World shipbuilding is an increasingly competitive international business. For long-term profitability and market advantage, the modern shipbuilder must continuously improve productivity and quality. Today, shipbuilders seek new technological solutions for the problems associated with steel fabrication and surface preparation/coating application, both of which often are regarded as “bottlenecks” in the flow of production.

In leading shipyards, careful selection of coatings and professional production planning now are recognised as critical to maintaining a smooth process flow and ensuring delivery on time, on budget, and at the right level of quality. With the coatings process accounting for up to 30 percent of total man-hours, integrating the entire coating process with automated steelwork activities needs to be managed extremely carefully to ensure maximum productivity and efficiency.

This article describes the approach taken by one leading marine consultancy to tackle this problem.

Background

A research programme at the University of Newcastle examined the techno-economic aspects of painting in shipbuilding. The result was the development of a computer-based cost estimation tool that allows shipyards to accurately estimate the costs involved in coating ships, from initial plate/section cleaning and shop primer application through final touch-up at the outfitting quay.

The cost estimation tool takes into account man-hour, power, and material consumption, and recognises variations in cleaning and application rates resulting from alternative surface preparation standard requirements, ship areas, and work locations. This involves an analysis of the coating process and its interaction with the other aspects of shipbuilding, namely steelwork and outfitting.

As a result of the research programme, a technical association was set up at the end of 1996 between Appledore International and International Paint. The aim of this association is to combine the shipyard production and engineering expertise of the consultants with the coatings experience of the paint manufacturer to improve coating productivity within shipyards.

Methodology

A three-phase approach to this work has been developed by Appledore International and International Paint. These phases involve technical benchmarking, cost analysis, and development of improved coating strategies using work study techniques.

Phase 1: Technical

Benchmarking of the Coating Process

Technical benchmarking of the existing coating process is a technique based on a shipyard technology audit. The aim of benchmarking is to analyse the whole
coating process, from pre-production activities through post-contractual obligations, to identify at what level of technology a shipyard operates (i.e., Level 1 to 4, with Level 4 being a world class operation). By further identifying technology “islands” within the system—activities with a higher or lower technology level compared to other activities in that area—this analysis can indicate areas where the coating process may benefit from increased investment, improved planning, or improved coating practices.

Benefits of technical benchmarking are that it gives the shipyard an overall understanding of its coating process, identifies current technology levels of the shipyard’s coating process, allows the shipyard to compare its processes and procedures with best world practices, identifies “islands” of low and high technology, and allows the shipyard to target investment, training, and improved management activities. The objective of a shipyard should not be to automatically target Level 4 technology. Rather, the objective should be for the shipyard to adopt a balanced process at the appropriate level of technology for its cost base.

Phase 2: Cost Analysis of the Coating Process

This phase provides estimates of the cost of coating vessels at the newbuilding stage and helps identify areas of potential improvement. A model is used to estimate the total cost of the coating process and to make comparison tests using alternative paint specifications or coating strategies. The model can be tailored to individual shipyard’s processes. It produces estimates of the following:

- shop primer application costs, including consumables and man-hours,
- man-hour consumption and costs for secondary surface preparation (i.e., all surface preparation after initial plate cleaning) and paint application at all coating locations within the shipyard, from paint halls to outfitting quays,
- power consumption for all areas of the coating process, and
- facility utilisation (i.e., distribution of secondary surface preparation and paint application man-hour consumption throughout the shipyard).

Benefits for the shipyard production planner are that this cost analysis process gives a true indication of the total cost of coating, including any reworking necessary, identifies man-hour expenditures at each shipyard coating location, and compares man-hour consumption with surface area processed at each coating location. Also, it identifies the most efficient shipyard locations for coating specific ship areas, and allows the shipyard to develop coating strategies based on the most efficient shipyard coating locations. In addition, the system can be used to evaluate different investment strategies.

Phase 3: Development of Improved Coating Strategies and Procedures

This phase of the procedure can be based on recommendations derived from phases 1 and 2 or it can be done as a separate activity. It aims to improve the coating process by
reviewing the five main factors that influence productivity in a shipyard. Following is an outline of each of these factors.

• Design—Structures should be designed to allow for access of paint applicators and inspectors, and structural parts that are difficult to clean and paint should be reduced or eliminated to ease preparation and application.

• Facilities—The suitability of facilities to carry out work, the ease of access for surface preparation and painting workers, and staging provisions all should be reviewed.

• Production technology—Equipment should be assessed to ensure it is well maintained, and the latest technology should be reviewed for its suitability for a specific shipyard (commensurate with the shipyard’s cost base).

• Management systems—Production planning, scheduling, and control should be assessed to ascertain if production bottlenecks are caused by ineffective management practices.

• Worker skill—Skill level should be assessed for the various tasks required for the job.

This phase involves work study techniques (i.e., *in situ* study of the work taking place) to make detailed assessments of the coating work being done in the shipyard over a set time period. This can highlight the most time-consuming coating activities at each location and, therefore, those activities where most benefit can be gained from improvement.

From the work study and general observations of the shipyard coating activities, recommendations can be made for process improvements that will benefit the shipyard most. A detailed estimation of the potential cost and man-hour savings of these recommendations also can be made to identify possible productivity improvements.

The main benefits of this type of analysis are that it identifies the percentage time utilisation of coating activities at each shipyard location, identifies improvements with respect to the five key factors of productivity, allows improvements to be targeted to those activities where the most benefit can be achieved, enables step-by-step improvement programmes to be drawn up, and allows cost benefits to be calculated for each recommendation using the cost estimation tool.

**Conclusions**

This approach has been successful in identifying potential reductions in time and costs associated with the coating processes for shipbuilding. Furthermore, it has shown benefits in achieving overall increased performance with a lower amount of re-work and consequent savings in man-hours and costs.

The methods used in this process have been applied to shipyards in Europe, the Far East, and the United States with the following results. In the European shipyards, the results of the analysis were used to justify cost savings brought about by major investments in coating facilities. In the Far East shipyards, work studies produced recommendations that led to significant reductions in man-hour consumption. And the results of work carried out in the US were included in a shipyard’s strategic improvement document.

This method of analysis also can be applied to steel fabrication facilities, where similar problems of production and coating exist.