



Building Ships on Time

How Can the Defence Procurement Agency More Accurately Monitor Progress?

Among the means the Defence Procurement Agency (DPA) of the UK Ministry of Defence (MOD) uses to measure its annual performance is programme slippage—the delay between the promised in-service date and the actual or projected in-service date. A recent MOD performance report indicates slippage for the top projects averaged approximately one year. Furthermore, many delays are not recognised until very late in the programme. Because MOD performance reports cover all areas of DPA programmes, the programme slippage they indicate includes more than shipbuilding programmes. Nevertheless, recent delays for programmes such as the Landing Performance Dock, Astute, and Auxiliary Oiler indicate slippage does specifically occur in shipbuilding.

The issue of programme slippage and the inability to recognise delays early in the programme led the DPA to ask the RAND Corporation to

- assess how shipbuilders 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 shipbuilders should report to it
- identify why ships are delivered late and understand why commercial shipbuilders have much better schedule performance.

To assess these issues, RAND researchers surveyed major shipbuilders in the United Kingdom, the United States, and the European Union;¹ reviewed literature on major metrics; and identified the primary causes of production delays for shipbuilders.

Abstract

UK military shipbuilding experiences considerable schedule slippage. To assess the reasons for this and means to improve it, RAND researchers surveyed major shipbuilders, reviewed relevant literature, and identified the primary causes of production delays for shipbuilders. Earned value management is commonly used to manage shipbuilding projects, and its application to military shipbuilding could help better manage progress. Other means to help reduce schedule slippage may include developing more realistic schedules and options to control, reduce, or resolve changes quickly.

How Do Shipbuilders Monitor Progress?

The researchers classified into six general categories the methods shipbuilders use to track schedule progress: earned value related, milestones, task oriented, actual versus planned, area/zone, and other (a residual category). The researchers also 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 (see the figure).

The shipbuilders reported that earned value management (EVM) metrics are the most commonly used metric in each phase of production, though less often in later phases. Milestones are the second most commonly used metric. 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.

RAND RESEARCH AREAS

- 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 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.

Corporate Headquarters
1776 Main Street
P.O. Box 2138
Santa Monica, California
90407-2138
TEL 310.393.0411
FAX 310.393.4818

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

© RAND 2005

¹ That is, EU shipbuilders outside the United Kingdom.

Shipbuilder Use of Metrics at Various Production Phases

Proportion of shipbuilders	2/3 or more	Earned value related	Earned value related	Earned value related	Earned value related		
	2/3 to 1/3	Milestones	Milestones	Milestones	Milestones	Earned value related	Earned value related
		Task	Task	Task	Task	Milestones	Milestones
		Real versus planned		Real versus planned	Real versus planned	Task	Task
	1/3 or less	Area/zone	Real versus planned Area/zone	Area/zone	Area/zone	Real versus planned Area/zone	Real versus planned Area/zone
		Other	Other	Other	Other	Other	Other
		Design	Module block	Assembly	Outfitting	Testing/ trials	Commissioning
		Production phase					

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 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 (unadjudicated) changes, which can help determine whether the amount of potential new work could cause the schedule to slip.

Why Are Ships Delivered Late?

Being able to track progress is but one part of the problem the DPA faces in its effort to improve schedule adherence. Other keys to solving this problem include setting realistic schedules 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. 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.

The commercial shipbuilding industry has very different schedule performance than does the DPA or other military programmes. When asked about schedule response, the common answer from commercial firms was “We are never late.” Of course, such performance is only that reported by the firms interviewed, and differences in commercial and military needs also contribute to differing schedule performance.

Other commercial and military differences stem from the timing and amount of change orders. Change orders or late product definition are most frequently cited by shipbuilders as the reason for schedule slips; the lack of timely technical information needed from a supplier or client is cited second most frequently.

Perhaps more significant is the total amount of change that occurs in a programme. The average value of change on commercial contracts is 4 percent of total contract cost; for military contracts, it is 8 percent. Furthermore, changes on military contracts take much longer to resolve, and take place much later in the production phase, than those that typically occur in commercial contracts.

Commercial shipbuilding contracts include more incentives for on-time delivery, e.g., liquidated damages, which the DPA has used on recent shipbuilding contracts. In contrast to military contracts, which seek to keep the shipbuilder in a cash-neutral position, the structure of commercial contracts also provides an incentive for on-time delivery, with 80 percent of the contract typically being paid on delivery. The practicality of such an approach in building a warship is unclear.

Conclusions and Recommendations

Among the means that shipbuilders use to monitor shipbuilding progress, EVM could be adapted most readily to DPA use. Nearly all shipbuilders use EVM to monitor the progress of design and production. The method is well established in many areas of business. As a result, there are extensive training, software, consulting, and literature resources for implementing it. Because UK shipbuilders already use EVM, the DPA would not, in applying it for its own purposes, be asking the shipbuilders to develop or implement new systems.

The inherent differences between commercial and military shipbuilding, including the mature technology typically used for the former and the unique needs of the latter, may limit the applicability of other commercial practices to efforts to reduce military production slippage. Nevertheless, the DPA may wish to consider such measures as setting appropriate incentives on ship contracts to encourage better schedule performance. It also may wish to require shipbuilders to report estimated delivery dates and critical path analysis, develop an internal set of schedule norms to set realistic schedule expectations, consider options to control or reduce changes (especially those late in the process), and resolve changes quickly. ■

This research brief describes work done for RAND Europe and the RAND National Security Research Division documented in *Monitoring the Progress of Shipbuilding Programmes: How Can the Defence Procurement Agency More Accurately Monitor Progress?* by Mark V. Arena, John Birkler, John F. Schank, Jessie Riposo, and Clifford A. Grammich, MG-235-MOD (available at <http://www.rand.org/publications/MG/MG235/>), 2005, 84 pp., \$18.00, ISBN: 0-8330-3660-2. MG-235 is also available from RAND Distribution Services (phone: 310.451.7002; toll free: 877.584.8642; or email: order@rand.org). 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. RAND's publications do not necessarily reflect the opinions of its research clients and sponsors. **RAND**® is a registered trademark.

RAND Offices Santa Monica • Washington • Pittsburgh • New York • Doha • Berlin • Cambridge • Leiden

RB-9116-MOD (2005)



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.