

**Benefits of Expanded Modularization
For
Ship Design & Construction**
EM-GD-010

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1.0 Introduction

Cost and schedule benefits from modular construction are nothing new, and these manufacturing and assembly approaches are being successfully implemented not only by foreign shipbuilders, but also by aircraft, automobile and home appliance industries. There have been many different studies made within and without the U.S. that predict significant cost and schedule savings. The Maritech Modular Tanker Consortium is but one research project that focused on developing a variety of equipment modules such as for the main propulsion plant. Other areas of successful modularization have been achieved with modular accommodations cabin units extensively used in the cruise ship building process. The U.S. Navy also portrayed savings from its “Affordability through Commonality” program.

Modular construction allows what is called early stage construction benefits. Examples of early stage construction in shipbuilding include on-unit and on-block outfitting. As opposed to on-board work, these on-shore stages allow workers direct and easy access to the work site (the block or unit) and the convenience of working under cover and where tools, equipment and material requirements are more readily available.

There are a number of rules of thumb that have been applied to estimate the savings. Labor costs on board can be 3-5 times higher than equivalent work done in the shop or on the platen. The figure below approximates further these savings across a variety of manufacturing and assembly stages of construction.

Stage	MHRS per Unit of Work
Panel	1
Sub-Assembly	1
Module	1
Unit	2
Block	4
Paint Cell	4
Mega-Block	6
Berth	8
Quay	12

Figure 1-1: Potential Levels of Productivity¹

Actual shipbuilding production data clearly reveals how these savings affect the costs of various ship systems such as piping, HVAC, and others. Insight from this information was used to assist RAND Corp document² for the British Ministry of Defence the potential savings from using these methods of construction.

An extrapolation of these early stage construction concepts can lead to additional benefits. Since modules can be relatively small, they can be manufactured and assembled

¹ “More Effective Planning of Early Ship Outfitting,” G.J. Bruce & T. Nielsen, presented to The Society of Naval Architects and Marine Engineers.

² “Productivity in Shipbuilding,” L.C. Deschamps, SPAR Associates, Inc. as reported to RAND Corporation, April 2003.

by smaller, more competitive manufacturers. Such alternative manufacturers can be significantly more efficient than the traditional fully-integrated shipyard that often struggles to maintain high levels of efficiency for the many different worker trades and facilities needed to build a ship.

As modules become more and more standardized, still more cost and schedule benefits can be garnered as efficiency increased from learning gained from repetitive manufacturing.

However, modular construction requires a much better level of engineering to be successful. Interfaces of systems between modules must be clearly defined and more appreciation for engineering to better support and simplify production processes needs to be developed. Engineering of the modules themselves, on the other hand, can be simpler to do due to their smaller size compared to the totality of a complex ship of many systems.

To support interchangeable weapons systems modules, relevant standardization of “feeder” support systems for the modules must be carefully engineered. These systems include all necessary inputs for the modules to operate and may include electrical power, necessary piping systems, HVAC, etc.

As shown below, there are many areas where cost and schedule benefits can be obtained from applying modular construction approaches to ship building. One area of potential interest compares cost and time savings of a modular ship design in comparison to the same ship but built in more traditional ways. This business case analysis (BCA) can provide a range of potential savings based on known and available production data.

This document focuses on a notional naval corvette and provides insight for what might be expected for other U.S. Navy acquisition programs such as the Littoral Combat Ships (LCS). Not only does modular construction reduce costs and construction time, but it also can reduce cost risk significantly.