issue 1-22

HSVA newswave

The Hamburg Ship Model Basin Newsletter

Delivered

The world's first zero-emission fast ferry

Cooperation between The Norwegian Ship Design Company and HSVA

The Design Challenge of Multi Mission Polar Vessels

GATERS – Comprehensive Review of Novel Rudder System

editorial

Dear reader,

Finally, it is time for SMM again! We are celebrating the 30th issue of vital exchange of ideas, business and contacts in the maritime community and beyond! This exchange is what we badly need in our world for a common understanding and future – and what we are sadly missing at large extent in the recent global developments.

On one hand, I am happy to meet old friends again and to make new contacts at this SMM – on the other hand I ask myself whether we as human beings really have learnt from the lessons in the past. Or are we continuing just into the same direction, real change to be found only in the phenotype of technical developments instead of using the everlasting creativity of mankind for the good?

However, with our team at HSVA we are proud to contribute to as many various topics as modelling the propeller of a historical ship through brand new innovative zero-emission vessels – all to be found in this issue of Newswave.

Best wishes,

Prof. Dr. Janou Hennig

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Zero Emission Shipping

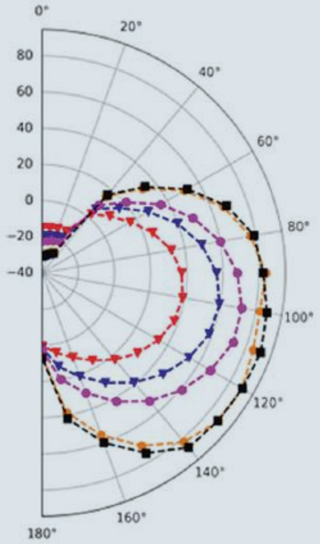
Cooperation between The Norwegian Ship Design Company (TNSDC) and HSVA

On the path to zero-emission-shipping and the decarbonisation of the worldwide maritime fleet, HSVA has set its sails to contribute to the design of the new eco-friendly vessels for the next generation.

by Peter Horn

In the dawn of new regulatory rules to reduce the CO_2 footprint of the shipping industry, the need for a new thinking in the design of ships arose. To fulfil the challenges and rules for environmental friendly shipping, hull form optimisation and improvement of appendages have been driving factors. With the new rulesets EEXI (Energy Efficiency Existing Ship Index) and CII (Carbon Intensity Index) that target the existing fleet those measures are still possible, more limited than with new buildings. Due to this other solutions will become more interesting, for example new concepts of powering assistance, e.g. wind propulsion or other energy saving devices.

Within this context, HSVA is happy to announce the cooperation with The Norwegian Ship Design Company (TNSDC) to support the design of the Zero-Emission-Bulker "With Orca" which will be equipped with wind assisted propulsion. We are eager to cope with the challenges of the design of new wind assisted ships. The performance of the vessel is not only determined by hull resistance and propulsive performance as for typical merchant vessels, but also by the drift of the ship and the interaction of all forces acting on the hull. In this project HSVA will investigate the interactions and effects caused by the forces placed high above the deck and their interaction with the rudder, liftable keel, wind, drift, propeller and the basic hull resistance. HSVA's in-house code ***EcoLibrium*** solves the force equilibrium in all degrees of freedom and at optimum thrust allocation to determine the minimum required power to drive the ship. This includes results for varying wind speeds and encounter angles so that polar plots for the vessel can be derived. It is expected that the vessel will make use of the wind as the main powering source for a significant stretch along its route.



Further studies will include the propeller effects for three operation modes: propeller in normal propulsion mode, propeller in feathering mode (zero thrust) and propeller in turbine mode (recuperation of energy from the flow).

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Multi Mission Polar Vessels

The design challenge of contradicting objectives

During the last few years several vessels designated for multi-mission operation in polar regions have been designed and many have been brought into service already. Several ships are also currently in the concept/design, testing or verification phase. Even though they all combine major operational targets their design targets vary so that each one needs a tailor-made concept to optimally meet the performance requirements.

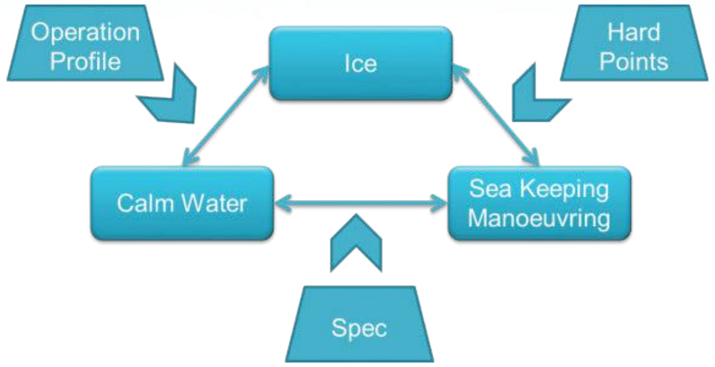

Figure 1: Balancing the design targets

by Quentin Hisette and Christian Schröder

Already here the challenge begins by defining balanced design targets in a way that the overall design is not excessively driven into one direction, compromising the overall performance. As an example: to increase the ahead ice breaking performance the bow flare angle should be as low as possible but thereby slamming pressures in waves at the bow are increased. This will reduce the comfort for the crew especially considering the rough seas encountered during transit to Antarctica (Southern Ocean, especially Drake passage). Therefore it is important to ensure that owners, designers and consultants work closely together already in the very initial design stage. All relevant requirements (bubble sweep-down, noise radiation, ice breaking capability, seakeeping, aerodynamics, ...) have to be openly discussed considering the overall scope as well as their effect on time and costs with the available budget and typically tight schedule.

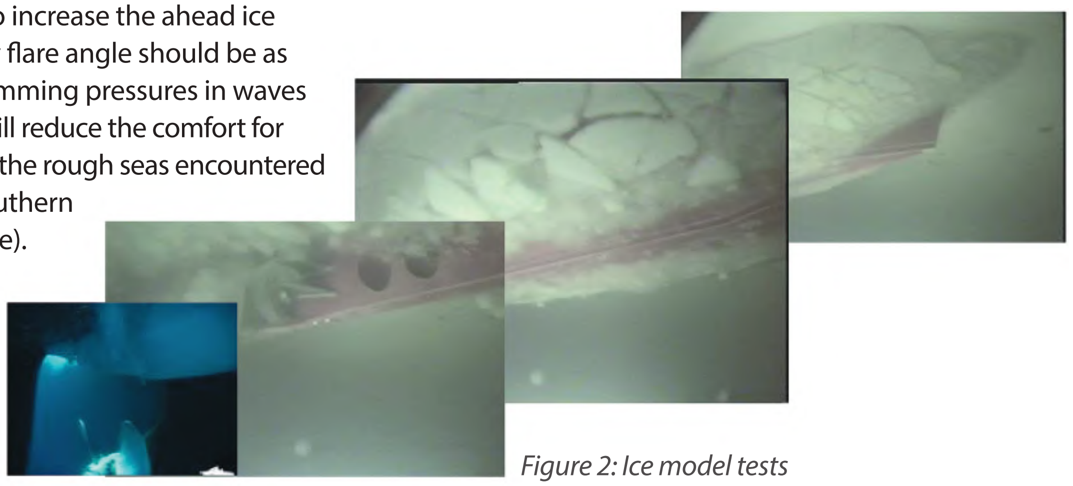

Figure 2: Ice model tests

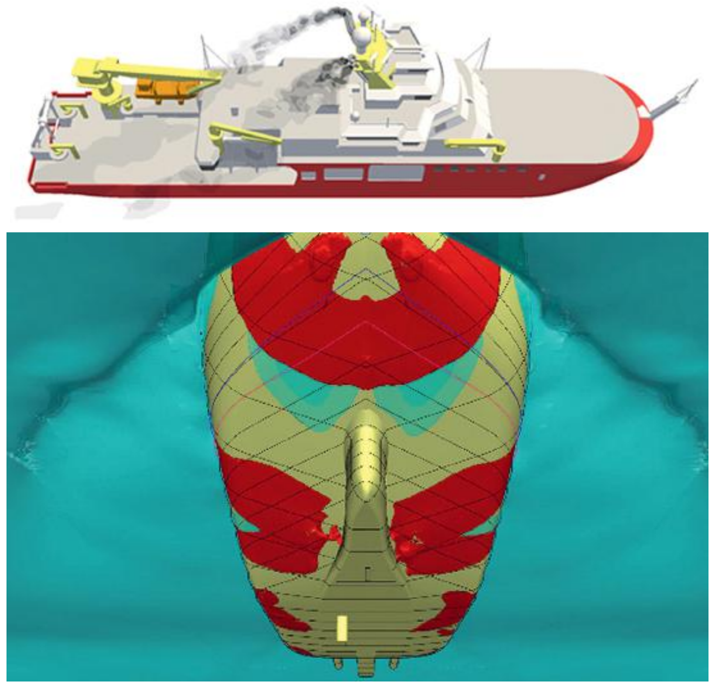

Figure 3: Exhaust gas dispersion simulation (top) and paint flow simulation (bottom)

During the concept design phase the overall ship parameters and the propulsion concept are defined. The required manoeuvring performance in ice is one major factor influencing the selection of the propulsion concept as well as the length-to-beam ratio. Azimuth/podded concepts increase the manoeuvrability in ice significantly, especially during astern icebreaking, where conventional concepts are hardly steerable. Secondly the length-to-beam ratio is of significant importance for the manoeuvrability (the smaller the ratio, the better the manoeuvrability). Additionally, considering the ice breaking capability ahead the beam is the predominant design driver which preferably leads to a long and slender ship.

Based on those examples it becomes clear, that especially the initial design phase is very important for the overall performance and several iterations are usually required. The design phase will in a second step more precisely define the hull form in detail and optimise it based on a weighted operational profile. To assist with this process, HSVA has developed multiple numerical tools that can be included in the optimisation loop, such as ν-SHALLO (early design), ***FreSCo***$^+$ (detailed predictions) and ***PerformIce*** (icebreaking predictions).

Based on the initial optimised hull form the model testing phase can begin. Here a pre-phase with a reduced scope to verify the analytical predictions and design expectations is of great benefit as small model modifications (e.g. optimisation of front skeg or headbox design) are possible to optimise the hull within a second model test loop if required. Afterwards the overall design verification can be completed by an extensive model test campaign. During the definition of the final testing scope the operational performance should also be verified with realistic scenarios to be modelled in the test basin, such as berthing in ice-covered ports.

Due to the development and possibilities in numerical simulations the model testing capabilities are more and more supported by numerical calculations. Therefore wind tunnel experiments are more and more replaced by CFD – DES simulations and paint flow tests are usually done by CFD tracer methods (both included in HSVA's viscous flow code ***FreSCo***$^+$) since their accuracy and evaluation capabilities have now outperformed the conventional physical paint flow tests.

Finally, after the approval and construction of the design, the full scale verification trials are carried out. This is always a very exciting moment for all project partners as several years of design and construction are now materialising and will be tested against the target requirements. Even after decades of design experience, verification trials, especially in ice, are still an adventure.

HSVA is a partner in the whole design cycle starting from the initial concept and propulsion concept idea until the final verification/acceptance trial. ■

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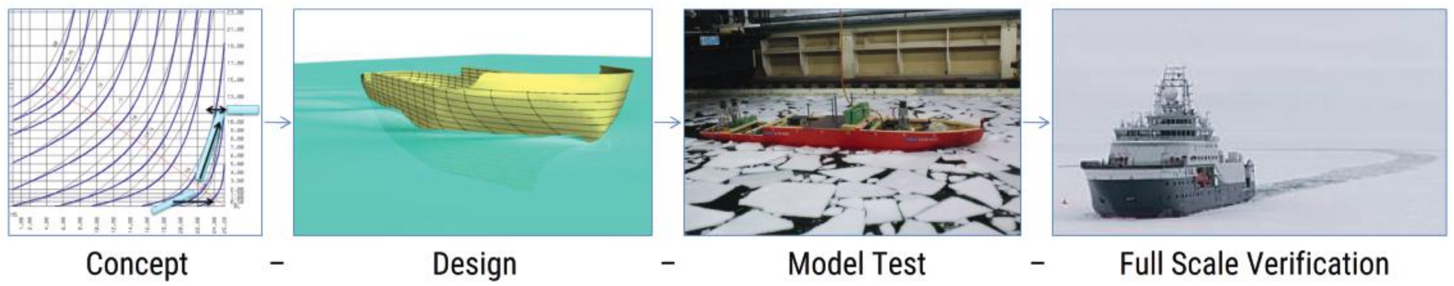

It's Elektrisk!

The world's first zero-emission fast ferry Medstraum from TrAM Project is successfully delivered!

MS Medstraum, the world's first fully electric and zero-emission fast ferry, classed as a high-speed craft, has embarked on the journey from Fjellstrand shipyard to her new home port, Stavanger.

by Yan Xing-Kaeding, Sören Brüns

As the TrAM[1] project's demonstrator vessel, MEDSTRAUM is designed for a service speed of 23 knots, carrying about 150 passengers and operating on a multi-stop commuter route between the city of Stavanger and surrounding communities and islands. As already published in the earlier Newswave issues, HSVA has been in charge of the hydrodynamic design, optimisation and experimental studies of the hull form and propulsion system of the catamaran. It's been hard work and revolutionary to reach a very high propulsion efficiency of almost 80%, which is essential for fast ferries driven by electric batteries. Today we are happy and proud to announce that the vessel has been successful delivered and now is ready for operation at 23 knots for an entire hour purely electric driven. ■

MS MEDSTRAUM

Will carry passengers between Stavanger, Byøyene, and Hommersåk for Kolumbus from late summer 2022.

Cruising speed during operation: 23 knots

Max. speed: 27 knots

Length: 30 meters

Width: 9 meters

Battery capacity: 1524 kWh (Corvus Energy)

Electric engines: 2 × 550 kW

Charge capacity: 2,3 MW

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HSVA offers a wide range of full scale measurements. From analysing measurements that were sent in, over witnessing of tests, to complete measurement campaigns, our customers can make their choice. Analysis of speed-power trial measurements is even free of charges for vessels that were tested at HSVA.

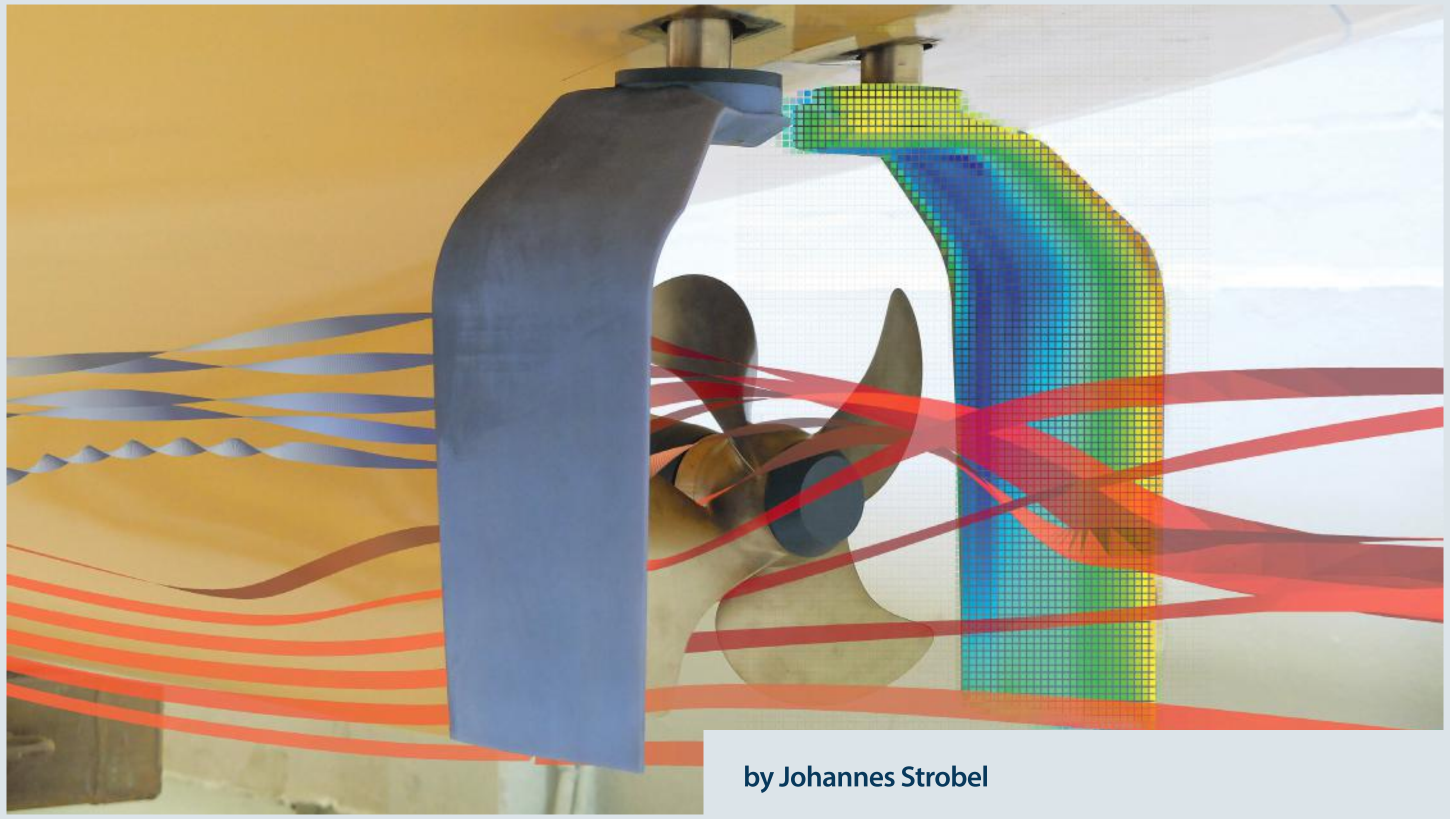
HSVA Full Scale Measurement Services:

- **Speed-power trials**
- **Manoeuvring trials**
- **Cavitation observation**
- **Measuring of pressure pulses and vibration**
- **Ice trials**

[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

Figure 1: TrAM project's demonstrator MEDSTRAUM



GATERS

A novel propulsion and manoeuvring system promising improved hydrodynamic efficiency

The unconventional Gate Rudder concept provided auspicious gains in propulsive efficiency during full scale observations. To prove the technology, the European GATERS project set out to review and thoroughly assess the rudder system. HSVA participates in a team of 13 European research and industry partners which form one of the last Horizon 2020 projects.

by Johannes Strobel

An advanced performance of the Gate Rudder System has been observed during a joint sea trial of two 240 TEU container vessels in Japan. The sister vessels were equipped with a Conventional Rudder and a Gate Rudder and sailed in parallel at the same time during the trials. Departing from these promising full scale observations, the GATERS project aims at exploring the hydrodynamic fundamentals of the concept and to provide dedicated assessment technologies for further large scale exploitation. Led by the University of Strathclyde, GATERS assembles four towing tanks, hydrodynamic experts as well as a shipyard and ship operator to further demonstrate the Gate Rudder System during real ship's operation. Beside comprehensive numerical and experimental test campaigns even a "rudder-propeller-retrofit" of an existing short sea General Cargo Ship will be realised within the GATERS project. This work package consists of design, manufacture and installation of the Gate Rudder System as well as the thorough assessment of the effectiveness of the retrofit through dedicated sea trials and voyage monitoring.

As a hydrodynamic consultant, HSVA put major effort on the numerical (CFD) and experimental (EFD) investigation of the Gate Rudder System. Extensive studies focussing on the speed-power performance in calm water have been carried out so far. Detailed CFD analysis in model and full scale as well as extensive model tests with a Conventional Rudder and a Gate Rudder revealed that existing scaling procedures might be revisited as they did not yet reliably coincide with the full scale observation. However, valuable knowledge has been gathered which will help to better understand the complex flow regime around the complete propulsion system of rudder and propeller.

The final goal will be the development of an approved numerical and experimental testing procedure which allows the prediction of the full scale performance of either a new ship or a retro-fitted ship being equipped with a Gate Rudder. Recent work and findings continuously led to new analysis approaches which are expected to deliver an approved methodology and scaling procedure, which will finally be demonstrated in a full scale trial of a retro-fitted cargo vessel towards the end of the project. Together with the GATERS partners HSVA pursues this challenging path and thus contributes to the overall objectives of energy savings and emission reductions in the maritime industry. ■

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How to measure Pod Thrust in the HYKAT!

At first let's make a quick introduction on cavitation test in general.

by Julia Schmale

During a standard cavitation test the propeller is run on a fixed propeller shaft speed. The thrust and torque is adjusted with the water speed of the tunnel, the higher the water speed, the lower the thrust of the propeller. All values are kept constant for the whole observation of the condition. This works this way for all propulsion systems which are connected directly to the shaft and the dynamometer.

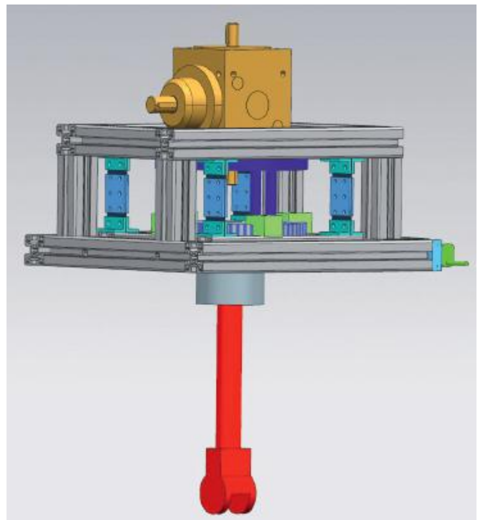

Figure 1: HSVA's construction of the pod scale

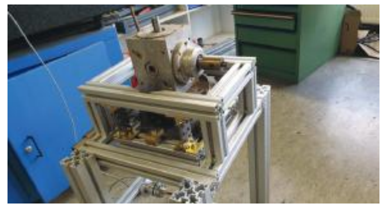

Figure 2: Measurement equipment ready for installation

Figure 3: Pod thrust being measured in the model

The general problem during the past years was to measure pod thrust during tests in HYKAT for podded propellers. The biggest problem was that thrust is quite essential for the K_T adjustment of the propeller during the tests. Luckily there is still the torque and the K_Q with which still cavitation tests can be done in HYKAT. In opposite to the tank tests it is not possible to install the measuring element in the pod gondola, due to high forces and low pressure.

For the project twin-crp-pod-ULCS (see also in Newswave 2021-1) it was essential to measure the thrust in HYKAT during the tests. HSVA's team of experts with their knowledge about the difficulties during cavitation tests has developed a new measuring device to measure pod thrust. The thrust is measured at the upper most part of the pod drive right before the gearbox. Two load cells measure the deflection in x-direction in the rack around the pod drive, where no other movements are allowed.

The new equipment meanwhile has undergone a phase of extensive testing, calibration and familiarisation and is now available for regular testing campaigns, allowing precise and reliable measurement of thrust; it was possible to measure thrust even in a closed and with the right speed circulating tunnel. From now on we are able to run cavitation tests with pods at the right K_T. ■

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The project is funded by the German Federal Ministry for Economic Affairs and Energy (reference number 03SX520A).

European Commission

The OMAE 2022 – International Conference on Ocean, Offshore and Arctic Engineering, took place from June 5-10 in Hamburg, Germany.

by Daniela Myland and Quentin Hisette

In the course of the conference, HSVA was present with a booth in the exhibition area with colleagues from our different fields of expertise (Dr. Christian Schmittner, Jan Lassen, Quentin Hisette and Dr. Daniela Myland). We thank all our visitors for the very interesting discussions and talks. We are looking forward to cooperating with you in interesting projects in the future.

Moreover, HSVA published three papers, one on ice-hull friction (OMAE2022-87734), one on machine learning based on compressive ice strength tests (OMAE2022-78885) and one on a new type of model ice developed within the research project FATICE at HSVA (OMAE2022-79014).

Finally, on June 10, HSVA organised the unique opportunity for OMAE 2022 participants to visit its facilities, which

Figure 1: HSVA booth

are usually open only to customers. During the tour our visitors attended live demonstrations of our main model test facilities and learned about different measurement techniques and special equipment used at HSVA. ■

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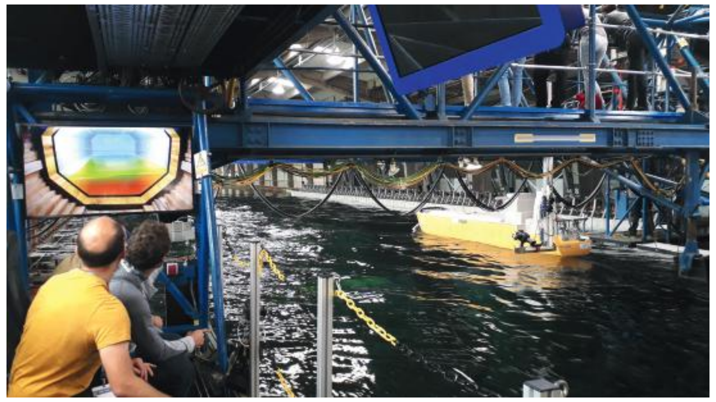

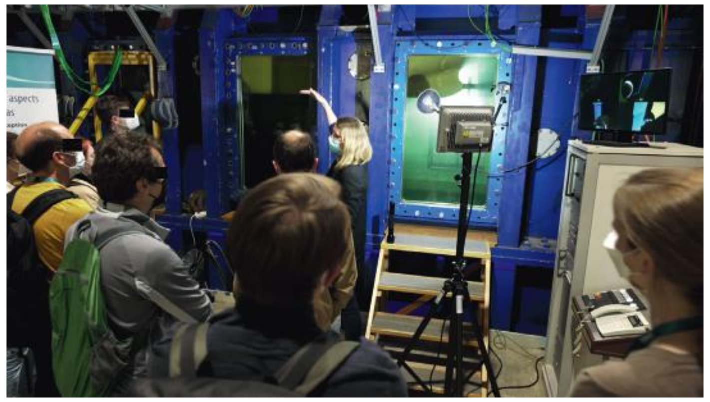

Figure 2: Model tests in waves in HSVA's large towing tank with «SHEAR-WATER« Ballast-Water-Free LNG Feeder & Bunker vessel model from GTT and Figure 3: Cavitation tests with complete ship model in HSVA's HYKAT

New Propeller for Cap San Diego

One attraction of the Hamburg harbor is the museum ship Cap San Diego, a cargo ship from 1961, which is open to public.

by Tom Lücke

The operating company Cap San Diego has installed a 1 : 11.45 scaled model of the ship's main engine and the propulsion chain in an exhibition room. Since this model would give only a complete impression for the visitors with an appropriate propeller, HSVA was asked for help.

A photo from the spare propeller on deck of the ship posed as model at HSVA for a redesign being typical for that time. This propeller model has been 3D printed from PLA in HSVA's workshop, where models for the daily model test campaigns are manufactured. Due to its large dimensions (about diameter = 0.5 m) the propeller was constructed separately as hub and blades.

We at HSVA are happy to have contributed to the finalisation of the main engine model for the Cap San Diego. ■

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Manasés Tello Ruíz

Manasés Tello Ruíz joined the Manoeuvring and Seakeeping Department at HSVA as a project manager and research scientist in October 2020. He joined HSVA after nine years' experience working in cooperation between Flanders Hydraulics Research and Ghent University in Belgium.

At HSVA Dr. Tello Ruíz is mainly dedicated to projects which require manoeuvring and seakeeping compliance investigations with national and international regulations. He also works on topics such as digital twin concepts, mathematical modelling of ship dynamics and the application of artificial intelligence to ship hydrodynamics. His background in manoeuvring, seakeeping and navigation in shallow and confined waters has been an important asset to the planning, evaluation and execution of challenging investigations. Model testing on tugs and manoeuvring investigations on waves have been two of his latest projects. Dr. Tello Ruíz enjoys spending his spare time running, playing futsal, dancing, or just walking along the Elbe's waters, charmed by the breeze of an ending day and the announce of another one to begin.