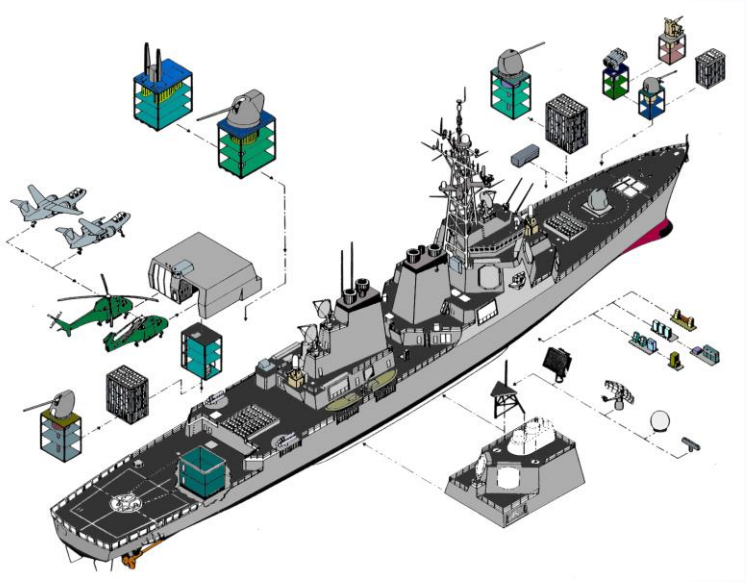
Flexible Warships – An Update



Jack W. Abbott

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ASNE Tysons Corner Chapter, September 30, 2014

Agenda

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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

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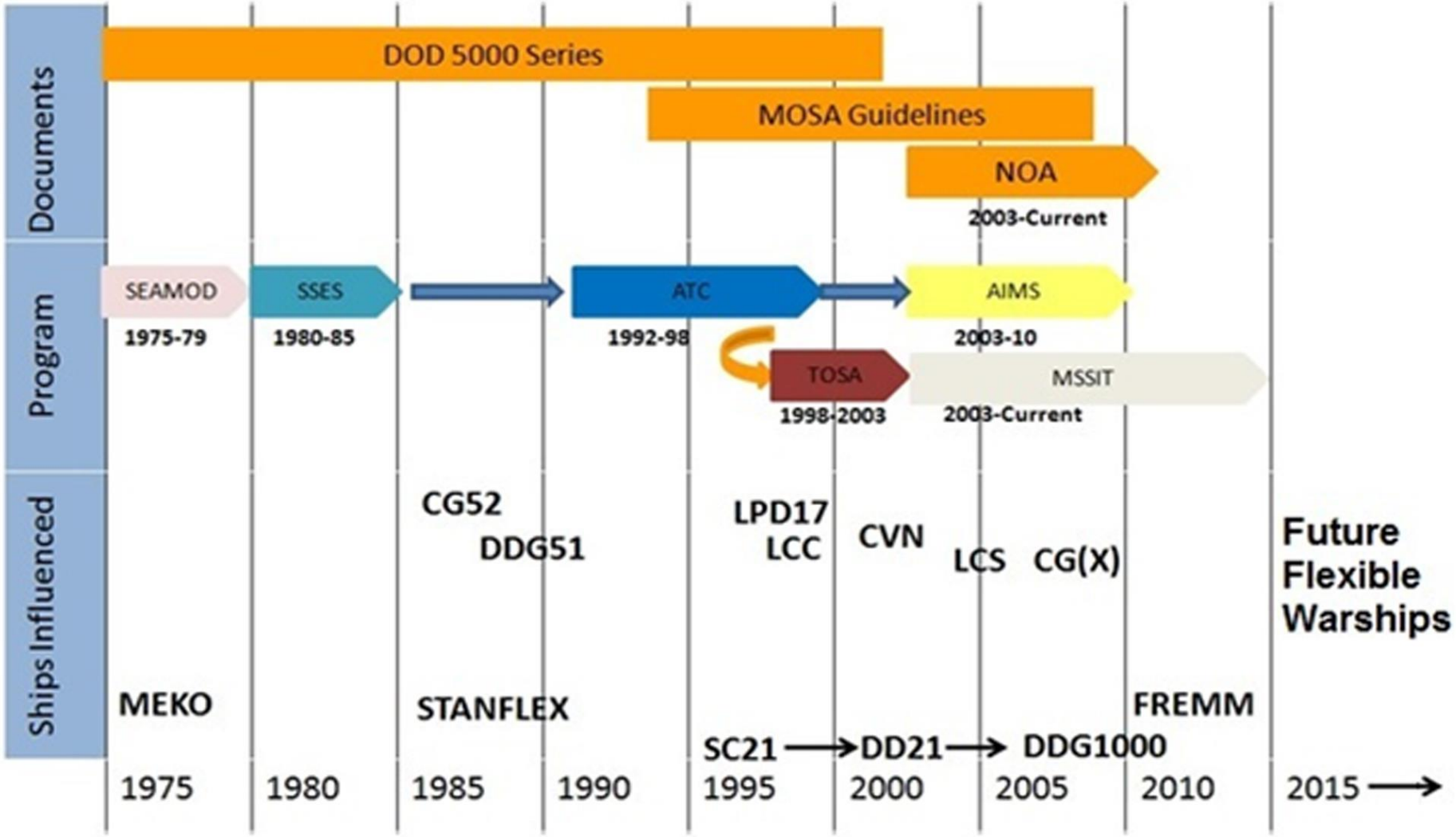
Level		Parameters		Applicable to
SHIP ARCHTECTURE (ZONES) LEVEL		SPACE AND WEIGHT		SHIP CLASS (DESTROYER)
EQUIPMENT AND MODULE STATION LEVEL		SIZE, STRUCTURE, SERVICES		SHIP TYPE (COMBATANTS)
COMPONENT LEVEL ---				
Physical Connections (Electrical, Fluids)		CONNECTOR PINS, FLANGES		FLEET
Digital Connections		API'S, MESSAGES		FLEET
Communications		LINKS		FLEET

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)**

Flexible Warships Initiative

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Final Flexible Ships Roadmap (document) was completed on 30 May 2014

Flexible and Common Warship War Room Efforts

(April 15, 2013 – July 15, 2013)

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

Flexible Warship Vision

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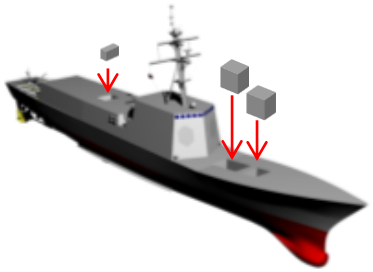
Top-level Objective: *Affordable Relevance over the Life Cycle*

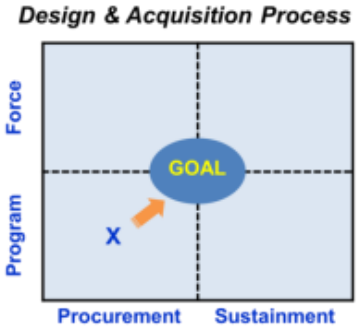
Goals:

- 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

Hull[1] / Arrangement

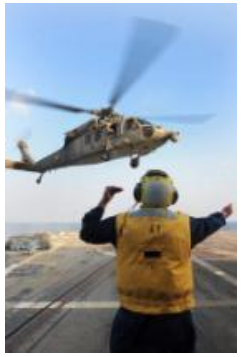
Propulsion

Messing & Berthing

Electrical Generation

Distributed Systems[2]

FASTER



Aircraft

Weapons

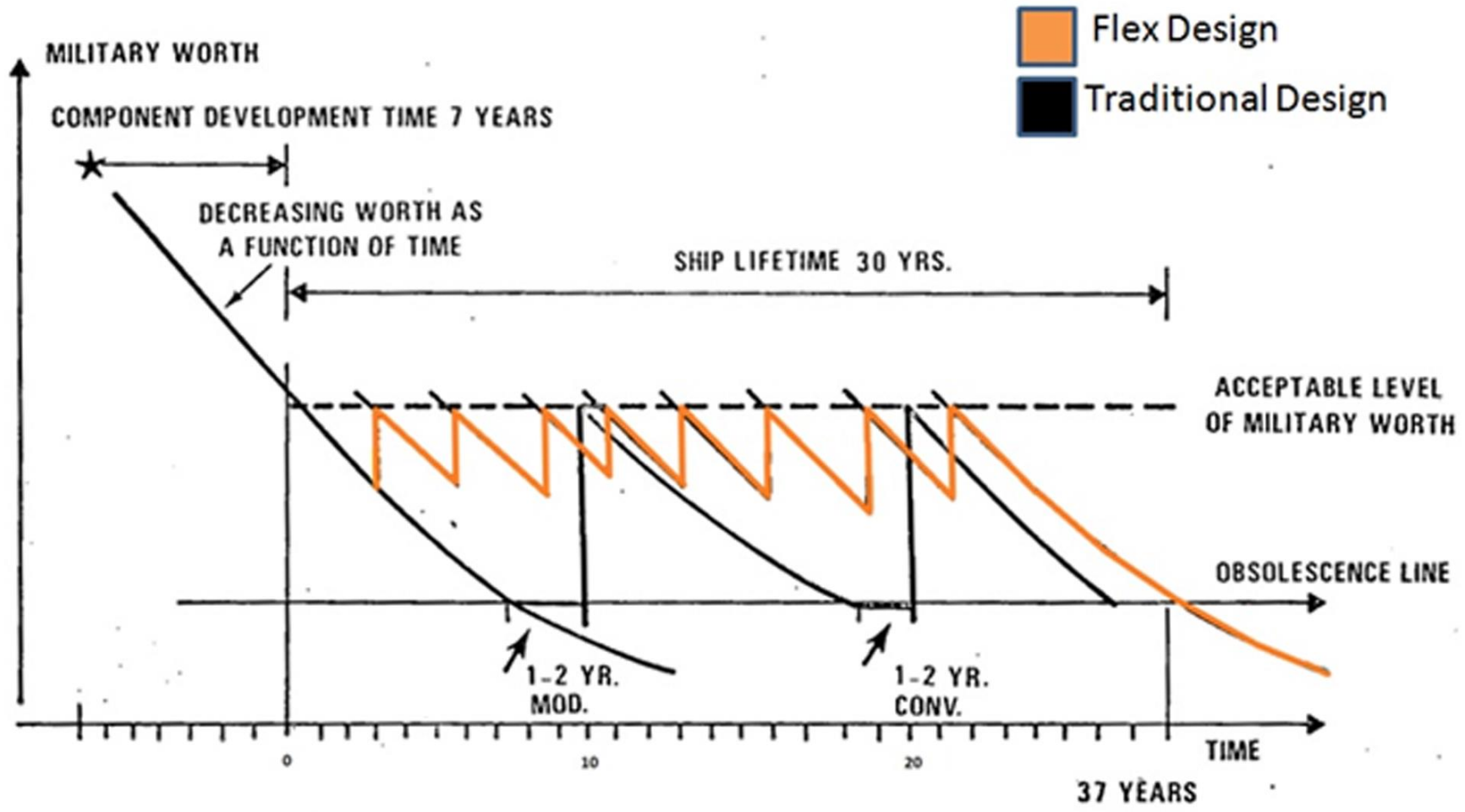
Sensors, Antennas & Arrays

Ship & Machinery Control Systems

Combat Systems & C4ISR

Unmanned Vehicles

Military Worth of a Flexible Warship



Warships Decommissioned Early

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DD 963 Spruance Class	DDG 993 Kidd Class	CG 47 Ticonderoga 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	• 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	• 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

Flexible Warship Attributes (1)

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Based on January 2014 Proceedings article, *Building The Surface Fleet Of Tomorrow*, by RADM Rowden

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

Flexible Warship Attributes (2)

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Based on January 2014 Proceedings article, *Building The Surface Fleet Of Tomorrow*, by RADM Rowden

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

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Open Combat Systems

Common Source Library

Standard Interfaces, Common Computing

Module Stations (Warfare Systems Superset)

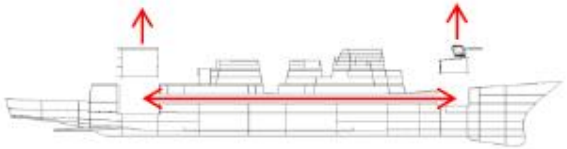
Flexible Infrastructure

Pre-Engineered Elements (PrEE)

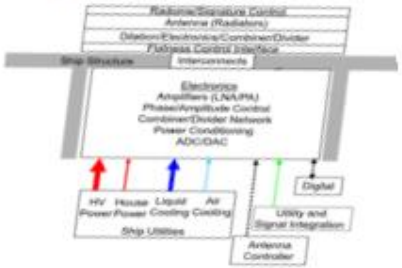
Distributed Systems Ways

Functional Element Zones (FEZ)

Module Access Routes



Aperture Stations



Mission Bay

Energy Magazine

Integrated Power System (IPS)

Surface Combatant Options

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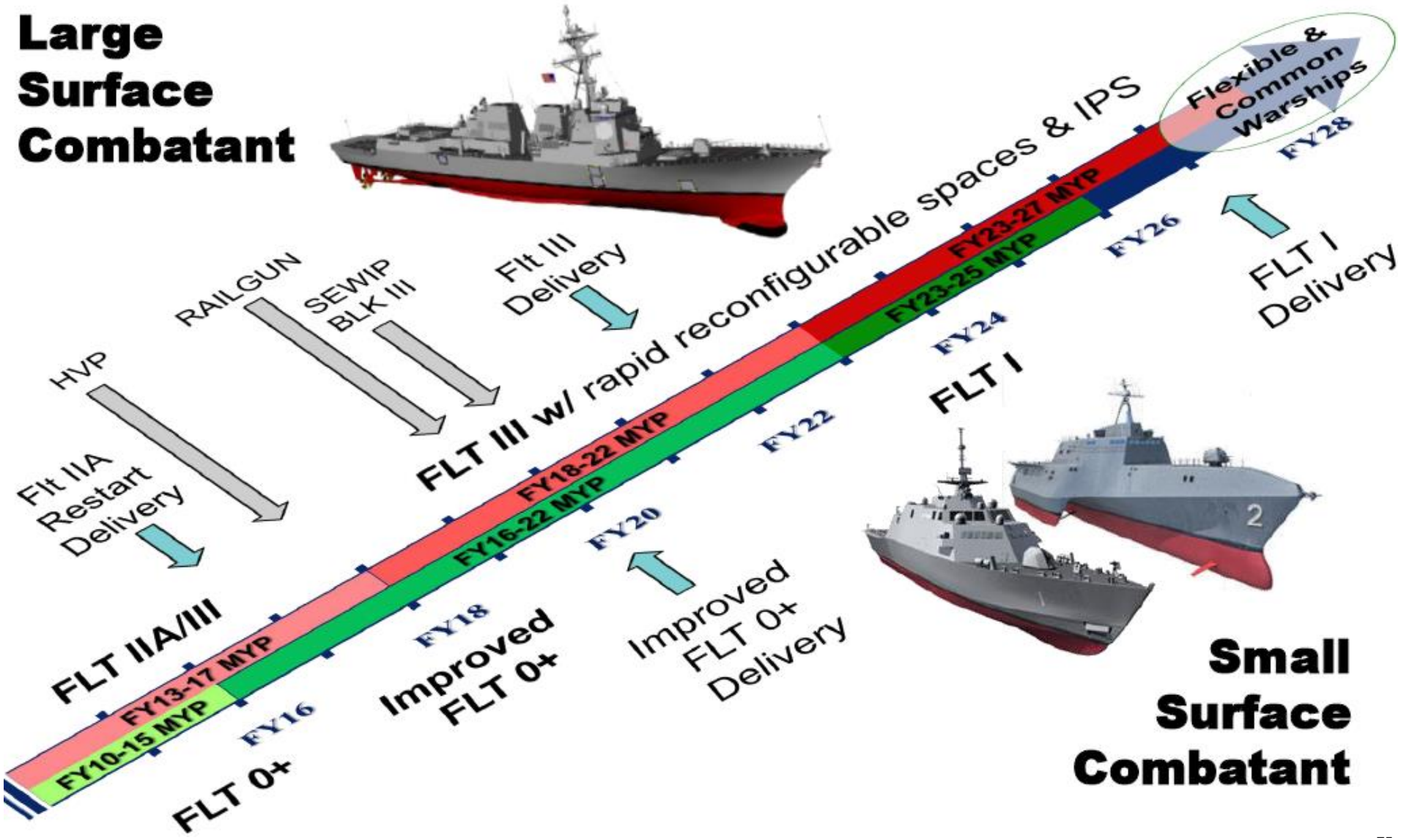

Flexible Ships Roadmap
(October 2013 – May 2014)

Flexible Ships Roadmap

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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**

DRAFT

Enabling the Vision

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Strategic Enablers:

Flag Officers, Program Mgrs	• Ensure **strong central leadership**, form a **powerful coalition**, and **communicate the vision**
PEOs, SYSCOMs	• **Roadmap** our existing plans and future opportunities
OPNAV, FLTCOMs, TYCOMs	• Provide **warfighting requirements** that will drive flexible, common, and open architectures into our ship designs and acquisitions
OPNAV, PEOs, SYSCOMs, Industry, Academia	• 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

Flexible Ships - Lines of Effort

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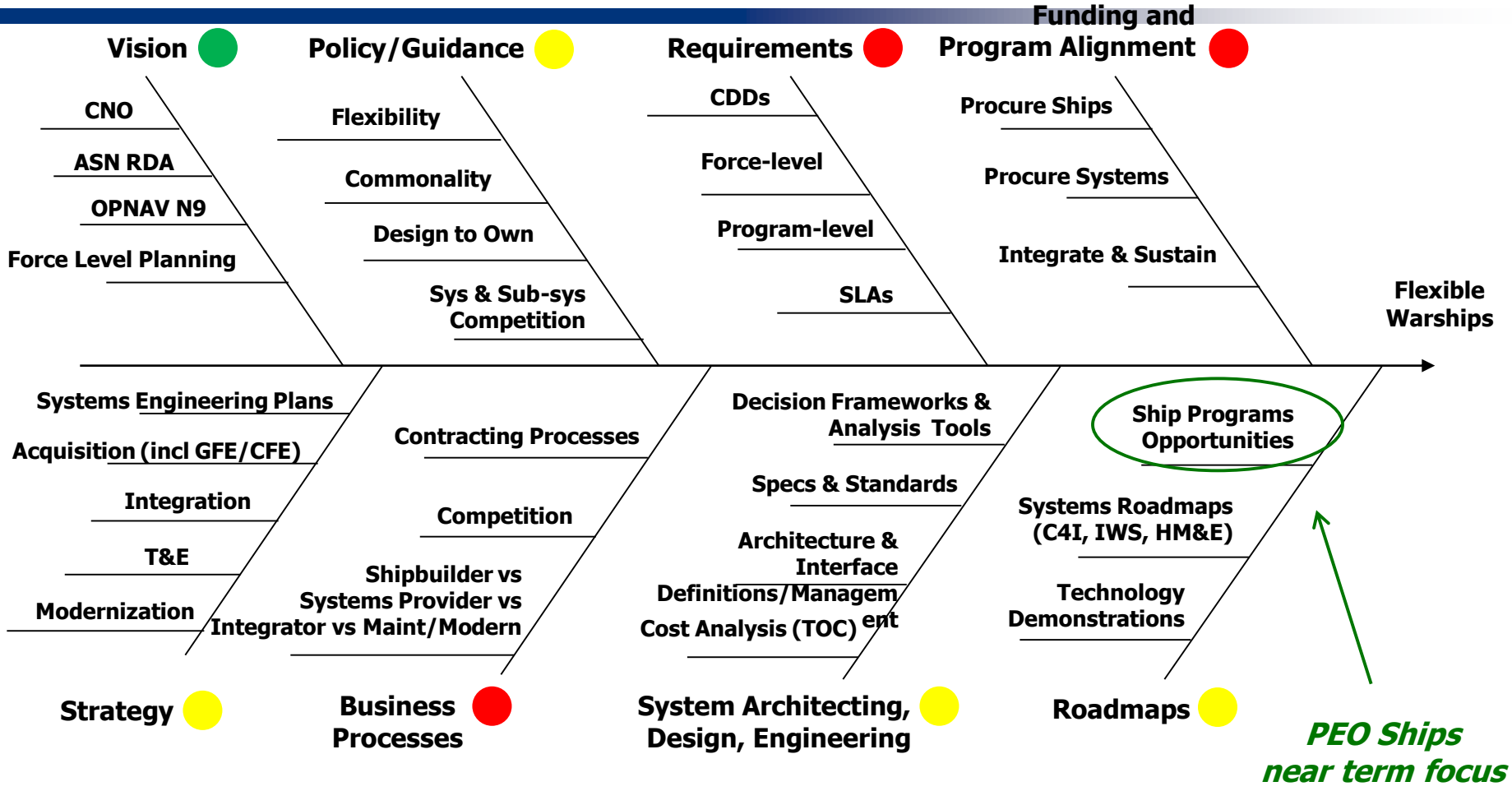

Recent leadership focus has created momentum
Significant challenges exist along the road ahead

Flexible Ships Roadmap Participants

Group	Organization
Roadmap Working Group	PEO Ships SEA 05 SEA 21 PEO C4I PEO IWS PEO LCS DASN RDT&E NSWC Carderock NSWC Dahlgren NSWC Headquarters OPNAV N96
Other Engagement	OPNAV N95 OPNAV N2/6 DASN Ships PEO Carriers PEO Subs Industry

Flexible Ships Roadmap (Table of Contents)

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Top Ten "Take Aways" on Using LCS Modularity for Future Flexible Warships

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- 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.

Top Ten "Take Aways" on Using LCS Modularity for Future Flexible Warships

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- 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.

Flexible Ship Acquisition Strategies

Acquisition Strategy	Description
Just-in-Time Payload Installation	Designated systems/equipment installed at the optimal point during the ship construction period
After-Delivery Payload Installation	Ships are delivered as platforms or "sea frames" and payloads are installed after contractual ship delivery at a designated outfitting location
Modular Design and Construction	Ships designed and constructed using modules or unit packaging schemes with standardized interfaces defined by a common fleet architecture
Family of Ships / Shared Payloads	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

Example of Flexibility Insertion Plans and Opportunities

Flexible Ships Back Fit: Amphibs

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◆ Availability of 6+ months (start)

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

Planned → Opportunity ⇢

Platforms	2014	2015	2016	2017	2018	2019	2020	2021	2022		2028+
LHD 1			Permanent SCD Approval (All)	C5I and HM&E Availabilities	LHD 5	LHD 4, LHD 8	LHD 6				
LPD 17		Permanent SCD Approval (All)	LPD 17 (19,21)	LPD 18, LPD 19		21	LPD 21				
LSD 41/49		Permanent SCD Approval	C5I and HM&E Availabilities	LSD 42	LSD 44		LSD 43, LSD 47, LSD 48				
LCC 19/20		Permanent SCD Approval	LCC 19, LCC 20	C5I and HM&E Availabilities	LCC 20				LCC 19		

Flexible Payloads (Feasibility/Maturity: Lo → Hi)

- Weapons Modules
- 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 Technologies & Architectures (Feasibility/Maturity: Lo → Hi)

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

Ship availability information based on NDE dated 14 March 2014

Summary

- 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