Project 031392
Sustainable Methods for Optimal design and Operation of ships with air lubricaTed Hulls (SMOOTH)
Contract no: TST5-CT-2006-031392

Instrument: STREP
Thematic: PRIORITY 1.6.2 Sustainable Surface Transport

Executive summary

Start date of project: 01-09-2006
Duration: 58 months

Project coordinator: dr. ir. H. Prins
Project coordinator organisation: MARIN

EXECUTIVE SUMMARY (PUBLISHABLE)

Introduction:

Generally, water or any other fluids are capable to carry bodies such as ships when the integrated pressure forces along the contact surface between body and fluid is equal the weight of the body. The better known law of *Archimedes* saying that the body must have the same weight of the water (fluid) the body in question displaces. This law is describing exactly the a/m situation under one precondition: It can be shown mathematically that these two descriptions are equivalent as long as the pressure along the hull is steady.

In other words, only the first definition is generally valid. This is important to note when investigating air-lubrication for ships. From the *Archimedes* definition one could question whether air-lubrication works as a mixture of water and air is less dense and one could suspect that the ship would sink when air is diluting the water. But as long as the air is kept under the same pressure than the water, the pressure forces onto the ship's hull are the same and the ship is floating at the same draught.

As long as there is no massive connection between the surrounding air and the air underneath a ship, i.e. the lower ambient pressure is not down carried to the air layer under the ship, this stable situation of carrying the ship with air instead of water persists. Only in case of such a massive conjunction of the two air reservoirs, e.g. in case of undersea gas eruptions, gas underneath a ship could cause the ship to sink.

Keeping this in mind, gas or air that surrounds a ship offers a tremendous advantage: Soon as the ship or the body in the fluid moves it is exposed to drag or friction, and drag or friction in air is approximately just 2 per cent of the drag or friction in water. When mankind understood these conditions, designers tried to reduce the ship's resistance. The bare friction was rarely addressed, although the idea of air-lubrication is traceable even till *Sir William Froude* (1810-1879), the believed father of the scaling laws for a ship's resistance.

The challenge is that it turned out to be very difficult to efficiently supply and stabilise the air underneath the ship. This is just saying that the application is difficult, the potential physical benefit is not in doubt.

Within the 6th framework programme SMOOTH it is intended to give air-lubrication another push and to develop the prediction tools and theoretical knowledge to successfully implement this technique in the daily practice of European ships. After three years of research it can be stated that the potential of an air layer or an air cavity is still free of doubt.

However, besides more technical and logistical problems that imposed a delay to the project, the investigated air-lubrication techniques of dispersed micro bubbles inside the ship's boundary layer turned out to be less attractive as just marginal improvements at full scale were found.

This finding is again stressing the importance of projects such as SMOOTH on the subject, as it were in particular these scaling effects being addressed by the SMOOTH project that kept scientists careful in their predictions and potential end-users suspecting the technique.

Partners:
The consortium of SMOOTH consists of leading European research institutes and industrial partners from seven different European countries, each of them with unique skills, either as knowledge providers, top hydrodynamic labs and universities, end-users or air-system and maritime paint suppliers, to contribute to the successful implementation of air-lubricated ships.

P001	MARIN – NL	P006	Atlas Copco – NL
P002	Akzo Nobel International Paint – GB	P007	New Logistics – DE
P003	Bureau Veritas – FR	P008	SSPA – SE
P004	Damen Shipyards – NL	P009	DST – DE
P005	Istanbul Technical University – TR	P010	TK Veerhaven – NL (management by DLD – NL)
P011	Imtech – NL		Steering Committee – EU

Table 1 Partners in SMOOTH

The diagram in Figure 1 gives an overview of the project management and organisation:

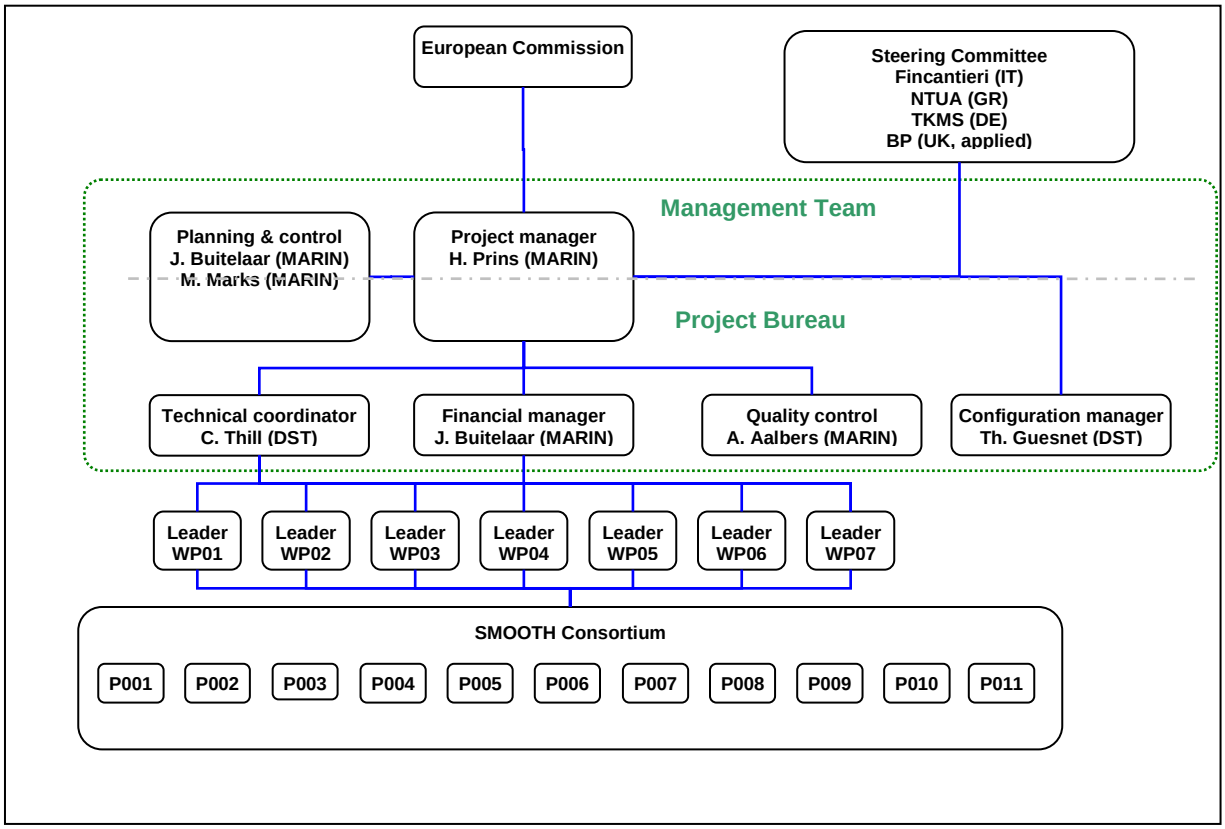

Figure 1 Management structure of SMOOTH

Objective:
The strategic objective of SMOOTH is to cover all aspects of air-lubricated ships still requiring research, such as in particular scale effects, and to assess the technique in a way that a technology transfer of air-lubrication into daily European shipbuilding and operation practice of both inland and coastal navigating ships is enabled.

Background:

Within the PELS project, a Dutch national project, a positive overall energy saving was achieved in all operational conditions of a ship when air lubrication is applied. Based on these findings the SMOOTH consortium estimates that ship efficiency improvements up to 20% will be feasible.

Expected results:
SMOOTH aims at a considerable reduction of fuel consumption, CO_2 discharge with at the same time improved safety by exploiting the new features of air lubrication.

Two important factors in ship safety are manoeuvrability and stopping performance. As the frictional resistance of a ship can be influenced by locally switching on and off the air-lubrication, either can be improved significantly compared to traditional vessels without air lubrication.
By applying this new, vanguard technology in cases when there is danger of collisions and groundings, avoiding the critical situation by better manoeuvrability or minimising structural damage by better stopping performance could sometimes prevent severe environmental pollutions.

Results of the last year:
Five of the seven work packages from the original description of work (DoW) were active in the last year of SMOOTH. The task description of the work packages and the related leader can be found in Table 2.

WP number	Task description	Leader
1	Project management	MARIN
3	Scale effects	ITU
4	Model tests on air-films	MARIN
5	Model tests on micro bubbles and air cavity ships	SSPA
6	Economic and risk evaluation	BV

Table 2 Task description

WP3 is investigating scale effects, effects that can do away the positive findings on scaled models compared to the real ship. It were these scale effects yielding to the overestimated performance of micro bubble (MB) lubricated ships, which finally changed the whole approach of SMOOTH.
In WP4 and WP5 model tests on air lubricated ships are conducted and analysed, with a focus to air films at the one hand and air cavities and micro bubbles at the other. Due to the failure of MB at full scale, the investigation was send back to lab, increasing the lab test scope to gain new insights. However, this shift of budget could not fully balance the cancelled full scale test series.

Besides the continuous WPs Management (WP1) and Dissemination (WP7, in this period just by permanent university staff), WP6, the economic and risk evaluation spans the whole duration of SMOOTH as all intermediate findings will be made subject to a critical evaluation.

Impact:

The impact of the technique being subject of the SMOOTH project is noticeable, which is stressed in the following example:

- There are about 5000 Dutch inland vessels sailing European inland waterways
- The average installed engine power is 800kW
- Considering a
    - loading of 80%
    - 180 g/kWh specific fuel consumption
    - 4500 operating hours on annual basis
- This yields
    - 2592000 tons fuel a year

- 8084448 tons CO_2 a year

SMOOTH is targeting to a 15% reduction of the consumed energy by drag reduction by means of air lubrication techniques. This would release “European” skies from 1212667 tons CO_2.
This example indicates the remarkable impact of the project. At this stage, the eventual reaching of the target is not in doubt, same as the convincement that the technique will be accepted by the practice once the project is accomplished.

Dissemination:
To keep this advantage for the European partners, controlled result dissemination is enabled by the installation of a Supervisory Board, supporting the control of the running project by interested end-users and being exclusively legitimated to receive the results of the research.
A SMOOTH closing conference is planned at the end of the project.

More information on this project will be made available via the internet. The project is establishing its own website with both a public part and a restricted area for project participants. The domain name is reserved and reads http://www.SMOOTH-ships.eu.

Coordinator:

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