NSRP Project RA 21-11
Task Order Agreement 2022-328

"Minimize Work Content in Production and Maintenance and Reduce TOC Using Early-stage Structural Design Optimization"

2023 NSRP All Panel Meeting Presentation
29 March 2023

NATIONAL SHIPBUILDING RESEARCH PROGRAM™
Taking Shipbuilding and Repair to the Next Level

Project Team: Software Developers; Major Shipbuilder; U.S. Navy; U.S. Coast Guard; ABS; Lean Design, Production Planning and Ship Design Expertise

- **MAESTRO Marine LLC**
  - *Project Lead; Naval Architects and Software Developers*
- **Austal USA**
  - *Shipbuilder with strong Concept/Preliminary through Functional and Detail Design*
- **NSWC Carderock Division, Code 65**
  - *U.S. Navy organization for structural design tools*
- **U.S. Coast Guard, Surface Forces Logistics Center**
  - *Depot Level USCG Maintenance and Engineering Center*
- **American Bureau of Shipping**
  - *Major U.S. Ship Classification Society and Technical/Safety Authority*
- **Robert Keane – Ship Design USA, Inc.**
  - *Former U.S. Navy Chief Naval Architect; Advisor for ship design tools and methods*
- **P. Jaquith & Associates**
  - *SME in Lean Design and Design for Production*
- **SPAR Associates, Inc.**
  - *SME's in ship cost-estimating and production planning*

The project team represents the U.S. shipbuilding enterprise:

- Key shipbuilder
- U.S. Navy and U.S. Coast Guard ship designers, owners and operators
- Major U.S. Ship Classification society
- Ship design, production and cost estimating specialists
- And is primed by the developers of the software being leveraged for the project.

Project Rationale

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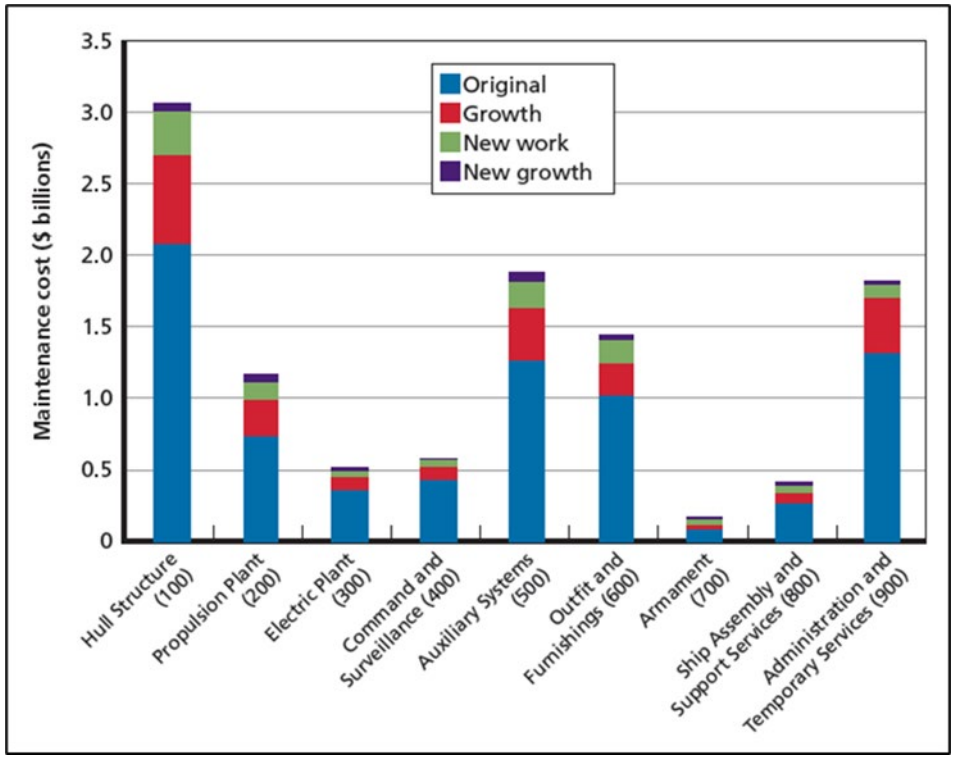
- Reduce ship construction costs with Lean Design principles while improving in-service structural performance
- U.S. Government Accountability Office (GAO) reported in its March 2020 GAO-20-2 Report, "Increasing Focus on Sustainment Early in the Acquisition Process Could Save Billions"
- The GAO found that in the seven-year period from 2012-2018, the Navy experienced over 27,000 days of unexpected maintenance delays across all of its ship classes—delays that increase sustainment costs and degrade readiness.

The project addresses these issues with enhanced design tools for early-stage structural design to augment traditional and less flexible methods.



Group 100 Hull Structures Leads U.S. Navy Surface Ship Depot Maintenance Costs by ESWBS, 2003-2015 ***[2017 RAND Report 1187]***

Project Objectives: during early-design use principles of Lean Design and higher fidelity, physics-based structural analysis to optimize structural scantlings for least work content, producibility, reduced acquisition cost, and more robust performance in-service

Project Objectives

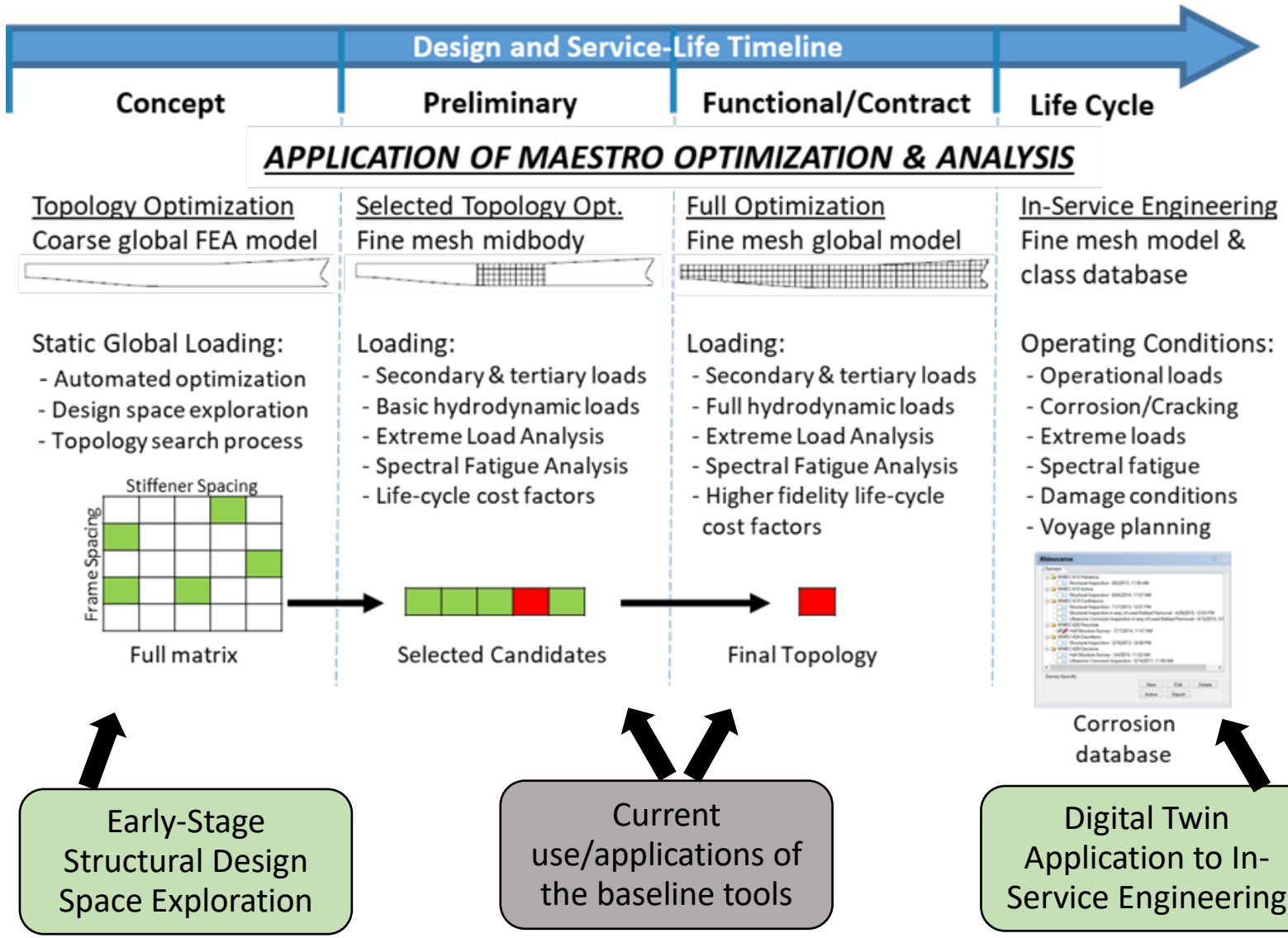
- Assure that structural design criteria are met while improving structural producibility and reducing design-build cycle time.
- Improve structural design and service-life assessment to reduce in-service corrosion, heavy weather damage, and structural fatigue cracking while mitigating excessive structural repair and maintenance costs and increasing ship availability.
- Provide comprehensive structural design space exploration capability for U.S. Navy and shipbuilder early-stage ship design processes resulting in robust structures with reduced acquisition and Total Ownership Costs (TOC).

The state of structural design practice today is largely unchanged from the early-stage structural design processes developed decades ago and still in use for ship design today.

Past structural designs for today's fleet have not withstood the demanding operating environment, resulting in excessive TOC and lost availability

Technology Transfer Approach: Provide Higher-Fidelity Structural Engineering from Concept Design though the Full Life-Cycle

Project focus is on extending the use of finite element analysis and enhanced software tools into early-stage design and also into the in-service phase of the life-cycle



Technical Approach: Early-stage Structural Design Space Exploration and In-Service Structural Digital Twin

- **Task 1. MAESTRO integration with Rhino:** Develop a universal Rhino-based modeling and finite element meshing interface to MAESTRO to reduce early-stage design start time and to facilitate generating design alternatives for analysis during early-stage ship design.
- **Task 2. Improve the handling of cost metrics:** Extend the producibility/work content tools to achieve more effective optimization of alternate structural designs reflecting reduced work content and cost to manufacture.
- **Task 3. Optimize structure for reliability and producibility as early in design as possible:** Develop a "Least Work Content" structural design algorithm for implementation in the Navy's ship synthesis model ASSET supporting early-stage design tools such as RSDE and ISDE.
- **Task 4. Implement a Structural Digital Twin:** Use the structural corrosion/condition database, and structural integrity and fatigue life assessment tools for in-service engineering.

These tasks produce practical design tools that result in:

- Improved strength and safety within specified weight constraints
- Lower acquisition costs
- Reduced in-service structural failures
- Reduced in-service corrosion degradation
- Increased life expectancy of applied coatings
- Reduced Total Ownership Cost (TOC)

Summary: "Minimize Work Content in Production and Maintenance and Reduce TOC Using Early-stage Structural Design Optimization"

Project Summary

- **Rationale:** Address documented excessive structural repair and maintenance costs and lost availability for U.S. Navy surface fleet
- **Comprehensive Team:** The project team includes key stakeholders and existing users of the base software tools
- **Core Objectives:** Reduce ship construction costs with Lean Design principles while improving in-service structural performance
- **Key Deliverables:** New MAESTRO software modules for early-stage design and for in-service engineering
- **Technology Transfer:** Distribution of practical ship structures software tools to the community
- **Project Schedule:** Project is in the second year of a two-year contract with completion in late 2023

To address comments, questions or for further information please contact:

MAESTRO Marine LLC Points of Contact:

Tobin McNatt
410-829-4272
tobin.mcnatt@maestromarine.com

Ming Ma, Ph.D.
410-739-3236
ming.ma@maestromarine.com

www.maestromarine.com