Aalto University
School of Engineering

MEC-E1004 Principles of Naval Architecture

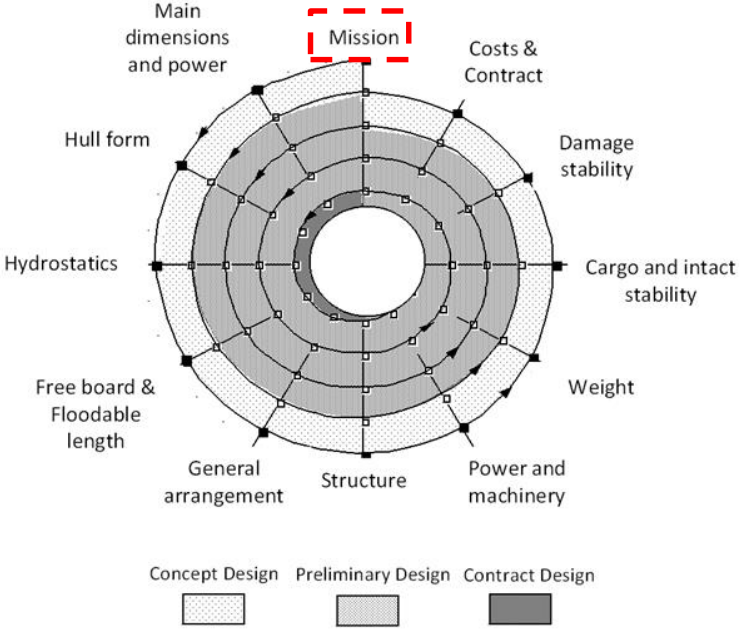
Lecture 1 –The design context

Learning points !

After the lecture, you will be able to:

- *List factors that need to be considered when defining the design context for a ship design project*

- *Define the design context of your project ship*



Assignment 1 - Design team & context

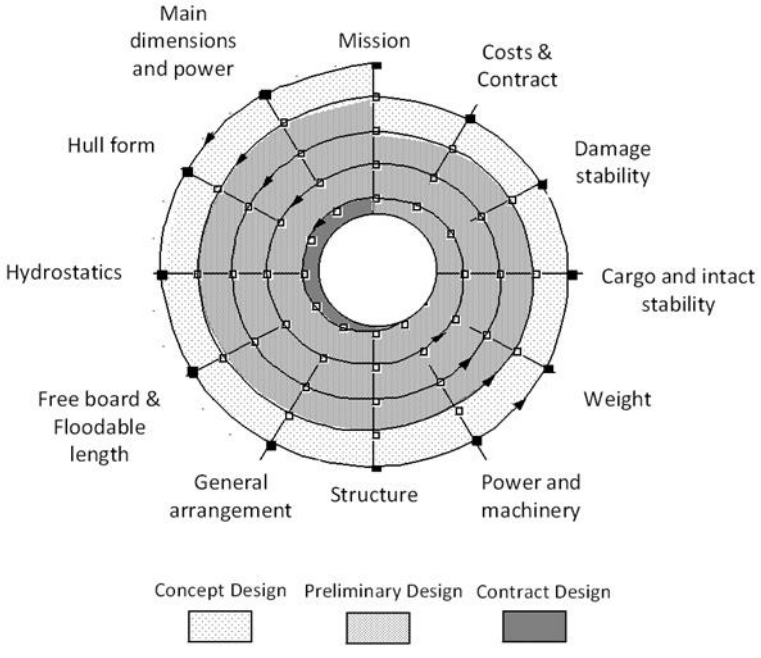
- Define a professional profile for each group member. Identify each members' professional strengths/skills according to study path, and describe how those will be utilized in the development of your ship project (max ½ page / person)

- Determine a schedule for your project work. Consider assignment descriptions and deadlines.

- Define the design context
  - *Design mission and objectives*
    - Design mission (or goal) is the overall aim of the design process
    - Design objectives = lower level measureable steps towards the goal
  - *Design variables, innovations, and boundaries*
    - Determine the key design characteristics/features that you aim to define, i.e. the expected outcome of your design task
    - Describe your design innovations and how these help you to reach your objectives
    - By defining your design variables you also set the boundaries of your design task. Briefly discuss the reasoning behind your design boundaries
  - *Design parameters*
    - Identify and describe factors affecting the performance of your design that you need to consider but that are beyond your control (e.g. fuel price, material costs, environmental conditions)
  - *Design constraints*
    - Identify and specify factors limiting your feasible design space (e.g. draft limitations, regulations)

Design phase

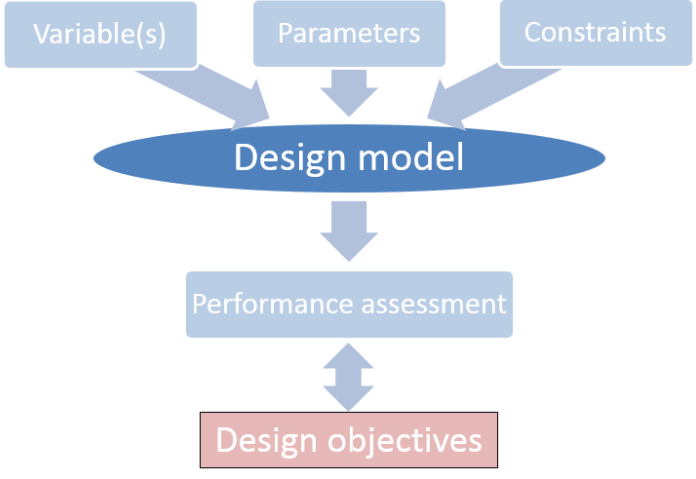
Task / design stage	Products	Objectives
Preliminary design	Hull structure, GA, Performance data, Lines drawing, Cost estimate	Good quality/price-ratio, Win the contract
Basic design	Preliminary layout of the systems Contracts of materials & equipment	Ship performance Planning the ship production
Detail design	Production & manufacturing drawings Material allocations	To describe all parts, details and manufacturing in the ship



Design context – what does it involve ?

Set design goal/objectives and functional requirements to meet those

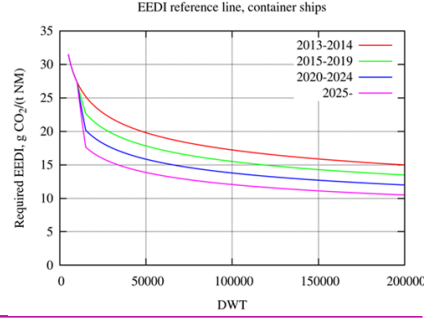
- Design variables
  - *All characteristic determined by the designer*
- Design parameters (not controlled by designer)
  - *Environmental, economic, and operational factors affecting the performance of a design*
- Design constraints
  - *Regulatory, technical, physical,…*
- Design boundaries
  - *System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



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
    - …
- 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
- General
  - *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?

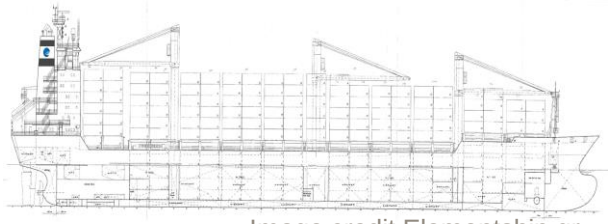
Image credit Stena Line

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



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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

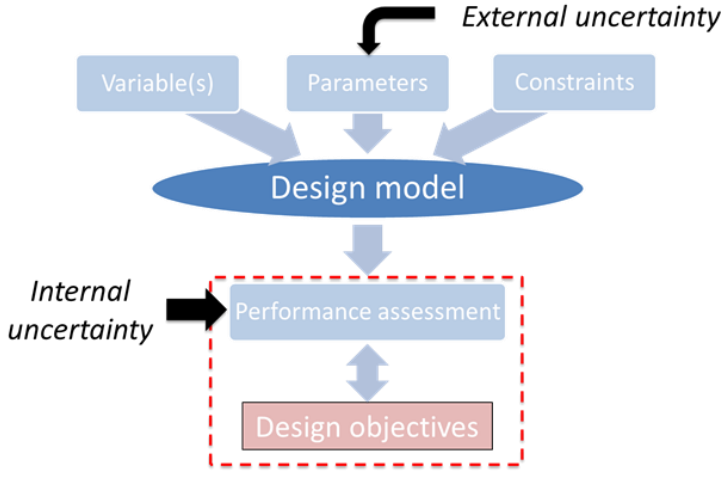
- Environmental
  - *Wind, waves, temperature, sea ice,…*
- Economic
  - *Building/material/component costs, maintenance costs, fuel price, port costs, manning costs, icebreaker costs, emission tariffs, …*
- Operational
  - *Loading/unloading times (using port-based cargo handling resources), waiting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

Image credit NOAA

Image credit joc.com

Design uncertainty

- External uncertainty
  - *Uncertainty in design parameters*
    - Market fluctuations require fast adjustment
    - Knowledge and understanding of markets important
    - Global trends and challenges might impact on market demand
    - New/future technology
      - Autonomous solutions, machine learning,…
      - New energy solutions (e.g. batteries, fuel cells)
      - New materials
      - …
- Internal uncertainty
  - *Uncertainty in applied design models, assumptions*



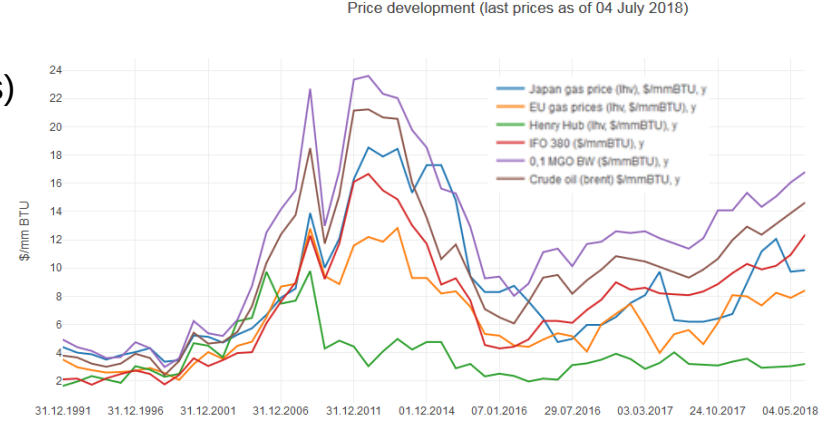


Image credit DNVGL

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

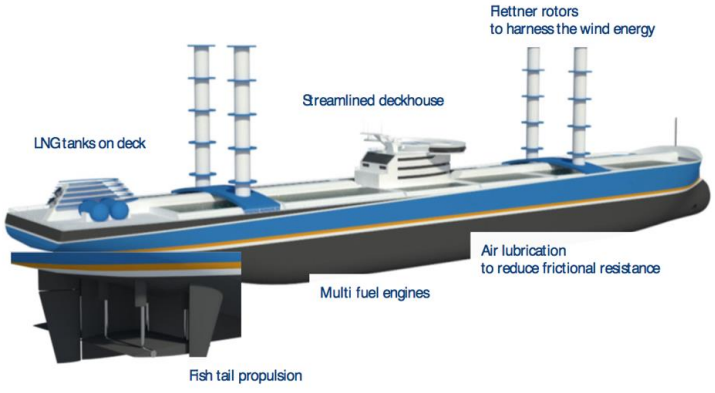
- Ship size and draft limits set by the route/ports, shipyard facilities, etc.

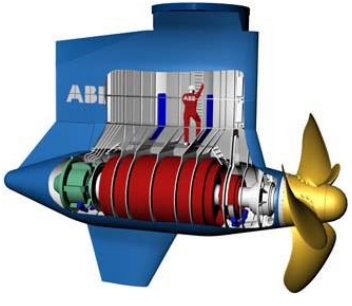
Technical constraints

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

Design constraints

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





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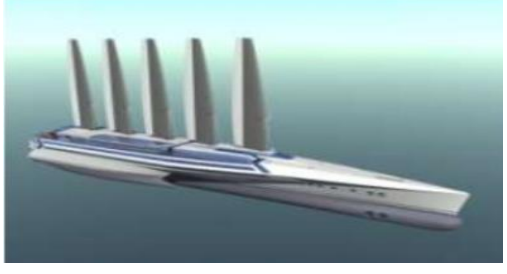

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Summary

Ship Design is a complex task including the identification and determination of

- *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)*