



Aalto University  
School of Engineering

# MEC-E1004 Principles of Naval Architecture

*Bonus Material*

*Naval Architecture and Ship Building – Your entry to the real world !*

# Summary

1. Process of a New Shipbuilding
2. What is Ship Design?
3. Ship Design Methodology
4. Entities Involved in the Process
5. Technical and Legal Documents Associated
  - Shipbuilding Contract
  - Ship Specification

# Decision Process

- Analysis of the marine transportation market
- Identification of a business opportunity
- Study of the fleet of ship(s) required
- Characterization of the ship (Concept Design)
- Analysis of the possible alternatives:
  - Relocation of a ship from the existing Owner fleet
  - Freight of a ship
  - Acquisition of an existing ship (2<sup>nd</sup> hand)
  - Building a new ship
- Selection of the Consultant/Designer
- Development of the Preliminary Design

# New building process

Steps of the commercial process of the Shipowner:

- Selection of the Yards
- Request for a declaration of interest from the Yards
- Send enquiries with request for quotation
- Analysis of the proposals from the yards
- Preparation of *Contract pro forma*
- Negotiation
- Discussion of the type of financing
- Signature of the Shipbuilding Contract
- Follow-up of the Construction
- Reception of the Ship

# Engineering Systems design process

An engineering system design process can be seen as a sequence of the following stages:

- **Analysis**

A process of partitioning or decomposing any system into its sub-systems and component parts to determine their separate and collective nature, proportion, functions, relationships, etc.

- **Synthesis**

A process of integrating a collection of sub-systems so as to create a system with emergent properties.

- **Evaluation**

A process of assessing the degree to which a solution satisfies the goals that were originally stated.

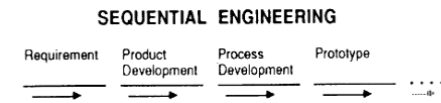
# What is ship design ?

- Process by which, from a marine or inland waterways transportation problem, characterized by transporting a given flow of a given cargo type from point A to point B, in a given time period
  - It is dimensioned a ship, specifying all of its systems
  - It is developed the information necessary to build and assemble it
- The application of the knowledge about Ship Design is not limited only to the actual development of the design of ships, it is equally necessary in other situations such as:
  - when the design is sub-contracted to others, or
  - when a 2nd hand ship is bought

# Types of shipbuilding projects

- **Routine Projects**
  - Projects which are not substantially different from the previous ones in the same class
- **Creative Projects**
  - Projects with substantial differences in the solutions taken, resulting from the introduction of new options
- **Innovative Projects**
  - Projects with substantial differences in the solutions taken, resulting from the introduction of options and values of variables outside of the interval normally used.

# Design methods



- **Sequential Engineering**

- Limitations

- Sequential and iterative process
- Hard working and costly

- **Concurrent Engineering**

- Definition

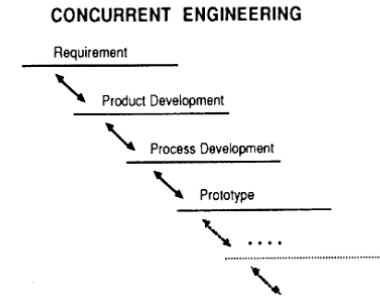
- It is the systematic approach to the integrated and simultaneous design of products and of the processes related to them.

- Objective

- It is intended that the designer takes into consideration, since the beginning, all the elements of the lifecycle of the product, since its conception until its availability, including the quality, the cost, the planning and the user requirements.
- The main objective is the minimization of costs along the lifecycle of the product while maximizing its quality and performance.

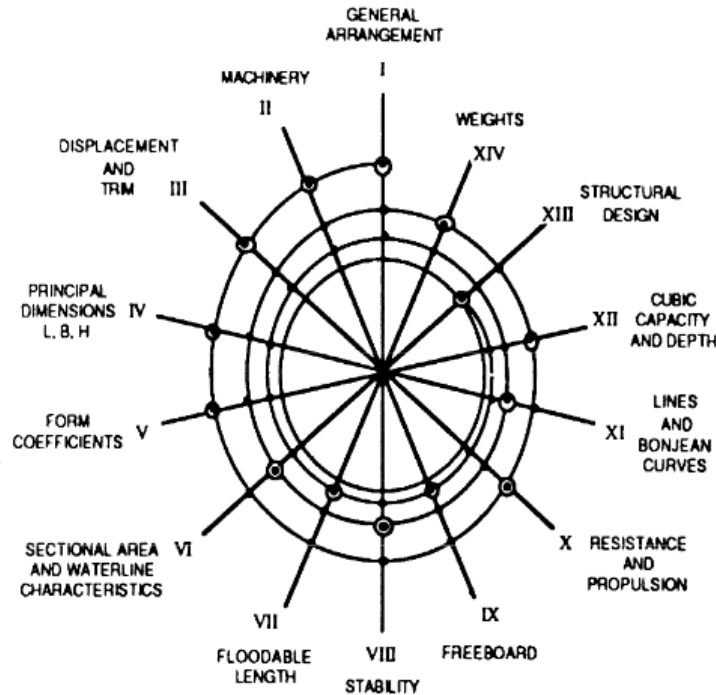
- Characteristics

- The flow of information is bi-directional
- Attempt to increase the knowledge of the product at the preliminary stage.





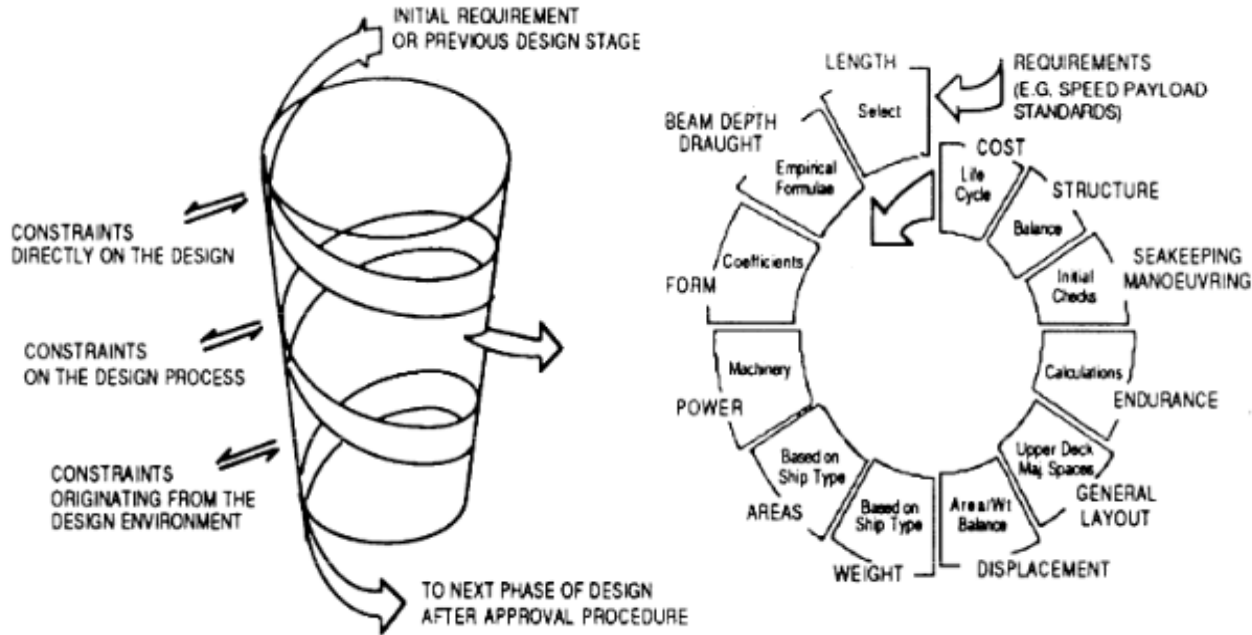
# Sequential Engineering



## Design Spiral

- Evans (1959) introduced the concept of design spiral, which represents the sequential and iterative aspects of the process

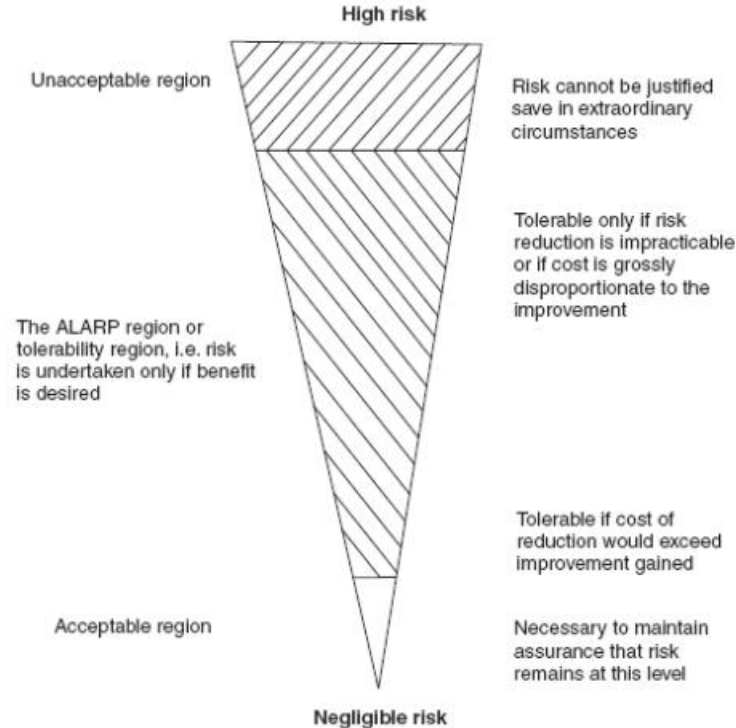
# Sequential Engineering



- Buxton (1972), introduced the economical aspects
- Andrews (1981), added the notion of a 3<sup>rd</sup> dimension, the time.

# The ALARP principle

- Design just to comply to the regulations is no longer an acceptable procedure
- **As Low As is Reasonably Practicable (ALARP)** - it is a principle to reach for a decision for the acceptability of a system



# Specific aspects of ship design

- **Automobile, Aeronautic Industries, ...**
  - Large series
  - Longer time to develop the design
  - Small variations in the design
- **Shipbuilding Industry**
  - Recreational boats
    - Series of the same design
  - Merchant Ships
    - Small series or single ships built
    - Shorter time to develop the design
    - Designs with big differences between them

# Ship Design Stages (1)

## 1. Concept design

- Definition of the ship type, deadweight, type of propulsion, service speed.

## 2. Preliminary design

- Determination of the main hull dimensions and of some form coefficients
- Determination of the elements necessary and sufficient to allow the estimation of the ship building and exploitation costs

# Ship Design Stages (2)

## 3. Contract Design

- Determination of the elements that define the general characteristics of the ship and its main equipment and that will annexed to the Shipbuilding Contract established between the Owner and the Builder.

## 4. Detail Design

- Detail of the design at all levels in order to supply all the information necessary to its manufacture and assembly.

# Information produced (1)

## 1. Concept Design

- Definition of the ship type, deadweight, type of propulsion, service speed.

## 2. Preliminary Design

- Sketch of the *General Arrangement*, defining the compartment configuration
- Preliminary Body Plan, sufficient to allow the evaluation of the stability and of the cargo capacities
- Prevision of the propulsive power
- Estimative of the lightship weight
- Estimative do ship cost

# Information produced (2)

## 3. Contract Design

- Ship Specification
- General Arrangement
- Body Plan, with enough detail to allow the manufacture of scaled models for testing in hydrodynamic towing tanks
- Classification drawings of the structures (midship section, typical bulkheads, shell expansion, bow and stern structures)
- Stability and longitudinal resistance computations
- Diagrams of the main piping systems (cargo, ballast, bilge, firefighting, etc.)

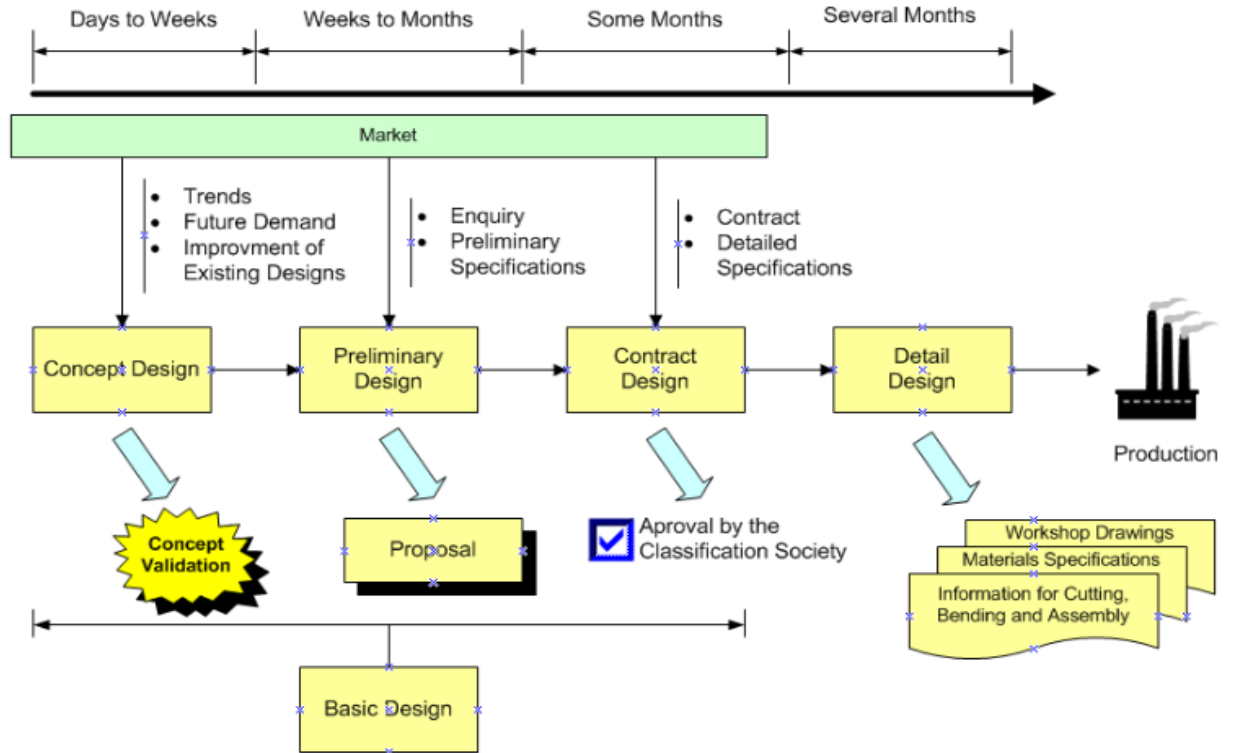


# Information produced (3)

## 4. Detail design

- Total fairing of the body plan, defining all the structural frames, decks, seams and butts of the shell plates
- Production drawings of the structures detailed to the block level
- Material Specifications
- Information for cutting, bending and assembly of plates and stiffeners (drawings, cutting tapes or files, moulds, pin-jigs, etc.)
- Isometric drawings of the piping systems (for manufacture)
- Arrangement of the piping systems (for assembly)

# Ship design time scales



# Entities involved in ship design/building

- Ship Owner
- Ship Designer
- Ship Builder
- Classification Society
- National Authorities

# Ship owner involvement

- The entity that starts and finishes the process
- Eventually develops the concept design of the ship
- Contracts the basic design
- Contracts the shipbuilding
- Detains the property of the ship after it is built, although it is not necessarily the entity that operates it

# Ship Designer involvement

- Entity which is responsible by the development of the basic design of the ship and which prepares the Ship Specification and the other technical documents
- It can be an independent design office or a department of a shipbuilding yard
- It can sub-contract the development of some parts of the design work to other designers

# Ship builder involvement

- Yard which is responsible towards the Owner by the shipbuilding complying to all the clauses of the Contract and in accordance with the Ship Specification
- Responsible by the development of the Detail Design for manufacture and assembly of the ship taking into consideration the facilities and equipment/capacities available at the yard
- Can sub-contract other entities for the development of some parts of the Detail Design
- Can sub-contract other yards to build some parts/blocks of the ship

# Class Society involvement

- Organization that establishes and applies technical standards for the design, manufacture and maintenance of installations in the marine field, such as ships and offshore platforms.
- Those standards are developed by the CS and published under the form of Rules.
- A ship built in compliance to the Rules of a CS can obtain from it a Class Certificate
- To issue the Certificate, the CS approves a set of design elements and carries out a set of inspections during the construction, to check the compatibility with the approved design
- It can also issue certificates of compliance with international standards of the IMO if they have such a mandate from the National Authorities

# Class Registry

- The first registry of ships (Lloyd's Register) was published in 1764
- It consisted in a list of ships with the following information:
  - Ship's name
  - Captain's name
  - Port of Registry
  - Port of destiny
  - Net tonnage
  - Number e dimension of the guns
  - Draught
  - Building place
  - Name of the Owner
  - Hull condition, using a scale *A/E/I/O/U*
  - Condition of the masts and sails, using the scale *G/M/B* (*God, Middling, Bad*)



# Class Rules (1)

- The first rules for the classification of wooden ships were published by Lloyd's Register in 1835 and aimed at the periodical survey of the ship in terms of maintenance
- The rules were more oriented for the selection of the timber and the type of connections than to the scantlings of the structure
- Rules based on a numeral obtained from the tonnage value

# Class Rules (2)

- In 1832 it was classified the first steel ship
- The first Rules for steel ships were published by Lloyd's Register in 1855.
- These Rules defined the scantlings of the structure as a function of the tonnage.
- In 1870 LR published new classification rules for steel ships, based on numeral values obtained from the ship dimensions
- In those rules were introduced new symbols of classification consisting in the notation 100A1, 90A1 or 80A1 followed by the Maltese cross



# Class Rules (3)

- The British Corporation Register of Shipping created a new process of classification of ships completely independent from the tradition inherited from the wooden ships
- It has become necessary to submit for approval drawings of the structural details
- From 1916 start to be used simple formulas for the determination of the scantlings of frames, beams, girders and stiffeners

# National Authority (Flag Administration)

- State Authority that has the responsibility of conceding the Building License and of verifying the compatibility with the international conventions from IMO and with the relevant national standards, issuing the respective Certificates.
- Can delegate in other recognized institutions (namely the Classification Societies) the competence to issue the certificates of conformity with the IMO conventions

# Ship Building Contract

- **Building a supplied Design**
  - The Owner supplies the Basic Design and requests the Building
- **Design and Building**
  - The enquiry is made in more generic terms, based on a measure of the cargo capacity (deadweight, cargo volume, lane length, TEU, number of passengers, etc.) and/or performance requirements
  - The Yard is responsible by the Design and Building

# Ship building contract – What is it?

- It is a legal document
- It is prepared by the technical staff of the contracting parties and the final version should be reviewed by lawyers
- It consists on a set of terms (clauses) and some enclosures
- The terms identify the contracting parties and define the conditions of the business transaction
- The enclosures
  - Price and payment conditions
  - Compensation
  - Milestones
  - Specification
  - Drawings

# Ship building contract – What is it?

- In most new buildings, conversions and repairs, it is the Builder that issues the first draft of the Contract
- The Contract is generally based on a *pro forma* document
- The most common *pro forma* Shipbuilding Contracts are:
  - SAJ, Shipowners Association of Japan (1974)
  - Norwegian Associations of Shipowners and Shipbuilders (2000)
  - MARAD Standard Form (1980), Maritime Subsidy Board (MSB) of the United States Department of Commerce
  - BIMCO NEWBUILDCON, Baltic and International Maritime Council (2007)
  - ✓ AWES (1972), Association of West European Shipbuilders, currently designated CESA - Committee of European Shipyards' Associations (2004)

# AWES ship building contract (1)

## 1. Subject of Contract

- Description and main characteristics of the ship
- Yard number
- Registry and Classification of the ship
- Decision of the Classification Society
- Sub-contracting by the yard

## 2. Inspection and Approvals

## 3. Modifications

- Due to the Owner
- Due to the Builder
- Due to Regulating Offices or to the Classification Society



# AWES ship building contract (2)

4. Sea Trials
5. Guarantee for Speed, Cargo Carrying Capacity and Fuel Consumption
  - Penalties, Limit of Acceptance, Rewards
6. Delivery of the Vessel
  - Place and Date
  - Documentation
  - Penalties and Rewards
  - Force Majeure
7. Price
8. Property
  - Generic drawings, Specifications and detail drawings
  - Ship

# AWES ship building contract (3)

9. Insurance

10. Default by Purchaser

- Penalties due to
  - Missing payments
  - Missing the delivery of the ship
  - Delays in the deliverance of the Owner's Supplies

11. Default by the Contractor

- Devolution of installments paid and penalties

12. Guarantee after Deliverance

13. Contract Expenses

14. Patents

# AWES ship building contract (4)

15. Interpretation, Reference to Expert and Arbitration

16. Condition for the Contract to Become Effective

17. Legal Domicile

18. Assignment

19. Limitation of Liability

20. Mail Addresses

# BIMCO new building contract (1)

- Form readily adaptable to all types of vessels in all jurisdictions, including features which will be needed for projects in China.
- More comprehensive provisions detailing obligations during production, particularly subcontracting, approvals and inspection, tests and trials, modifications, and buyers suppliers.
- Buyer's relationship with Class is more clearly defined.
- Mechanisms included to avoid delays in delivery in the event of minor defects.
- Wordings for refund and performance guarantees, vetted by banking lawyers, which are suitable for use in projects in China.

# BIMCO new building contract (2)

- Harmonized refund provisions in the event of termination.
- Clearer legal provisions dealing with permissible delays, builders' guarantees, responsibilities and exclusions from liabilities, insurance and termination.
- Responsibility clauses expressed mutually where possible, producing a more balanced contract.
- Comprehensible force majeure clause with an easy-to-check list of force majeure events.
- Checklist of documentation required on delivery.
- New IMO Hazardous Materials Inventory and Protective Coatings clauses.

# BIMCO new building contract (3)

- Modernized dispute resolution provisions clause incorporating reference to the latest dispute resolution methods including Class and expert determination, mediation and arbitration.
- Clear provisions relating to provision of refund and performance guarantees.

# Typical Clauses of Shipbuilding contract

(Typical Risks : Currency fluctuations and steel prices)

- ***Force Majeure***
  - Means any event or occurrence beyond the reasonable control and without guilt or negligence from the Seller that he didn't manage to avoid or bypass
  - Can include for instance, natural disasters, floods, storms, aggravated weather conditions and other Acts of God, fires, explosions, riots, wars, sabotage, labor problems of the Seller (including strikes, but excluding lockouts), energy blackouts, and acts of the government.
- **Default by Contractor (*Incomprimento pelo Contractado*)**
  - Defines the procedure in the case of non compliance with critical requirements (speed, cargo capacity,...)
  - Establish penalties and limits of acceptance of the ship

# Payment schedules

(Typical Risks : Currency fluctuations and steel prices)

- Independently from the type of financing, the payment of the ship to the Builder is generally composed by installments in function of the progress of the construction, in accordance to the stated in the Contract
- A typical installment plan can be as follows:
  - 10% at *Contract Signature*
  - 10% at *Materials Arrival*
  - 10 % at *Keel Laying*
  - 20% at *Launching*
  - 50% at *Delivery*



# Refund guarantees

(Typical Risks : Currency fluctuations and steel prices)

- What are they?
  - Guarantee of repayment of pre-delivery installments for buyer
  - Not a guarantee of yard's performance
- Who are the refund guarantors?
  - Banks-Export-import banks
  - Insurance companies
  - Importance of credit rating
- Why are they important?
  - Security
  - Financiers will require these

# Ship Specification (1)

- Technical description of the Ship and of all its systems
- Annexed to the Shipbuilding Contract
- Must be signed in every page by the representatives of both the Yard and of the Owner

# Ship Specification (2)

- Ship
  - Main dimensions
  - Service speed
  - Classification Society and class notation
  - Cargo, ballast and fuel capacities
  - Autonomy
  - Rules and Conventions considered
- Hull
  - Type of hull construction and materials
  - Surface treatment, painting, cathode protection
- Machinery and Equipment

# Ship Specification (3)

- For each System
  - Specification of the components (pumps, compressors,...), quantities and nominal characteristic (flow rate, pressure,...)
  - Driving type, required power
  - Piping, nominal diameters, materials
  - Extension of supply
- Owner Supplies

# Ship Specification (4)

- In the description of the systems, generally there are no references made to commercial brands
- The identification of the brands decreases the negotiating capacity for the purchasing of the equipments
- However, there are some components (main machinery, auxiliary machinery, cargo pumps,..) which eventually the Owner requires to be from a determined maker (or model) and therefore must be identified in the Specification (generally the main machinery)
- In case of occasional contradictions between the Specification and the drawings, the drawings must prevail

# Ship specification examples (1)

## Deadweight Capacity

- The vessel's deadweight is to be about 145,000 metric tonnes at design draught of 16.00 m in salt water (density 1025 kg/m<sup>3</sup>).
- The specified deadweight to include fuel and lubricating oils, provisions, consumable stores, fresh water, crew and effects plus spare parts and equipment in excess of what is required by Classification Society, as well as items supplied by the Buyer and Owner's extras.

# Ship specification examples (2)

## Speed

- The trial speed on summer draught (abt. 17.10 m) in deep, calm sea with clean hull will be about 15.0 knots with main engine developing 20,300 BHP, which corresponds to its selected maximum continuous rating (MCR). Correction for wind and waves to be done only if weather conditions in excess of Beaufort 2 (two).
- The service speed is estimated to be abt. 14.0 knots at 160,000 TDW and under conditions as above, including a sea margin of 15%.
- Verified speed trial test report to be provided, including a curve showing speed/power on the draught under trial conditions as well as a curve giving the service speed under conditions given above.

# Ship specification examples (3)

## Buyer's Deliveries (Owner Supplies)

- The following items to be furnished by the Owner:
  - Equipment, materials and hand tools for bosun's store, paint room, engine room, engine workshop, pumpman shop, electrical workshop except those listed elsewhere in specification.
  - All bedding (blankets, covers, pillows, sheets, except mattresses), towels and table cloths.
  - All cook's and steward's utensils (silverware, dishes, glasses, pots, pans, cutleries, crockery,...)
  - .....



# Ship specification examples (4)

## Buyer's Deliveries (Cont.)

- Buyer's supplies are to be delivered to Builder's yard, free of cost, in perfect condition, properly packed and individually identified. Buyer is to cover all expenses of insurance until the arrival of the shipyard.
- The Builder will be responsible for storing and handling, after the delivery to the shipyard.
- A detailed list of Buyer's furnished equipment and materials is to be presented to Builder at the early stage and a schedule will be prepared for deliveries.

# Ship specification examples (5)

## Drawings for Buyer's Approval

- Drawings from the Builder or its subcontractors which require Buyer's approval prior to commencement of work, shall if otherwise not explicitly agreed, be submitted to Buyer in four (4) copies with a covering letter.
- Buyer to have a reasonable time, not exceeding fourteen (14) calendar days, to study received drawings, whereafter one (1) copy (approved) should be returned to the Builder with Buyer's approval and/or possible comments and with a covering letter.
- When the Buyer find it is impossible to return the approved drawings within the above specified time, the Buyer shall notify the Builder without delay. In case delay is in excess of 7 calendar days and no notice is given by the Buyer, drawings to be considered approved.

# Hull Insurance Contract

- Covers errors in design, material or workmanship and similar “latent defects”
- Initiated with the so-called **Inchmaree Clause**, introduced as a part of the first edition of the English hull insurance clauses, from The Institute Time Clauses-Hull (ITCH), 1888
- The insurance covered loss or damage to hull and machinery through bursting of boiler, breakage of shafts or through any latent defect in the machinery or hull
- The English clause have been revised twice recently, on 2002 and 2003
- The Comity Maritime International (CMI) harmonizes marine insurance clauses

# The concept of Latend effect

- A defect in the construction of a ship or machinery that is not readily discernible to a competent person carrying out a normal inspection.
- Discovery of a latent defect does not give rise to a claim on the ordinary hull policy, but damage caused thereby is usually covered.

# Inchamaree clause

- Standard clause in Marine Insurance contracts
- Covers risk of events not directly linked to perils at sea such as, but not necessarily limited to, loading accidents
- It protects property damaged or destroyed as the result of the negligent acts of the crew.
- The name is derived from a steamer in which a pump was damaged by its crew's negligence.
- A British Court, in 1884, held that such an accident was not a *peril of the sea* and so not covered by the standard wording of insurance contracts of the time
- Since then, maritime insurance contracts specifically address that by including a comprehensive clause on such risks that, while not directly linked to perils of the sea, nonetheless relate directly to shipping

# The UK Marine Insurance Act

- UK Marine Insurance Act (MIA), 1906
- Reviewed in 1909, 1963, 1994, 2002, 2003

# References

- Norwegian Marine Insurance Plan 1996, Version 2003
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- American Institute Hull Clauses (June 2,1977)
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# Organisations

- Baltic and International Maritime Council ([www.bimco.org](http://www.bimco.org))
- British Marine Equipment Association
- Comite Maritime International ([www.comitemaritime.org](http://www.comitemaritime.org))
- Community of European Shipyards Associations - CESA ([www.cesa-shipbuilding.org](http://www.cesa-shipbuilding.org))
- Hill Dickinson Marine Lawyers ([www.hilldickinson.com](http://www.hilldickinson.com))
- MARAD - US Maritime Administration ([www.marad.dot.gov](http://www.marad.dot.gov))
- Society of Maritime Industries ([www.maritimeindustries.org](http://www.maritimeindustries.org))
  - UK Shipbuilders and Shiprepairers Association ([www.ssa.org.uk](http://www.ssa.org.uk))
  - Nordic Association of Marine Insurers ([www.cefor.no](http://www.cefor.no))
  - Norwegian Marine Insurance Plan ([www.norwegianplan.no](http://www.norwegianplan.no))
  - Norwegian Maritime Law Association
  - Norwegian ShipOwners Association