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Monitoring the Progress of Shipbuilding Programmes

How Can the Defence Procurement Agency More Accurately Monitor Progress?

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Summary

Introduction

The Defence Procurement Agency (DPA), part of the UK Ministry of Defence (MOD), provides services and equipment for the national security of the United Kingdom. This task requires efficient capital management. One of the keys to efficient capital expenditure is good programme management.

Cost and schedule control and estimating are central competencies of programme management. Controlling cost and schedule is the principal focus of this report. Continually updated knowledge of project status is important for both operational planning (determining when the customer will have use of the asset) and financial management (determining cash flow needed to support the programme). A good control system can also aid programme improvement by identifying problem areas before they greatly affect production. Accurate estimating of changing programme needs allows an organisation to make best use of limited funding. The importance of estimating and control has been recognised by the DPA in that two of the five key targets monitored are related to cost and schedule performance.

The DPA measures its annual performance against five key targets. Key Target 2 relates to programme slippage, i.e., the delay between the promised in-service date and the actual or projected in-service date. The MOD indicates average programme slippage results
in product delivery approximately one year later than the date origi-
nally anticipated at Main Gate (MOD, 2002a). Moreover, for mili-
tary shipbuilding, slippage is often recognised very late in the pro-
grame, making it more difficult to overcome. Although measures of
slippage cover MOD programmes broadly, recent shipbuilding pro-
grames such as the Landing Platform Dock, Astute, and Auxiliary
Oiler have been documented as suffering slippage as well (Scott,
2004).

These issues led the DPA to ask the RAND Corporation to

• assess how shipbuilders (and other industries) track programme
  progress and how they identify a set of metrics that are used to
  measure progress
• consider how the DPA should monitor programmes and
  recommend the types of information that should be gathered
  from shipbuilders to help the agency to independently assess
  shipbuilding progress
• identify why ships are delivered late and understand why com-
  mercial shipbuilders have much better schedule performance.

Methodology

To address these issues, RAND researchers

• surveyed major shipbuilders in the United Kingdom, United
  States, and European Union\(^1\) and conducted follow-up, in-
  depth interviews with representatives of these firms; from these
  surveys and discussions, we identified which metrics are most
  commonly used to track shipbuilding progress

\(^1\) 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 that participated consist of Finland,
France, Italy, the Netherlands, and Spain (see Table 1.1 for the full list of shipbuilders).
• asked, for comparison purposes, representatives of the project management department of a major oil firm about their methods for tracking project progress
• reviewed literature on these major metrics to assess the advantages and disadvantages of each
• identified the primary causes of production delays for shipbuilders.

How Shipbuilders Monitor Progress

We classify the methods identified to track schedule progress metrics into six general categories: earned value related, milestones, task oriented, actual versus planned, area/zone (such as compartment completion), and other (a residual category). We asked the shipbuilders to report their primary schedule control metric during each of the six phases of shipbuilding: design, module block construction, assembly, outfitting, testing/trials, and commissioning.

Figure S.1 shows the proportion of shipbuilders using a particular metric at each phase of construction. Earned value management (EVM) metrics are the most commonly used in each phase of production, though less frequently in later phases; milestones are the second most commonly used.

US shipyards are more likely than UK or EU shipyards to use EVM throughout production, largely because of the US Department of Defense requirements for EVM on most acquisition programmes. UK and EU shipyards are more likely to use non-EVM metrics such as compartment completion (area/zone) and milestones, particularly towards the end of production.
What Progress Information Should the DPA Require of Shipbuilders?

The DPA should request from shipbuilders the basic information needed for EVM. The core measures are

- actual cost of work performed
- budget cost of work performed
- budget cost of work scheduled
- estimate at completion
- budget at completion.

From these measures, most of the derived EVM metrics can be calculated. These data should be readily available, since most UK
shipyards already track production progress with an EVM system. Beyond the total programme level, these data should be reported at a lower level of detail (i.e., by work breakdown structure, major activity, and trade levels) and collected both cumulatively and by time period.

Because EVM does not account for how activities should be placed in sequence or what their effects are for critical paths, additional schedule control information should be tracked. The DPA should ask shipbuilders to provide updated, forecasted completion dates for each progress report. These reports should present revised critical path analyses for high-level activities on the network schedule. The agency should also track programme-specific milestones for each ship. Finally, the DPA should monitor the value of unresolved (un-adjudicated) changes, which can help determine whether the amount of potential new work could cause the schedule to slip.

Developing Realistic Schedule Expectations

Being able to track progress is but one part of the problem the DPA faces in better schedule adherence. Other keys to solving this problem include the schedules the DPA itself sets for production and understanding elements of commercial shipbuilding that ensure on-time delivery that could be adapted to military construction.

The DPA typically sets initial in-service dates based on operational needs. The production schedule required to meet these dates may not be realistic or result in the most cost-effective procurement. The DPA should consider developing schedule norms similar to those used by other industries and based on prior programme performance to determine whether its production schedules are realistic.

Adapting Commercial Practices

Commercial shipbuilding has very different schedule performance than does the DPA or other military programmes. When asked about
schedule performance, the common response from the commercial firms was: ‘We are never late’. (Of course, such performance is only that reported by the firms we interviewed, not that for all commercial firms.) The reasons for their better, on-time performance include differences in commercial and military needs, in how each sector manages change, and in incentives of commercial contracts.

**Change Orders and Late Product Definition: Major Contributors to Schedule Slips**

We asked each shipbuilder to identify the factors that contribute to schedule slippage. The most frequently identified category was change orders/late product definition, cited nearly half the time (see Figure S.2). The second most cited reason for schedule slippage was the lack of timely technical information needed from a supplier or client.

**Figure S.2**

*Causes of Schedule Slips Reported by Shipbuilders (percentage)*

![Pie chart showing the causes of schedule slippage. Change orders/late product definition is the most significant factor, with 46% of responses. Lack of technical information is the second most significant at 23%. Other categories include material availability, productivity, weather, unexpected equipment failures, etc., each contributing less than 10%.](image)
Perhaps more significant is the total amount of change that typically occurs in a programme. The average value of change on commercial contracts is 4 percent of the total contract cost; for military contracts, it is 8 percent. Furthermore, changes on military contracts take much longer to resolve, from four to 22 weeks, compared with one to five weeks for commercial contracts. Changes on military contracts also occur much later in the production phase than do those for commercial contracts. Shipyard representatives reported that more than half the change in commercial contracts occurs during the design phase. About 40 percent of military contract changes occur during design, with more taking place in the later phases of production, particularly in assembly and outfitting.

**Commercial Incentives Heavily Weighted Towards On-Time Delivery**

Commercial shipbuilding contracts include more incentives for on-time delivery. The contracts may impose significant liquidated damages for late delivery, costing thousands of pounds per day. To avoid such penalties, commercial shipbuilders are willing to spend money on outsourcing to get the project back on track. The full order books for many commercial contractors provide a further incentive for on-time delivery; if one programme is delayed, other programmes will also slip. Because most commercial contracts are for fixed prices, commercial shipbuilders want to move production through a facility as quickly as possible to maximise profit. The DPA has used liquidated damage clauses on recent shipbuilding contracts (e.g., for the Astute and Type 45 programmes), but whether such clauses serve as schedule incentives is debatable.

The structure of commercial contracts also provides an incentive for on-time delivery. Typically, 80 percent of the contract value is paid on delivery. The shipyard carries the financial burden on the ship (i.e., interest on the loan needed for its construction) until delivery. In contrast, military contracts are typically paid using progress milestones that are intended to keep the shipbuilder in a cash-neutral position. Some of the initiatives under Smart Acquisition (the MOD’s acquisition process), such as the Public Finance Initiative, are moving procurement strategies to more commercial terms and incen-
riages. Still, the practicality for such an approach for a warship is unclear.

Conclusions and Recommendations

Nearly all shipbuilders use EVM as a method to monitor the progress of design and production. The method is well established in many areas of business (commercial and military), not just shipbuilding. As a result, there are extensive training, software, consulting, and literature resources for implementing it. Because UK shipbuilders already use this methodology as part of their internal control process, the DPA would not, in applying it for the agency’s own purposes, be asking the shipbuilders to develop or implement new systems. The effective use of EVM will require the DPA to staff Integrated Project Teams (IPTs) with EVM professionals. The DPA has the opportunity to improve its change management on shipbuilding programmes, which could benefit both cost and schedule performance.

In sum, the DPA should consider the following actions to improve the schedule performance of its shipbuilding programmes:

- Develop an internal set of schedule norms to set realistic expectations.
- Consider options to control or reduce changes, especially those late in the process.
- Resolve changes quickly.
- Require shipbuilders to report EVM data that the shipyards already track for internal purposes.
- Make the EVM process a management control function of the IPT.
- Require shipbuilders to report estimated delivery date and critical path analysis.
- Set appropriate incentives on ship contracts to encourage better schedule performance.