Aalto University
School of Engineering

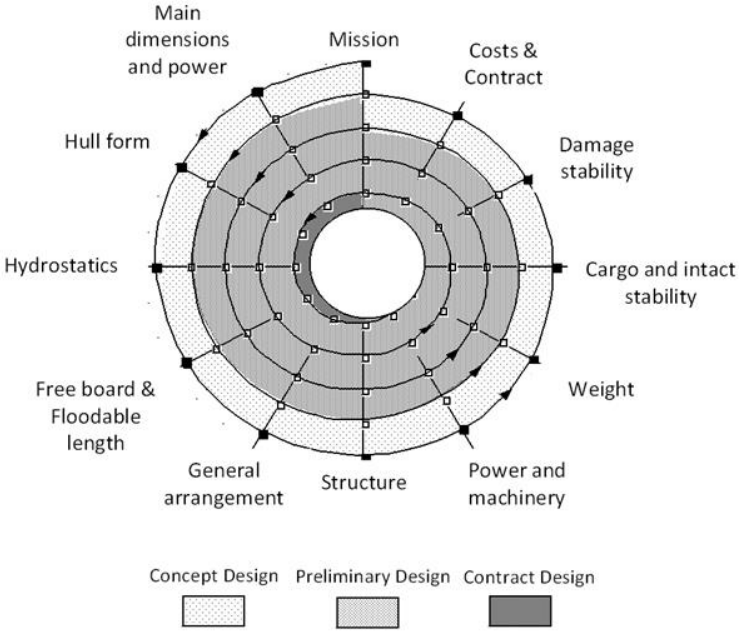
MEC-E1004 Principles of Naval Architecture

Lecture 1 –The ship design context

Learning points !

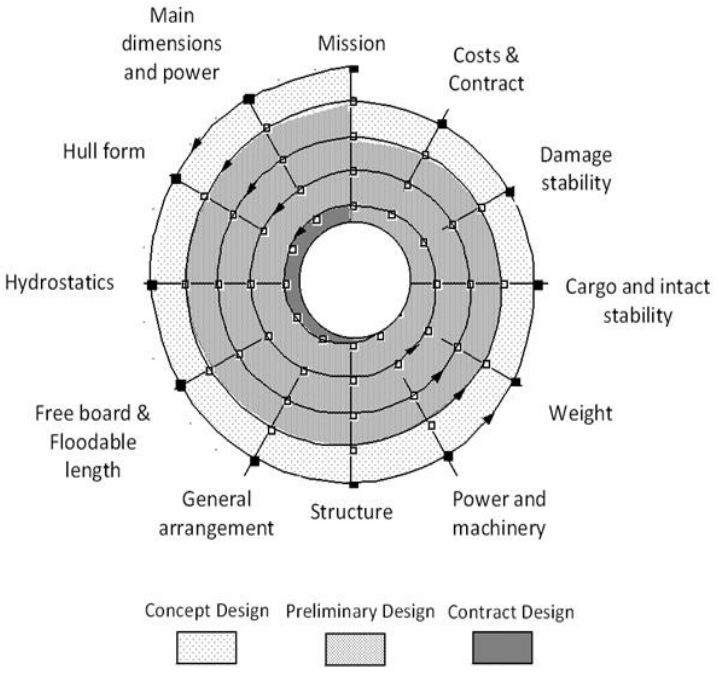
After the lecture, you will :

- *Have an overview of ships and the ship design process*
- *Be able to list factors that need to be considered when designing a ship*
- *Be able to define the design context of your PNA project ship*



Design steps and phases

Design stage	Products	Objectives
Concept design	Mission definition, main dimensions	Primitive data to start the preliminary iterative design stage
Preliminary design	Hull structure, GA, Performance data, Hull form, cost estimates	Good quality/price-ratio product and win a contract
Contract design	Preliminary layout of the systems Contracts of materials & equipment	Ship performance Planning the ship production
Detail design	Production & manufacturing drawings Material allocations	To describe all parts, details and manufacturing in the ship



Dry cargo ships

- General Cargo

- Container ship

- Bulk carrier

- RORO ship

Dry cargo ships

- Live stock ships

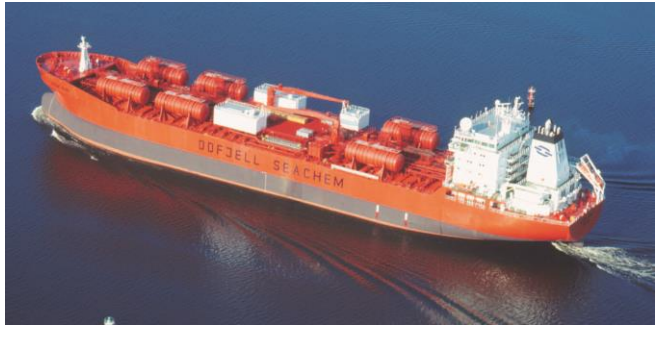
- Lumber Carrier

Wet cargo ships

- Liquefied gas carrier

- Oil Tankers

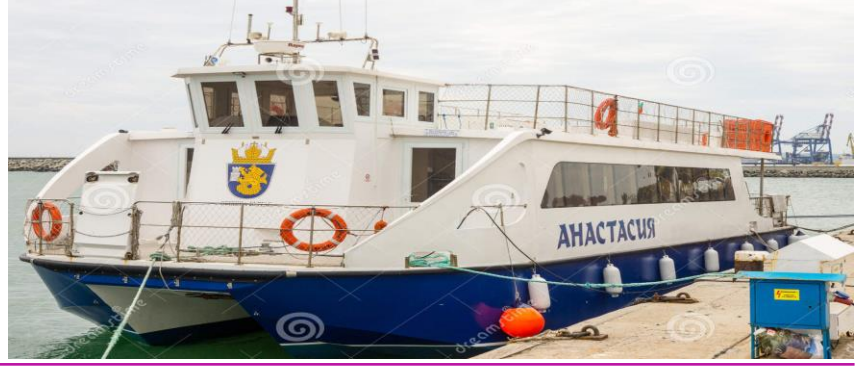
- Chemical Tanker



Passenger ships

- Passenger ships

- Ferries (cross-channel, coastal, harbour)



Harbour/ocean work craft

- Tug

- Pilot craft

- Dredger

- Floating drydock

- Floating cranes

Ship types (Fishing vessels)

- Trawlers

- Fish factory ships

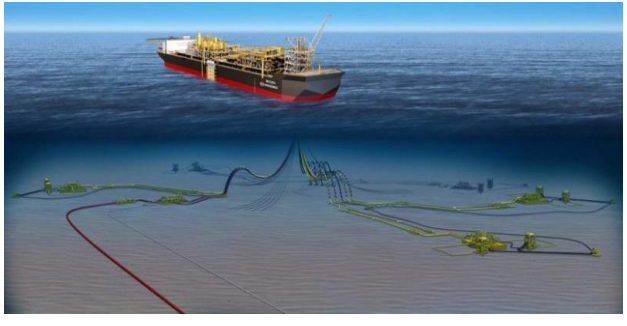
Offshore vessels and ice breakers

- Supply ships

- Pipe layers

- Drill ships

- FPSO



- Ice breaker

High speed craft

- Multi-hulls

- Small water plane area SWATH

- Surface effect ship

- Hydrofoil

Naval Ships

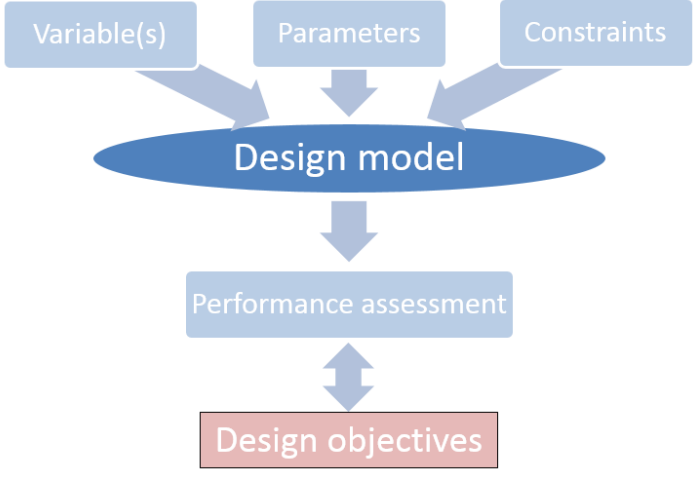
- Aircraft carrier, frigate

- Submarine

Design context – what does it involve ?

Set design goal/objectives and functional requirements to meet those

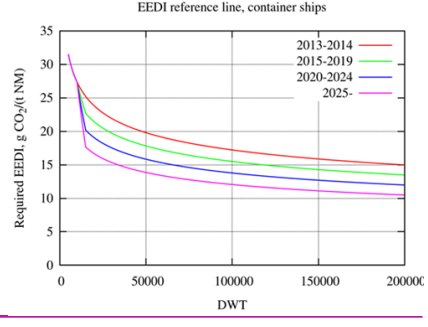
- Design variables
  - *All characteristic determined by the designer*
- Design parameters (not controlled by designer)
  - *Environmental, economic, and operational factors affecting the performance of a design*
- Design constraints
  - *Regulatory, technical, physical,…*



Design goals and objectives

Defined in different ways for different types of ships

- Cargo ships, supply ships, etc.
  - *Design objectives expressed in technical terms*
    - Transport capacity / Payload
    - Ability to operate in the intended operating area
    - Loading/unloading time
    - …
- General Cruise ships / cruise ferries
  - *A multitude of design objectives, some of which are difficult to express in pure technical terms*
    - Passenger capacity, space per passenger, crew size,…
    - Aesthetics (→ compromises between form and function), passenger experience, wow factors,…
      - Cruise ship concepts are generally developed in close cooperation with the ship owner/ cruise line
    - Most cruise ships are unique
      - Even sister ships are often far from identical
  - *Speed*
  - *Fuel consumption/emissions per performed ton*NM (or e.g. TEU*NM)*
    - Energy Efficiency Design Index (EEDI)
      - Attained EEDI should be below required value, which depends on ship type and size



Design goals and objectives

Shipowner vs. shipyard perspective

- Shipowner perspective
  - *What kind of ship (deadweight, speed, etc.) will provide the best economic performance (revenues vs. capital and operating costs)*
    - Consideration of brand image
      - E.g. with regards to environmental friendliness
    - Alternatives to newbuilding: second hand, conversion
- Shipyard perspective
  - *What kind of ship (type, size, speed, main dimensions, hull shape, propulsion system) meets the customer's economic and technical requirements as well as all relevant rules and requirements?*
    - Is our offer competitive with offers from competing shipyards?
    - Will we make enough profit for our owners?

Image credit Stena Line

Image credit Meyer Werft

Design variables and boundaries

Design variable = any characteristic of a design that is determined by the designer

- Determined by the designer → exact known value

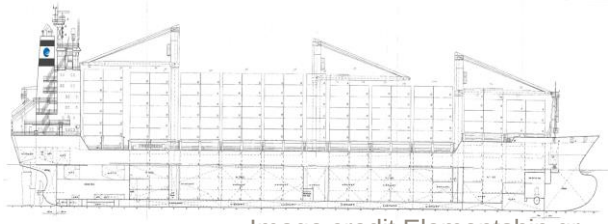


Image credit Elementship.gr

How to limit the design task?

- What are our design variables?
  - *What is included in the design task, what is not?*
- Do we consider just a ship, or a wider maritime system
  - *For instance: a ship can be a part of a wider transport system / supply chain (from factory to customer)*
    - Port design variables
      - Cargo storage, loading, unloading
    - Fleet design variables
      - Number of ships, ship speed, ship size
    - External resources
      - E.g., icebreakers

Image credit Rolls-Royce

Design parameters

- Environmental
  - *Wind, waves, temperature, sea ice,…*
- Economic
  - *Building/material/component costs, maintenance costs, fuel price, port costs, manning costs, icebreaker costs, emission tariffs, …*
- Operational
  - *Loading/unloading times (using port-based cargo handling resources), waiting time for ships to berth, waiting time for icebreaker assistance,…*

Image credit NOAA

Image credit joc.com

Design uncertainty

- External uncertainties
  - *Uncertainty in design parameters*
    - Market fluctuations require fast adjustment
    - New/future technology
      - Autonomous solutions
      - Alternative fuels
      - New materials
      - …etc.
- Internal uncertainties
  - *Uncertainties in assumptions of applied design models*

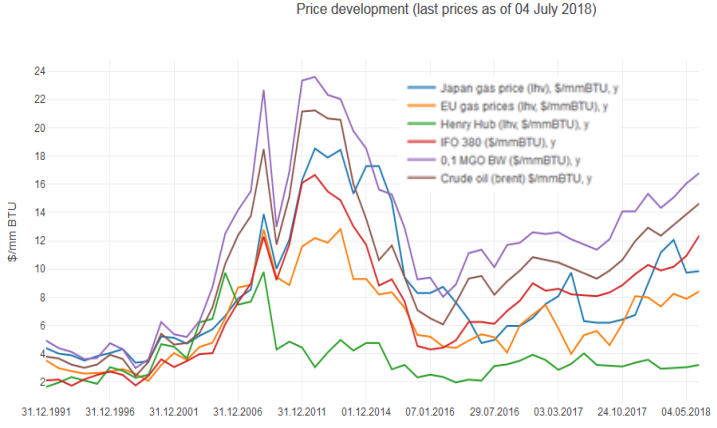


Image credit DNVGL

Design constraints

Question: Can you mention any design constraints?

Design constraints

Regulatory constraints

- International Regulations
- Classification Society Rules
- National / Flag state requirements
- Local speed limits to limit swell, or to reduce the risk of collisions

Physical constraints

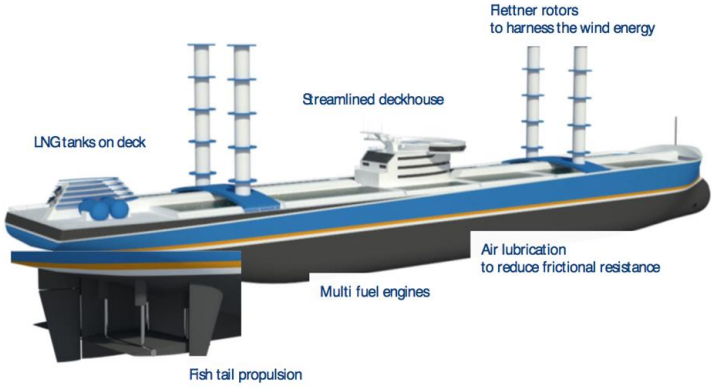
- Ship size and draft limits set by the route/ports, shipyard facilities, etc.

Technical constraints

- Technical limits of building material
- Limits of batteries
- Etc.

Design constraints

…perceived constraints must not prevent you from thinking outside the box



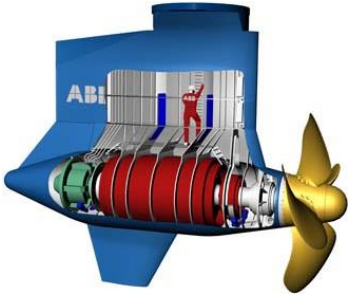
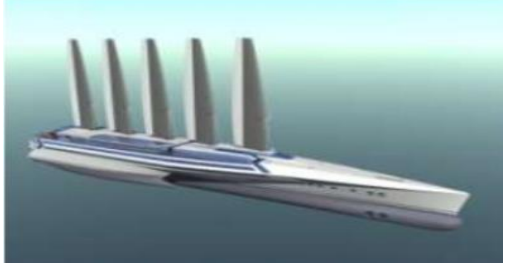


Image credit ABB



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International regulations

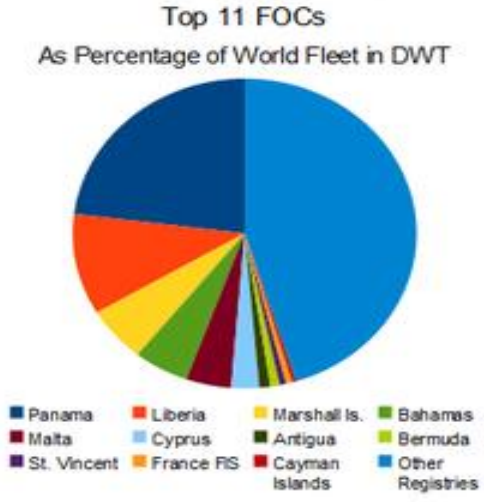
- Shipping laws, rules, and regulations are available to ensure:
  - *Integrity of hull*
  - *Safety of the crew*
  - *Safety of the passengers,*
  - *Integrity of the cargo*
  - *Clean marine environment.*
- Some key international marine regulations:
  - *International Maritime Organization [IMO], International Labor organization [ILO]*
  - *International Association of Classification Societies [IACS]*
  - *The European Maritime Safety Agency [EMSA]*
  - *The Cruise Lines International Association*
  - *The Baltic Environmental Protection Commission*

Class Rules & National Regulations

- **Classification Societies**
  - *Conduct surveys and develop Rules and Regulations*
  - *Focus on quality, safe and sustainable shipping*

- **Flag State Control**
  - *One of the basic premises of the IMO conventions*
  - *Supervise that the ship fulfils the IMO Conventions by conducting surveys and collaborating with Classification Scocieties*

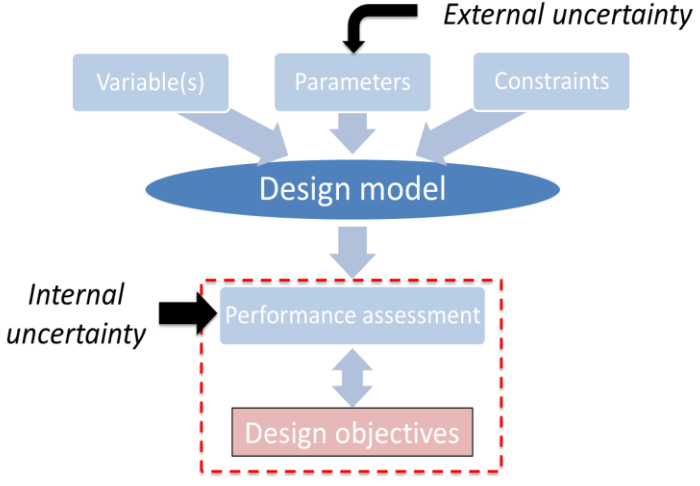
- **Port state control**
  - *Complementary instrument to flag state control*
  - *Conduct basic safety, security and equipment surveys*



Summary

Ship Design is a complex task

- *Design objectives/requirements*
  - Different types of design objectives/requirements for different types of ships
  - Determination of boundaries for the design task
- *Design variables*
- *Design parameters (economic, environmental)*
  - Often subject to uncertainty
  - Markets, environmental operating conditions,…
- *Design constraints (legal, physical, technical)*



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Thank you !

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