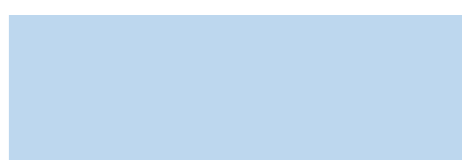


*Flexible Warships in Foreign Navies:  
Applications for Future U.S. Navy Surface Combatants*

*ASNE DAY 2015  
March 5, 2015  
Authors: Nicholas Abbott, Tony Jang, Darren Leap, Alexander B. Schaps*



# Agenda



- Introduction to “Flexibility”
- Foreign Navy Flexible Warships:
  - Germany, Denmark, United Kingdom, The Netherlands, Italy and France
- Summary of Flexibility Enablers on Foreign Warships
- Positive Impacts of Flexibility Enablers on Foreign Warships
- Flexibility Enablers Applied Over the Life Cycle
- US Flexible Warships:
  - History,
  - Applications for the US Navy - Future Flexible Warships
- Observations & Analysis
- Recommendations

# Flexibility Definition



- Flexibility is defined as:  
“The ability of a ship to adapt to universal or alternate solutions with the benefit of increased capability, reduced cost or both.”

# Key Attributes of Flexibility

## NAVSEA Flexible Ships Roadmap 2014



Attribute	Description
Adaptability	Ships built with the ability to accept systems/equipment that can be removed and replaced according to specified time/cost objectives to adapt a ship's capabilities to a given mission.
Modularity	Ships built with standardized interfaces and modular components that reduce the complexity of producing/integrating systems and modernizing capabilities.
Scalability	The ability of hardware/software combinations to be increased/decreased to match capability requirements of different sized ship platforms without sacrificing performance.
Payload Commonality	Payload systems developed independently of ship platforms using standardized design specifications allowing the same systems to be applied across multiple platforms.

# Flexibility Enablers (1 of 2)

- Production Modularity – *The use of production processes that use standardized design elements as the building blocks to produce customized ships. This includes the use of modularized equipment to facilitate streamlining of outfitting and furnishing.*
- SWAP-C – *Growth Margins for Size, Weight, Power and Cooling.*
- Flexible Design Provisions – *The incorporation of considerations that support technology insertion or mission reconfiguration at reduced cost. This includes design benefits that aren't included in other categories (e.g. access routes).*
- Modular Payloads/Stations – *Modular Stations - ship spaces that are designed with standard module interfaces. Modular Payloads are the packaging of equipment or systems that can easily be integrated into a ship space or module station.*

# Flexibility Enablers (2 of 2)



- Flexible Mission Spaces (Mission Bay) - *Ship spaces that support reconfiguration for multiple missions using multiple module stations.*
- Open Infrastructure – *The built-in ability of a ship platform to easily accommodate change. This includes the use of a common computing, data, communications infrastructure.*
- Open Standards – *The use of requirements that are not customized for a ship or a payload module.*
- Commonality - *The use of items that are shared with other subsystems or naval platforms.*

# Flexibility Enablers to Flexible Ship Roadmap



Flexibility Enablers	Key Attributes of Flexible Ships			
	Adaptability	Modularity	Scalability	Payload Commonality
Production Modularity	X*	X*	X	
Flexible Design Provisions	X			
Modular Payloads / Stations	X	X		X
Flexible Mission Spaces (Mission Bay)	X	X		X
Open Infrastructure	X		X	

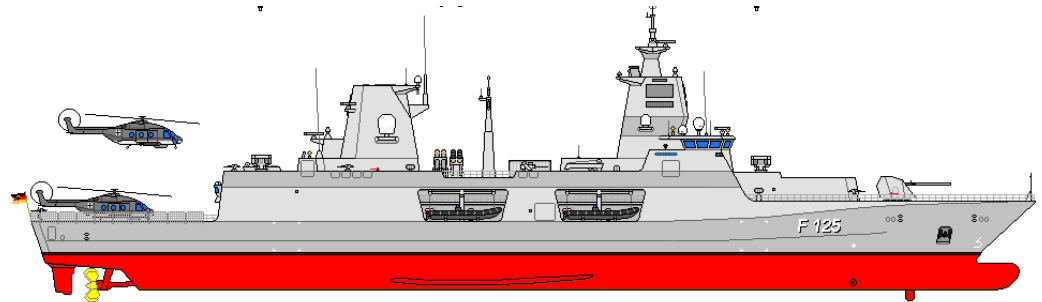
\*Production modularity that uses modularized equipment.



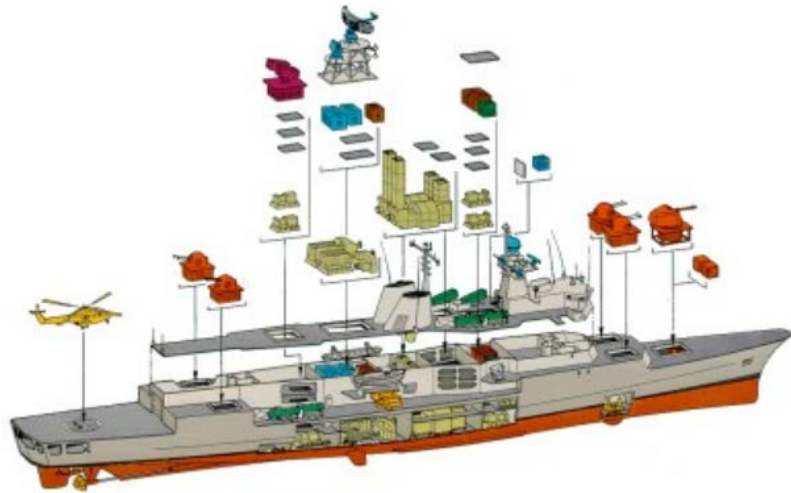
# Germany



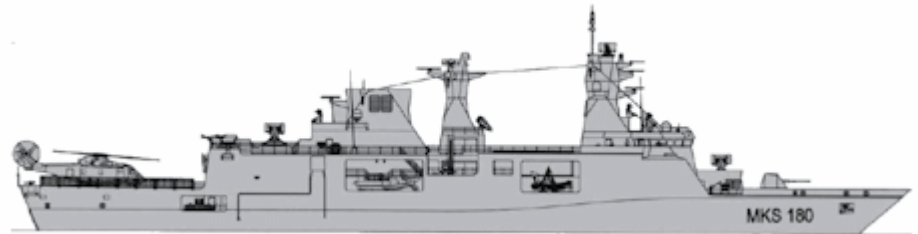
Code	Function Unit Type
	Dual-Purpose Gun Function Units
	Surface-to-Air Missile Function Units
	Surface-to-Surface Missile Function Units
	Anti-Submarine Warfare Function Units
	Fire Control Function Units
	Communication/Navigation Function Units



F125 Class



MEKO Concept

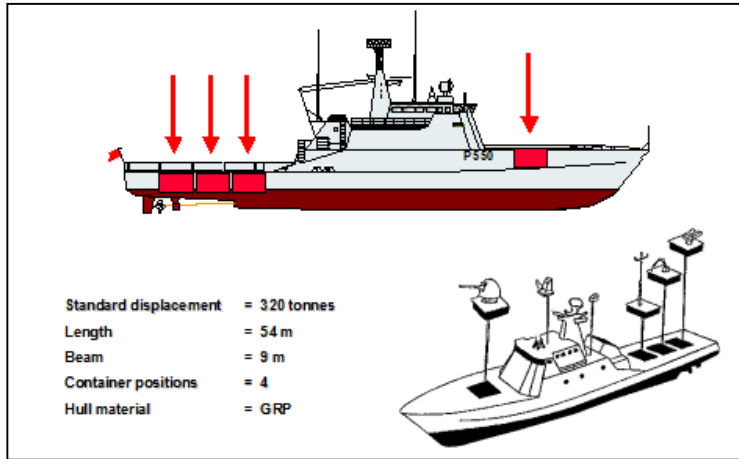


MKS 180

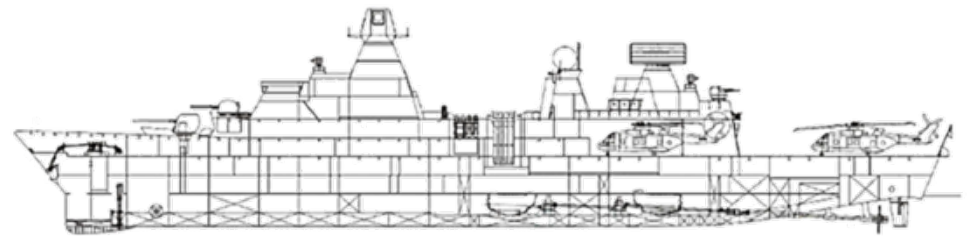




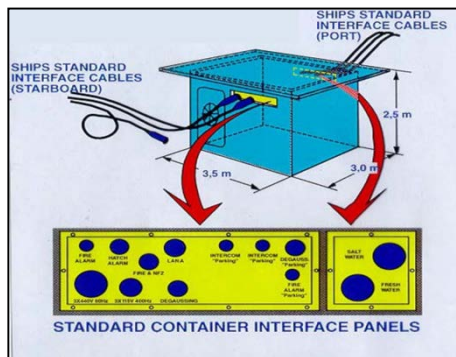
# Denmark



StanFlex 300 Ship Source: RDN



Large Displacement Classes



StanFlex Container Source: RDN



# Danish Frigate F363 Modularity Features



StanFlex Modular VLS Station & Payload



Straight Run Service Piping and Cabling



Optional Bolt-on Lightweight Armor



Midship Container Storage Area



Modular Gun on ISO Container Mounts

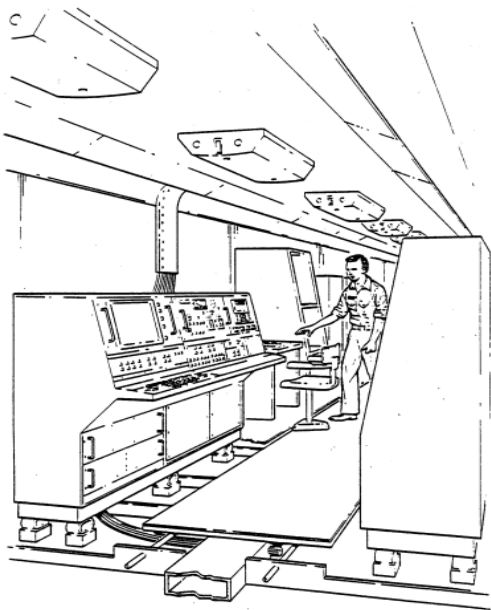


Extra-Large Cabling Tray and Penetrations

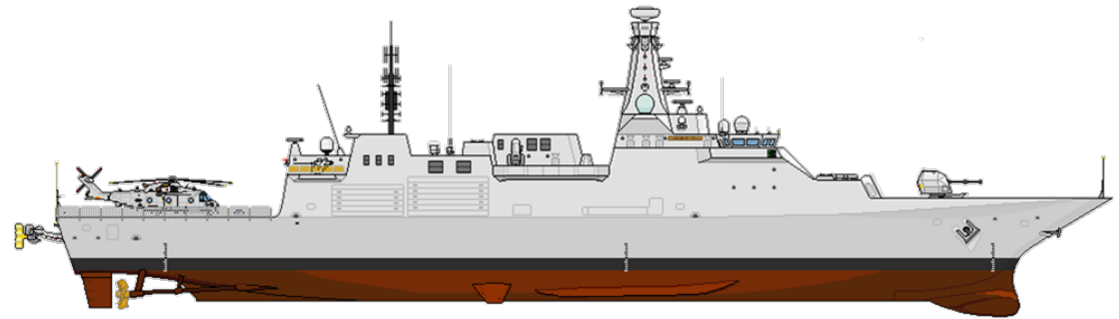
Photos taken by AOC on F363  
tour on 2014-11-12



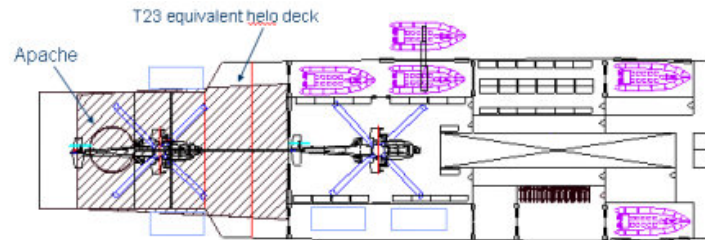
# British Cellularity Concept



Cellularity Concept circa.  
1985



Type 26 GCS



Type 26 GCS Mission Bay Concept.

Image Source: Navy Matters.



# The Netherlands



Image Source: Damen Schelde Naval Shipbuilding



CROSSOVER



# Italian FREMM and PPA Modular Frigate Concepts



- Surface Combatants

- Building new 7000-ton Bergamini-class FREMM frigates
- Developing new units (e.g. PPA multi-role patrol vessel)



Bergamini class FREMM GP  
Image source: the-blueprints.com



Modular PPA Concept



Amphibious Support PPA  
Concept



Humanitarian Relief  
PPA Concept

Source: Italian Navy





# French Flexible Warships

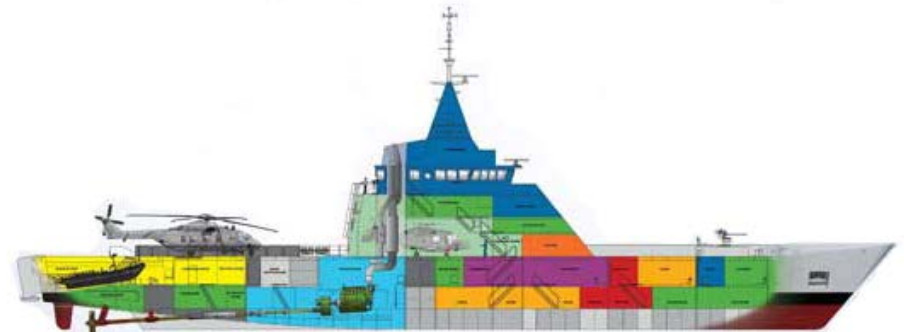


## SOME OF THE POSSIBLE VARIANTS

- FREMM multi-mission base
- Multi-mission FREMM with increased capability in Anti Air Warfare
- Multi-mission FREMM with increased capability in Anti Submarine Warfare
- Multi-mission FREMM with increased capability for Land Attack



FREMM and its variants (Source: DCNS)



<span style="color: green;">●</span>	AVIATION FACILITIES	<span style="color: grey;">●</span>	MAIN SWITCHBOARD	<span style="color: grey;">●</span>	PASSAGE WAY
<span style="color: yellow;">●</span>	SPECIAL FORCS	<span style="color: orange;">●</span>	ACCOMODATION SPACES	<span style="color: purple;">●</span>	RECREATION SPACES
<span style="color: cyan;">●</span>	ENGINE ROOM	<span style="color: red;">●</span>	SANITARY SPACES	<span style="color: grey;">●</span>	FUEL TANKS/WATER BALLAST
<span style="color: orange;">●</span>	SICK BAY	<span style="color: blue;">●</span>	COMBAT SYSTEMS	<span style="color: green;">●</span>	SERVICE SPACE

Gowind Family (Source: DCNS)

# Flexibility Enablers Summary per Ship Class (1 of 2)



MEKO:

MEKO Ships (1,560–5,690t)
MEKO 361 (3,360t)
F260 Braunschweig (1,840t)
F215 Brandenburg (4,490t)
F219 Sachsen (5,800t)



F125:

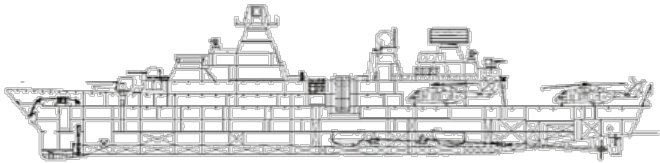
F125 Class (7,200t)

Key Flexibility Attributes	
<span style="display: inline-block; width: 15px; height: 15px; background-color: yellow; border: 1px solid black;"></span>	Production Modularity (Reuse of Design Elements for Multiple Ships)
<span style="display: inline-block; width: 15px; height: 15px; background-color: green; border: 1px solid black;"></span>	Production Modularity (Production Optimized using Modular Equipment)
<span style="display: inline-block; width: 15px; height: 15px; background-color: red; border: 1px solid black;"></span>	SWAP-C
<span style="display: inline-block; width: 15px; height: 15px; background-color: purple; border: 1px solid black;"></span>	Modular payloads & stations
<span style="display: inline-block; width: 15px; height: 15px; background-color: blue; border: 1px solid black;"></span>	Reconfigurable Mission Bay



SIGMA:

SIGMA 9113 (1,692t)
SIGMA 9813 (2,075t)
SIGMA 10513 (2,335t)
SIGMA 10514 (2,365t)



STANFLEX:

L16 Absalon Class (6,600t)
F361 Iver Huitfeldt (6,645t)
P570 Knud Rasmussen (1,720t)

# Flexibility Enablers Summary per Ship Class (2 of 2)



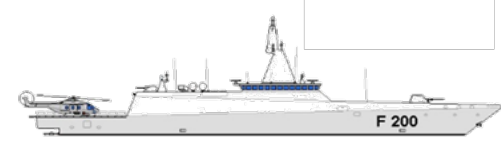
FREMM: ? ?

D650 French Variant (6,600t)  
F590 Italian Variant (6,900t)



PPA: ? ? ? ? ?

PPA (est. 4,500t)  
Under Development



GOWIND: ? ? ?

L'Adroit (1,450t)  
Gowind 2500, Egypt (est. 2500t)  
SGPV of Malaysia (3100t)



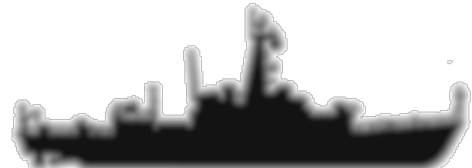
Type 26 GCS: ? ? ? ?

Type 26 GCS (est. 6,500t)  
Under Development



MKS 180: ? ? ? ?

MKS180 Class (5,000t max)  
Under Development



Crossover: ? ? ? ?

Damen XO (4,500 -5,600t)  
Under Development

Key Flexibility Attributes	
?	Production Modularity (Reuse of Design Elements for Multiple Ships)
?	Production Modularity (Production Optimized using Modular Equipment)
?	SWAP-C
?	Modular payloads & stations
?	Reconfigurable Mission Bay



# Flexibility Enablers over the Life Cycle



Flexible Enablers	Production Modularity	SWAP-C (Growth Margins)	Modular Payloads & Stations	Flexible Mission Space (Mission Bay)	Open Infrastructure	Commonality	Open Standards
<b>Production</b>							
Schedule	Reduced Build Schedule & Schedule Risk	Reduced Integration Risks	Reduced Build Schedule & Schedule Risk	NC	Reduced Design Time	Reduced Design Time	Reduced Procurement Lead Times
Cost	Reduced Labor	Increased Material Costs	Reduced Labor	NC	Reduced Unit Costs	Reduced Unit Costs	Reduced Unit Costs
<b>Pre &amp; Post Deployment</b>							
Maint & Training	NC	Reduced Maintenance Time	Reduced Training & Reduced Maintenance Time	NC	Reduced Training	Reduced Training	Reduced Training
<b>Deployment</b>							
Availability	NC	Increased Ao - (Reduced Maintenance Time)	Increased Ao - (Reduced Maintenance Time)	NC	NC	Increased Ao - Common Spares/ Redundancy	NC
<b>Overhaul &amp; Repair</b>							
Maint & Training	*Reduced Maintenance Time	Reduced Maintenance Time	Reduced Training & Reduced Maintenance Time	NC	Reduced Training	Reduced Training	Reduced Training
Cost	*Reduced Labor	Reduced Labor	Reduced Labor	More Flexibility per Ship	Reduced Labor	Reduced Unit Costs (Quantity Buy)	Reduced Unit Costs (Spares)
<b>Technology Upgrades</b>							
Maint & Training	*Reduced Maintenance Time	Reduced Maintenance Time	Reduced Training & Reduced Maintenance Time	NC	Reduced Training	Reduced Training	Reduced Training
Cost	*Reduced Labor	Reduced Integration Time	Reduced Integration Time	Reduced Integration Time	Reduced Integration Time	Reduced Unit Costs	Reduced Unit Costs
Integration Risks	*Reduced Risks	Reduced Risks	Reduced Risks	Reduced Risks	Reduced Risks	NC	NC
<b>Disposal</b>							
Cost	*Reuse of Modularized Equipment	NC	Reuse of Payloads / Reduced Labor	NC	NC	Resue of Common Hardware	NC



# Observations and Analysis



What can we learn from foreign flexible warships?

- Foreign Navies made decisions in favor of building flexible warships for near term savings. These include:

- Improved construction process
- Mission Reconfiguration Capability in a Single Hull
- Use of a common hull (platform) for multi-national use

Flexibility benefits are proven and are driving decisions for wider adoption by these navies.

# Recommendations for Future U.S. Warship Development



Top Priorities for Implementation of Flexibility:

1. Use modular payloads
2. Develop a process based cost model
3. Help equipment suppliers learn “what’s in it for them”
4. Implement common hulls

The concept of a Flexible Warship can help the Navy achieve both cost and capability goals for its ships.

Questions?

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**Thank You**