Cost Prediction via Quantitative Analysis of Complexity in U.S. Navy Shipbuilding

LT Aaron T. Dobson, USN

Prof. Olivier de Weck	Dr. Eric Rebentisch	Prof. Mark Thomas
Thesis Supervisor	Thesis Advisor	Thesis Advisor

As the sophistication and technology of ships increases, U.S. Navy shipbuilding must be an effective and cost efficient acquirer of technology-dense one-of-a-kind ships all while meeting significant cost and schedule constraints in a fluctuating demand environment. A drive to provide world-class technology to the U.S. Navy's warfighters necessitates increasingly complex ships, which further augments the non-trivial problem of providing cost effective, on-schedule ships for the American taxpayer. The primary objective of this study was to quantify, assess, and analyze cost predictive complexity-oriented benchmarks in the pre-construction phase of the U.S. Navy's ship acquisition process via an adaptation of research produced by Prof. de Weck and Sinha in 2012.

Complexity was quantified via three overarching factors:

- Component complexity – an aggregation of eight factors including performance levels, re-use, risk, and performance tolerance levels. Each factor was normalized, weighted, and summed by subsystem.
- Interface complexity – an assessment of the interfaces in each subsystem.
- Subsystem topological complexity

Each subsystem's quantified net complexity was mapped to its procurement cost as published by U.S. Congressional reports.

This study used commercially available software such as Mathwork's MATLAB software to analyze the numerical cost data and assess the fidelity of the predictive benchmarks to the datasets. The end result was that a consideration of complexity via the methods and algorithms established in this study supported an exponential cost versus complexity relationship to refine the current cost estimation methods and software currently in use in U.S. Navy shipbuilding.

Naval Engineer
Master of Science in Engineering and Management