The IMPROVE Project

IMPROVE, http://www.improve-project.eu, is a three-year research project supported by the European Commission under the Growth Programme of the 6th Framework Programme. The project started in October 2006.

The main objective of the IMPROVE project is to design 3 different types of next generation vessels by integrating different aspects of ship structural design into one formal framework and applying it. The nature of shipbuilding in Europe is to build small series of very specialized ships (the opposite of the Korean and Chinese shipyards). Thus, the IMPROVE project will address ships which, with their complex structures and design criteria, are at the top of the list for customization. The three innovative products are:

1. LNG Carrier: AKERYARDS has designed and built 17 LNG carriers (from 50 000 m3, 75 000, 130 000 m3 to latest 154 500 m3). In the framework of IMPROVE, they are studying the design of a 220 000 m3 unit.
2. Large RoPax ship: ULJANIK Shipyard (Croatia) in the last 5 years has designed several car-carriers, ConRo and RoPax vessels. For a long period ULJANIK has a strong cooperation with the GRIMALDI GROUP as respectable ship owner regarding market needs and trends.
3. Chemical tanker: SZCZECIN shipyard (SSN, Poland) has recently built several chemical tankers (40000 DWT)

As the proposed methodology is based on multi-criteria structural optimization, the consortium contains not only designers, but also shipyards and ship-owners / operators (one per product). The research activity has been divided in three main phases:

1. Definition of stakeholders' requirements and specification of optimization targets and key performance indicators. In addition, project partners (particularly the shipyards) designed reference or prototype ships, one per each ship type, in a "first design loop".
2. All technical developments related to the selected structural optimization tool. Several modules such as fatigue assessment, vibration level investigation, ultimate strength, load assessment, production and maintenance cost, optimization robustness will be delivered and integrated into the existing tools (LBR5, OCTOPUS, and CONSTRUCT).
3. Application of the developed optimization platforms for the three target products.

In brief the IMPROVE project proposes to deliver an integrated decision support system for a methodological assessment of ship designs to provide a rational basis for making decisions pertaining to the design, production and operation of the three new ship generations. Such support can be used to make more in-formed decisions, which in turn will contribute to reducing the life-cycle costs and improving the performance of those ship generations.

New Innovative Ropax Ship Concept

For the new RoPax design extensive structural analysis are performed to evaluate global structural feasibility and eliminate hard spots regarding stress concentrations problem. The arrangement of cargo space without pillars requests sophisticated structure solutions. Reducing height of deck structure is a very demanding task and can result in many benefits regarding general ship design, e.g.:

- Lower VCG (better stability).
- Reduced light ship weight (increased deadweight)
- Smaller Gross Tonnage

The challenge is to improve Rule structural design at the early (concept) stage of design and to find optimal design solution with the IMPROVE tools and continue the design process in preliminary stage (where more detailed FEM calculations are performed) with the better starting point/design. Decrease of production cost (optimum sequence of production for ULJANIK environment) is the relevant design objective. Regarding general ship design the other targets are:

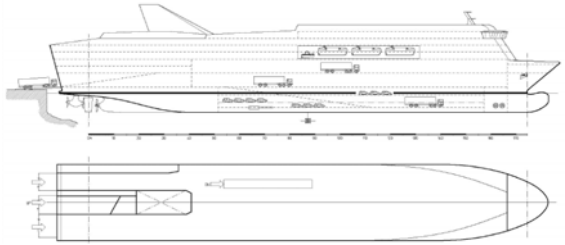
- Selection of resistance friendly hull form
- Smaller propulsion engine for same speed
- Reduced fuel oil consumption
- Selection of hull form in order to reduce length of engine room (increased length of cargo space)

The objectives in the multi-criteria decision making process will be considered using rational models:

- to assess sea keeping as well as manoeuvring performances,
- to assess design loads and accidental loads at the early design stage.
- to assess fatigue at the early design stage,
- for assessment of ultimate strength at the early design stage,
- to assess vibrations at the early design stage,

The main characteristics of the new ship are:

Length overall	abt 193 m
Length btwn perp	180 m
Breadth	29.8 m
Design draft	7.5 m
Block coeff.	0.53
Trial speed	24.5 kn
Main engine power (MCR)	14940 kW
Active rudder output	5000 kW



LNG Carrier Structural Optimisation

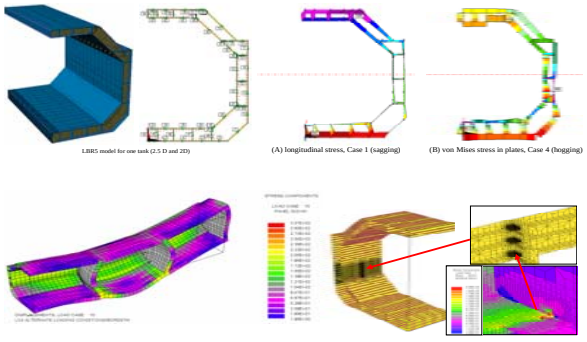
The development of a new LNG concept is one of the targets of the FP6 IMPROVE project. The first phase of this activity related to the identification of stakeholder's requirements and the definition of key performance indicators. In parallel, several calculations have been performed to test the existing tools and to evaluate the potential gain at the concept design. These activities, associated with the definition of a 220000 m³ QuatarFlex prototype, including the aspects related to the naval architecture and general arrangement, have been re-grouped in the so-called "first design loop".

The second phase concerns the development of new modules to be integrated in the optimization tools in order to satisfy the requirements defined in the first phase. The final phase will be the application of the new (improved) optimization tools for the final LNG product. The main target will be the multi-objective structural optimization of the prototype defined by "the first design loop". However, some feed-back concerning the naval architecture point of view could be expected in this phase.

The prototype has been designed by AKERYARDS during the "first design loop" phase. All the aspects related to the general arrangement, propulsion, hull shape and also the initial dimensioning of the structure have been investigated. The main characteristics of this prototype are:

Length overall	317 m
Length btwn perp	303 m
Breadth moulded	50 m
Design draft	12.5 m
Gross Tonnage, abt	145,000 (UMS)
Net Tonnage	43,500 (UMS)
Service Speed	20.0 knots

Several existing tools were used in the first design loop. A fast scantling optimization of the prototype with minimal construction cost objective function using a home-developed tool LBR5. NAPA was used to built a steel model for the cargo part of the prototype and a three tanks model for the cargo part of the LNG was built using VERISTAR-Hull.

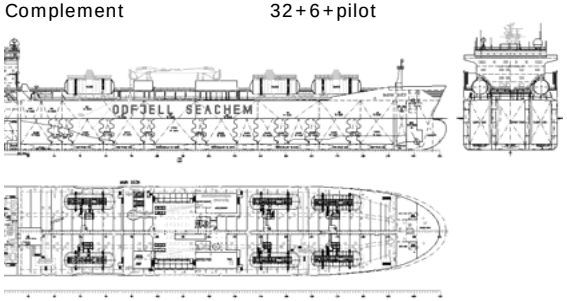


LBR5 model for one tank (2.5 D and 2D) (A) longitudinal stress, Case 1 (sagging) (B) von Mises stress in plates, Case 4 (hogging)

Tanker Structural Optimisation

The third product being developed under the IMPROVE project is a chemical Tanker suitable to carry chemical cargoes IMO type I/II/III, petroleum products, vegetable animal and fish oils and molasses. The Vessel has the following main particulars:

Tonnage	30,000 GT
Deadweight	40.000 t
Length o.a.	182 .80 m
Length b.p.	175.25 m
Breadth moulded	32.20 m
Depth to main deck	17.95 m
Draught	11.50 m
Cargo tank capacity	52,100 m^3
Speed at design draught	15.30 kn
Complement	32+6+pilot



The chemical Tanker has gone through optimization of the midship structure. In the optimisation numerous characteristics of the tanker's structure have been treated, either as constraints or as objectives, depending on the assumed available information, resembling therefore a possible scenario in the early stage of design development.

To perform this task successfully a novel approach based on vectorization and omni-optimization was exploited. Omni-optimization assumes a capability to perform several types of optimization, e.g. single- and multi-objective, using the same optimization algorithm, or the omni-optimizer.

The interest is to gain more knowledge about the capabilities of this arrangement and optimize it for reduction in weight and increase in safety. Omni-optimization is performed with a simple genetic algorithm though the re-formulated 'vectorized' structural optimization problem. The overall process is managed through Matlab where also the structural response and strength calculations are performed.

Vectorization assumes converting constraints into additional objectives and their optimization alongside original objectives. This very fact enhances both the optimization search and the design investigation as the original problem principally becomes unconstrained. Precisely, vectorization has shown capability to significantly improve the search for the optimum design alternatives, but it has also allowed for an easy handling of design criteria, thus benefiting the objective of the design.

IMPROVE Consortium Members

The project consortium consists of 17 complementary partners from 9 member and 1 candidate member states; 3 ship owners/operators, 4 universities, 3 shipyards, 2 ship design companies, 2 engineering companies, 2 software companies, a classification society and an International Association of Universities.

ANAST, University of Liege	Belgium
Aker Yards shipyard	France
Uljanik shipyard	Croatia
Szczecin New Shipyard	Poland
Grimaldi	Italy
Exmar	Belgium
Tankerska Plovidba Zadar	Croatia
Bureau Veritas	France
Design Naval & Transport	Belgium
Ship Design Group	Romania
MEC	Estonia
Helsinki University of Technology	Finland
University of Zagreb	Croatia
NAME, Universities of Glasgow & Strathclyde	UK
Centre of Maritime Technologies	Germany
BALance Technology Consulting GmbH	Germany
WEGEMT	UK

More information about the IMPROVE project can be found at the project website

http://www.improve-project.eu

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Improve

Design of Improved and Competitive Products using an Integrated Decision Support System for Ship Production and operation

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SIXTH FRAMEWORK PROGRAMME

ULg UNIVERSITÉ de Liège