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The United Kingdom’s Ministry of Defence (MOD) tasked the RAND Corporation to assess the outsourcing and outfitting practices of various countries’ shipbuilders in an effort to provide recommendations for the ministry to better manage the production of two new aircraft carriers, as well as other new ships for the Royal Navy. The research effort finds that the shipbuilders in the United Kingdom should continue to use their current outsourcing practices as they build the new warships. However, these builders also should consider expanding these efforts by having subcontractors build crew cabins, meeting rooms, dining facilities, galleys, and other portions of the ship that could be supplied and installed as modules. Simultaneously, the shipbuilders should take advantage of outfitting practices used to build commercial vessels in other parts of Europe and Asia that allow the installation a variety of equipment—pipes, electrical gear, and heating and ventilation systems—at the earliest possible phase in the ships’ production.

So concludes this study, performed between May and September 2003, of options open to the MOD as it manages the production of the Royal Navy’s two new aircraft carriers. We suggest that by taking advantage of the outsourcing and construction practices used in other parts of Europe and Asia to build commercial vessels, the MOD will be able to produce the new carriers more effectively and efficiently, preserve the United Kingdom’s military ship industrial base, and maintain the production schedules of other warships being built for the Royal Navy.
The Problem

The MOD is planning to produce two new aircraft carriers to replace the Royal Navy’s three existing Invincible-class carriers. These Future Aircraft Carriers (CVFs) are planned to enter the Royal Navy inventory in 2012 and 2015, respectively. The CVFs could be the largest warships ever constructed in the United Kingdom.

The anticipated size of the CVF makes it unlikely that any single UK shipyard will be able to produce the vessel, given current production capacities. Instead, the MOD’s plans call for major portions, or super blocks, of the carriers to be constructed in several shipyards, which upon completion would be transported to one shipyard for final assembly. Earlier RAND research noted that the near-simultaneous demands from several MOD programmes might seriously strain the available capacity of the UK shipbuilding industrial base.1 In particular, there may not be a sufficient workforce at the various shipyards to meet the demands of the CVF, Astute, Type 45, and Military Afloat Reach and Sustainability (MARS) programmes.

What Was RAND Hired to Do About the Problem?

RAND’s research analysed production options open to the MOD that will allow it to acquire the CVF in the most efficient and effective manner, preserve the United Kingdom’s warship industrial base, and minimise disruptions in the schedules of other Royal Navy warships slated to be produced at the same time. It focused on the costs and utility of using outsourcing (i.e., subcontracting certain construction work to other firms or hiring temporary workers to augment in-house labour) to expand the workforce needed for CVF production, and of advanced outfitting (i.e., installing equipment foundations, pipes, power distribution systems, heating and ventilation systems, modular cabins, and other components during the early stages of con-

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1 Evaluating Options for the CVF: Workload and Workforce Analysis, unpublished RAND research, September 2002.
struction) to reduce the total workload demand of the programme. In particular, we explored and sought to

- understand the current outsourcing and advanced outfitting practices of UK shipbuilders
- compare and contrast these practices with those of US, EU,\(^2\) and Asian shipbuilders
- provide recommendations to the CVF Integrated Project Team and other MOD shipbuilding programmes on how outsourcing and advanced outfitting could be used.

**How Did RAND Study the Problem?**

We reviewed past studies and related literature on outsourcing and outfitting, and created and conducted two surveys—one on outsourcing, the other on outfitting—of selected shipbuilders in the United Kingdom, United States, European Union, and Asia. In addition, our research team conducted follow-up interviews with managers of the shipbuilders who had been surveyed as well as other industry experts.

The survey on outsourcing practices requested both quantitative and qualitative data. We asked for data on outsourcing of functions associated with constructing the hull and other large structures (sand blasting, priming, painting, or fabricating) and with preparing and installing subsections of ships (e.g., machinery; piping; electrical power distribution systems; heating, ventilation, and air conditioning [HVAC] systems; accommodations; common areas; galleys; weapon systems). Upon receiving responses from the shipbuilders, we conducted on-site interviews with them to ensure our understanding of

\(^2\) For simplicity, throughout this report, the authors use the term ‘European Union’, or ‘EU’, to refer to those non-UK European shipbuilders surveyed (even though the United Kingdom is an EU member). Specifically, EU countries here consist of Denmark, Finland, France, Italy, the Netherlands, and Spain (see Table 1.1 for the full list of shipbuilders).
the survey responses and to address more complex issues not covered by the survey questions.

The survey of outfitting practices was similar to its outsourcing survey. We asked various shipbuilders in the United Kingdom, United States, and European Union to provide quantitative and qualitative data on the level of advanced outfitting they typically use to accomplish various functional tasks at different stages of construction. The survey asked about how much outfitting the shipbuilders perform at each stage and the cost or time outfitting tasks take at the unit or block, grand block, and assembled ship stages of construction. We also posed questions about factors that limit the ability to do more advanced outfitting. Upon receiving the completed surveys, we conducted on-site visits and interviews with managers at each shipyard to ensure that we had completely understood their responses.

**What Did RAND Find Out?**

**Outsourcing Practices**

The survey found that shipyards employ two types of outsourcing: total and peak. *Total outsourcing* involves a shipbuilder subcontracting a complete functional task, such as electrical, HVAC, or painting, to an outside firm. In this case, the shipbuilder retains no in-house labour capability to perform the function, although the shipyard may provide facilities (e.g., painting sheds) or materials and equipment to the subcontractor. *Peak outsourcing* occurs when a shipbuilder uses a subcontractor or temporary labour to augment in-house capabilities during times of peak demands. This is done to reduce the shipyard workforce when demands decrease if faced with strict national labour policies limiting the ability to terminate workers, or to accelerate operations when schedules start to slip.

Figures S.1 and S.2 show the extent to which the shipbuilders we surveyed use each type of outsourcing. Figure S.1 shows the results for UK shipbuilders, and Figure S.2 for US and EU shipbuilders.
UK and US shipbuilders rely on subcontractors very little, either for total functional areas or for meeting peak demands. The majority of the EU shipyards we surveyed use total subcontracting extensively, maintaining in-house capabilities primarily in the structural areas. Total outsourcing is typically a key component of a long-term corporate strategy to focus a shipbuilder on core competencies while simplifying organisational structures and reducing overhead costs associated with facilities and capital investment. Shipbuilders also use peak subcontracting to augment their in-house workforce during periods of peak demands or when there are tight schedules to meet.

The survey also suggests that cost savings are not the primary reason shipbuilders use total or peak outsourcing. Although the cost of outsourcing may be slightly less than the cost of maintaining capabilities in-house, shipyards that use outsourcing do so mainly to control their workforce in the face of cyclical demands for certain skills. Tough labour policies in certain countries make it difficult and costly to adjust permanent workforce to meet varying demands. In addition to better workforce management, shipbuilders that use total outsourcing believe the quality of the end product is better with subcontractors who specialise in certain areas, such as accommodations.

**Outfitting Practices**

The degree to which shipyards use advanced outfitting is shown in Figure S.3. The figure depicts the results of RAND’s survey of practices at different UK, US, and EU shipyards, with the vertical axis measuring the percentage of outfitting accomplished during early phases of construction. The points in the figure represent a specific shipyard’s practices, which we have connected to represent ranges. While it shows our survey results only for the electrical power distribution tasks of installing cable, switchboards, and hangers, it is generally representative of outfitting practices associated with HVAC, piping, joinery, painting, and insulation.
### Figure S.1
**Use of Outsourcing at UK Shipyards**

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<th>Swan Hunter</th>
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<th>Appledore</th>
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**Outsourcing key:**

- ☒ = Total
- ☒ = Peak (blue: maximum outsourced)

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### Figure S.2
**Use of Outsourcing by US and EU Shipbuilders**

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<tr>
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**Outsourcing key:**

- ☒ = Total
- ☒ = Peak (blue: maximum outsourced)

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1. Packaged pipe outsourced.
2. Ducting purchased and installed with in-house labour; HVAC in hotel areas subcontracted.
3. Crew accommodations/common areas done in-house.
4. Blocks built/outfitted at Baltic subsidiary.
5. Superstructure with hotel functions built at Baltic subsidiary.
The data suggest that UK shipbuilders accomplish lower levels of advanced outfitting than do most shipbuilders in the United States or European Union, not just for electrical power distribution tasks depicted but for a variety of other tasks. The figure also suggests that it is reasonable to plan for at least 80 percent advanced outfitting (i.e., before the work is to be done on the assembled ship). There are some exceptions, however. The oval in Figure S.3 represents shipyards where the customer will not permit cable splicing to be performed in advance. In such cases, an 80 percent advanced outfitting goal may not be appropriate.

What Policy Implications Flow from RAND’s Findings?

Outsourcing
With respect to outsourcing, two general messages emerge from the research:
• One size does not fit all.
• Policymakers should not expect total outsourcing to result in significant cost savings.

The CVF and other MOD programmes should allow shipbuilders to follow their current total outsourcing practices. Having said that, the CVF and other MOD programmes should encourage shipyards to use subcontractors when demands exceed in-house capacity, as is likely to be the case over the next decade for UK shipbuilders. However, the current UK shipbuilding subcontractor base is very limited. Other than in the northeast area of the country, the historical lack of demand for subcontractors has resulted in a sparse supply of applicable subcontracting firms. Temporary labourers may also help to meet increased demands but may involve higher costs and lower productivity than do qualified subcontractors.

One area where the CVF programme should consider total outsourcing encompasses accommodation and personnel support functions, such as cabins, common areas (such as meeting rooms and dining facilities), and galleys. These ‘hotel’ functions are an area where many UK shipbuilders are starting to turn to subcontractors. For example, a subcontractor will build all the cabins for the Type 45 programme. It is also an area where a subcontractor can produce higher-quality products at lower costs than a shipyard.

**Outfitting**

With respect to outfitting, our research suggests that UK shipbuilders could do higher levels of advanced outfitting in pipe work, electrical, and HVAC functions. US and EU shipbuilders typically outfit their blocks and grand blocks to higher levels in these areas than the current practices of UK shipbuilders. Goals of 80 percent outfit at the super block stage are reasonable and achievable.

UK shipbuilders could achieve these higher levels by using more finished products—e.g., packaged machinery units, complex pipe assemblies, and modular cabins and galley—than they typically have in the past. Using such packaged products can also increase the
degree of outsourcing done by UK shipbuilders by having subcontractors produce the items.

By using more advanced outfitting, shipbuilders should be able to build the CVF with fewer labour hours. Although our survey suggests the labour savings are highly variable and depend on various factors, it is reasonable to assume that performing outfitting tasks at the block and grand block level requires 25 percent fewer labour hours than doing them on the completed ship (or super block) when it is in the dry dock.

**Recommendations**

In terms of outsourcing, our recommendations for the CVF and other MOD shipbuilding programmes are as follows:

- Identify as soon as possible the subcontractors that could participate in the shipbuilding programmes. (These may include non-UK firms.)
- Begin matching the appropriate subcontractors to the construction needs of specific shipyards.
- Involve any major subcontractors in the ship design process.
- Ensure that production designs are nearly complete before construction begins and that the shipyards have adequate manufacturing plans and processes that include the integration of any necessary subcontractors.

For advanced outfitting, our recommendations are as follows:

- Encourage shipyards to develop manufacturing plans that strive to produce super blocks that are at least 80 percent outfitted before they are sent to the assembly shipyard.
- Involve all shipyards in the design process and encourage the sharing of information on advanced outfitting practices.
• Ensure production designs are nearly complete before construction begins and that the necessary equipment and materials are available in a timely fashion to facilitate advanced outfitting.