Flexible Warships – An Update

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ASNE Tysons Corner Chapter, September 30, 2014
1. Modularity Background
   - Definitions, Types, Levels
   - Historical Review

2. Flexible Warship Initiative
   - Op 96 90 Day War Room Effort
   - Future Surface Combatant (FSC) Ship Concept Study
   - PEO LCS Ships Roadmap
Definitions

- **Module**: A structurally independent building block of a larger system with well-defined interfaces.

- **Modularity**: A design approach in which a system component acts as an independently operable unit, subject to periodic change.

- **Open System**: A system that employs modular design and uses consensus-based standards for key interfaces.
Characteristics of Modularity

- Partitioned into discrete scalable and reusable modules consisting of isolated, self-contained functional elements

- A detailed systems engineering process that emphasizes a functional analysis and the identification of key interfaces

- Makes use of commonly used industry standards for key interfaces to the largest extent possible
Types of Modularity

- **Mission Modularity**
  - Systems are made up of multiple Mission Modules
  - Installation of alternate Mission Systems
  - Mission System Technology Insertion

- **Production Modularity**
  - Equipment procurement using standard interfaces
  - Maximizing early staging for equipment assembly (modules)
  - Off-ship testing of modules
  - Module installation in completed zones/compartments

- **Component Sharing**
  - Common parts or systems
  - Common standards and interfaces

- **Software Modularity**
  - Open Architecture Computing Environment (OACE)

- **Maintenance Modularity**
  - Standard interfaces for subassemblies vice vendor unique
Levels of Modularity

- **Component Level (Physical, Digital Interfaces)**
  - Focused more on component interchangeability vice system interchangeability

- **System Level (Equipment and Module Stations)**
  - Multiple ship systems are modularized or have open system standards defined for their key interfaces

- **Total Ship Architecture Level (F/E Zones)**
  - The concepts of modularity and open systems architectures are applied to the entire ship
  - Can include the development of special innovative hulls that facilitate the installation of modules/open systems
# Levels of Modularity vs. Standardization

<table>
<thead>
<tr>
<th>Level</th>
<th>Parameters</th>
<th>Applicable to</th>
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<tbody>
<tr>
<td>SHIP ARCHITECTURE (ZONES) LEVEL</td>
<td>SPACE AND WEIGHT</td>
<td>SHIP CLASS (DESTROYER)</td>
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<tr>
<td>EQUIPMENT AND MODULE STATION LEVEL</td>
<td>SIZE, STRUCTURE, SERVICES</td>
<td>SHIP TYPE (COMBATANTS)</td>
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<tr>
<td>COMPONENT LEVEL ---</td>
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<tr>
<td>Physical Connections (Electrical, Fluids)</td>
<td>CONNECTOR PINS, FLANGES</td>
<td>FLEET</td>
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<tr>
<td>Digital Connections</td>
<td>API'S, MESSAGES</td>
<td>FLEET</td>
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<td>Communications</td>
<td>LINKS</td>
<td>FLEET</td>
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Historical Background
Historical Background

- **SEAMOD & SSES (1975 – 1985)**
  - Weapons systems payloads and platform independence
  - Variable Payload Ships

- **MEKO (1975 – Current)**
  - Multi-purpose combination ships with modular weapons and electronics systems built for Germany and 10 other countries

- **STANFLEX (1985 – Current)**
  - Royal Danish Navy’s modular ships which can change ship configuration for various mission capabilities

- **DDG 51 (1985 – Current)**
  - Modular Weapon Stations for VLS (SSES A and B Module Size)

- **LCS (2003 – Current)**
  - Modular Mission Packages (SUW, MCM, ASW)

- **Flexible Warship Initiative (2013 – Current)**
Final Flexible Ships Roadmap (document) was completed on 30 May 2014
Flexible and Common Warship War Room Efforts
Future Surface Force: FLEXIBLE WARSHIPS

• A Platform
  - Scalable
  - Modular
  - Open Architecture
  - Integrated Power

• A Relevant Payload
  - Combat/Weapons System Capability Insertion
  - Objective Architecture
  - Scalable

• Interface Standards
  - Combat and Ship Systems

• SLA
  - Space
  - Weight/KG
  - Power
  - Cooling

Small, Medium and Large ships executing as appropriate, in all phases of warfare
Goals:

- More efficient and frequent capability insertion
- More efficient technology refresh to overcome obsolescence
- Greater mission flexibility and adaptability
- Increased efficiencies in acquisition, ship design, construction, and logistics

Strategy:

- Decouple the design where it makes sense
  - Target systems that change rapidly
  - Lower the bar for future technology insertion and adaptability
  - Design to interfaces and allocations
- Set program requirements to meet force-level objectives
  - Reduce variation and customization
  - Drive both acquisition and O&S cost reduction
Pace of Change

SLOWER
- Hull¹ / Arrangement
- Propulsion
- Messing & Berthing
- Distributed Systems²

FASTER
- Aircraft
- Weapons
- Sensors, Antennas & Arrays
- Combat Systems & C4ISR
- Ship & Machinery Control Systems
- Unmanned Vehicles
Military Worth of a Flexible Warship
### Warships Decommissioned Early

#### DD 963 Spruance Class
- Commissioned 1975-83 with 35 year service life
- All 31 ships decommissioned 1998-2005, 11.5 years early
- Non Aegis; Cost to remain relevant
- DDG 51 coming on line
- Shipbuilding industrial base pressures

#### DDG 993 Kidd Class
- Commissioned 1981-82 with 35 year service life
- All 4 ships decommissioned 1998-99, 18 years early
- Non Aegis; Cost to remain relevant
- DDG 51 coming on line
- Shipbuilding industrial base pressures

#### CG 47 Ticonderoga Class
- Commissioned 1983-87 with 35 year service life
- First 5 ships decommissioned 2004-05, 15.5 years early
- Cost to remain relevant
- Bias for new ships within industrial base, the congress & Navy
- CGX coming on line
Flexibility

- Ships built with the ability to accept mission systems/equipment that can be removed and replaced pier-side, in a short period, to adapt a ship’s capabilities to a specific mission.
- Flexibility features, such as easily reconfigurable spaces and modular payloads, enable continuous modernization and adaptability while increasing operational availability through reducing time spent in overhaul.

Modularity

- Ships built with common design interfaces and modular components that reduce the complexity of adding, adapting, and modernizing capabilities.
- Common modular hull sections allow the creation of ship variants during new construction by selecting hull modules to meet different requirements.

Scalability

- Ability of hardware/software combinations to be increased or decreased in size to match the capability requirements of different sized ship platforms without sacrificing performance
- Example: Air and Missile Defense Radar (AMDR). Scalability is being designed into this radar so that it can be fitted on future small combatants, big deck amphibs, and next generation carriers, providing commonality savings in logistics, maintenance, and training.

Commonality

- Capabilities developed independently of ships using standardized design specifications which allow the same systems, at various scales, to be applied across multiple ship platforms
- This attribute commoditizes capability, reducing costs associated with logistics, maintenance, and training
Future Surface Combatant (FSC) Ship Concept Study
(October 2013 – April 2014)
Flexible Warship Design Enablers

- Open Combat Systems
- Module Stations (Warfare Systems Superset)
- Flexible Infrastructure
- Pre-Engineered Elements (PrEE)

- Distributed Systems Ways
- Functional Element Zones (FEZ)
- Module Access Routes

- Aperture Stations
- Mission Bay
- Energy Magazine
- Integrated Power System (IPS)
Flexible Ships
Roadmap
(October 2013 – May 2014)
Flexible Ships Roadmap

Roadmap purpose:

To identify plans and opportunities to insert flexible architectures and technologies in surface ship programs while considering benefits, programmatic risk, and fiscal climate.

- Show key steps toward greater levels of flexibility and cost-efficiency over the life cycle
- Promote wider integration of flexible architectures and technologies
- Align ship and systems development efforts
- Prioritize opportunities based on assessment value, cost, decision points, technology readiness, and risk
- Guide investment for future ship acquisitions and modernizations
- Build an information repository to aid programs in making cost-effective acquisition and systems engineering decisions
- Influence other flexible & common warship enablers such as interface definition and management, business case efforts, requirements and specifications development, acquisition strategy, funding alignment, and organization alignment
Enabling the Vision

Strategic Enablers:

- Ensure **strong central leadership**, form a **powerful coalition**, and communicate the vision

- **Roadmap** our existing plans and future opportunities

- Provide **warfighting requirements** that will drive flexible, common, and open architectures into our ship designs and acquisitions

- Establish a **business model** that supports flexible warships

- Define, standardize, and manage **modular interfaces** and **technical architectures**

- Invest in **technology advancements** that support flexibility

- Conduct design and production **risk reduction** prototyping, at-sea tests, and demos
Recent leadership focus has created momentum
Significant challenges exist along the road ahead
# Flexible Ships
## Roadmap Participants

<table>
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<th>Group</th>
<th>Organization</th>
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<td>Roadmap Working Group</td>
<td>PEO Ships&lt;br&gt;SEA 05&lt;br&gt;SEA 21&lt;br&gt;PEO C4I&lt;br&gt;PEO IWS&lt;br&gt;PEO LCS&lt;br&gt;DASN RDT&amp;E&lt;br&gt;NSWC Carderock&lt;br&gt;NSWC Dahlgren&lt;br&gt;NSWC Headquarters&lt;br&gt;OPNAV N96</td>
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<td>Other Engagement</td>
<td>OPNAV N95&lt;br&gt;OPNAV N2/6&lt;br&gt;DASN Ships&lt;br&gt;PEO Carriers&lt;br&gt;PEO Subs&lt;br&gt;Industry</td>
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<td>Executive Summary</td>
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<td>Roadmap Charter</td>
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<td>Flexibility in Ships to Date</td>
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<td>Payload-Platform Decoupling</td>
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<td>Flexible Payloads</td>
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<td>Flexible Ship Technologies and Architectures</td>
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<td>Acquisition Strategies</td>
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<td>Ship Platforms – Forward Fit Opportunities</td>
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<td>Summary of Flexibility Insertion Plans and Opportunities</td>
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<td>Enablers</td>
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<td>Way Ahead</td>
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<td>Appendix 1 – Charter</td>
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<td>Appendix 2– Modular Adaptable Surface Combatant</td>
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<td>Appendix 3 – Assessment Report on Using LCS Modularity</td>
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Top Ten “Take Aways” on Using LCS Modularity for Future Flexible Warships

• LCS Modularity provides the ability to adapt to changing conditions (operational demand, technology and threat) through mission re-configuration and upgrade of the modular Mission Package.

• LCS Modularity provides improvements to the legacy fleet that is equivalent to various ship predecessors (e.g. FFGs, MCMs, PCs, etc.) through the ability to change focused missions using modularity.

• LCS Modularity provides the ability to achieve evolutionary acquisition with incremental developments through Mission Package upgrades.

• Experience in the organizational approach (e.g. MSSIT and PEO LCS structures) will be of great value to future Flexible Warship acquisition programs.

• LCS Modularity successfully met technical challenges to implementation thorough excellent systems engineering discipline.
• The process used to define and manage the LCS Technical Architecture can be transferred to future Flexible Warship developments (e.g. ICD Development, IV&V Development, ICM Development).

• LCS Modularity could be expanded on future Flexible Warship applications to include: Mission Modularity (total Combat System), Production Modularity, Component Sharing and Maintenance Modularity.

• The LCS ICD could be expanded to cover additional forms/types of modularity.

• LCS Mission Package modules could be installed on other ship platforms besides LCS.

• Modularity could be expanded on the LCS – given time and money.
<table>
<thead>
<tr>
<th>Acquisition Strategy</th>
<th>Description</th>
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<tbody>
<tr>
<td>Just-in-Time Payload Installation</td>
<td>Designated systems/equipment installed at the optimal point during the ship construction period</td>
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<tr>
<td>After-Delivery Payload Installation</td>
<td>Ships are delivered as platforms or “sea frames” and payloads are installed after contractual ship delivery at a designated outfitting location</td>
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<tr>
<td>Modular Design and Construction</td>
<td>Ships designed and constructed using modules or unit packaging schemes with standardized interfaces defined by a common fleet architecture</td>
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<tr>
<td>Family of Ships / Shared Payloads</td>
<td>Modular design and construction approach extended to a family of ships (e.g., medium and large surface combatants) wherein the platforms use mostly common hull modules, and the payloads are common and usable/re-usable across ships in the family</td>
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Example of Flexibility Insertion
Plans and Opportunities
Flexible Ships Back Fit: Amphibs

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- **Flexible Ship Technologies & Architecture**
  - Flexible Payloads
    - Feasibility/Maturity
      - Hi
      - Lo
  - Flexible Ship-wide Data Infrastructure
  - Common Computing (CS & C4I)
  - Energy Storage Modules
  - Payload Zones / Module Stations
  - Space/Weight/Power/Cooling Service Life Provisions (modernization-ready)
  - Rapid Removal Routes
  - Flexible Infrastructure

- **Mission Support Equipment Modules**
- **Unmanned Vehicle Modules**
- **LCS Mission Modules (on other ship classes)**
- **Topside Apertures Modules**
- **Multi-Functional / Multi-Band Apertures (Integrated Topside)**

**Flexible Ship Availability Information**

- **2014**
  - LHD 1
  - LPD 17
  - LSD 41/49
  - LCC 19/20

- **2015**
  - LHD 1
  - LPD 17
  - LSD 41/49
  - LCC 19/20

- **2016**
  - LHD 1
  - LPD 17
  - LSD 41/49
  - LCC 19/20

- **2017**
  - LHD 1
  - LPD 17
  - LSD 41/49
  - LCC 19/20

- **2018**
  - LHD 1
  - LPD 17
  - LSD 41/49
  - LCC 19/20

- **2019**
  - LHD 1
  - LPD 17
  - LSD 41/49
  - LCC 19/20

- **2020**
  - LHD 1
  - LPD 17
  - LSD 41/49
  - LCC 19/20

- **2021**
  - LHD 1
  - LPD 17
  - LSD 41/49
  - LCC 19/20

- **2022**
  - LHD 1
  - LPD 17
  - LSD 41/49
  - LCC 19/20

- **2028+**
  - LHD 1
  - LPD 17
  - LSD 41/49
  - LCC 19/20

**Availability of 6+ months (start)**

**SCD** Ship Change Document (approval window ends approx 1 year prior to start of avail)

**Hi** Feasibility/Maturity

**Lo** Feasibility/Maturity

**C5I and HM&E Availabilities**

**Permanent SCD Approval**

**Combined Weapon Modules**

Ship availability information based on NDE dated 14 March 2014
The *flexible warships* vision resides at the force level, demanding technical and business approaches that serve capability and cost objectives beyond the boundaries of individual systems or ships classes.

Sustained, coordinated leadership is crucial to enabling the implementation of the vision within and across programs.

The *Flexible Ships Roadmap* is intended to guide decision-makers in investigating and seizing opportunities to drive flexibility into the Surface Fleet.