

Naval shipbuilding in the United Kingdom

RAND Europe research summary

Over the next 15 years, the United Kingdom (UK) will embark upon its largest naval shipbuilding programme in recent memory. This effort will be challenging, as it follows a period of reduced warship and submarine demand that has led to consolidation and reduction in the capacity of the UK shipbuilding industrial base. From 2001 to 2005, researchers at RAND Europe have studied, on behalf of the Ministry of Defence (MOD), many aspects of the proposed shipbuilding programme. This research, spread over nine specific studies, looked at the broad issues of demand and supply across the general shipbuilding and nuclear submarine shipbuilding industrial bases, in addition to challenges facing specific programmes such as the Type 45 destroyer and the Future Aircraft Carrier (CVF). Other research concentrated on the factors affecting UK shipbuilding, such as the differences between military and commercial ship construction, outsourcing and outfitting practices, and initial fuelling options for nuclear submarines. Processes available to the MOD for monitoring the progress of future shipbuilding programmes were also examined. Together these reports represent a significant body of work that has already proved influential and should remain useful to those responsible for making decisions that will affect the future of the UK's shipbuilding industrial base. Some findings of these studies, such as costs and specific procurement recommendations, will become less relevant as programmes move forward and decisions are taken. Therefore, the purpose of this overview is to highlight RAND's research in these areas, paying particular attention to those recommendations that are more enduring and will likely retain their long-term value to defence policymakers.

Key research findings and recommendations

One of the most important findings that consistently arose from the RAND research is the **importance of a comprehensive, long-term, MOD shipbuilding strategy or plan**. Such a plan will help the MOD define its future shipbuilding goals and courses of action, establish a schedule or roadmap to meet its plans, and highlight such areas of required future investment as facilities or workforce requirements and skills. More specifically, a long-term strategy will help to eliminate the "boom and bust" cycle that has plagued shipbuilding production and design, make more efficient use of shipyard facilities and workforce skills, and exploit the government's 'smart buyer' expertise. Additionally, it will help the MOD better understand the financial implications of its acquisition strategy and anticipate problems

Abstract

From 2001–2005, researchers from RAND Europe were commissioned by the UK Ministry of Defence to undertake a series of studies to examine many key aspects of the UK's future naval shipbuilding programme. Together these reports represent a significant body of work that has already proved influential and should remain useful to those responsible for making decisions that will affect the future of the UK's shipbuilding industrial base. The purpose of this policy overview is to highlight the key findings drawn from the RAND research and to provide concise summaries of each study.

by allowing the MOD to independently assess shipyard demand, and it should lead to reduced cost and schedule risk through greater programme certainty. By examining its shipbuilding strategy in the long term, the MOD can ensure that it retains the technical and programme management skills necessary for effective project control, finds its optimum level of responsibility and risk, and plays a more active role in shaping the future of the industrial base. Of course, such planning must also take into account operational requirements and the need to deliver ships to the Royal Navy in a timely manner that meets mission needs. Three main conclusions regarding long-term planning were made:

- **The MOD should attempt to smooth, or 'level-load,' the production and design demands it places on the industrial base.** Several factors will impact this 'loading,' such as drumbeat between ships in a class, duration of design/build, total force size, and expected time in service of each platform. However, the considerable benefits include better workforce and facilities use, more stable financial costs, and a greater ability for the industrial base to make long-term investment decisions.
- **Long-term planning may force the MOD to re-evaluate its competition policy.** In order to best use the industrial base, competition may not always be the default option; in some cases, it may be in the MOD's interest to allocate work for certain types of warships. However, this should not excuse the need to obtain value for money in procurement, and the MOD will need to work closely with industry to ensure that this remains the case. Competition will likely remain a viable

This product is part of the RAND Corporation research brief series. RAND research briefs present policy-oriented summaries of an individual peer-reviewed document or body of published work; current or completed work; and innovative research methodologies.

RAND Europe
Westbrook Centre
Milton Road
Cambridge CB4 1YG
United Kingdom
TEL +44.1223.353.329
FAX +44.1223.358.845

Hans Pung
hpung@rand.org

© RAND 2005
RB-9205-MOD

www.rand.org/randeurope

option in most cases, but this is only one factor in the long-term value for money consideration.

- **Long-term planning will require the MOD to work more closely with industry** than previously, in order to understand factors impacting its plans. This closer working relationship may require the MOD to supply industry with more information regarding long-range plans, future budgets, and procurement options. However, it should also reduce risk in shipbuilding programmes by providing the government with greater understanding and certainty regarding industrial capacity as well as better progress indicators, such as earned value metrics. Similarly, long-term planning may also encourage shipyards to work more closely together as they act to use complimentary skills and facilities, advance skill synergies (such as design resources), and give the MOD procurement options which result in greater industrial efficiencies.

Our research also reveals that the Ministry of Defence should consider a number of alternative strategies to improve its design and production efficiencies, within the context of a long-term shipbuilding strategy:

MOD placement of multi-ship contracts may provide industry with incentives for long-term facility investment and skill training. 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 modernised facilities. Only with longer-term contracts and prospects will the shipyards be able to justify this type of major investment. The benefit to the MOD is that the shipbuilders should achieve greater efficiencies and pass reduced costs onto 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.

A critical number of shipbuilding trades and skills are difficult to recruit and retain. To meet peak workload, the shipyards will have to hire and train new workers. However, after the peak, workers will likely become redundant. Therefore, **UK industry should focus on training skills that are readily employable outside the shipbuilding industry.** In this way, any resulting unemployment after a shipbuilding peak can be minimised. The MOD should discuss with other government departments (such as the DFES and the DTI) the potential of training programmes or incentives for these skills.

As the MOD's future shipbuilding programme unfolds, UK shipyards and firms will likely need to share design, as well as production, resources to best accomplish the plan. One difficulty in sharing design resources is that shipbuilders and design firms often have different 3D CAD/CAM tools. Thus, interchanging data and working cooperatively on a common design is difficult. **The MOD should facilitate a discussion among the firms and shipyards to explore whether the industry should adopt a common set of design tools that are interoperable, or develop industry standards that would allow design work to be easily interchanged.** Common design tools will also lead to common product models and databases and would benefit the MOD in life-cycle logistics support.

Regardless of planning efforts employed, periods of peak demand will likely remain in any future shipbuilding plan that may strain, if not exceed, industry's capacity. **During these periods, the MOD should mitigate this demand through a number of options to include outsourcing, subcontracting to smaller shipyards, or completing the work outside the UK.** Increasing use of outsourcing will decrease the labour required to be resident in a shipyard; likewise, subcontracting any peak demand work to smaller shipyards with excess capacity will ease peak demands. Finally, the MOD could also consider relaxing the current defence industrial policy in

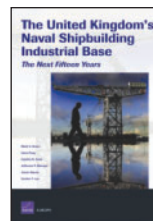
order to allow peak workload to be completed outside of the UK.

One of the reasons given for schedule slippage and cost increases on recent naval shipbuilding programmes has been the high number of changes introduced after production has begun. The MOD should be aware of this trend and guard against it through the following measures. First, the MOD should **ensure that designs are mature before proceeding into production**; second, programme managers should strive to **reduce the number of both government- and industry-introduced change orders** into a mature design. Finally, when changes are proposed to a design, the MOD should attempt **to resolve these changes as quickly as possible** in order to reduce schedule slippage.

Within warship production, the MOD can encourage best practices in order to reduce cost and shorten build schedules. RAND's research highlighted the potential benefits of **increasing the use of advanced outfitting in warship construction and encouraging the use of greater outsourcing, where appropriate.** Of note, both of these tasks require a mature pre-production design that should facilitate greater outfitting. Additionally, the **use of commercially available equipment solutions may be less costly than ones that conform to traditional military standards**, given no adverse impact on operations or safety.

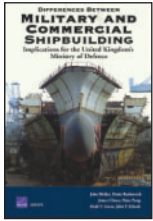
RAND Europe shipbuilding research summary

The RAND research commissioned by the MOD fell 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.

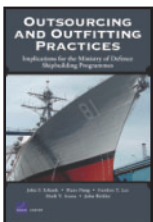


The United Kingdom's Naval Shipbuilding Industrial Base: The Next Fifteen Years: In this study, the MOD wished to know whether the UK's existing naval shipbuilding industrial base had the capacity to meet the requirements of the planned naval programme. Using extensive surveys and a breadth of data, 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 focused 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

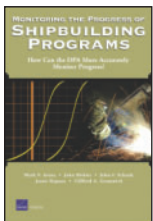
competition policy in light of industrial base constraints, and explore the advantages of interoperable technologies for sharing design work.



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.

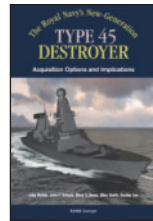


Outsourcing and Outfitting Practices: Implications for the MOD Shipbuilding Programmes: This study focused on the risks of current UK shipbuilding practices and the cost implications of using alternative manufacturing options for CVF. Based on a literature review on outsourcing and advanced outfitting, 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

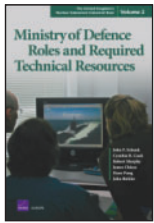
MOD should exercise options such as using construction practices from the commercial industry together with commercially available equipment in place of military standard equipment, given no adverse impact on operations or safety. Regarding personnel cost savings and complement-reducing initiatives, 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, by 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



The United Kingdom's Nuclear Submarine Industrial Base, Volume 3: Options for Initial Fuelling: The final report in the series focused 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.

Further reading

- Arena, Mark V., John Birkler, John F. Schank, Jessie L. Riposo, Clifford Grammich, *Monitoring the Progress of Shipbuilding Programmes: How Can the DPA More Accurately Monitor Progress?*, Santa Monica, CA, USA: RAND Corporation, MG-235-MOD, 2005.
- Arena, Mark V., Hans Pung, Cynthia R. Cook, Jefferson P. Marquis, Jessie Riposo, Gordon T. Lee, *The United Kingdom's Naval Shipbuilding Industrial Base: The Next Fifteen Years*, Santa Monica, CA, USA: RAND Corporation, MG-294-MOD, 2005.
- Birkler, John, Denis Rushworth, James R. Chiesa, Hans Pung, Mark Arena, John F. Schank, *Differences Between Military and Commercial Shipbuilding: Implications for the United Kingdom's Ministry of Defence*, Santa Monica, CA, USA: RAND Corporation, MG-236-MOD, 2005.
- Birkler, John, John F. Schank, Mark V. Arena, Giles K. Smith, Gordon T. Lee, *The Royal Navy's New-Generation Type 45 Destroyer: Acquisition Options and Implications*, Santa Monica, CA, USA: RAND Corporation MR-1486-MOD, 2002.
- Raman, Raj, Robert Murphy, Laurence Smallman, John F. Schank, John Birkler, James R. Chiesa, *The United Kingdom's Nuclear Submarine Industrial Base. Volume 3: Options for Initial Fueling*, Santa Monica, CA, USA: RAND Corporation, MG-326/3-MOD, 2005.
- Schank, John F., Jessie Riposo, John Birkler, James R. Chiesa, *The United Kingdom's Nuclear Submarine Industrial Base, Volume 1: Sustaining Design and Production Resources*, Santa Monica, CA, USA: RAND Corporation, MG-326/1-MOD, 2005.
- Schank, John F., Cynthia R. Cook, Robert Murphy, John Birkler, Hans Pung, James R. Chiesa, *The United Kingdom's Nuclear Submarine Industrial Base, Volume 2: Ministry of Defense Roles and Responsibilities*, Santa Monica, CA, USA: RAND Corporation, MG-326/2-MOD, 2005.
- Schank, John F., Roland Yardley, Jessie Riposo, Harry Thie, Edward Keating, Mark V. Arena, Hans Pung, John Birkler, James R. Chiesa, *Options for Reducing Costs in the United Kingdom's Future Aircraft Carrier (CVF) Programme*, Santa Monica, CA, USA: RAND Corporation, MG-240-MOD, 2005.
- Schank, John F., Hans Pung, Gordon T. Lee, Mark V. Arena, John Birkler, *Outsourcing and Outfitting Practices: Implications for the Ministry of Defence Shipbuilding Programmes*, Santa Monica, CA, USA: RAND Corporation, MG-198-MOD, 2005.

This research brief describes work done by RAND Europe that is documented in the titles noted in the text (available at <http://www.rand.org/publications>, or RAND Distribution Services: [phone: +1 310.451.7002; toll free: +1 877.584.8642], email: order@rand.org).

RAND Europe is a nonprofit research organisation providing objective analysis and effective solutions that address the challenges facing the public and private sectors around the world. RAND Europe's publications do not necessarily reflect the opinions of its research clients and sponsors. RAND® is a registered trademark.

RAND Offices Santa Monica, CA • Washington, DC • Pittsburgh, PA • Jackson, MS • Doha, QA • Cambridge, UK



EUROPE

THE ARTS
CHILD POLICY
CIVIL JUSTICE
EDUCATION
ENERGY AND ENVIRONMENT
HEALTH AND HEALTH CARE
INTERNATIONAL AFFAIRS
NATIONAL SECURITY
POPULATION AND AGING
PUBLIC SAFETY
SCIENCE AND TECHNOLOGY
SUBSTANCE ABUSE
TERRORISM AND
HOMELAND SECURITY
TRANSPORTATION AND
INFRASTRUCTURE
WORKFORCE AND WORKPLACE

This PDF document was made available from www.rand.org as a public service of the RAND Corporation.

This product is part of the RAND Corporation research brief series. RAND research briefs present policy-oriented summaries of individual published, peer-reviewed documents or of a body of published work.

The RAND Corporation is a nonprofit research organization providing objective analysis and effective solutions that address the challenges facing the public and private sectors around the world.

Support RAND

[Browse Books & Publications](#)

[Make a charitable contribution](#)

For More Information

Visit RAND at www.rand.org

Explore [RAND Europe](#)

View [document details](#)

Limited Electronic Distribution Rights

This document and trademark(s) contained herein are protected by law as indicated in a notice appearing later in this work. This electronic representation of RAND intellectual property is provided for non-commercial use only. Permission is required from RAND to reproduce, or reuse in another form, any of our research documents for commercial use.