Integrating Modular Adaptable Ship (MAS) Technologies into Ship Design

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Building an Affordable Future Fleet in an Evolving World

- Face uncertain times
  - The threat is evolving
  - Our technology is evolving
  - Lean times ahead
- Ships and their systems must be robust, flexible and adaptable
  - Design process should anticipate changing requirements
  - MAS technologies can keep ships relevant over their design service life

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Design Strategies

- **Optimized Point Design**
  - (many commercial ships & Navy Auxiliaries)
  - Fixed Design

- **Robust Design**
  - (service life allowance
    Build in capability to meet threat over service life)
  - Fixed Design

- **Modular Adaptable**
  - (Mission Modules
    Flexible Infrastructure etc.
    Morph ship to match threat Over service life)
  - Flexible Design

Requirements
- Fixed
- Changing

Need to analyze “Requirements Risk”

A combination of strategies is likely optimal

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Modular Adaptable Ship Technology Examples

- “Modular Hull Ship” (bow, stern, variable Parallel Mid-Body)
- “Mission Bay” (like LCS)
- Container Stacks/Slots/Interfaces
- Weapon/Electronics Modules / zones
- Aperture Station
- Aircraft, boats, UUV, UAV, USV
- Electronic Modular Enclosures (EME)

Flexible Infrastructure
Technology / Product Maturity Goal for Ship Integration

• TRL 7 achieved
  – Prototype near or at planned operational system. Represents a major step up from TRL 6, requiring the demonstration of an actual system prototype in an operational environment, such as in an aircraft, vehicle or space. Examples include testing the prototype in a test bed aircraft.

• Industrial Base ready to produce the product
• Approved Specifications / Standard Drawings exist
• Approved Design Guidance / Handbooks exist
• Ability of Government and industry/shipyards to accurately and promptly predict work and costs

• Ability to accurately and promptly evaluate Value and Cost Benefit over the life of a ship/ship class including an understanding of the impact of changing requirements

Timing with respect to ship acquisitions depends on risk
Valuing Modularity and Flexibility

- How are requirements likely to change over the life of the ship?
- How are capability gaps measured and addressed in the Design and Modernization process?
- How do individual technologies and associated CONOPS facilitate adaptation to changing requirements?
- In performing a Cost Benefit Analysis, how are costs compared with the ability to adapt to changing requirements
  - Possibly use Real Options Theory

Consider the Design and Modernization Process as a MIMO controller for the Ship Configuration & CONOPS. The latter must provide sufficient “control authority” or “control bandwidth” to provide acceptable performance.

How much of what type of modularity should a ship design incorporate?
Design Strategies

- **Optimized Point Design** (many commercial ships & Navy Auxiliaries) - Design Fixed
- **Robust Design** (service life allowance, build in capability to meet threat over service life) - Design Fixed
- **Modular Adaptable** (Mission Modules, Flexible Infrastructure etc., Morph ship to match threat over service life) - Design Flexible

Requirements Fixed

Requirements Changing

- Historic Strategy
- Proposed Strategy for combatants

Need to analyze “Requirements Risk”

Keep Robust Design, but shift to Modular Adaptable Design