design.

Lessons for the United States

Now, what does all this mean for the United States? There are two important ways in which the UK and U.S. shipbuilding environments are similar. First, as I mentioned earlier, both countries are having to deal with the issue of sustaining design resources during lulls between classes at the same time, as they will be ramping up production for several classes of ship. Second, in both countries, naval demands dominate the shipbuilding sector. Neither country builds large ships for the global commercial or warship export markets. Thus, the MOD in the United Kingdom and the Department of Defense (DoD) in the United States essentially set demand conditions for the national shipbuilding industry: They decide the nature of the programs in terms of their number and size; the nature of the market, that is, whether it's run by competition or allocation; and, at least indirectly, the number of firms that will survive.

Considering these similarities, we here make some tentative recommendations for the U.S. industrial base. They are tentative because we have not recently made a comprehensive study of the U.S. shipbuilding industry, but on the basis of our current knowledge, these are some actions that could merit consideration by DoD, 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 interval, 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.

- Incorporate shipyards' prospects for obtaining non-Naval shipbuilding clients into long-range planning. The U.S. Coast Guard, for example, will be undertaking a shipbuilding program of substantial scope, though the ships will not involve the same demands as the large Navy ships do. At the same time, foreign military sales can be expected to decline.
- Resist any impulse to shift more responsibility for assurance of safety and performance to the private sector. DoD should not offer greater autonomy in making safety- and performance-related decisions at the price of more liability for risk. 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 default method for obtaining value per dollar for certain ship types. 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.
- Be prepared to close and consolidate industry elements, however politically unpalatable. It may be true that every element makes some unique contribution, but it may not be true that every such contribution is worth what it takes to sustain it. In particular, it may be difficult to support a multifirm design base. At the same time, some thought should be given to maintaining diversity in the industrial base, so yards should not be closed simply on financial grounds. It may be that what is needed is not fewer shipyards but smaller ones.
- 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 may be difficult to reconstitute, particularly for such specialized capabilities

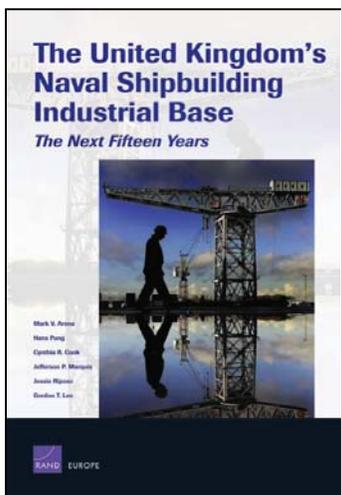
as nuclear propulsion or submarines. Options for sustaining the design and integration base include spiral development and the design of prototypes or one-hull classes.

- 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 yards and the 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.
- Encourage more outsourcing and advance outfitting. For maximum effectiveness at enhancing efficiency, subcontractors should be involved as early as possible in the design-and-build process, and, where possible, large ships should be built in blocks that are mostly outfitted before they are assembled.

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

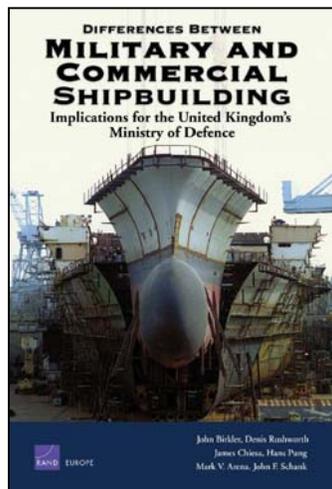
Appendix RAND Europe Shipbuilding Research Summary

RAND research commissioned by the UK Ministry of Defence has fallen into two specific categories—discrete and comprehensive analysis. The discrete studies examined specific MOD shipbuilding programmes or challenges to determine such things as how to best acquire specific warships, employ specific production techniques, or measure progress or effectiveness. The comprehensive studies looked at broader aspects of the shipbuilding programme such as the capacity and robustness of the naval shipbuilding industrial base and its ability to move into other markets, like commercial shipbuilding. The following paragraphs summarise each of the specific research projects to date, highlighting their purpose and key findings. Full citations are given at the end.



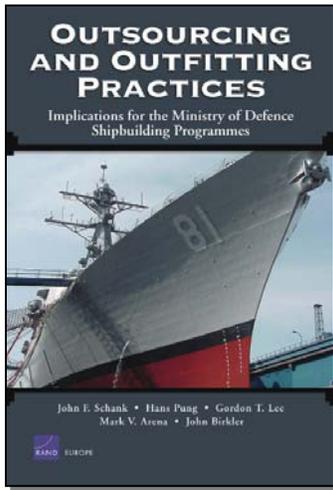
The United Kingdom's Naval Shipbuilding Industrial Base: The Next Fifteen Years: In this study, the MOD wished to know whether the UK's existing naval shipbuilding industrial base had the capacity to meet the requirements of the planned naval programme. Using extensive surveys and a breadth of data, RAND Europe researchers evaluated the capacity of the UK naval shipbuilding industrial base and the effect of alternative acquisition requirements, programmes, and schedules on it. Given the MOD's shipbuilding plan at the time, the researchers focussed on its potential impact in the areas of labour, facilities, and supplier demand. Overall, they found that, in the context of the 2004 planning assumptions, the overlap of certain large programmes would cause a near-term peak in workload demand, followed by a steady decline in production labour demand. An exception to this was the demand pattern for technical workers, which would show an initial decrease followed by a rapid upswing. RAND also conducted an analysis of whether existing facilities could meet future MOD programme demand and suggested areas where further investigation was necessary. Finally, RAND surveys of both shipyards and suppliers indicated that an increased workload would not be problematic for the supplier base. To minimise such inconsistencies

and concerns, RAND Europe suggested that the MOD in the near term consider, among other options, shifting the scheduling of the labour demand ("level-loading"), examining other options to meet peak demands, and using alternative facilities to assist major construction during peak workload times. For the long term, the researchers recommended, among other alternatives, that the MOD regularly obtain industrial planning perspectives as part of its strategic process, define an appropriate role for the UK's supporting offshore industry, reconsider the feasibility of its competition policy in light of industrial base constraints, and explore the advantages of interoperable technologies for sharing design work.

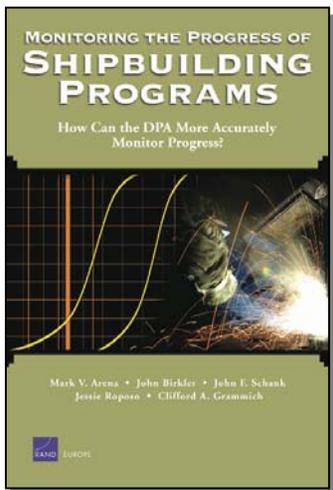


Differences between Military and Commercial Shipbuilding: Implications for the UK's Ministry of Defence: One apparent challenge within the UK shipbuilding industrial base is that it relies almost entirely on a single customer – the MOD – for survival, which could limit motivation to improve in efficiency or advance the state of the shipbuilding art. As such, the desire for a continuing efficient and robust shipbuilding industry prompted the MOD to request an assessment of the UK shipbuilding industry's ability to compete more broadly in commercial or foreign military markets. Based on literature reviews, a survey of shipbuilders, and interviews with shipyard personnel, RAND Europe found that the prospects for broadening UK shipyards' customer base were poor. The UK would face strong competitors in attempting to re-enter the commercial shipbuilding market. RAND researchers concluded that the UK has a stronger industrial base to support naval export sales than it does in the commercial arena, but that the match between most current UK military ship products and global demand is not a close one. The naval export market is largely focused on modestly priced frigates, economic exclusion-zone patrol vessels, and small conventionally powered attack submarines. UK warships are, in general, more complex

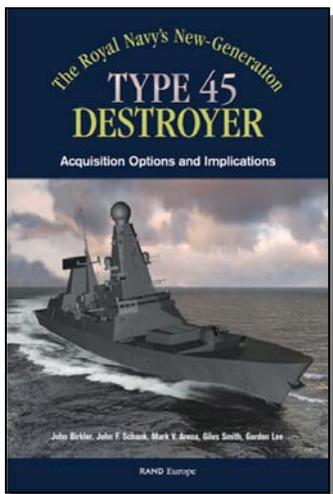
and expensive than potential buyers demand, and the industry does not currently produce non-nuclear submarines. The researchers noted that although events within the shipbuilding industry may break in the UK's favour, development of new designs and technologies would require investment – of high risk and low probability of payoff – by shipbuilders and equipment suppliers, and the government.



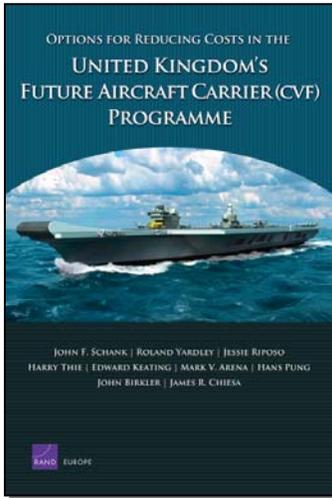
Outsourcing and Outfitting Practices: Implications for the MOD Shipbuilding Programmes: This study focused on the risks of current UK shipbuilding practices and the cost implications of using alternative manufacturing options for CVF. Based on a literature review on outsourcing and advanced outfitting, RAND researchers found, in general, that UK shipbuilders should continue to use their current subcontracting practices but should also take advantage of standards such as those used in commercial advanced outfitting in the rest of Europe and Asia. These standards focus on the extensive use of subcontracting and installation and assembly at the earliest possible construction phase. They encouraged MOD shipbuilding programmes to identify subcontractors as early as possible and to subsequently include them in the design process. By taking advantage of commercial production practices, RAND suggested that the MOD could produce their ships more effectively and efficiently, preserve the UK's military ship industrial base, and maintain the production schedules of other warships being built for the Royal Navy.



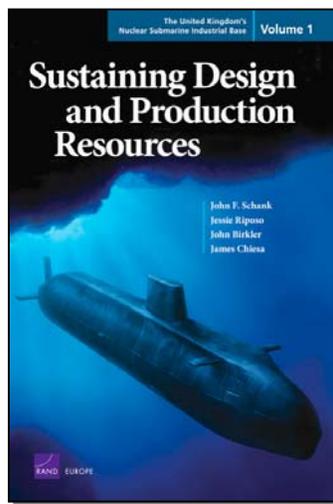
Monitoring the Progress of Shipbuilding Programmes: How Can the Defence Procurement Agency More Accurately Monitor Progress? As part of the annual assessment of its large projects, the MOD measures “slippage” – the delay between a promised in-service date and the actual or projected in-service date. In response to the slippage of some recent shipbuilding programmes, as well as difficulty distinguishing programme delay, RAND Europe was asked to analyse how major shipbuilders and contractors monitor programme progress, to consider what information would be useful for shipbuilders to provide the agency, and to help clarify the reasons for late ship delivery and differential schedule performance between commercial and military shipbuilders. After surveying major US, UK, and other European shipbuilders, the researchers found that earned-value management was the most common method used to monitor progress. From this and other metrics and procedures observed, RAND Europe recommended that the DPA consider adapting some of the current commercial practices, including incentives for on-time deliveries and the use of on-site representatives to quickly resolve late decision changes.



The Royal Navy's New-Generation Type 45 Destroyer: Acquisition Options and Implications: In 2001, the MOD commissioned RAND Europe to analyse the costs and benefits of alternative acquisition paths and evaluate near-and long-term strategies that would yield the highest value, encourage innovation, use production capacity efficiently, and sustain the UK's core warship industrial base when procuring the Type 45 destroyer. RAND researchers used future demand data for Royal Navy ships, commercial work and naval exports, and the existing capacities of select UK's shipbuilders to qualitatively and quantitatively evaluate the effects of various options to acquire and build the Type 45. More specifically, the analysis involved a comparison of the advantages and disadvantages of: having one or two shipbuilding companies produce the Type 45 over the next 15 years; allocating work competitively or directly in the case of two producers; and whole-ship versus block production. The researchers found that competitive production of the Type 45 at two shipyards would likely yield approximately the same overall cost as sole-source production at one shipyard and made recommendations regarding block production and direct allocation of the work.

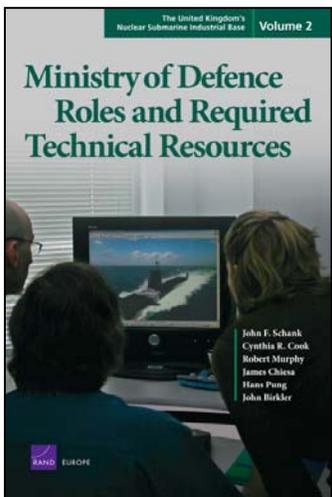


Options for Reducing Costs in the UK's Future Aircraft Carrier (CVF) Programme: Prior to the MOD's selection of an alliance to manage the prime contract for the CVF, RAND Europe was asked to examine available design and manning data to suggest reductions in whole-life costs and manpower requirements of the carriers. The research found that to reduce acquisition costs, the MOD should exercise options such as using construction practices from the commercial industry together with commercially available equipment in place of military standard equipment, given no adverse impact on operations or safety. Regarding personnel cost savings and complement-reducing initiatives, the researchers endorsed the practices of both private-sector shipbuilding companies and other navies. They also made several recommendations including promotion of a cross-trained workforce and using civilians to augment the ship's crew for non-warfare responsibilities. Options suggested for reducing the complement examined the trade-offs of increased up-front investments in technology with the corresponding manpower reductions.

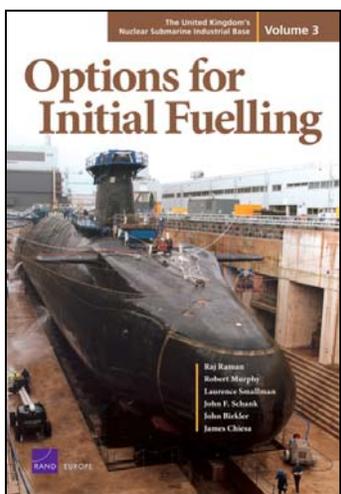


The United Kingdom's Nuclear Submarine Industrial Base. Volume 1: Sustaining Design and Production Resources: The construction of the *Astute*-class attack submarine presents complex and unique challenges that require special skills, facilities, and oversight not supported by other shipbuilding programmes. Therefore, the MOD expressed concern about the vitality of the submarine industrial base due to recent trends such as budget constraints and a lack of long-term focus on industrial base efficiencies by naval planners. RAND researchers designed analyses to determine the actions that should be taken firstly to maintain nuclear submarine design capabilities, and secondly to schedule nuclear submarine production for efficient use of the industrial base. Design and production profile assessments indicated that there was the potential for a significant loss of specialist nuclear submarine design and production skills due to insufficient programme demands. Further, recovery of these skills for future programmes, if possible, would likely be expensive and problematic. RAND Europe researchers concluded that the risks to the submarine design base could be mitigated by evolving the development of the *Astute*-class, utilising continuous design work, and through design collaboration with the United States or another submarine-producing

country. To sustain the production industrial base, RAND Europe recommended that the MOD alter the dates for commencing the follow-on SSBN and the MUFC to produce overlaps and long-term production. These overlaps would likely smooth not only the total production demand but also the demand for broad skill categories, help promote operation at peak efficiency, and potentially reduce production costs by 5-10 percent per boat.



The United Kingdom's Nuclear Submarine Industrial Base. Volume 2: MOD Roles and Required Technical Resources: Historically, the MOD has exercised significant authority and responsibility in design, development, and integration of its nuclear submarines. However, in a push for a smaller role for government, the MOD transferred much of its acquisition responsibility to industry. With past cost and schedule problems confronting the *Astute*-programme, RAND Europe was asked how the MOD could best reengage in effectively overseeing submarine design and production. RAND researchers suggested appropriate roles for the MOD in partnership with its prime contractor for each phase of future submarine acquisition. Based on management best practices, they proposed a middle-ground alternative approach—a 'partnership' model—between the hands-on and hands-off acquisition models used in the past. While acknowledging the progress made in this regard, they suggested changes to the evolving MOD acquisition structure, new staffing levels, and ways to address some potential impediments, such as the loss of submarine expertise within the MOD.



The United Kingdom's Nuclear Submarine Industrial Base. Volume 3: Options for Initial Fuelling: The final report in the series focussed on options for initial fuelling for the *Astute* programme. Cost increases in maintaining regulating licenses at both BAE Systems' Barrow-in-Furness shipyard and Devonport Management Limited (DML) prompted the MOD to consider consolidating its nuclear fuel-handling capabilities at the existing DML site. RAND researchers concluded, however, that consolidation would have complex implications for cost and scheduling of the *Astute*-class programme, which is already in progress. They compared various aspects of the two shipyards in regard to three cases hypothesized for distributing the share of *Astute*'s fuelling between the yards. As a result of this analysis, it was recommended that the MOD not consider refuelling the *Astute* first-of-class at DML. The researchers further considered an arising BAE Systems' proposal to fuel the submarines at Barrow in a way that reduces the risks of nuclear accidents, and recommended that MOD officials take immediate action in reviewing the proposal. They also suggested that the MOD promptly examine the transportation challenges associated with moving the *Astute* submarines from the Barrow docks to the open sea.

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