Resilient Acquisition: Unlocking High-Velocity Learning with Model-Based Engineering to Deliver Capability to the Fleet Faster

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As the nation's security needs call for a growing naval fleet, the public-private industrial base will be stressed to perform at a high level of operational excellence. While reaching the required fleet size is a major challenge, ships are the delivery vehicles for complex weapons systems whose design and production is equally critical to deliver capability that the Fleet needs. Underperformance in defense acquisitions is found to be caused by complexity, uncertainty, and risk manifested through poor requirements that are unadaptable to the changing reality of the global security landscape.

This thesis hypothesizes that use of model-based engineering (MBE) will enable the needed efficiency and responsiveness. MBE consists of digital tools motivated by the principles of traceability and high-velocity design iteration that collectively connect requirements to technical specifications in a model-centric format in contrast to the document-based form prevalent today. Given the problem of disengagement between the request for proposal and the finished product, prior case examples of using MBE elsewhere in the defense and industrial establishment show a bridge for the divide between capability requirements and technical realization.

An original process-based shipbuilding production model further demonstrates how understanding effects of component changes affects overall system production. Changes in a ship's required operational capabilities, translated to technical design parameters, are mapped to production steps. Simulation results demonstrate that applying MBE contributes to increased early requirement fidelity, decreases in rework through missed changes, and more rapid design iteration when the models used are properly verified and validated.

Verification and validation (V&V) must be performed in a very specific environment to engender confidence in model usage through a systemic framework. The domain of MBE can be expanded to include definition of cybersecurity requirements for a new weapon system to illustrate an iteration of model-based system design. The modeling of these requirements contributes to validated resilience upon delivery, decreasing the likelihood that cyber-physical systems will be forced to rely on time-consuming updates that delay the capability delivery.

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