

# Overview of the issues raised by ship modularity's introduction into the law of the sea

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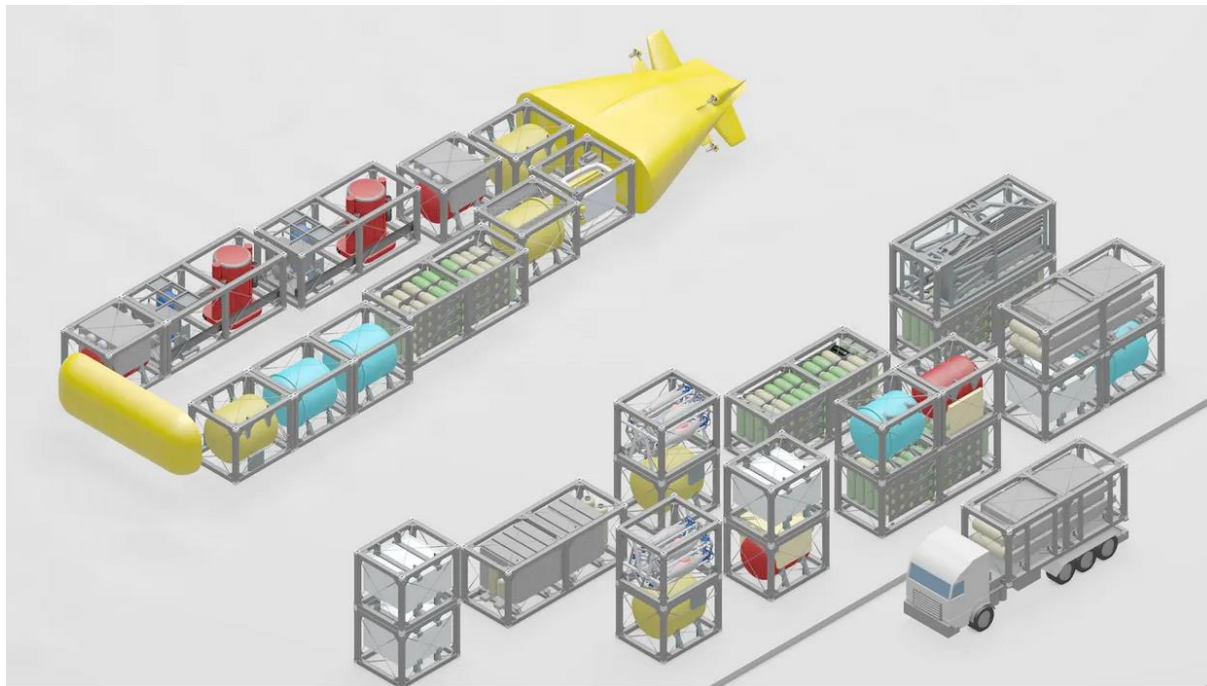
Knowledge for Tomorrow





# Starting Point

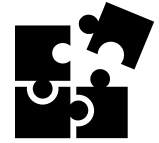
- **MUM Project** (tkMS) – Modifiable Underwater Mothership
- Autonomous and modular ship



**Fig. 1:** tkMS, *MUM*, <https://www.thyssenkrupp-marinesystems.com/en/products-services/innovations/mum-modifiable-underwater-mothership>



# What is modularity?



- *“The quality of consisting of separate parts that, when combined, form a complete whole.”*

Cambridge Dictionary

- More than *“splitting up a product for later assembly, [...] there needs to be a certain level of flexibility in the way that the parts are recombined.”*

S.O. Erikstad

- Also applies to other fields of science: biology, languages, mathematics, etc.



# Modularity applied to ships - I



- *“Explicit actions towards subdividing the ship into well-defined parts and components that can later be recombined according to given rules and procedures.”*

S.O. Erikstad

- *“Modularity involves creating fixed boundaries, defined interfaces, and defined ship services (such as power and cooling) to standard portions of a ship, which are termed modules.”*

J.F. Schank *et al.*

- *“The Littoral Combat Ship is less of a ship, and more of a battle network component system, consisting of a sea frame, a core crew, assorted mission modules, assembled mission packages, mission packages crews, and a reconfiguration support structure.”*

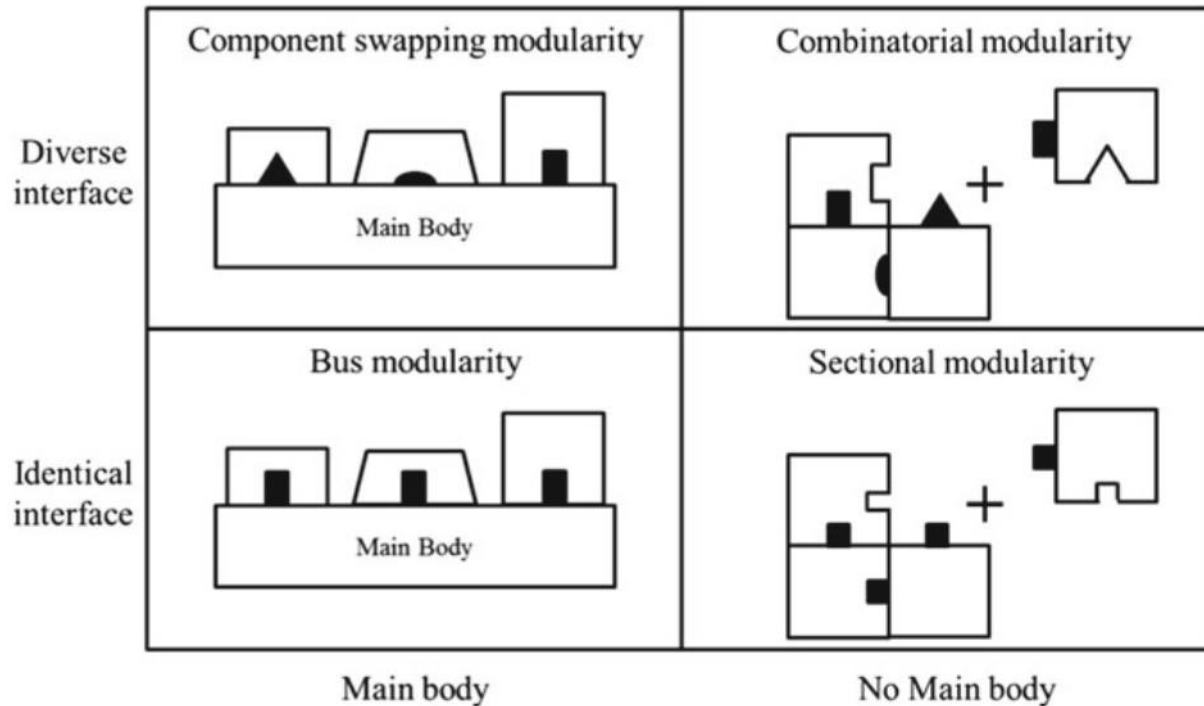
R.O. Work





# Modularity applied to ships - II

**1<sup>st</sup> issue:** What classification to use for ship modularity?



**Fig. 2:** Different types of ship modularity, Erikstad, *Design for modularity*, p. 334



# Modularity applied to ships - III



- Other authors on the different types of ship modularity:
  - J.F. Schank *et al.*: Common modules; Self-contained modules; Modular installations
  - Naval Research Advisory Committee: Capability swapping modularity; Component sharing modularity; Bus modularity; Construction/Design modularity

**2<sup>nd</sup> issue:** No uniform terminology



# Modularity applied to ships - IV



- Modularity finds application at different stages of a ship's life:
  - S.O. Erikstad:
    1. Design
    2. Production
    3. Operation
  - R.O. Work:
    1. Construction
    2. Configuration
    3. Mission



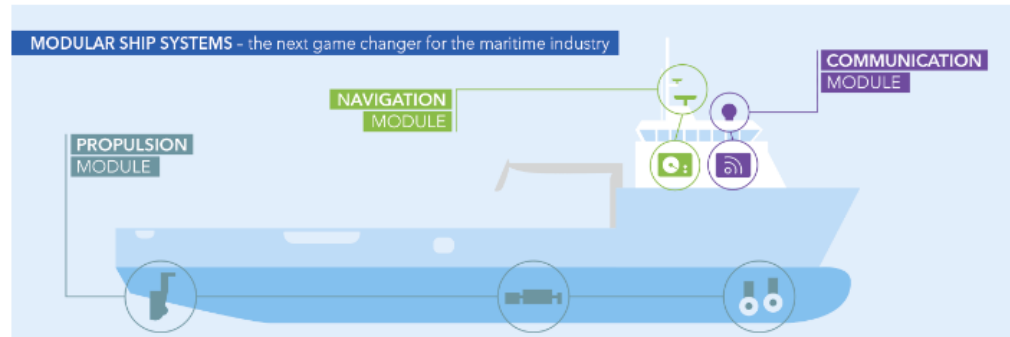
# Design Modularity



- Standardisation of separate components of a vessel

→ Components of a ship

→ On a ship level



**Fig. 3:** DNV, MIDAS, <https://www.dnv.com/expert-story/maritime-impact/MIDAS-The-future-of-modularization.html>



**Fig. 4:** Erikstad, *Design for Modularity*, p.338 from Ulstein Design

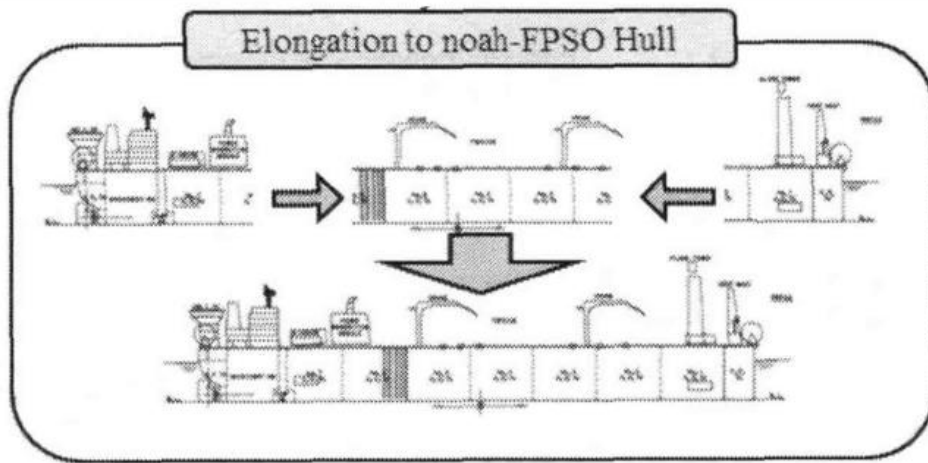




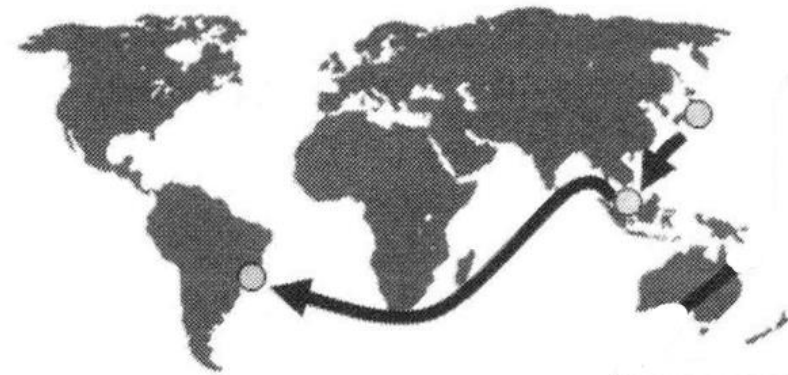
# Production Modularity



- Construction of modules in separate shipyards, assembly in another one.



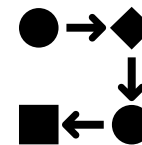
**Fig. 5:** Different modules of the New Offshore Adapted Hull platform for Floating, Production, Storage and Offloading - Tanaka, Takano, *Next Generation Hull-Platform "noah-FPSO Hull" Based on Modular Design and Construction Concept*, p. 3



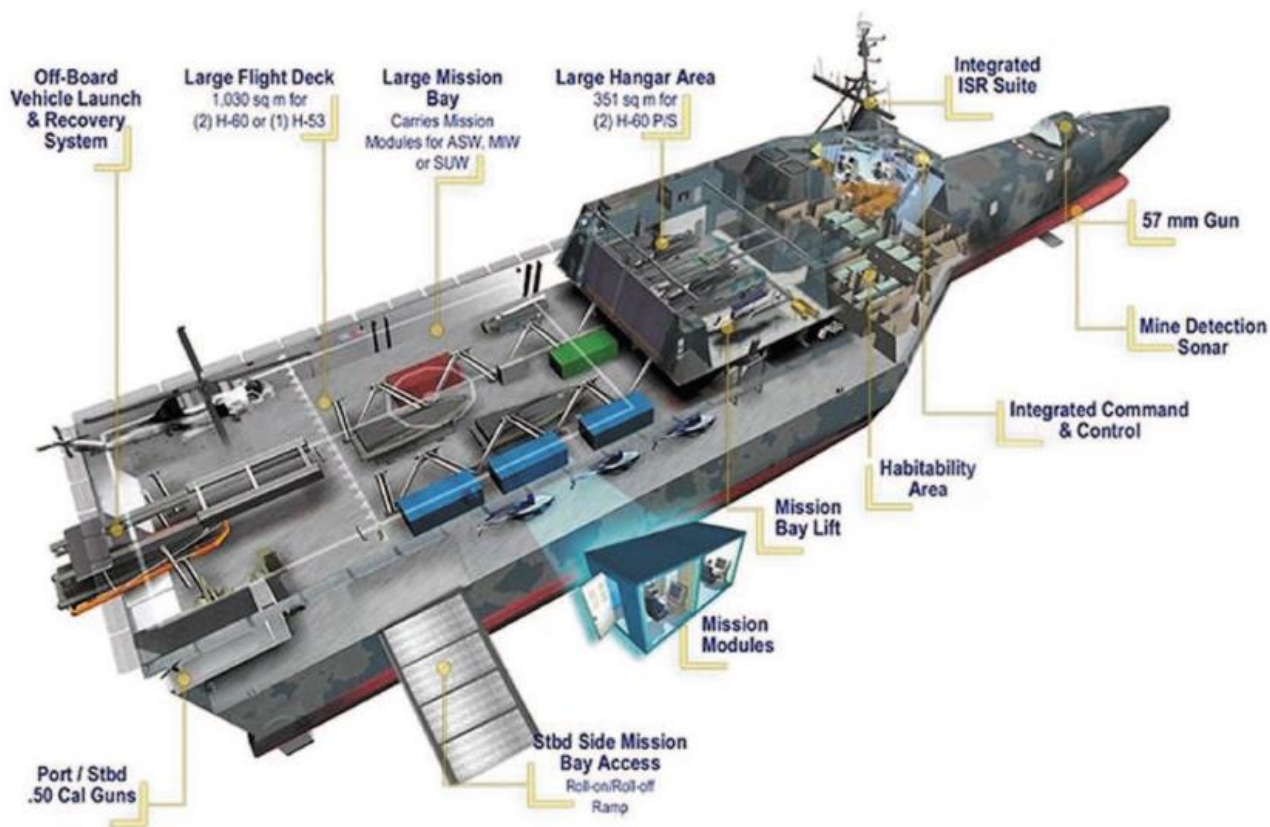
**Fig. 6:** Construction and assembly places of the noah-FPSO – *ibid.*



# Operation Modularity



- Replacement of specific components in case of failure
- Modules swap to adapt to new regulations and missions



**Fig. 7:** Lexington Institute, *Littoral Combat Ship*



# Law of the sea issues - I



**3<sup>rd</sup> issue:** Core incompatibility between certain types of modularity and the understanding of ships

- Broader context of the relationship between technical novelties and legal developments
- Ships understood in different conventions as possessing unchangeable parameters



# Law of the sea issues - II



**4<sup>th</sup> issue:** How to systematise law of the sea issues around ship modularity?

- Design and Production modularity: Economical and some legal considerations outside the scope of the law of the sea.
- Operation modularity: Three different levels representing potential law of the sea issues
  - **1<sup>st</sup> level**: Modules swapping in order to carry out repairs
  - **2<sup>nd</sup> level**: Modules swapping in order to modify the functionality of the ship
  - **3<sup>rd</sup> level**: Modules swapping in order to modify the technical features of the ship



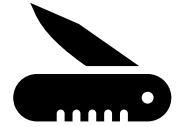


# 1<sup>st</sup> level: Repairs

- In the face of greater standardisation, possible changes as to which stakeholder the classification societies will consider for issues of maintenance:
  - End-user of the vessel, or
  - Original Equipment Manufacturer (OEM)
- But: Compliance with the International Safety Management (ISM) Code?
  - “10. Maintenance of the ship and equipment: The Company should establish procedures to ensure that the ship is maintained in conformity with the provisions of the relevant rules and regulations and with any additional requirements which may be established by the Company.”*



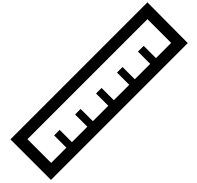
## 2nd level: Functionality



- Diverse potential issues such as:
  - Addition of a module carrying out military objectives on a civilian ship?
    - Questions relating to humanitarian international law, UNCLOS where military and civilian vessels are clearly differentiated from one another
  - Addition of a module carrying out autonomous functions on a “regular” ship?
    - Questions relating to the legal framework around autonomous and unmanned vessels regarding ship security
  - Addition of a module able to perform exploration and exploitation of the seabed?
    - Questions relating to the definition of a ship, for such a device could be considered as a (mobile) offshore installation.



## 3<sup>rd</sup> level: Technical features



- Changes in length, breadth, stability by adding or removing modules will lead to questions relating to ship security
  - On the IMO level, the SOLAS Convention does not take into consideration the possibility for a ship to change such features.
  - On the level of classification societies, rules exist on the conversion of ships when features such as the overall length change.



# Potential developments



- What type of modularity to regulate?
  - Operational modularity (Three levels)
- Which stakeholder to regulate modularity?
  - Classification societies? IMO? UNCLOS amendments?
- How to regulate modularity?
  - Inspiration to be drawn from another disruptive technology's introduction into the law of the sea: Maritime Autonomous Surface Ships (MASS)
  - Regulatory Scoping Exercise (RSE) by the Maritime Safety Committee (MSC) of the IMO?
  - Goal-Based Standards as a methodology?
  - New class of modular ships?







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Thank you for your attention!



Danke für Ihre Aufmerksamkeit!

