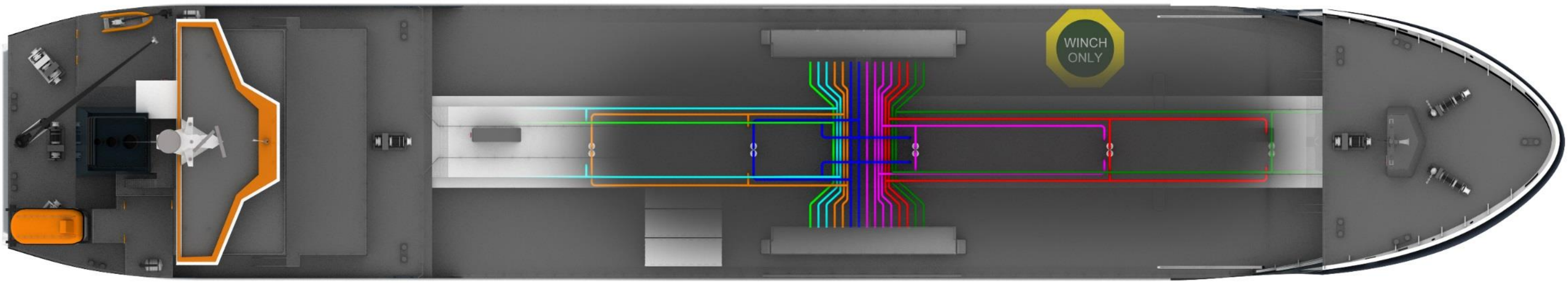
KNUD E. HANSEN A/S

NAVAL ARCHITECTS • DESIGNERS • MARINE ENGINEERS



Hamburg, October 2014

Brian Bender Madsen

OVERVIEW OF PRESENTATION

1. INTRODUCTION OF KNUD E. HANSEN A/S

2. ECO SHIP DESIGN ?

3. WHAT IS OUR OPTIONS ?

4. TAILOR MADE -KEH DESIGN PHASES
   - ¤ OUR OPTIONS
   - ¤ INITIAL/CONCEPT DESIGN
   - ¤ BASIC DESIGN

5. CASES/ESTIMATES
   - ¤ Duct on VLCC and Mid size Tanker

6. BANK statements

7. QUESTIONS

THE BACKGROUND

WE HAVE PROVIDED TAILOR MADE CONSULTANCY AND DESIGN SERVICES TO THE GLOBAL MARITIME INDUSTRY

SINCE 1937

- MORE THAN 650 VESSELS HAVE BEEN BUILT TO OUR DESIGN
- MORE THAN 400 HULL LINES DEVELOPED AND MODEL TESTED
- MORE THAN 225 CONVERSIONS HAVE BEEN CARRIED OUT TO OUR DESIGN
- THOUSANDS OF SURVEYS, ONSITE SUPERVISION AND OTHER SERVICES

KNUD E. HANSEN A/S – GLOBAL OFFICES

Geographic Location of Recent Projects

THE KEH CONCEPT

OUR EXPERIENCED STAFF IS THE FOUNDATION OF OUR ACTIVITIES.

MODERN DESIGN TOOLS AND PROJECT PLANNING MAKES KNUD E. HANSEN A/S.

A FAST AND RELIABLE PARTNER.

Knud E. Hansen A/S focus:

- **BRING ADDED VALUE**
- **LONG TERM RELATIONSHIP**
- **DIRECT DIALOGUE AND TAILORED RESPONSE**
- **COMPETENCE AND QUALITY**
- **ON-TIME DELIVERY**

KEH KEY SERVICES

Knud E. Hansen A/S provides to clients worldwide the following services:

Newbuildings

- General Naval Architecture
- Marine Engineering
- Stability and Safety Engineering
- Structural Engineering
- HVAC Design

General

- Energy optimisation
- Project management
- Inspection and Supervision
- Seatrials and Delivery

VESSELS TYPES




- FERRIES (RO-Pax)
- RO-RO & RO-CON
- **TANKERS**
- CRUISE VESSELS
- MULTI PURPOSE VESSELS
- MILITARY VESSELS
- CONTAINER VESSELS
- OFFSHORE WIND, OIL & GAS
- YACHTS
- GENERAL CARGO VESSELS




TANKER PROJECTS CURRENTLY ON OUR TABLE

- 6.300 DWT IMO 2 (Internal project)
- 16.000 DWT IMO 2 (Internal project)

- 14.000 DWT ASPHALT/BLACK PRODUCTS
- 14.250 DWT IMO 2
- 19.999 DWT IMO 2 (pending)
- 24.000 DWT IMO 2 (Awaiting financing)
- 45000 cbm LNG Tanker (KEH short listed)
- OPTIMIZING VLCC (FINISHED)

ECO – SHIP DESIGN

WHAT DOES ECO STAND FOR ?

Environmentally Creative Object

Evolving Creative Opportunities

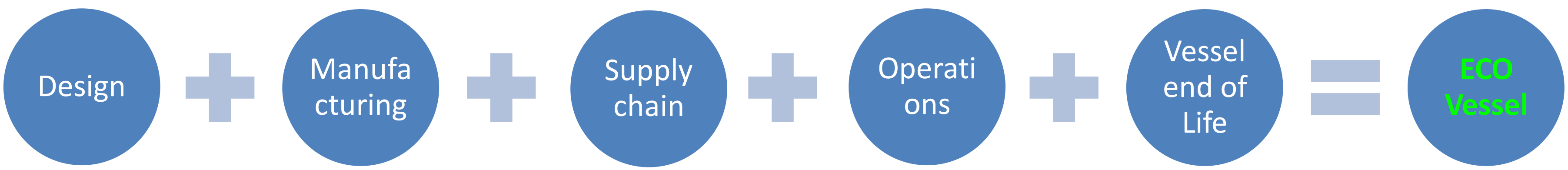
Engineering Change Order

Energy Cost Optimization

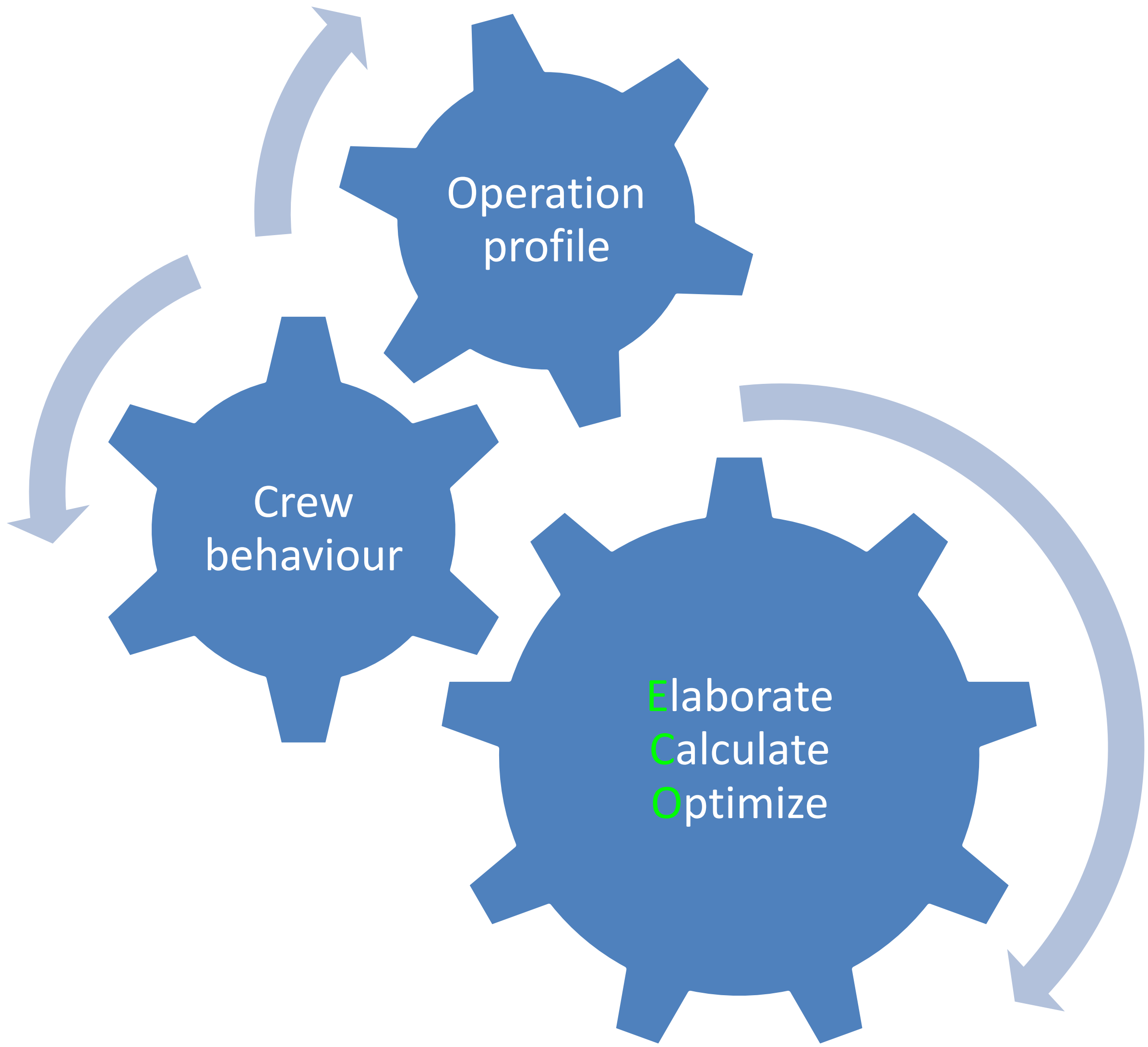
Elaborate Calculate Optimize

Energy Companies Obligation

THE ECO EQUATION



WHAT DOES KEH SUGGEST!



WHAT IS THE OPTIONS ?

The Ship designers can manage Three of the Five ways to be improve the efficiency of a Vessel operation.

- Reduce the hull resistance in Loaded/Ballast condition
- Increase the propulsion system efficiency
- Improve the power plant efficiency
- --
- Improve the Crew behavior & operational efficiency
- **OPERATION PROFILE…**Draft, speed, Pool rating, laden/ ballast, operation area

IMPROVING HULL RESISTANCE

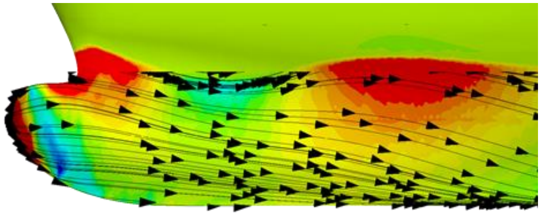
- **Design for available cargo and route**
  a suitable sized ship gives a higher degree of utilization and a lower lightweight.

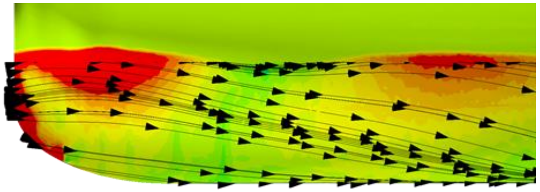
- **Evaluate Main Dimensions**
  could reduced FO consumption compensate for higher port costs?

- **Optimise hull for operational profile**
  get the best overall performing hull by looking at more than only the contract point. Modified hull forms shall be considered

- **Optimise hull for low added resistance in waves**
  the sea is rarely flat -a fact which is often overlooked in the design stage.

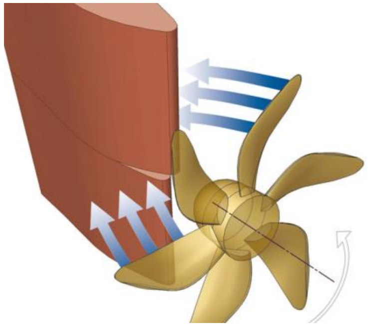
- **Make superstructure more aerodynamic**
  A superstructure shaped for lower resistance doesn’t cost much more than the good thoughts.



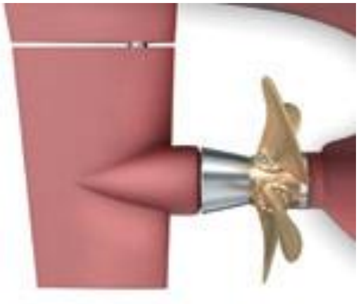


IMPROVING PROPULSION

- **Larger propeller diameter / low RPM**
- **Optimizing for complete propulsion train**
  (SFOC vs RPM vs Propeller)
- **Energy Saving Devices (ESD)**


Twisted rudder

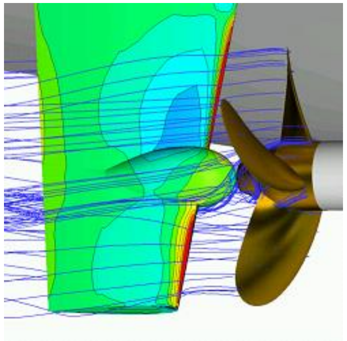

HHI Fin


Propeller Cup


Duct

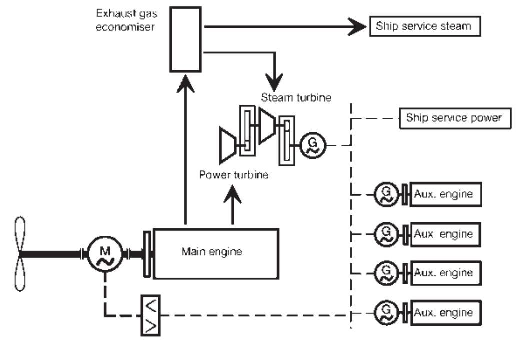

Pre Swirl Stator


PBCF


Costa bulb

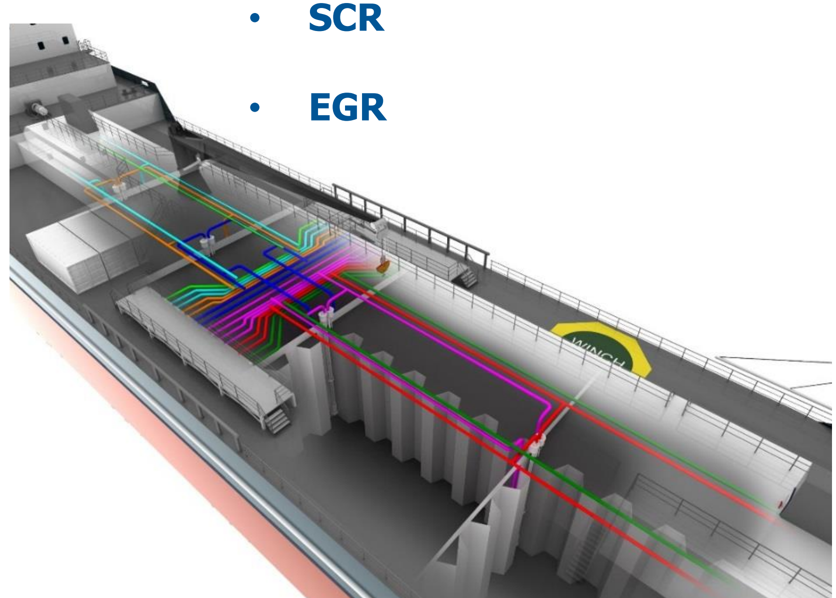
IMPROVING MACHINERY AND SYSTEMS

- **De-rating for lower SFOC**
- **Hybrid drives for better utilization e.g. Shaft Generator**
- **Electrical power plant**
- **Automated Demand-driven Control of Machinery and Cargo Systems** (e.g. frequency controlled fans, automatic light etc)
- **Waste Heat Recovery**
- **HVAC Optimization**
- **WB handling**



Future options

- **Scrubber**
- **SCR**
- **EGR**



IMPROVING OPERATION / CREW BEHAVIOR

- **Make an efficient layout**
  Reduce time in port by faster loading/unloading.

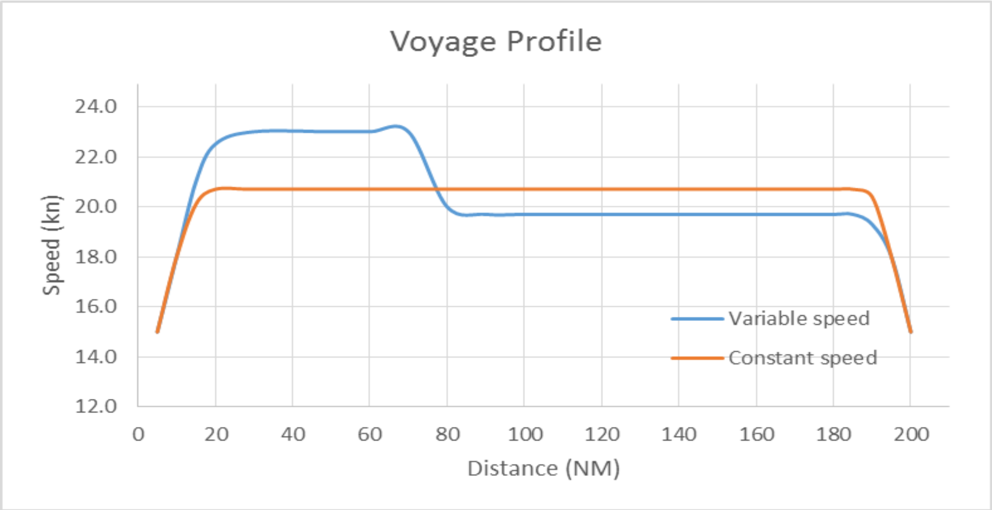
- **Better crew comfort**
  Better facilities attracts the better crew. Better crew takes more responsibility, understands and involves in new technologies.

- **Monitoring - analyse – action**
  Reduce FO consumption by monitoring (consumption, thrust/torque, weather etc), making crew aware, trim optimization, route planning, utilization degree of auxiliaries etc.

- **Better strength / stability**
  Faster turnaround if there is more flexibility in where cargo can be placed.

Consequence of a	5	min delay increases FO consumption by					2.6%
	Round trip	Port call	distance	sailing time	speed	Consumption	
	hours	hours	nm	hours	knot	t/day	t/trip
Planned	13	3.00	190	10.00 @	19.00	2.03	20.3
Delayed	13	3.08	190	9.92 @	19.16	2.10	20.8

Consequence of catching up speed. (Data for 200m RoRo)



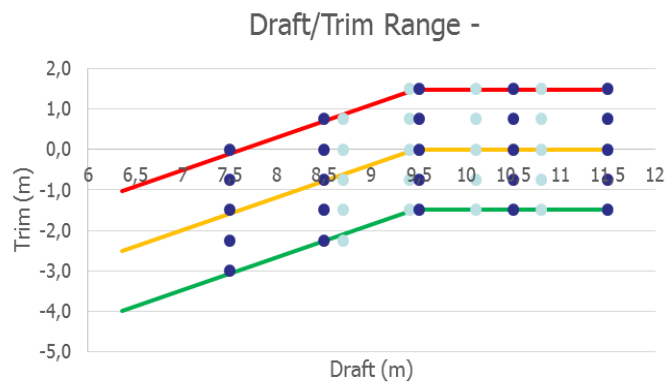
For both voyage profiles the average speed is 19.9 knots and sailing time is 9½ hours.
Additional cost for variable speed curve is 4.8%.
(Data for 200m RoRo)

OPERATION PROFILE !!!!!!!!!

OPERATION PROFILE !!!!!!!!!

Its about getting the vessel that you need you operation profile is the most important key!

Load condition →	Sea	Port	Dynamic positioning
Propeller load (kW)	15,000	0	2-4,000
Electricity production (kW)	900	5,500	3-6,000
Time in service (days/year)	140	55	170



Example

Harbour hours per Year	1760
Ballast voyage hours per year	1500
At Sea hours per Year	5500

Sailing time matrix			Draught (m)			
			6	7	8,6	
Speed (Kn)		At sea-%	30	40	30	100
	6	35	10	15	10	
	10	35	10	15	10	
	13	30	10	10	10	
		100				100

Ship operation profile 30 % outside ECA

	outs. ECA	in ECA	Total
Days at sea	90	129	219
Days harbour	45	55	100
Cargo opr.	20	25	45
Total	155	209	364

TAILOR MADE – SHIP DESIGN

- **DETAILED APPROACH……….**KEH has a very detailed/strong calculation tool which take almost all the variables and risks into account and gives a good support to the decision process.

- **SIMPLIFIED APPROACH…..** Another approach is to simplify the decision process; Before starting on each individual Fuel saving devices on a Vessel a general/quick analysis of the fleet is carried out.

DETAILED APPROACH

MAKE "GUESTIMATES" FOR A GREENER and MORE EFFICIENT FLEET

Estimated assumptions based on history, experience and the vision of the owner regarding the type and condition of the fleet that will be examined.

- New-building or Retrofitted ships or combinations
- Potential investment scenario
- Fuel price
- Variations of fuel price in the future
- Life Cycle period
- Type of market-Freight rates

	4 Cases	Ships number	
		Retrofits	New
1	All Eco friendly Newbuildings	0	10
2a	All Retrofits-to become eco-friendly-5 yr old	10	0
2b	All Retrofits-to become eco-friendly-10+15 yr	10	0
3a	Mix New-Retro(5 yr old)	5	5
3b	Mix New-Retro(10+15 yr old)	5	5
4	Totally Non Eco-friendly	0	10

Ship:	
Total nr.ships:	10
Type of ship:	Tanker
Enter DWT:	60000
Enter LWT:	10000

Fuel:	
Fuel consumption(t/day):	30
Working days/year:	250
Fuel consumption/year(t/year):	7500
Fuel Price($/MT):	730

Life study period (years):	25
Select of bulk carrier:	Supramax
Select Route:	Atlantic
Enter T/C rate ($/day):	10000
Enter Sale price of 5yr old ship($):	15000000
Enter Newbuilding price ($):	20000000

DETAILED APPROACH

- Green technologies that will be applied

Fuel saving Design Technologies

Impoved hull design:		
Hull form optimisation (assymetric body design)	1	0.08
Bulb modification (bulbous bow)		0.04
Design for both calm &seaway operations	1	0.01
Evaluation of added resistance		0.01
Propeller & Rudder design:		
High performance propeller series		0.06
Contra-Rotating podded propulsion concept		0.1
Thruster/Vortex Fins		0.04
Pre-Duct-Mewis Duct		0.06
Pre-Duct-Schneekluth		0.05
Boss-Cap Fins	1	0.03
Rudder Bulbes-Twisted rudders		0.04
Propeller coatings	1	0.04

Technologies to protect the environment and compliance with future legislations

Ballast Water Convention		
	Ballast water treatment systems(minimum ballast)	1
	Ballast water free design	
MARPOL I	Oil:	
	Dipose off at shore	
	High speed centrifuges	1
	Biodegradable fuels and oils(biodiesel)	
	Water lubed stern tube	
MARPOL IV	Sewage:	
	Dipose off at shore	
	Sewage treatment system	1
	Membrane bioreactors	
	Vacuum toilets	
MARPOL V	Garbage:	
	Dispose off at shore	
	Waste compressors	
	Incinerators (also for heat recovery)	1

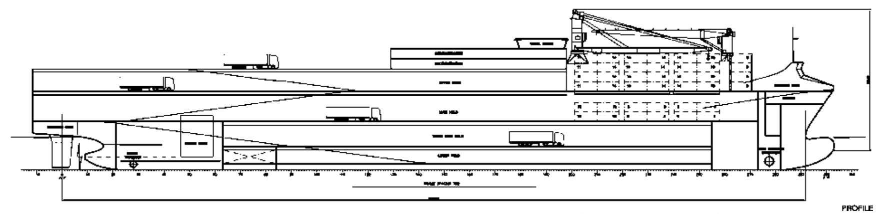
Eco-friendly Operational Technologies

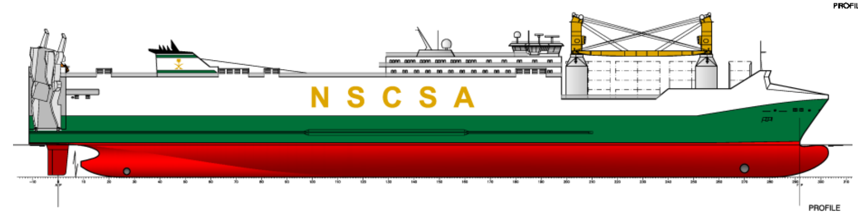
MARPOL VI	Air-pollution:			
	Operational aspects			
	Slow streaming(5% speed reduction)	1		0.13
	Hull cleaning			
	Course keeping ability			
	Manouvering ability			
	Weather Routine			
	Optimum dynamic trim		0.02	
	Cold ironing			
	Crew Training			
	On board monitoring for energy efficiency			

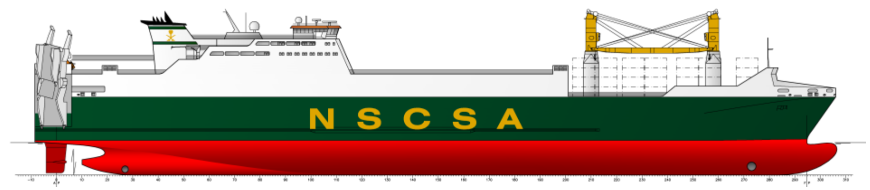
TAILOR MADE -KEH DESIGN PHASES

Typical KEH scope

- Feasibility study
- Initial / Concept Design
- Tender / Contract Design
- Basic Design
- Detail Design



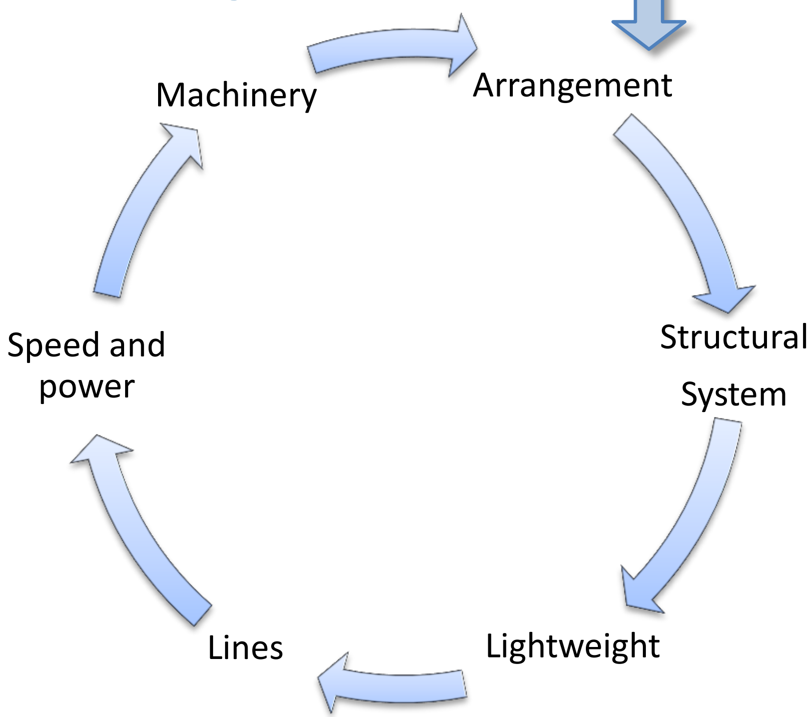




INITIAL/CONCEPT DESIGN

Step 1.1; Meeting with owner

Step 1.2; Design spiral



Step 1.3; Meeting / presentation

Purpose for this stage is to find the most suitable vessel only concentrating on major items.

Design criteria's as max dimensions, capacity, speed, operation profile to be discussed with Owner.

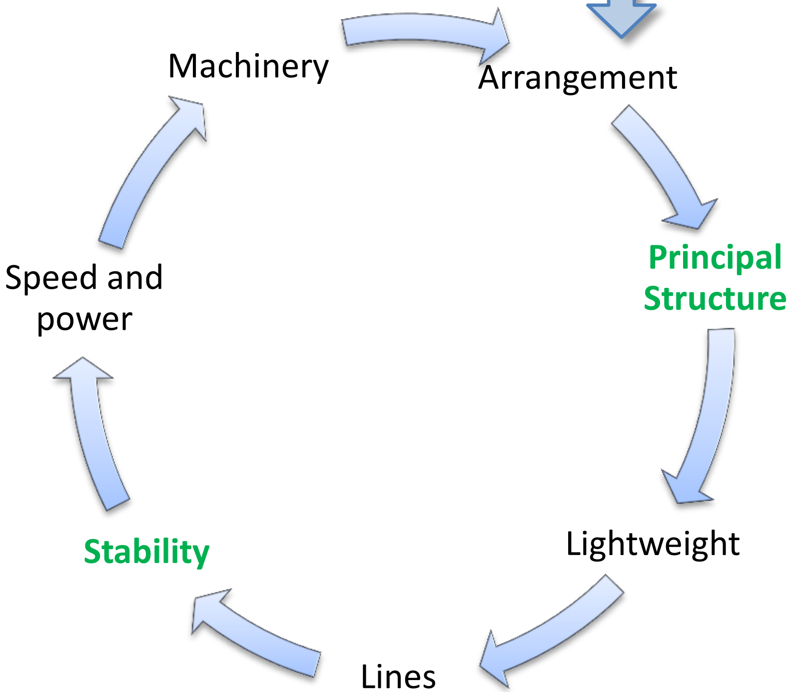
This stage has high focus on:

- General arrangement
  - Tank configuration
  - Cargo handling philosophy
- Machinery configuration analysis
- Optimum main dimension analysis
- Future legislation

TENDER/CONTRACT DESIGN

Step 2.1; Decision of concept

Step 2.2; Design spiral



Step 2.3; Meeting / presentation

After the concept has been decided all previous documentation will be updated and detailed.

This stage will introduce new documentation;

- General Arrangement
  - Ventilation
  - Accommodation
  - Rescue / escape
  - Etc…
- Engine room arrangement
- Electrical power configuration
- Midship Section
- Intact and damage stability
- Specification

EXSISTING VESSELS.... Simplified approach

QUANTIFY AMOUNTS OF USD......EXAMPLES

VLCC 300.000		
SFOC-Sea	175	g/kWh
SFOC-Harbour	200	g/kWh
Power cons. At Sea	22.050	kW/hr
Power cons. Harbour	500	kW/hr
Days in Sea	295	days
Days in Harbour	70	days
Fuel cost-HFO	650	USD/ton
Fuel cost-Lo-S	950	USD/ton
Avg. daily Cons	92,61	ton/day
Basis cost-Sea	17.757.967	USD/year
Basis cost-Harbour	159.600	USD/year
Total cost	17.917.567	USD/year
Design optimize-2%	**355.159**	**USD/year**
Design optimize-6%	**1.065.478**	**USD/year**
Design optimize-10%	**1.775.797**	**USD/year**

Aframax 110.000		
Design optimize-2%	224.693	USD/year
Design optimize-6%	674.078	USD/year
Design optimize-10%	1.123.463	USD/year
Handymax 50.000		
Design optimize-2%	115.970	USD/year
Design optimize-6%	347.911	USD/year
Design optimize-10%	579.852	USD/year
Handysize 30.000		
Design optimize-2%	86.978	USD/year
Design optimize-6%	260.934	USD/year
Design optimize-10%	434.889	USD/year
Handysize 19.999		
Design optimize-2%	50.737	USD/year
Design optimize-6%	152.211	USD/year
Design optimize-10%	253.685	USD/year
6.500		
Design optimize-2%	36.241	USD/year
Design optimize-6%	108.722	USD/year
Design optimize-10%	181.204	USD/year

ENERGY OPTIMISATION –EXISTING VESSELS

Largest contributors for reducing FO consumption:

- Operation: Monitoring – Analyzing – Action
- Hull and propeller cleaning
- Energy Saving Devices
- Trim optimization (CFD or modeltest)
- Cargo ventilation / HVAC
- Optimization of other systems (pumps, cooling etc)

In case of changed design point (slow steaming):

- Lines change, savings up to 6%
- De-rating of ME, savings up to 6%
- Propeller replacement, savings up to 5%

VLCC – Simplified approach

Client require

- Min. 5 % saved – 6 Vessels – ROI max. 1 Years – Vessel must not be taken out of Service

- Quantified amounts of USD equal to 5 % saved = approx. 900 kUSD/Year
- Which ESD option may be available for retrofit during scheduled dry docking or in-service:

-Waste heat recovery would technical be feasible but did not comply with ROI request

-Duct considered feasible

Preliminary budget: Duct maker Design fee 175k USD

	Duct – Materials	500k USD/Vessel
	Project handling	25k USD
	Finance cost	20k USD/Vessel
Total cost/Vessel		555k USD/Vessel → Retrofit case valid

Model test results has shown 6-10% saving (depending on speed and trim)

Fitting duct would also be applicable for New buildings same as waste heat recovery (ROI >1 year)

BANKS

WHEN DOES RETROFITTING MAKE SENSE FROM THE BANK´S POINT OF VIEW?

$$$...Project management capacity of owner
$$$...Project improves consumption ranking to first 30% of peer group
$$$...Vessel operating in the „right“ market segment
$$$...Expected improvements are plausible / realistic (independent confirmation)
$$$...Payback period 12 – 18 months
$$$...Suitable financing volume (usually more than one ship, sister ships, fleet programs etc.)
$$$...Timing: Retrofitting during first dry docking

- New buildings „unbeatable“ by existing fleet
- Provide good financing opportunities for bank
- **But:** New buildings are a threat to the bank´s shipping portfolio

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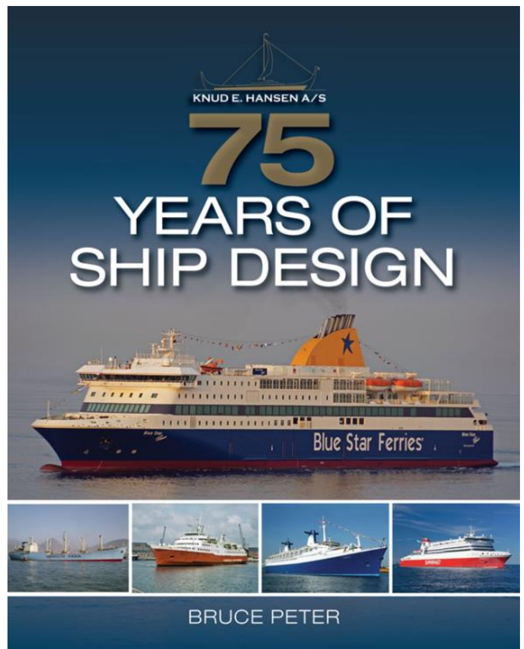
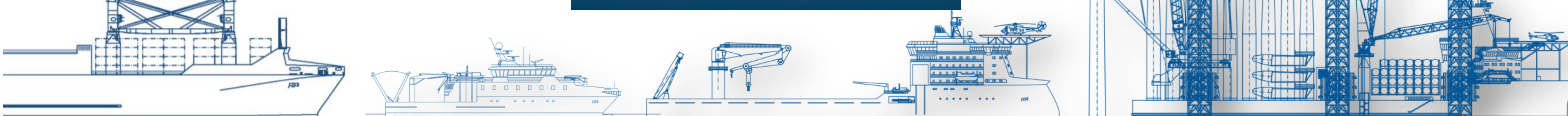
THANK YOU FOR YOUR KIND ATTENTION





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