



# Energy Efficient Safe SHip OPERAtion

## SHOPERA PMC Meeting Oslo 3-4/4/2014

WP 5 – Adaptation/Integration of Tools –  
Multi-objective Optimization Platform

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**Title:**

Adaptation/Integration of Tools - Multi-objective Optimization Platform

**Objectives:**

- To integrate software tools for the hydrodynamic / maneuverability assessment of ships in adverse weather conditions into a ship design software platform.
- To set-up and apply multi-objective optimization procedures in the design of selected ships for the minimum powering requirement ensuring safe operation in adverse weather conditions, while keeping the right balance between economy, efficiency and safety of the ship and the environment.

# Description of WP5

<b>Participant number</b>	1	6	7	9	10	11
<b>Participant short name</b>	NTUA	IST	UDE	FSG	ULJ	VTT
<b>Person – months / participant</b>	21	6	2	5	6	7

<b>Participant number</b>	17	18	19	20	21	
<b>Participant short name</b>	DUT	NAP	DAN	FNK	CAL	<b>TOTAL</b>
<b>Person – months / participant</b>	2	10	2.5	1	2	<b>64.5</b>

- Development of software tools and optimization procedures:  
**NTUA – IST – VTT – DUT – NAP**
- Expertise on the assessment of hydrodynamic behavior of ships, interconnection with WP4:  
**UDE**
- Expertise on ship design and ship building:  
**FSG – ULJ**
- Data and expertise on the operation of ships and on the definition of the optimization problem and the development of the software tool:  
**DAN – FNK – CAL**
- Elaboration of the optimization studies:  
**NTUA – IST – VTT – NAP**

# Description of WP5

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Planned optimization studies shall be implemented in two phases:

- **Global optimization**, to identify favourable combinations of main dimensions, form parameters and other integrated characteristics.

These studies should be carried out applying as far as possible simplified, semi-empirical models (level 1 methods).

- **Detailed optimization**, including hullform details. For selected ship types and sizes, based the global optimization results, applying as far as possible medium complexity procedures (level 2), developed or refined in WP2 and/or WP4.

Refined numerical models (level 3, CFD type methods) will be applied as necessary, but their use will be kept at minimum.

	Ship Type	Design in WP6	Global optimization	Detailed optimization
1	Bulk carriers	✓	2	1
2	Containerships	✓	2	1
3	Tankers	✓	2	1
4	Cruise ships	✓	1	1
5	Ro-Ro ferries	✓	2	1
6	Ro-Ro cargo ships	✓		
7	General cargo ships	✓	1	
8	Car carriers	✓		
9	LNG carriers	✓	1	
10	LPG carriers	✓		
	<b>TOTAL</b>		<b>11</b>	<b>5</b>

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## PROPOSAL:

### ➤ Global optimization:

- ✓ Software development by NTUA and NAP. Technical expertise provided by DUT, UDE, DAN, FNK, CAL, FSG, ULJ
- ✓ Elaboration of optimization studies by NTUA
- ✓ Evaluation of results in collaboration with DAN, FNK, CAL, FSG, ULJ

### ➤ Detailed hullform optimization (possibly with fixed main particulars):

- ✓ Software development by IST, VTT and DUT (engine dynamics). Technical expertise provided by UDE
- ✓ Elaboration of optimization studies by IST and VTT
- ✓ Evaluation of results in collaboration with NTUA, UDE, DAN, FNK, CAL, FSG, ULJ





## 5.1.1 Evaluation of suitability / selection of hydrodynamic tools for integration.

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For the **Global Optimization Studies**: Selection of **Level 1 Criteria**, based on the outcome of Task 1.3.

- ✓ Relevant report, which will be subsequently incorporated in D5.1, to be prepared by **NTUA (M10)**.

For the **Refined Optimization Studies** (hullform optimization): Selection of appropriate **software tools** among those developed in WP2.

- ✓ Relevant report, which will be subsequently incorporated in D5.1, to be prepared by **IST** in its capacity as the WP2 leader (**M10?!).**

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For the **Global Optimizations** using Level 1 methods, selection of suitable software platform to facilitate:

- ✓ Development of the hullform and internal layout based on a selected set of design variables.
- ✓ Definition of Loading Conditions
- ✓ Evaluation of Level 1 Criteria for Maneuverability, along with Intact Stability Criteria and other Regulatory Requirements
- ✓ Assessment of Building and Operational Cost, Annual Income and Selected Economic Indices (e.g. NPV or RFR)
- ✓ Elaboration of optimization studies (i.e. a general purpose optimization software)

Relevant report (which will be subsequently incorporated in D5.1) on the selection of software platform, to be prepared by **NTUA (M11)**.

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For the **Refined Optimization Studies** (hullform optimization) selection of software platform to facilitate:

- ✓ Development of the hullform based on a selected set of design parameters.
- ✓ Transferring of the hullform details to the selected software tools for the assessment of the hydrodynamic performance (including Maneuverability in adverse conditions).
- ✓ Elaboration of optimization studies (i.e. a general purpose optimization software)

Relevant report (which will be subsequently incorporated in D5.1) on the selection of software platform to be prepared by **IST or VTT** (a partner involved in the Refined Optimization Studies) (**M11?!).**

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### For the **Global Optimizations**:

- ✓ Final selection of ship types and sizes to be optimized
- ✓ Definition of design variables, objective functions and constraints
- ✓ Definition of case study scenarios

A proposal may be developed by **NTUA** in close collaboration with the WP5 members and the WP6 leader, to be discussed and finalized during the planned 2<sup>nd</sup> Plenary Meeting in Hamburg (**M12**).

Similar discussions for the **Refined Optimization** may start in **M13**, once the corresponding decisions for the Global Optimizations have been obtained. Then, an amendment of D5.1 may be issued.

### Global Optimization

- ✓ Tools for the parametric development of ship designs: **NTUA**
- ✓ Tools for the technical evaluation of ship designs: **NTUA & NAP**
- ✓ Economic evaluation (building and lifecycle costs and revenues) **NAP**
- ✓ Level 1 Criteria and assessment of safety of navigation: **NTUA**
- ✓ Integration of tools, formulation of optimization environment: **NTUA**
- ✓ Technical Expertise: **UDE, DAN, FNK, CAL, FSG, ULJ**

**Start: M 10**

**End: M 24**

### Refined Optimization

- ✓ Software tools for the parametric development of hullforms: **IST?**
- ✓ Development/Integration of software for the hydrodynamic analysis (resistance, propulsion and seakeeping) of alternative hullforms: **IST/VTT**
- ✓ Development/Integration of software for the analysis of maneuverability and safety of navigation of alternative hullforms: **VTT/IST**
- ✓ Simplified models of engine dynamics: **DUT**
- ✓ Integration of tools, formulation of optimization environment: **VTT?**

**Start: M 18?! (5.1.2: M11?!)**

**End: M 24**

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### Global Optimization

- ✓ Conduct of global optimization studies of ship's main dimensions and main characteristics (NTUA).
- ✓ Evaluation of results (all).

**Start: M ~~25~~ 18    End: M 30**

### Refined Optimization

- ✓ Conduct of Refined, local hull form optimizations for selected cases based on the outcome of the global optimizations (IST, VTT).
- ✓ Evaluation of results (all).

**Start: M 25**

**End: M 30**



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Task	Title	Due Date
1.1	Met-ocean description	9/24
1.2	Identification of ships and risk analysis of marine accidents	6/12
1.3	EEDI and safety criteria	9
2.1	PF methods for seakeeping and loss of stability in extreme seas	15/30
2.2	PF methods for maneuvering in waves	15/30
2.3	PF methods for maneuvering in confined waters	15/30
4.4a	Steering Devices	24
4.4b	Engine Dynamics	18
4.5	Level 1 Methods for Maneuverability in Adverse Conditions	30
4.6	Intact Stability	30

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WP5 provides output to WP6 (Application / Case Studies).

In addition, the derived 'optimum' designs on the Pareto Fronts can be used:

- ✓ As points of reference in the assessment of the results of WP6
- ✓ As supporting material for the guidelines to be submitted to IMO in WP7 for the minimum required power and steering performance to maintain maneuverability under adverse conditions.

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D No	Deliverable Name	Due Date
D5.1	Set-up of integrated optimization platform and definition of optimization problem	12
D5.2	Development and implementation of parametric models	24
D5.3	Optimization studies – Evaluation of results in view of EEDI requirements	30

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MS No	Milestone Name	Due Date
MS10	Set-up of integrated optimization platform and definition of optimization problem	12
MS11	Development and implementation of parametric models	24
MS12	Optimization studies – Evaluation of results in view of EEDI requirements	30

# Project Time Plan

	Duration [months]																																							
	Year 1												Year 2												Year 3															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36				
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