1-23

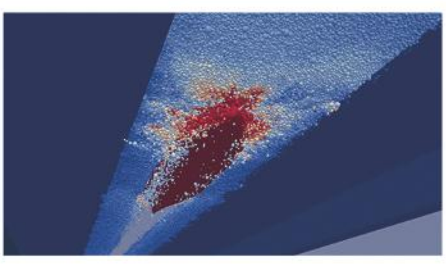
HSVA newswave

The Hamburg Ship Model Basin Newsletter

FLARE

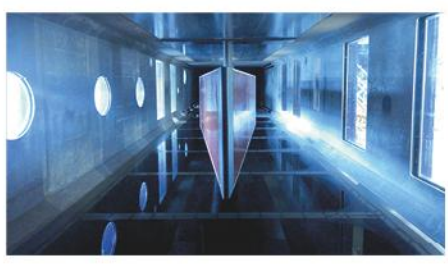
throws light into ship flooding risks

Powering of Ice Class Ships
How to Beat the Rules



Propeller Design
New Frigate F126

Skin Friction
Smooth – Sleek – Laminar



editorial

Dear reader,

We warmly welcome you to the latest edition of our NewsWave. It is our pleasure to once again provide you with exciting insights into our recent projects and developments.

Sustainability has become an essential aspect in today's business world. We all have to recognize the need to actively address the environmental challenges we face. We understand that sustainability goes beyond being just a buzzword; to balance the overall significance for mankind with HSVA's economic efficiency, we work both on technical solution – see our articles on skin friction, bulbous bow optimisation and Air Lubrication Systems – and on a step-by-step improvement of our own processes to minimize our ecological footprint and use resources more efficiently.

Excellence is a central element of HSVA's corporate culture. We strive to offer you high-quality products and first-class customer service. To achieve this, we continuously invest improving our processes and techniques such as discussed in this NewsWave for as various topics as model tests for navy vessels, model tests in ice, or new thrust measurement equipment for testing VSPs. Excellence, for us, means never standing still but always striving to become better. Therefore, we are keen on getting your feedback.

As a company, we must also meet the evolving demands of the market. In this edition, we would like to introduce you to our research programs and institutional partnerships, which help us to stay in tune with the times. We collaborate closely with leading institutions to develop new technologies and innovations that are not only sustainable but also meet the needs of our customers. Examples of successful cooperation projects are the EU funded projects FLARE and TrAM as well as FlettnerFLEET on advanced wind propulsion concepts, funded by the German Federal Ministry of Economic Affairs and Climate Action. On the other hand, in-house development as ManoeLisa enhance our portfolio based on our own – as such independent – excellent in-house research forces.

We hope that this edition of our company newsletter offers you insights into our sustainable and excellent endeavours.

Thank you for your trust and continued support.

Warm regards,

Prof. Dr. Janou Hennig

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Figure 1: The model of a damaged RoPax ship in irregular beam seas in the HSVA large towing tank

EU project FLARE throws light into ship flooding risks

The EU project Flooding Accident Response (FLARE) was completed in November 2022. The overriding objective of FLARE was to develop a novel risk-based methodology and software framework for the assessment and containment of flooding risk in line with IMO high-level goals.

by Petri Valanto

Framework: Inside such a software framework, the risk evaluation of damage cases, which involve the risk of large-scale passenger fatalities from any single accident, is increasingly based on numerical simulations. The quality of any software framework is not better than the tools used in the risk analysis. The more reliable these tools are, the better for the safety of human life on board, and for the economy of the vessel.

Numerical tools: Some numerical tools are well suited for a large number of scenario investigations, based on automated damage area definition, while other tools are better suited to investigate a limited number of damage scenarios thoroughly, allowing for more reliable investigations. In the former category simpler numerical tools are used in broader sense for risk assessment in the design stage of ships. In the latter category the HSVA uses the software rolls. Both approaches are needed and they complement each other. ▶

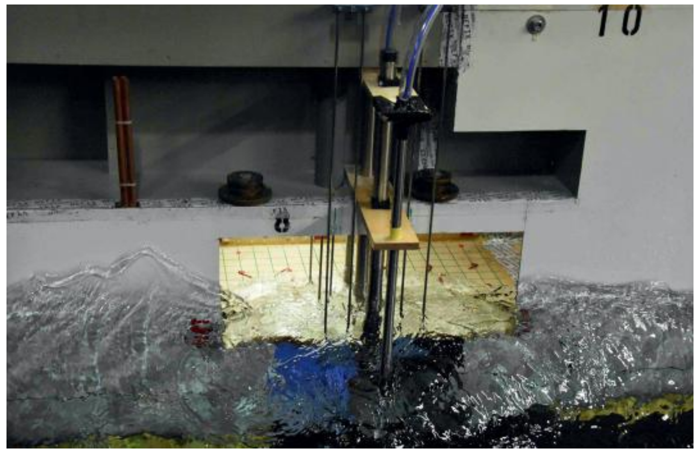

Figure 2: Measurement of flow speed and local water elevation at the damage opening in a gradual flooding case

Figure 3: Controllable sliding doors for the damage opening in a transient flooding case, in which the damage opening speed cannot be ignored

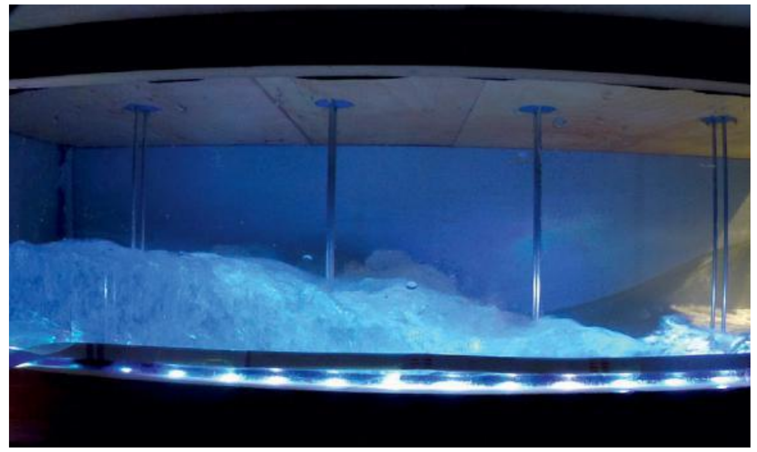

Figure 4: Dynamic water ingress in a compartment of a damaged RoPax in a transient damage case

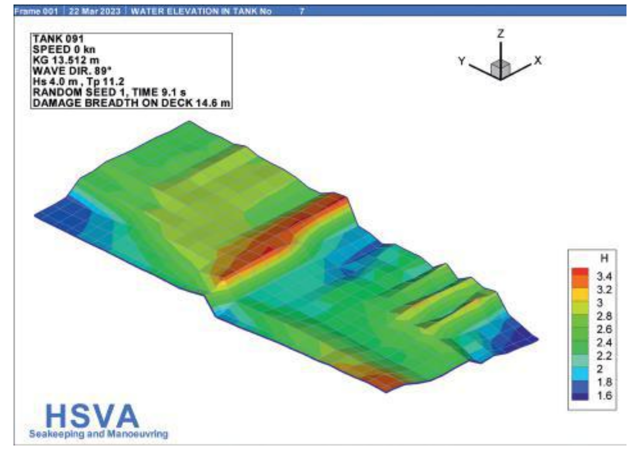

Figure 5: Dynamic water ingress in a compartment of a damaged RoPax in a transient damage case computed with shallow-water-equations in a benchmark case

Test Campaigns: HSVA worked mainly together with other partners in FLARE Work Package WP4. The main objective of the WP4 was to test and improve the accuracy and reliability of existing numerical flooding simulation tools in realistic large-scale flooding scenarios on cruise and RoPax ships. This was achieved by: (1) Verification of numerical models with model tests to throw light on "knowledge-gaps" such as flow in large open spaces and in complicated internal arrangements. (2) Benchmarking of numerical models using dedicated model test results. The HSVA model tests using a RoPax design provided by Meyer Turku (MT) concentrated on the details of the ship flooding and capsizing process in a damage case. Following test series were carried out:

(a) measurements of the roll damping of the vessel in intact condition in various floating positions and in several typical damaged conditions. The measured roll damping coefficients show a clear dependence on the heeling angle, which should be taken into account in numerical simulations.

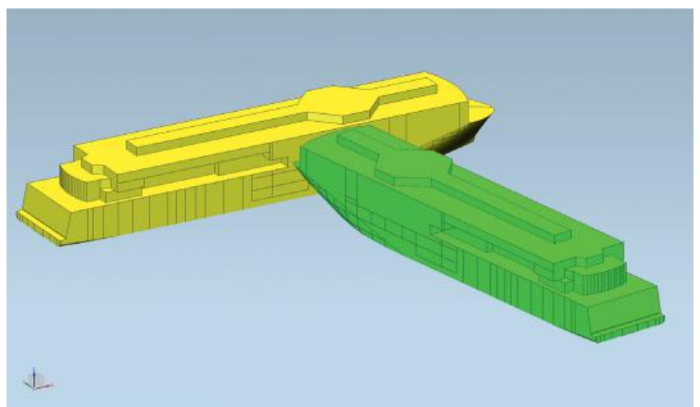

Figure 6: Depiction of a typical ship collision accident leading to a hull breach or damage opening on the ship side

(b) tests on the gradual flooding case with an open side damage carried out in regular waves and in irregular beam seas. Important data was gathered on the inflow and outflow through the damage opening.

(c) tests on the transient flooding case with a side damage having a variable opening speed carried out in calm water and in irregular beam seas to investigate rapid capsize.

An open benchmark study on time-domain simulation of flooding and motions of damaged passenger ships was organised in the FLARE project. Model test data by both HSVA and Maritime Research institute Netherlands (MARIN) were used for benchmarking the codes in three parts: (a) flooding fundamentals (MARIN), (b) flooding of a cruise ship (MARIN), and (c) transient and gradual flooding of a RoPax vessel (HSVA). Studying the data from the sophisticated model test campaigns, benchmarking the numerical codes against it, and comparing different modeling techniques allowed real progress to be made in improving these tools for the benefit of ship design and passenger safety.

Active flooding mitigation on board a vessel is probably known since the first humans crossed any water on a raft, but the idea has not yet found its way to the IMO rules. Adding active systems to the ship, which would mitigate the effects of flooding in case of a damage, would be a promising way to elevate the safety level of both newbuildings and existing ships. Their application would make it possible to increase the safety level of the existing fleet at moderate cost. In order to promote this idea the effects of following flooding mitigation methods were studied by HSVA: (1) Counter flooding, (2) Recovery of lost buoyancy in a damaged compartment, (3) Deployment of a watertight barrier on the trailer deck.

Numerical simulations were carried out with HSVA Rolls for selected damage cases on the current RoPax design, with and without active flooding mitigation measures. The following model tests showed that the active mitigation systems could be easily realised also in a physical ship model. Both the computations and scale model tests demonstrate the applicability of active flooding mitigation to prevent ship capsize, also in transient cases. This is quite a unique new result in the ship damage stability considerations.

"The Times They Are A-Changin' ": The ship damage stability considerations are still very conservative, not only in the rules but also in the mind-setting. The numerical simulation capabilities are continuing their slow but inevitable progress. The modeling will eventually move away from the mostly hydrostatic considerations towards dynamic simulations in time domain, better reflecting the reality. On its part the work done in FLARE has paved some of the way forward.

FLARE received funding from the European Union under the Horizon 2020 program, grant no. 814753.

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Figure 7: CAD-model of MT RoPax showing the controllable damage opening and (1) the deployable watertight barrier on the vehicle deck. Inside the model there are the devices for (2) automatic counter flooding and for (3) recovery of lost buoyancy in a flooded compartment. The three active systems for flooding mitigation were successfully tested both in numerical simulations and in model tests

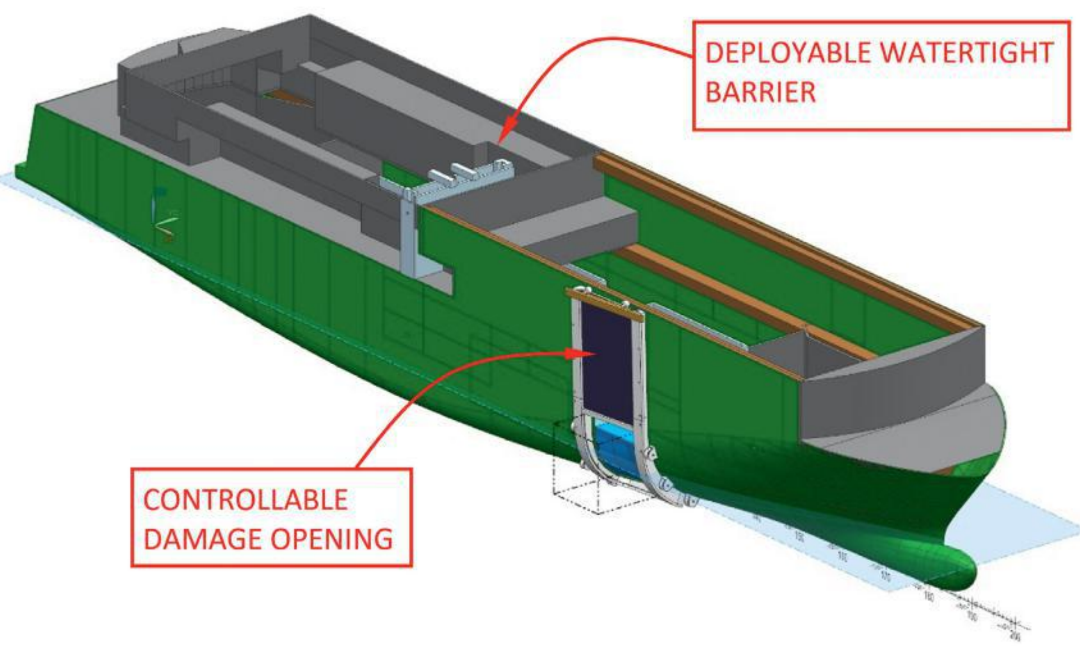

Figure 1: Ship model sailing in brash ice channel

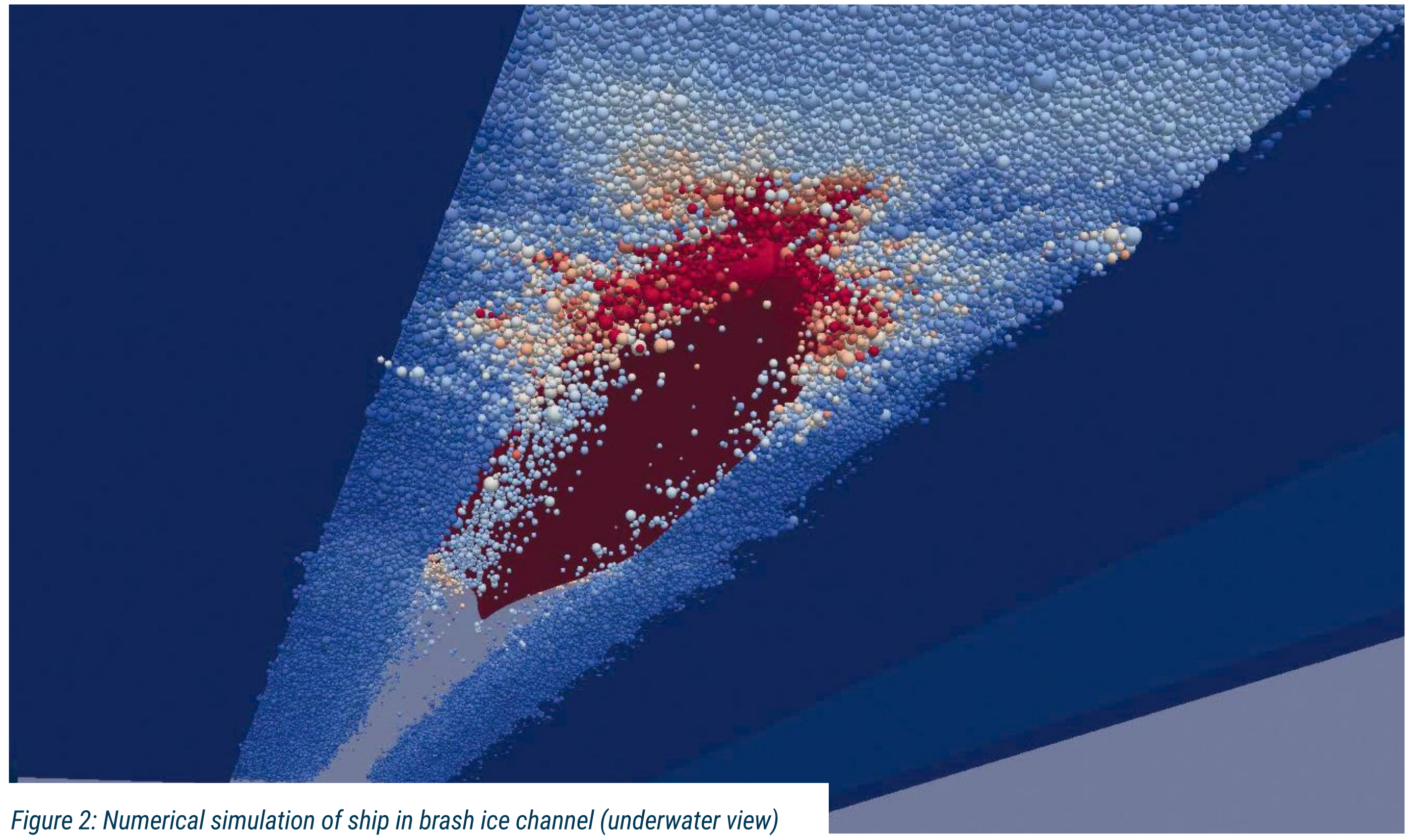

Figure 2: Numerical simulation of ship in brash ice channel (underwater view)

Powering of ice class ships: how to beat the rules

The minimum required engine output power of ice-classed vessels is defined by classification society rules which are usually based on the "Finnish-Swedish Ice Class Rules" (FSICR). The rules provide formulas to calculate the brash ice channel resistance and required engine power at reference speed of 5 knots based on few main dimensions, hull shape characteristics and propulsion key data. For typical merchant vessels the rules calculation based ice power will be far off the required power for service speed in open water. This often leads to inefficient overall propulsion / powering concepts.

by Quentin Hisette and Daniela Myland

Did you know that there are possibilities to reduce the minimum engine power required for ice class approval? In an early design stage the powering requirements can be reduced by hull shape optimisation, proper selection of propeller type, dimensions and design point, as well as adjustments of operating conditions in ice (e.g. ice waterlines). HSVA offers a wide range of consulting works for the design phase, from basic lines review to detailed CFD-based optimisation of the ship's performance in ice and ice-free waters. Once the hull design is completed, it is possible to receive an Ice Class (IA, IB or IC) approval based on brash ice model tests in HSVA's large ice model basin or based on theoretic brash ice performance predictions. Both brash ice model tests as well as theoretic brash ice performance predictions based on direct propulsion calculation and resistance formula lead to less conservative results compared to standard rules calculation. Depending on the method (direct calculation or model tests) and ship hull geometry the reduction in power requirements compared to a standard rules calculation is on average between 20 and 50 %. In view of increased design aspects from carbon reduction control and novel powering concepts with limitations in "fuel" capacities the harmonisation between power demand in ice (@ 5 knots) and open water (@ service speed) is gaining even more importance.

For further information and consultation, please contact us at info@hsva.de or attend our upcoming webinar in the second half of 2023. Demonstrate your interest for the latter by sending us an email and you will receive the Save the Date as soon as it is available.

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The MARINTEC CHINA 2023 will take place from 5 to 8 December 2023 at Shanghai New International Expo Centre (SNIEC), China.

HSVA will have its own stand in the German Pavilion. Our subsidiary SDC Ship Design & Consult GmbH will also be on board.
We are looking forward to seeing you.

Website of the German Pavilion: https://marintec.german-pavilion.com

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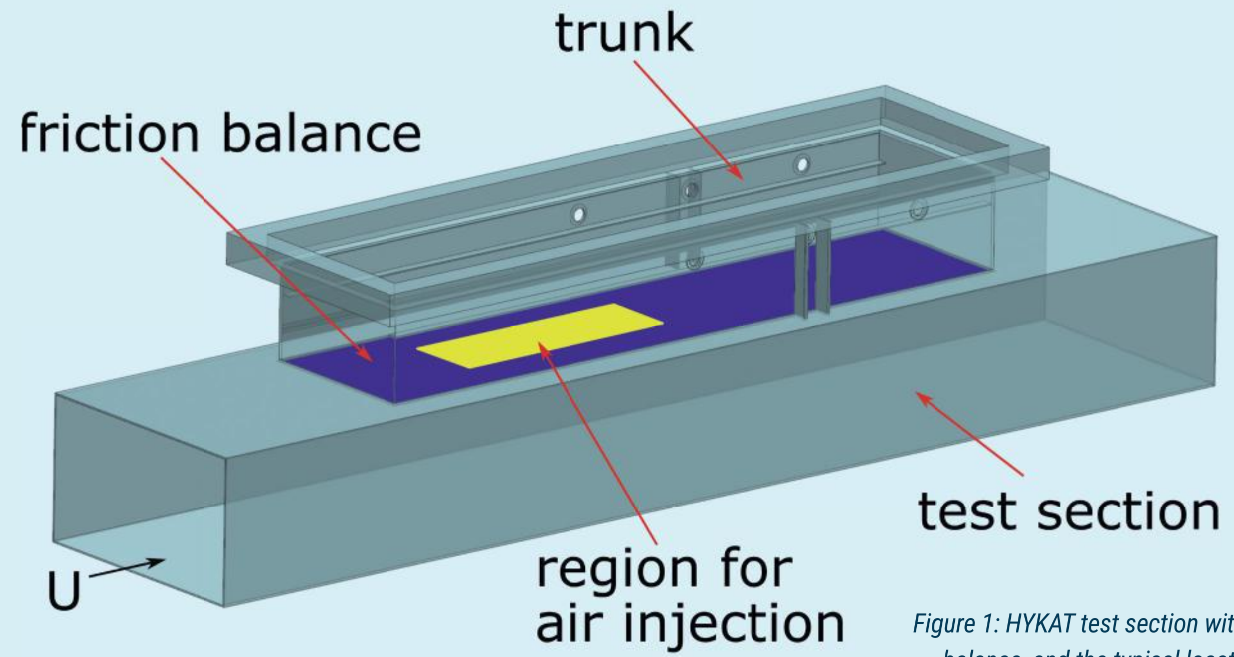

Figure 1: HYKAT test section with the trunk, friction balance, and the typical location for air injection

Testing of fluid dynamic properties of Air Lubrication Systems

The decarbonisation targets of the International Maritime Organization (IMO) for the maritime industry are tightening with the introduction of the carbon intensity index (CII), energy efficiency index for existing ships (EEXI), and energy efficiency design index (EEDI). This sparked the development of new technologies to further improve the efficiency of ships by reducing the overall resistance of the ship.

by Jonathan Lemarechal and Thierry Maquil

The reduction of wave resistance due to ever improving hull lines and a decreasing operational ship speed over the last decade shifts the attention to reducing the skin friction by implementing new technologies like air lubrication systems (ALS).

The skin friction occurs at the interaction of the hull of a vessel and the water. This interaction also generates the so called turbulent boundary layer, which equalises any velocity differences between the water and the ship. The injection of air into a turbulent boundary layer can reduce the skin friction significantly with fundamental research projects stating reduction of up to 50 % in laboratory experiments. The successful implementation of an ALS from the hydrodynamics point of view needs to take into account the achieved drag reduction and the required air flow rate. But also possible adverse effects such as an increased viscous pressure resistance have to be considered. Finally, the overall benefit of an ALS must consider the efficiency of the (air) supply systems. ▶

The effectiveness of the injected air bubbles in reducing skin friction strongly depends on the bubble size and flow speed, which influence the buoyancy, stratification, and coalescence characteristics. In absence of reliable scaling laws it is desirable to investigate the physics under conditions as close as possible to ship conditions, i.e. a turbulent boundary layer representative for a ship (Reynolds number $Re_x > 10^8$) and full scale bubbles as injected under the flat bottom of the vessel by the ALS. To a certain extent modern CFD methods are able to simulate this complex flow. However, these mostly require experimental input to overcome the approximations of RANS models (direct simulation of multiphase flows resolving the bubble-flow is out of scope for practical applications due to the high computational effort). Nevertheless, fulfilling these requirements experimentally is also challenging.

The capabilities of HSVA's Hydrodynamics and Cavitation Tunnel (HYKAT) enable testing at conditions relevant for ALS application. The large test section of 11 m length, 2.8 m width and 1.6 m height and a maximum flow velocity of 10 m/s allows testing at Reynolds numbers of up to $Re_x = 10^7$. Furthermore, the pressure range of 0.15 bar to 2.5 bar absolute pressure provides the possibility to study the influence of draught performance of the ALS. The boundary layer developing on the ceiling of the facility is used to simulate the boundary layer of the flat bottom of the vessel. Above the ceiling of the test section a hollow space (trunk) with 1 m height is available for the ALS installation, see fig. 1. For ALS testing the trunk is sealed off by a flat plate with the ALS and/or the friction balance. The friction balance is used to measure the integral skin friction over a large plate. Furthermore, pressurised air can be provided for the ALS. The air flow rate is regulated and measured. For the characterisation of the air bubble carpet a video system is installed.

From ALS tests in HYKAT it is possible to estimate if an ALS is capable of reducing the skin friction by comparing the measured friction force without any ALS installed, the ALS switched off, and the ALS in operation. Furthermore, the stability of the air carpet as well as the overall flow field can be examined and quantified with best precision. HSVA has been partner for various suppliers of ALS for many years. Furthermore, HSVA is active in research projects investigating friction reduction technologies such as AIRCOAT[1]. Besides laboratory testing in HYKAT, HSVA also carries out sea trial measurements and supports verification of ALS on ships.

[1]The AIRCOAT project has received funding from the European Union's Horizon 2020 research and innovation program under grant agreement N° 764553, https://aircoat.eu/.

European Commission

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ManoeLisa

from mining data to virtual manoeuvring investigations

ManoeLisa – To verify a specified or desired performance of a ship when subjected to harsh environmental conditions is an important task in ship design. The new developments in the analysis and processing of information, combined with state of the art technology, allow digitalisation of a multitude of processes and systems.

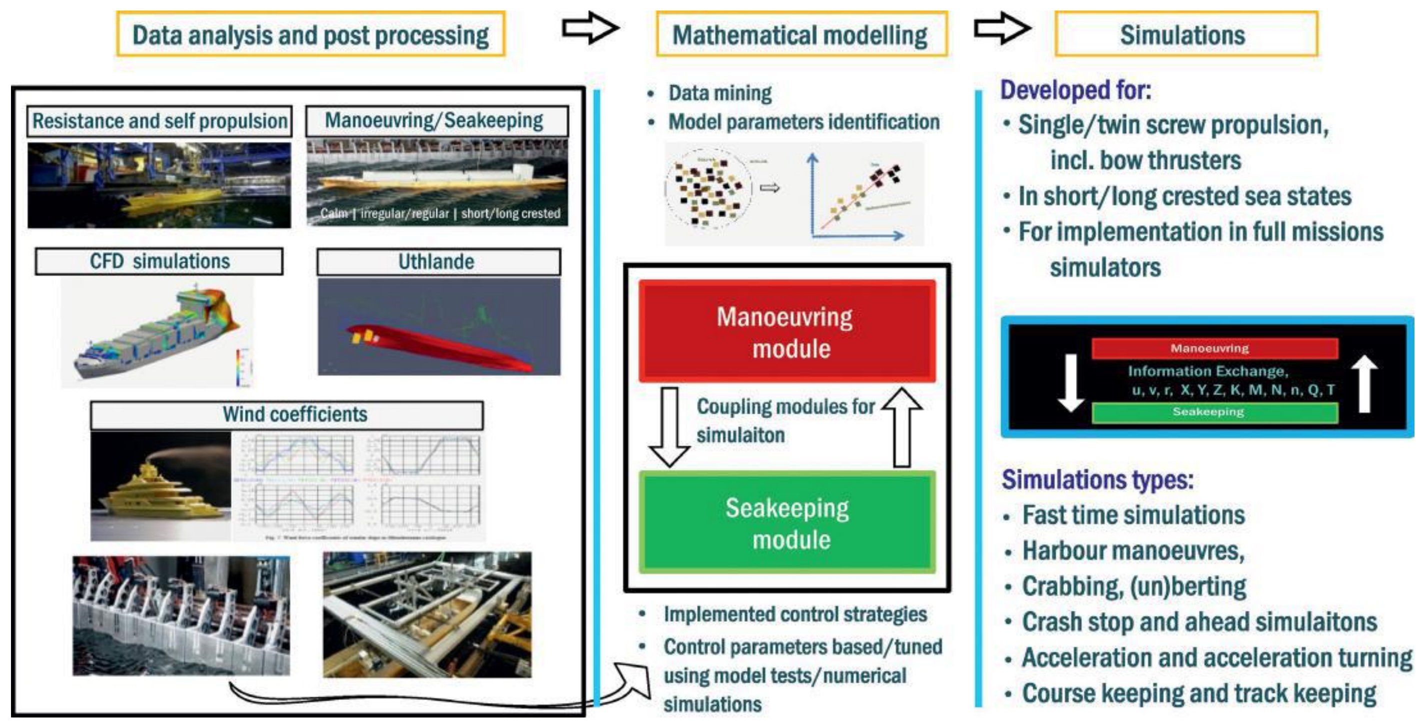

Figure 1: Illustration of the different modules comprising ManoeLisa

by Manasés Tello Ruíz and Jan Lassen

The digitalisation of the ship and its environment is key instrument towards a safer and more reliable ship design. Virtualising the ship dynamics and its environment provides a platform for better understanding the ship's behavior and response to environmental excitations. It is useful for identifying problems, investigate alternative solutions, and to an extend recommend optimal handling operations of the ship, among other possibilities.

ManoeLisa is an in-house software developed to combine all ship dynamic aspects (manoeuvring and seakeeping) in one model (see illustration in fig. 1). This is constructed in a modular way implemented at various levels of accuracy and effort. It also allows integrating user defined control strategies or manual inputs and options to monitor the respective engine limits (torque and power) during the simulation. For instance, making use of these capabilities it can be used to evaluate manoeuvres such as acceleration turning, track and (astern) course keeping in current, wind and waves.

ManoeLisa offers a platform for fast time manoeuvring evaluations in realistic environmental conditions, suitable for instance for the evaluation of compliance with NATO STANAG and STANREG requirements. Up to now, ManoeLisa allows the modelling of controllable and fixed pitch propellers, single and twin propulsion units, as well as active transverse tunnel thrusters, to name just a few. Its flexibility allows easy extension to any desired manoeuvring investigation.

ManoeLisa is based on concepts such as, modular approach for physics modelling, the two-time scale approach, and navigation and guidance algorithms to autonomously steer the ship. The digitalisation of the ship is based on data mining and regression algorithms evaluated over data gathered from numerical (CFD, potential methods) and experimental. ManoeLisa is in continuous development, aiming to provide a better overview of the ship's performance overall as well as of its specific components.

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Bulbous bow optimisation

Rising fuel prices, new regulations and increased awareness on the environmental impact of shipping has been a significant factor in the shipping industry and a driving factor for new buildings for years. With the EEXI and CII in place pressure now also rises to act on the efficiency of the existing fleet. One of the easiest and best working solutions in those cases often is a bulbous bow retrofit, especially as the operating conditions of older vessels tend to have changed significantly towards slower speeds and/or different loading conditions.

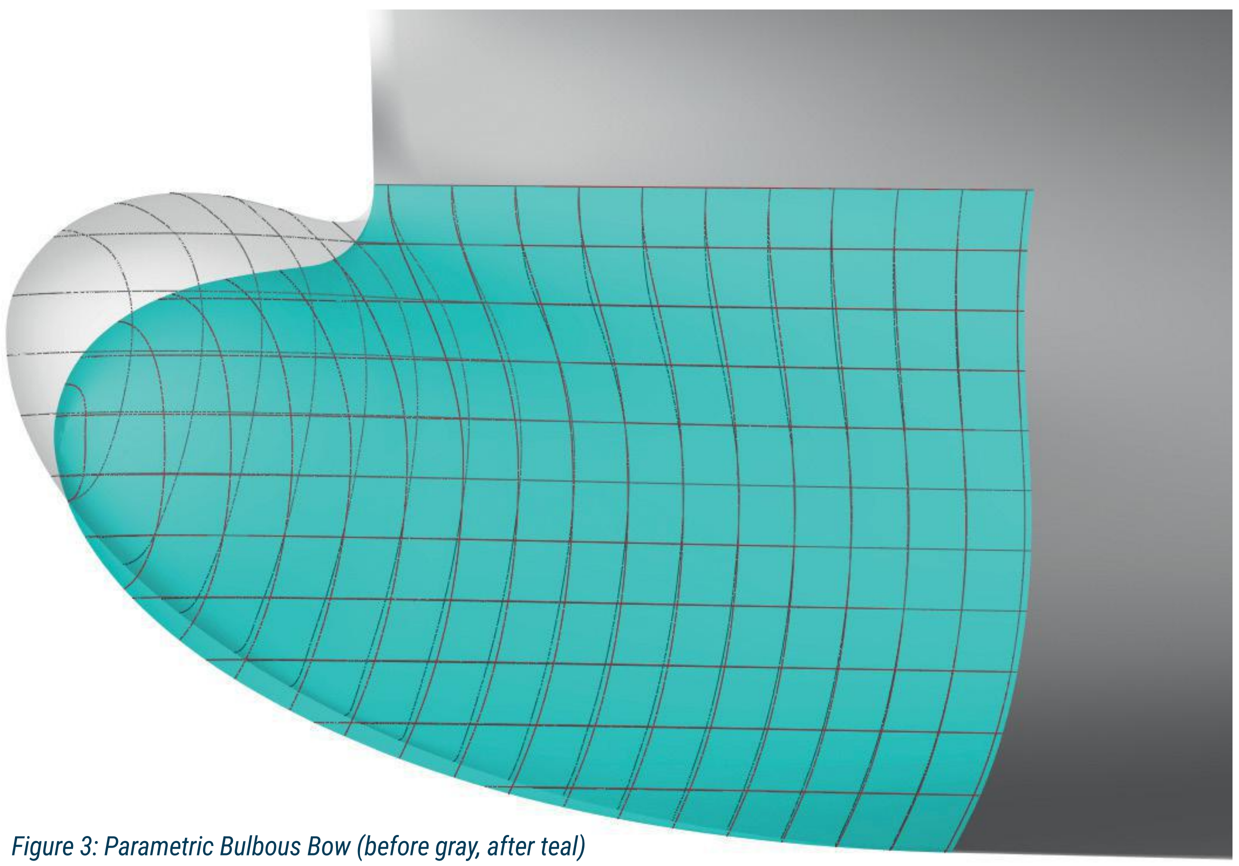

Figure 3: Parametric Bulbous Bow (before gray, after teal)

by Willy Maschen

Moreover optimisation of these vessels mostly has been focused on single operating points, typically the contractually relevant one. This is often associated with maximum power rating and maximum speed on design draught, which is often far from the real operating scenario. Performance in other conditions often suffers from narrow focus. Thus, changes to the bulbous bow can have a significant benefit on the operational performance and improvements can be found in the range from 5 to 20 %. When assuming average values, such as a delivered power of 6000 kW with a SFOC of 170 g/kWh, a VLSFO price of 600 $ per ton, a power saving of 8 % would result in a reduction of CO_2 emissions of more than 150 t per year and in annual savings of more than 200,000 $ in fuel costs.

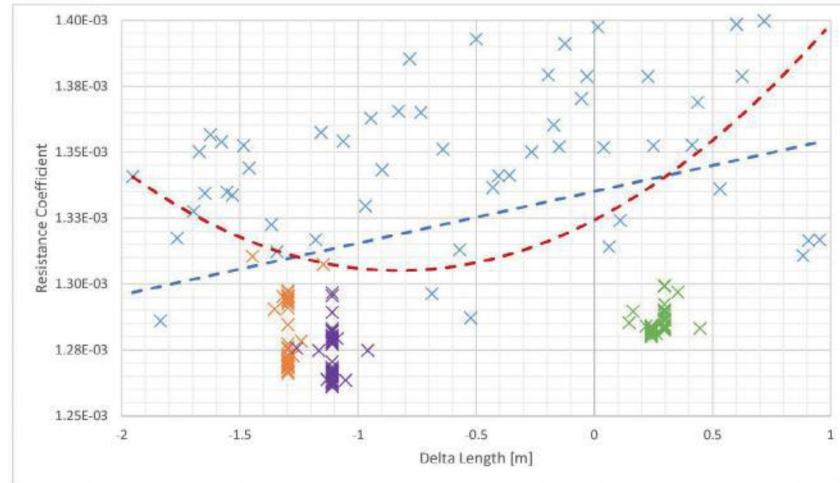

Figure 1: Design exploration and optimisation

HSVA performs detailed bulbous bow optimisation, using parametric and automated solutions to investigate a magnitude of designs and optimise the bulbous bow design towards the actual operation of the vessel. This is done using advanced optimisation algorithms.

The typical procedure in such a bulbous bow optimisation is to create a fully parametric bulbous bow model in the design software CAESES. This bulbous bow model enables topology control – such as width, height, length, volume and volume distribution by varying a limited number of parameters describing the geometry. This allows for utilising partly automated algorithms to analyse and to optimise the design considering the actual operational profile. At this stage the resistance of the variantes is estimated by potential flow calculations.

In the beginning about 100 designs are created in order to explore the design space. For that a quasi random algorithm, the SOBOL algorithm is used, allowing to gain knowledge about the impact of each parameter and the tendencies that lead to overall improvement.

After the structured analysis a set of promising designs is used as starting point for object oriented optimisation. An optimisation algorithm, typically the T-Search that now varies single parameters and iterates towards the best possible outcome, is used to find the designs that lead to the lowest resistance achievable.

The resulting hull forms receive a final fairing and are then being simulated with CFD (RANS) utilising the code ***FreSCo+*** jointly developed by HSVA and Hamburg University of Technology. These more precise simulations aim at confirming the outcome of the optimisation and at quantifying the final savings. The speed power prediction derived from these calculations may also be used – in combination with the required sea trials – as the basis for the EEDI/EEXI certification after conversion.

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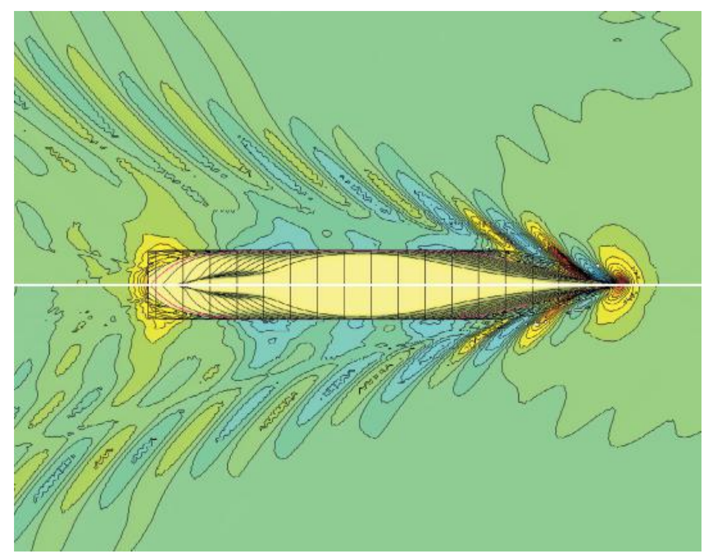

Figure 2: Before (top) and After (bottom)

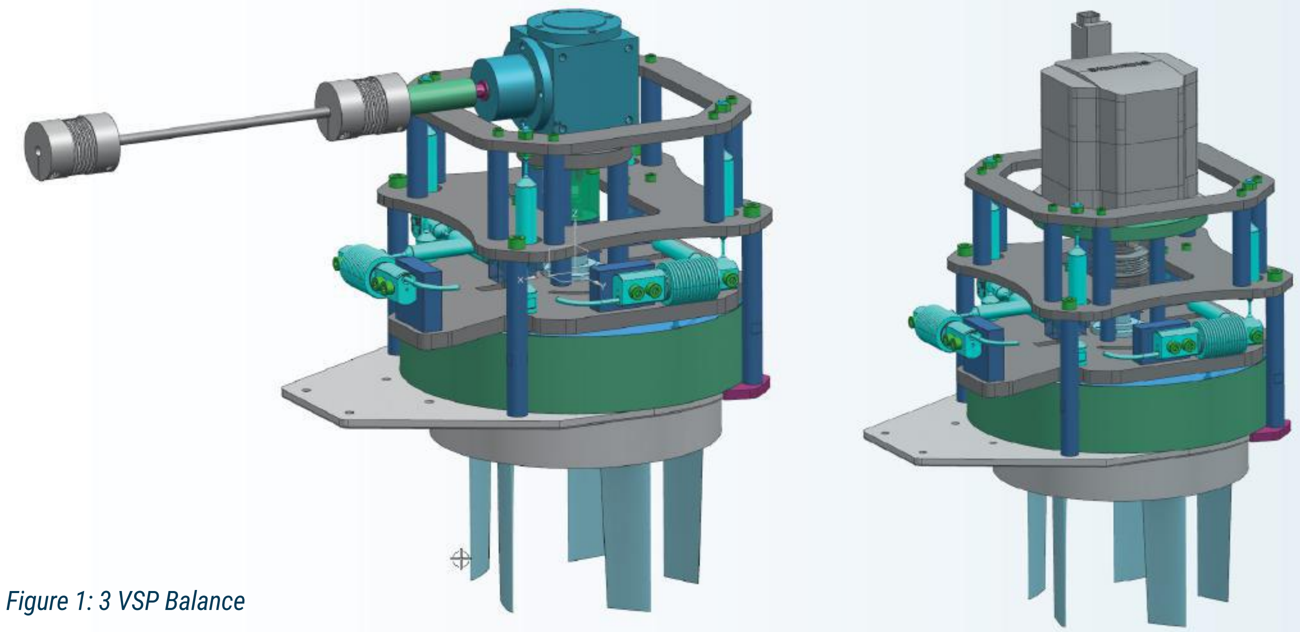

Figure 1: 3 VSP Balance

Figure 2: VSP Model with two VSP units in HYKAT (by courtesy of Fr. Fassmer GmbH & Co. KG, J.M. Voith SE & Co. KG, Meyer Fassmer Spezialschiffbau and Bundesministerium für Wirtschaft und Klimaschutz)

Testing of VSP systems at HSVA

new thrust measurement equipment

Cycloidal propulsion systems, with its most prominent representative Voith-Schneider-Propeller (VSP) have gained attraction for special purpose vessels by recent developments and upgrades to the technology. For supporting these developments and for improving the handling of these propulsion systems in model tests HSVA has developed new measurement equipment.

by Thierry Maquil, Christian Schröder and Oliver Reinholz

Conventionally, only torque could be measured at the input of the Model-VSP unit supplied by Voith Turbo Marine. Using adapted and refined testing procedures, this arrangement delivers solid measurements in satisfying agreement to the figures and feedback we receive from sea trials. Anyhow, the information about the thrust and the thrust deduction fraction is not known. To close this gap an internal project was started to develop a thrust measurement for VSP units both for cavitation tests in the HYKAT as well as for propulsion tests in the Large Towing Tank. A prototype (see fig. 1) was developed by HSVA's engineers within a challenging time frame of just a few weeks, dedicated mostly for the purpose of cavitation tests. Initial tests have been done with the new equipment in HSVA's HYKAT to test the new equipment under extreme conditions. During these tests the complete model with all measuring equipment is immersed and thus needs to be waterproofed. Beside the water tightness the pressure in the HYKAT (variable from 250 mBar and 2500 mBar) was an additional design criterion that needed to be considered during the development. The functionality of the new balance was tested on two different VSP units by different plausibility checks and an extensive test program.

Consequently, the new force balance was updated and improved for usage in the Large Towing Tank. Additional aspects due to the different measurement environment in the towing tank have been taken care of. First test campaigns delivered very satisfying results and – for the first time at HSVA – delivered an insight into the thrust and thrust deduction fraction situation on VSP-propelled vessels. The new force scale is also capable of measuring the torque by bypassing the internal losses in the model VSP units, thus providing a valuable separate source of torque values in order to continuously monitor the quality of incoming measurements. With the general concept proven in model tests, the technology will now be further refined and brought to full production readiness. Further, once the optimisations are incorporated into the prototype, an additional unit will be manufactured to be able to have the system installed on both ship sides. On the horizon, open water tests with VSP units and a dedicated new procedure for the Reynolds Number correction of open water curves are high up on HSVA´s agenda.

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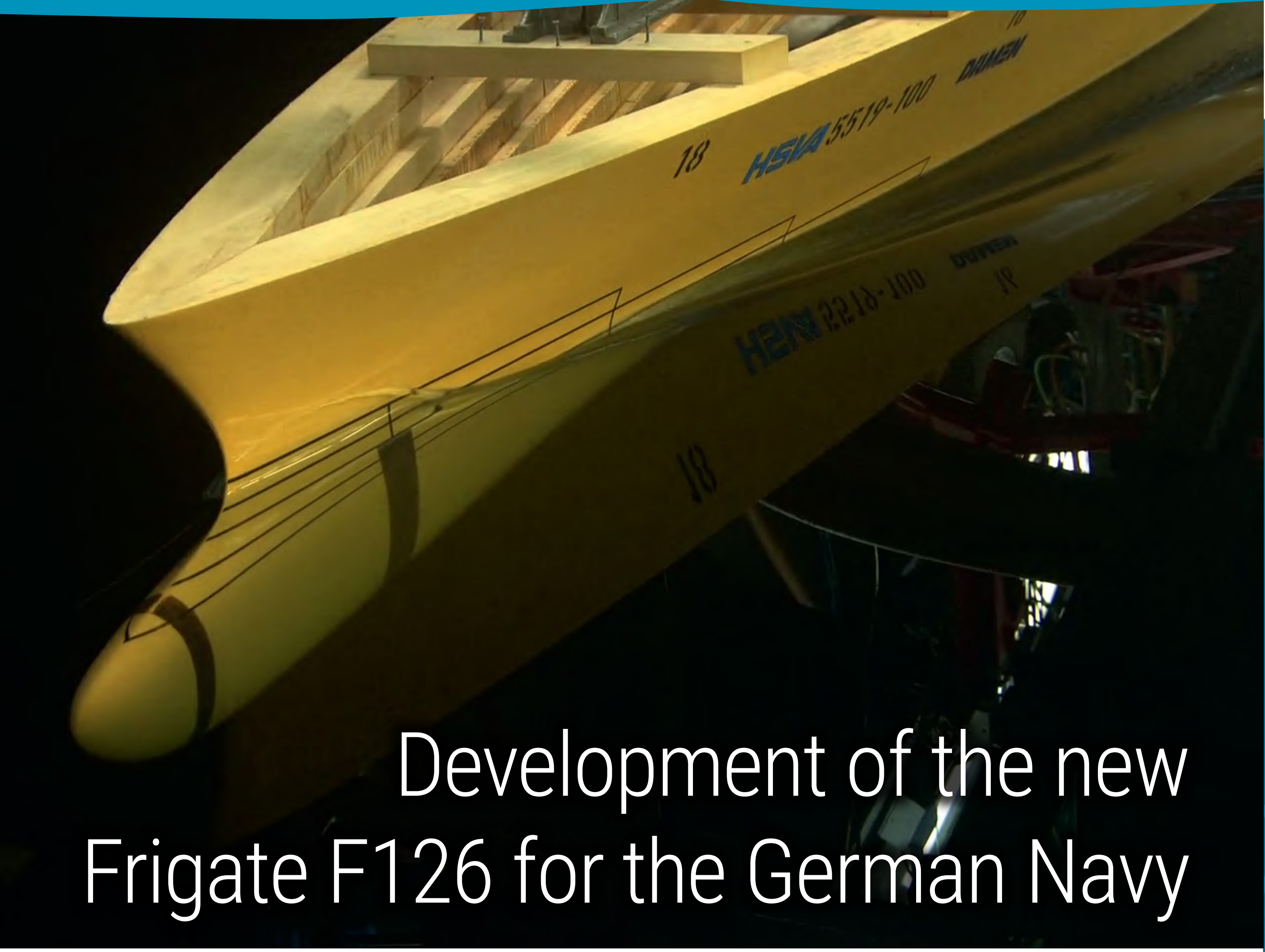

Development of the new Frigate F126 for the German Navy

In close cooperation with our customer Damen Naval and the propeller manufacturer KONGSBERG we had the opportunity to perform the challenging propeller design for the new frigate F126 right from the start.

by Tom Lücke

Instead starting the model tests with suitable stock propellers and designing the propellers based on these results, the first propulsion- and cavitation tests were based on an initial design by HSVA, followed by a final redesign with only minor changes for fine tuning. In this case the in-house CFD propulsion- and wake predictions played an important role for providing the important design boundary conditions. Especially for this type of naval platform the challenge lays in achieving high efficiency by low underwater radiated noise for silent operation of such a ship.

We are looking forward to closing this development circle by means of the feedback from sea trial results in the near future. Since full scale observation windows will be installed on the first ship, as a propeller designer I am keen on the results of the outstanding cavitation observations.

We at HSVA are happy and proud to serve as a valuable link for our customers in the field of hydrodynamic and cavitation with all our effort and fields of expertise for such complex developments.

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Flettner rotors give you a tailwind

Flettner FLEET

Wind propulsion has been recognised as a valuable contribution to reduce power consumption of ships in operation, not least due to the tireless work of the International Wind Ship Association IWSA. The potential of wind assisted propulsion technologies has been recently demonstrated in a string of demonstrators from various technology providers, including Eco Flettner from Germany. Besides direct savings in energy cost (OPEX) wind propulsion technologies have an important added benefit in view of the current international emission control regulations:

Figure 1: "Annika Braren sporting an Eco Flettner rotor" (Photo: courtesy of Rörd Braren Bereederungs- GmbH & Co. KG)

Foto: Uwe Heimhold

by Jochen Marzi and Niklas Kühl

Providing a substantial contribution to the sum of propulsive forces, wind assisted propulsion devices are set apart from other energy efficiency improvements as they are recognised as a technology to reduce engine power which can be treated separately from the overall performance of the vessel in chapter B-2 of the IMO's 2021 Guidance on Treatment of innovative Energy Efficiency Technologies for calculation and verification of the attained EEDI and EEXI (MEPC.1/Circ.896).

For all vessels > 5000 GT wind assisted propulsion will further help to achieve an improved cII ranking MEPC.339(76) and thus add operational benefits.

Within this scenario, further research and development to improve the potential of wind assisted propulsion systems is a must for the maritime industry. Consequently and as part of its Maritime Programme the German Federal Ministry of Economic Affairs and Climate Action awarded a research grant to explore advanced concepts for wind assisted propulsion using Flettner rotors to a team involving key technology providers, ship designers and operators as well as classification and research groups. Led by MARIKO in Leer the FlettnerFLEET team investigates optimised concepts for the use of Flettner rotors on board existing vessels as well as new ship designs tailor made for the use of wind propulsion. HSVA plays an important role in the project by providing both, aerodynamic as well as hydrodynamic analyses for optimised designs using wind (assisted) propulsion.

Based on fundamental design requirements, a catalogue of decisive components will be defined and systematically examined with the help of numerical methods. This will include a systematic analysis of the arrangement of rotors in combination with other superstructure elements for an existing vessel to find least interference effects.

For new designs further optimised configurations will be sought to exploit the best possible interaction between a multitude of rotors and elements of the superstructure as well as large scale on board equipment, such as e.g. cranes on a heavy lift carrier. To meet these requirements, HSVA develops fast and configurable analysis tools for the aerodynamic flow over a ship superstructure, including the effects of single or multi-rotors. The sketch below indicates a first conception based on an inviscid 2D flow analysis that combines super positionable potential flow results enhanced with overlapping grid strategies to obtain robust, near-to-real-time results for various configurations with minimised turnaround times.

In addition HSVA investigates the effects of guide vanes mounted in front and aft of a rotor to increase the lift over drag ratio as well as to extend the range over which a Flettner rotor can provide additional propulsion forces. These fundamental concepts will feed into the in-house EcoLibrium tool already presented in NewsWave 2-21, to assess the overall performance of the new wind assisted propulsion systems over the entire operational envelop of the vessel and thus create a "digital twin" for wind performance.

Ultimately, the project will deliver a comprehensive design catalogue for ships with wind assisted propulsion systems based on Flettner rotors.

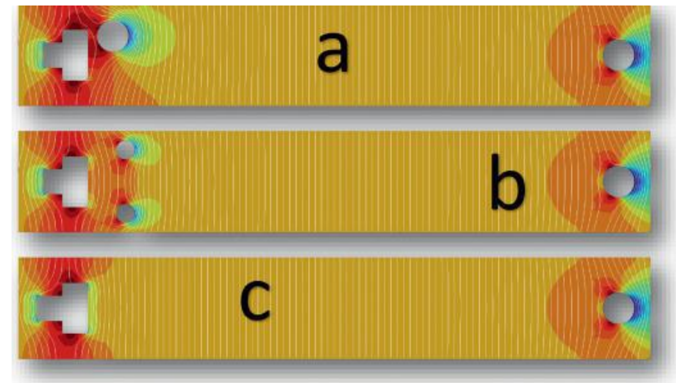

Figure 2: Dynamic pressure distribution and tracer-particle lines (left) indicated on Annika Braren's deck region and (right) for different rotor arrangements

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This project is partly funded by the Federal Ministry for Economic Affairs and Climate Action.

Federal Ministry for Economic Affairs and Climate Action

Skin friction is a major source of ship resistance and hence a cause of energy consumption. In view of the ever more urgent efforts to reduce both energy costs and the associated emissions, attention is being focused first and foremost on producing ship hulls that are as smooth and fouling-free as possible.

Smooth – sleek – laminar

Figure 1 (left): NeWS experimental set up in HYKAT

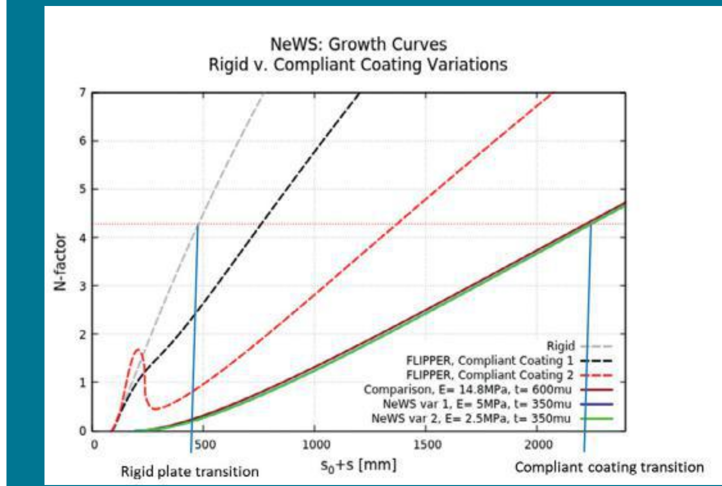

Figure 2: Comparison of transition onset for rigid surfaces and different compliant coatings

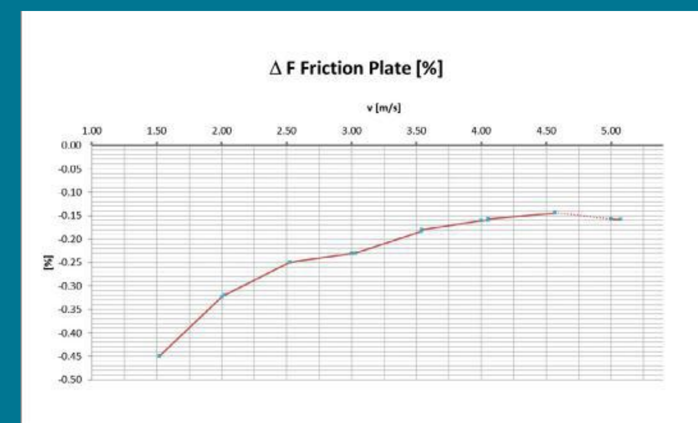

Figure 3: Reduced friction force on plate with compliant coating compared with rigid surface (%)

by Jochen Marzi

Significant improvements have been achieved during the development of advanced antifouling coatings in recent times. Yet, it is evident that there is no "friction less" motion in a real fluid. A major difference exists however between the two flow regimes: laminar and turbulent flow. Skin friction in a laminar flow is at least one order of magnitude lower than in turbulent flow. But the drawback is that laminar flow is only stable for small Reynolds Numbers up to max. $5 \cdot 10^6$ for the flow over a plate. Further downstream turbulent disturbances will be amplified and transition will occur. For real ships this means that the flow over the hull will be turbulent already after less than 1 m distance. In stark contrast to traditional technical solutions nature indicates that laminar flow regimes can be maintained over larger distances, dolphins being a prominent example. Dolphin skins are flexible and made up from different layers which allow to control and stabilise a laminar flow regime over a larger length which allows them to travel at higher speed as would be possible in a turbulent flow regime. Therefore it would be of great interest to find a flexible coating mimicking the effect of a dolphin skin to reduce friction effects over a longer distance along a ship hull. The idea of a compliant coating has been developed together with material partner IFAM from Bremen already several years ago, and a first demonstration has been successfully presented in the FLIPPER project in 2018.

In continuation of this first attempt, the same partners joined forces again in the NeWS project, funded by the German Federal Ministry of Education and Research to develop practical applications of the material concept developed earlier. This included a shift to a complete silicon based composition of the elements of the compliant coating which could also be treated with a state-of-the-art antifouling on the outside. HSVA performed basic boundary layer stability analysis to investigate the required material parameters to obtain the necessary damping effects of the compliant coating. During this exercise a material combination could be found which delays the transition by a factor larger than 4. Fig. 2 compares the onset of transition for a rigid plate (grey) and different compliant coatings. The NeWS coating shifts transition from 480 mm for the rigid plate to more than 2200 mm.

Based on these findings IFAM developed and manufactured a set of all silicone tiles which were applied to different test plates mounted on a dedicated ship like front end to HSVA's well known friction test configuration. These were tested in HYKAT in a comprehensive measurement campaign comparing them with a rigid plate coated with the same antifouling.

Results shown in fig. 3 indicate that the frictional resistance of the test sections could be reduced between 16 % and 23 % over a relevant speed range, thus indicating that a compliant coating together with an antifouling can in principle be applied in a technically relevant environment to reduce friction forces beyond the turbulent forces over a smooth plate.

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This project is partly funded by the Federal Ministry of Education and Research.

Federal Ministry of Education and Research

HSVA team successfully conducted the service trial for the first zero-emission fast catamaran Medstraum!

The world first zero-emission fast ferry Medstraum was successfully delivered by Fjellstrand shipyard on the 14th of July 2022. The ship was developed and built within the TrAM[1] project. In August 2022 a HSVA team boarded Medstraum for conducting trials in the Stavanger area.

by Yan Xing-Kaeding and Sören Brüns

The speed-trials were performed according to ITTC standards as also reflected in the ISO standard 15016:2015. Measurements were carried out for three engine settings using two double runs each in head and following winds respectively. Weather conditions were close to ideal in the Stavanger bay with moderate wind and almost no waves. A photo of Medstraum during sea trials is shown in fig. 1. Factors, such as current, wind, seaway, displacement, water temperature and salinity as well as possible shallow water effect, were considered for the correction of measured results.

An evaluation of corrected sea trial measurements shows that both the model test prediction and the full scale CFD trial prediction have been confirmed by sea trial results, see fig. 2. In general, a very good agreement has been observed, the deviation between corrected trial measurements, model test and CFD results is below 3 % in average – showing that the ambitious goals with respect to the speed-power performance have been fully met – also thanks to a comprehensive optimisation involving HSVA experts.

Medstraum is currently operating in scheduled service and the experience from daily operation confirms that the vessel and its electrical systems are working as intended and even surpass the performance targets. The vessel operator Kolumbus' project manager is highly satisfied with the vessel and said: "The energy consumption is well within the values used for the dimensioning of the battery package. The scale model testing of Medstraum proved remarkable results on propulsive efficiency and resulted in very favorable numbers on energy consumption for various relevant speeds."

[1] The TrAM H2020 project has received funding from the European Union's Horizon 2020 research and innovation program under grant agreement No 769303.

European Commission

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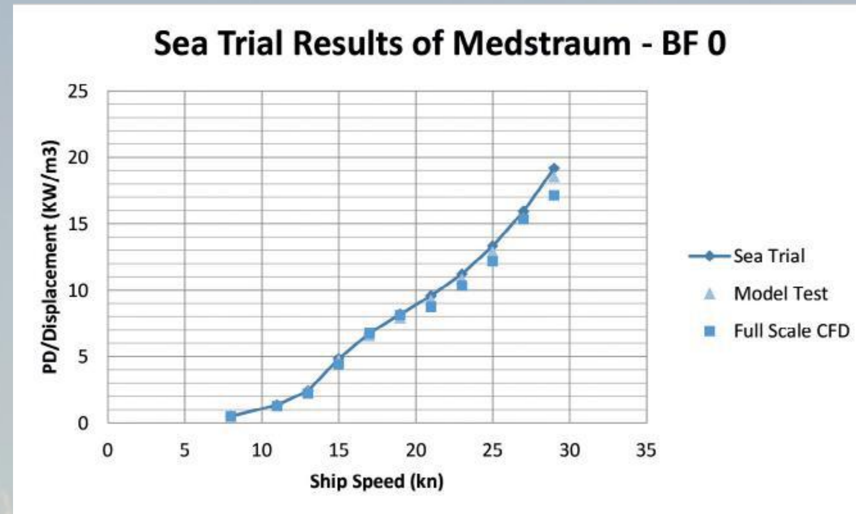
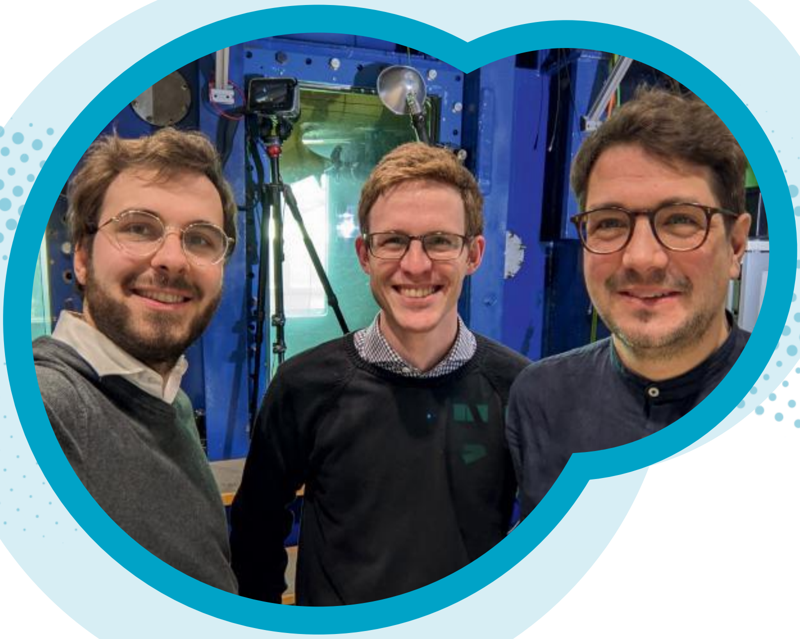


Figure 2: Sea trial results compared with the model test and CFD full scale prediction

Figure 1: Photographs during sea trial measurements in Stavanger (August 2022)

Sebastian Felten
Björn Carstensen
Thierry Maquil



Sebastian Felten joined the HSVA as project manager and researcher in mid-January 2023 after receiving his Master's degree in Naval Architecture from Hamburg University of Technology. At HSVA, Sebastian will be in charge of both calm water tests and cavitation experiments. As part of his master's thesis at the TUHH, he worked on the simulation of wave energy converters. In the context of his bachelor thesis he also had contact with ice experiments which he evaluated statistically. In his free time he trains for his first half marathon, loves cooking and travelling.

Björn Carstensen joined HSVA as a project manager and researcher in mid-January 2023. He strengthens the team of HSVA in projects for calm water tests and cavitation tests. Björn is currently finishing his PhD, dealing with the design and evaluation of energy saving devices in real operating conditions and with research on the topic of propeller-rudder-interaction. He is happy to apply his gained knowledge in his new position and gain further expertise during challenging projects. Björn loves to spend his spare time with his family. Furthermore, he likes to go hiking with his tent and afterward gain new energy from a cup of coffee with a big piece of cake.

Thierry Maquil joined HSVA as a project manager and research scientist in October 2021. At HSVA Thierry is mainly dedicated to projects in HYKAT and in our cavitation tunnels. His background and extensive experience in numerical simulation of cavitation with the in-house RANS solver ***FreSCo+***, his knowledge in experimental measuring campaigns (wind tunnel testing and acoustic measurements in the marine domain) has been an important asset to the planning, evaluation and execution of tests in the HYKAT. With the growing interest in the underwater noise levels Thierry puts special focus on hydro-acoustic radiation of propellers and is exhausting the outstanding abilities of the HYKAT. Thierry rides his bike to work everyday and off the job enjoys beeing with his family.

in brief

We were glad to welcome the Federal Government Coordinator of the Maritime Industry and Tourism, Mr.Janecek, at HSVA. We had an interesting exchange about leadership and innovation in the maritime industry and enjoyed the meeting with inspiring conversations.