#teamHSVA

Dr. Rupert Pache joined the HSVA management team as the Division Manager Ships in March of this year. In this role, he is responsible for the technical and strategic development of the ships division at HSVA. Besides the technical supervision of the project work his responsibilities encompass product development and the technical advancement of our services.

Originally from Stuttgart in southern Germany, he moved to Hamburg to study naval architecture at the Hamburg University of Technology. He worked as a research assistant at the university, focusing on fluid dynamics applications in ship hydro- and aerodynamics. He completed his PhD on data-based modeling of aerodynamic forces on ship superstructures. Prior to joining the HSVA team, he worked as a management consultant in project and data management, supporting various national and international shipbuilding projects. He now brings his diverse insights and management experience to HSVA.

In his free time, he enjoys spending time with his family in Hamburg and taking trips to the seaside. He also likes running along the river Elbe.

1-26

HSVA newswave
The Hamburg Ship Model Basin Newsletter

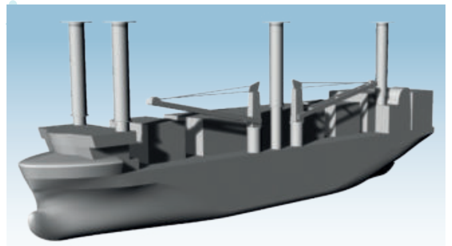
Project TT-Schall

How to Reduce Underwater Radiated Noise

Design Assistance
for Complex Ice Breaking Vessels

30 Years after the Accident
the ESTONIA Sinking Reassessed

FlettnerFLEET Project
Integrating Wind-Assisted Propulsion



Dear reader,

since 2026 is an even calendar year, the SMM in Hamburg - the world's leading maritime trade fair - is already on the horizon. We as #teamHSVA are very much looking forward to welcoming the global maritime industry back to Hamburg. As you will read in this issue of our NewsWave, our topics remain diverse and highly relevant. We cordially invite you to visit our booth (B4.EG108) at SMM for technical discussions, as well as to meet old and new partners and friends.

As you continue reading this issue of NewsWave, you'll find fascinating articles on underwater radiated noise, artificial intelligence, the latest findings on the sinking of the MV Estonia, the effect of hull roughness, counter-rotating propulsion systems, optimisation of multi-mission icebreaking ships as well as integrated wind-assisted propulsion.

The topics presented in this issue of NewsWave are based on our work on commercial industrial projects, internal research and development projects, our participation in international committees, and publicly funded research projects. We are proud and thankful to have the opportunity to work in such an inspiring and versatile environment.

Both the diversity of the topics presented and the versatility of work environments clearly demonstrate just how exciting the work at #teamHSVA is, and what impressive skills are required and are present in all these areas.

The combination of world-leading test facilities and the outstanding capabilities of #teamHSVA makes HSVA an excellent partner to the global maritime industry and a key link between ship designers, shipping companies, and the maritime supply industry. Are you facing a challenge in the maritime sector? Let's talk and find a solution together!

Although the global maritime industry will be gathering in Hamburg this year, our team members are travelling the world and visiting various countries in Europe as well as China, India, South Korea, Canada, the USA, and Japan in 2026. We are convinced that visiting our partners on site at their premises is a key to the best possible cooperation. At the same time we are always pleased to welcome you at HSVA and provide our services to you as a world-leading ship model basin! We are looking forward to welcome you!

At this point my thanks go to all the great authors and the whole #teamHSVA for the excellent work and I wish you, dear reader, a lot of fun and inspiration in reading this issue of HSVA's NewsWave!

See you latest at SMM 2026

Philip Augener

Dr. Philip Augener
Managing Director

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How to Reduce Low-Frequency Underwater Radiated Noise

Propeller cavitation is often the dominant source of underwater radiated noise (URN) from ships, affecting a wide frequency range. The low-frequency noise contribution (below 100 Hz) appears to be significantly influenced by the periodic dissipation of sheet cavitation.

by Lars Koopmann

In most cases, sheet cavitation cannot be avoided due to the need for maximum propeller efficiency. The sheet cavitation volume on the blade of a single-screw ship typically reaches its maximum shortly after the 12 o'clock position and then decreases again as the blade continues to rotate downwards. In terms of acoustics, the temporal variation in the cavitation volume is crucial. Reducing the sound pressure level requires a more gradual dissipation.

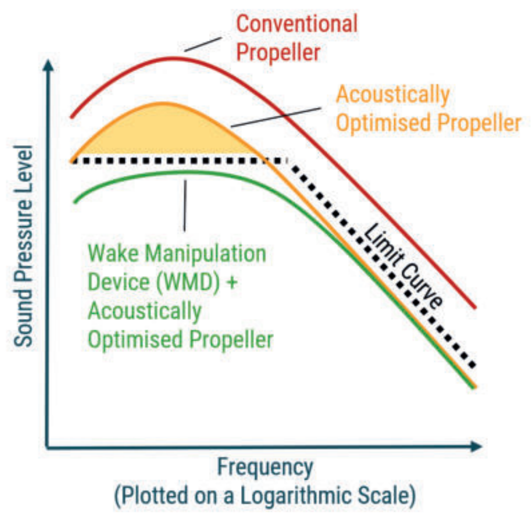

Figure 1: Schematic diagram illustrating the reduction of URN by means of a WMD

As part of the research project TT-Schall, the aim is to develop a device located upstream of the propeller which manipulates the inflow in such a way that the dissipation of sheet cavitation is positively influenced in terms of acoustics. We call this Wake Manipulation Device (WMD). Figure 1 illustrates the intended reduction of URN by using a WMD.

The development work in TT-Schall is based on both intensive numerical and experimental studies. As part of the project, we will continue to develop our skills:

- The HSVA will expand its capabilities in the areas of cavitation studies and hydroacoustic measurements. This involves further development of synchronous data acquisition for high-speed recordings, pressure fluctuation measurements and acoustic measurements. This will enable cause-and-effect relationships to be identified more clearly in future.
- Minimising the background noise from the model ship's propulsion system is intended to improve the signal-to-noise ratio during acoustic measurements in our large Hydrodynamics and Cavitation Tunnel HYKAT. This is particularly essential for the study of silent propellers.
- The cavitation model is being further developed using our in-house RANS code ***FreSCo+***. This also includes an assessment of noise emission.

We are happy to report on the progress of the project in future issues of the NewsWave.

The research project TT-Schall started in January 2026, and the duration is three years. The joint project is being carried out in collaboration with JASCO ShipConsult, Ecerllence, VULKAN Group and Ulm University of Applied Sciences.
Thanks to the German Federal Ministry for Economic Affairs and Energy and Projektträger Jülich (Project Management Jülich) for funding and supporting this important project.

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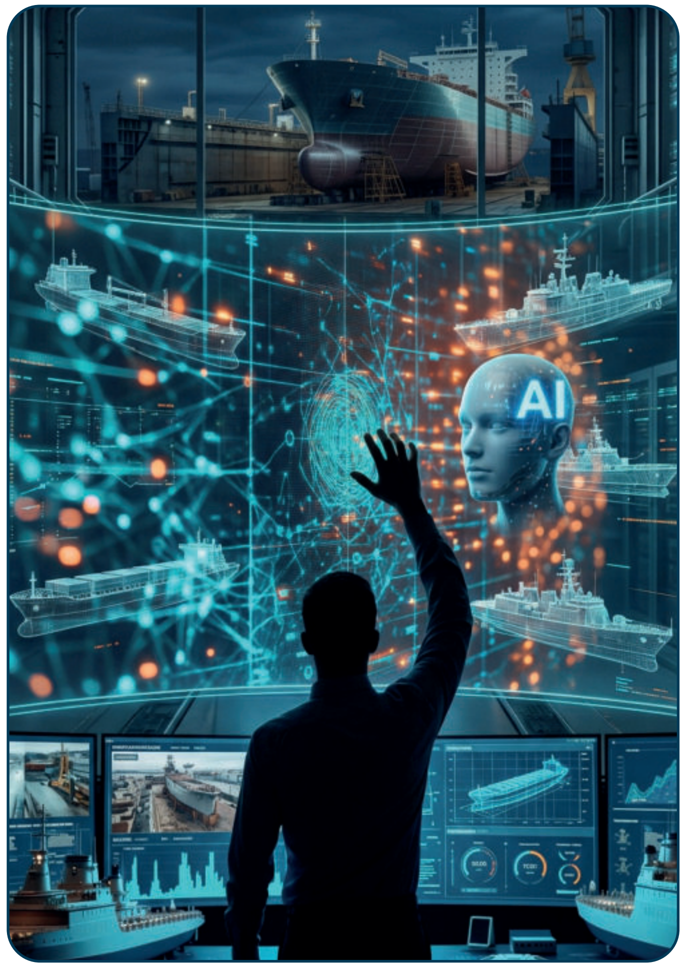
Application of Artificial Intelligence in the Maritime Sector

by Jonas Wagner and Jan Richter

The excitement regarding potential applications of artificial intelligence (AI) has unmistakably reached the maritime sector – there is scarcely an issue where the possibility of using AI to deliver a solution faster, better or more cost-effectively than with conventional methods is not being discussed. Even though the gap between aspiration and reality is wider in almost no other area than in the costs and benefits that are associated with the use of AI.



This is partly due to the fact that the term 'AI' is frequently used as a synonym for machine learning, data science and, in some cases, even statistics, which makes it significantly more difficult to assess the challenges and opportunities of the respective technologies in a nuanced way.

AI in the sense of systems that simulate human intelligence and its corresponding behavior is primarily (though not exclusively) based on large language models. From a model basin's perspective, its main application is likely found in the administrative sphere. But when focussing on a technical environment, machine learning (ML), as a subfield of artificial intelligence, plays a significantly greater role.

However, fundamental challenges associated with machine learning methods are often overlooked or ignored. Mistakes and / or false assumptions range from the training data to be used and the corresponding data preparation, through the strengths and weaknesses of the respective models and algorithms, to the expected outcomes. On the other hand and provided that data set, tools and objectives are chosen carefully, promising opportunities for the productive application of such methods can be identified in many areas of the hydrodynamic field. Be it in traditional model testing, ship design, CFD or data analysis – the possibilities are manifold. One brief example of a productive application of machine learning will be illustrated in the use case on the next page.

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Machine Learning Use Case Example in a Ship Model Basin

Selecting the right task and method

The most important step when applying machine learning tools consists in identifying suitable tasks. ML tools usually perform best on structured, vast and clean data sets. One exemplary task that matches these requirements exists in the prediction of the propeller open water characteristics on the basis of a propeller's geometric parameters. A selection of HSVA's propeller data base featuring more than 2000 open water test results (more than 40.000 data points) has therefore been split into a training and a test set (80 / 20) and prepared for machine learning. Regarding the method, it has been decided to apply a Random Forest (RF) algorithm, since these are well known for being flexible, fast, efficient and comparatively robust against overfitting.

Training and fine-tuning

While Random Forests are generally able to perform with an unlimited amount of variables, in praxis it is recommended to reduce their number to a reasonable amount. Following a sensitivity study, ten descriptors have been selected and fed to the algorithm. While the first results were already promising, further improvements could be reached via optimised data filtering and a RF parameter tuning.

Model performance and limitations

While their training takes only little time (less than one hour on a conventional office notebook), the final models – one for the thrust coefficient KT and one for torque coefficient KQ, each consisting of 500 trees – are fully converged and able to perform a prediction on the whole HSVA propeller data base in less than one second. With a median Root Mean Square Error of approximately 2 % with respect to the test set, the results prove the high effectiveness of the Random Forest model. As it can be seen in Figure 1, both typical as well as rather complex open water curves are accurately reproduced by the model.

It should be noted, though, that the accuracy naturally decreases in areas where there is only limited data available. Especially in areas of rare variable combinations, typical machine learning errors occur, resulting in (mostly easily identifiable) inaccurate open water curves. In order to alow for the model's application in daily business, these limits need to be identified and its scope must be restricted accordingly.

Fields of application

In praxis, there are many possible applications for the Random Forest-based prediction of propeller open water characteristics. The tool can support the early design phase (especially when linked with a corresponding prediction model for thrust deduction and wake fraction) or can be utilised to automatically "live-check" propeller open water tests and further improve the internal quality assurance.

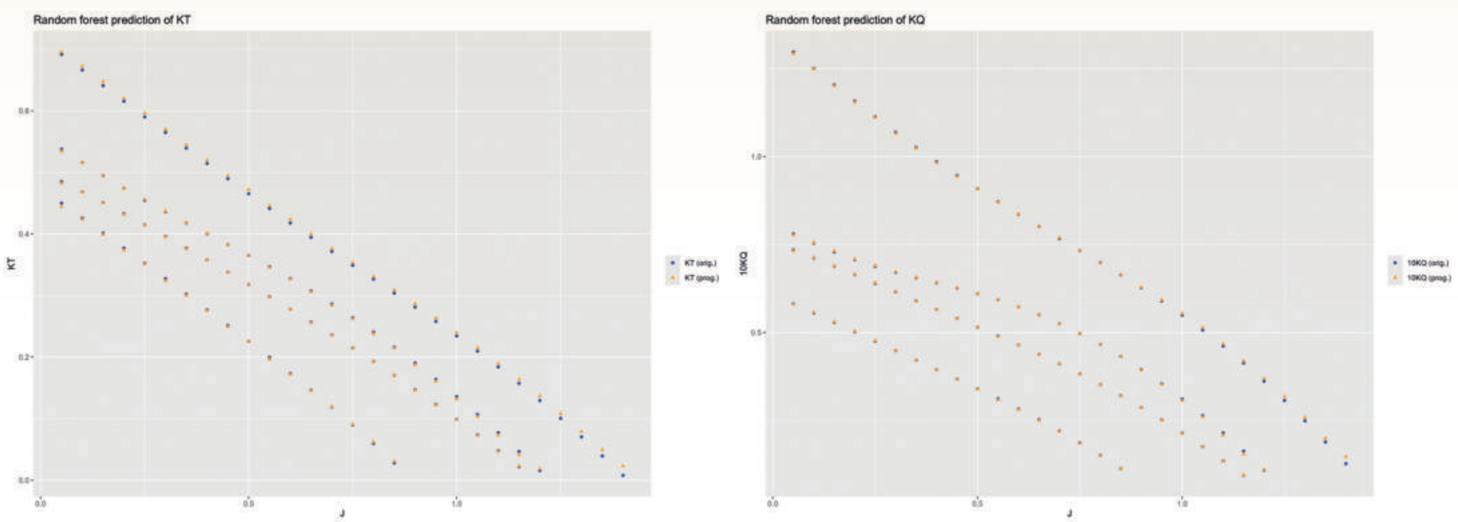


Figure 1: Propeller Open Water Curves (two simple and two more complex shapes): Model Test Results vs. Prediction. Left: KT. Right: KQ.

30 YEARS after the ACCIDENT
REASSESSING the LOSS of MV ESTONIA through a STATISTICAL APPROACH

The tragic sinking of the MV Estonia in September 1994 remains one of the most severe passenger ferry accidents in history, resulting in 852 fatalities and only 137 survivors. Historically, such catastrophic events have often led to improved or revised safety regulations, as well as further research into vessel safety and damage stability, which is also the case for MV Estonia.

by Shinwoong Kim and Lars Johnsen

After the accident, extensive and rigorous investigations have been carried out by various organisations. From that, the root cause of the accident has been assumed to be understood, and the consequent sinking process has been considered to be well established.

However, in September 2020, a new video recording made by an underwater ROV was published by the Discovery Channel, showing a new, previously unknown, penetrating damage on the starboard side of the MV Estonia wreck lying on the seabed (see Figure 2). Also, new video footage on the state of the doors in the center casing on the vehicle deck became available.

Based on the new evidence, the Estonian Safety Investigation Bureau (ESIB) initiated a preliminary assessment of the new information on the MV Estonia accident. The objective of the ESIB investigation was to assess the validity of the conclusions presented in previous investigations and to assess whether the safety investigation of the accident should be re-opened, considering the new information.

As part of the ESIB investigation, HSVA, together with the Kiel University of Applied Science, has taken a role in the numerical simulation of the sinking process of the MV Estonia. One of the objectives of the HSVA investigation was to shed light on whether the New Side Damage (NSD) on the starboard side was already present while the MV Estonia was still afloat, or whether it resulted later from the contact of the sinking MV Estonia with the seabed.

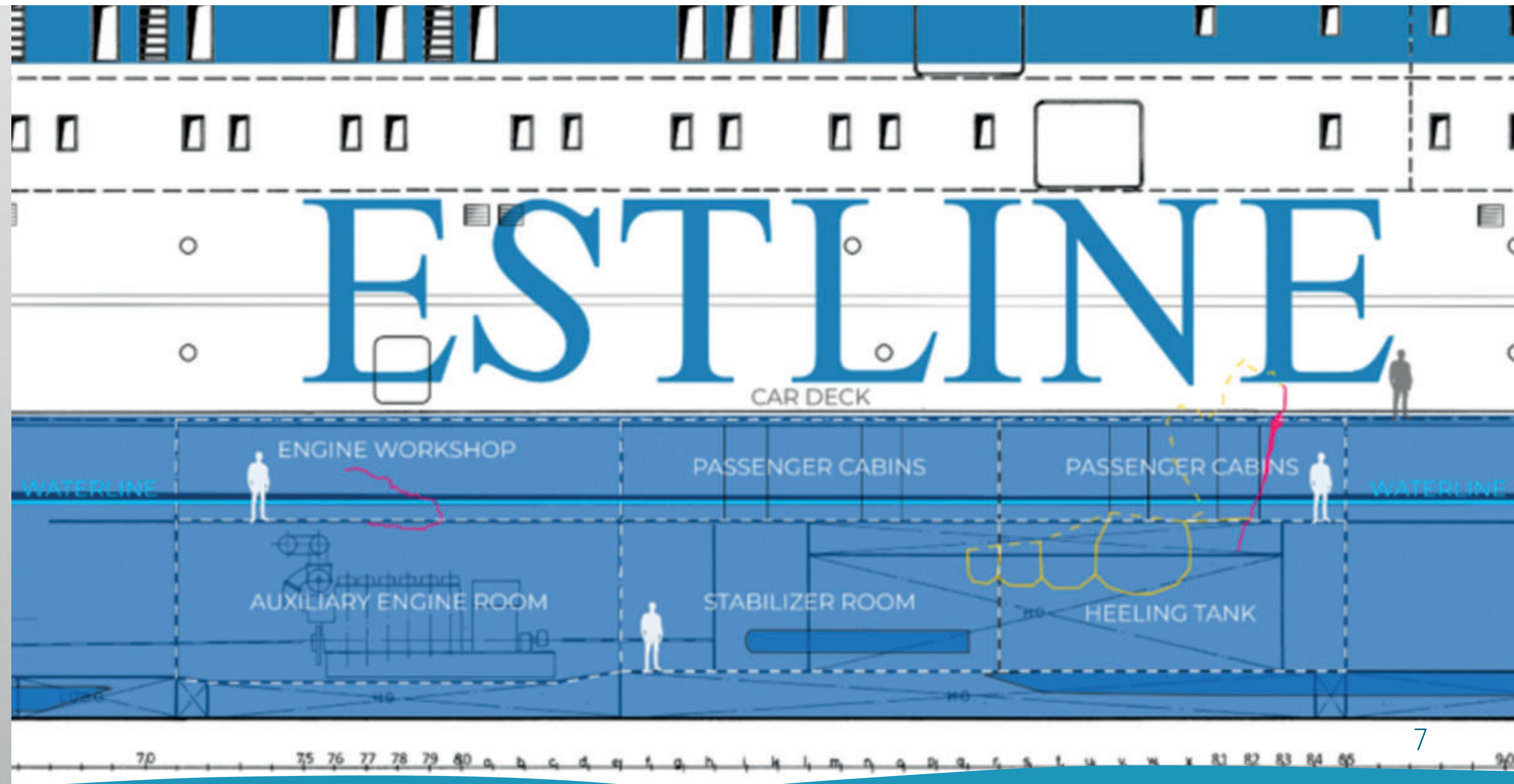
For the current study the time-domain ship motion simulation tool HSVA-Rolls was used. Initially developed by Prof. Heinrich Söding and his graduate students after the accident in 1994 at the Institut für Schiffbau at the University of Hamburg, it has been adapted and used by HSVA for several decades. During the course of the last 25 years HSVA has carried out, led, and participated in 6 large research projects on RoPax ship safety using HSVA-Rolls. Several accident processes have been shed light on and consequences drawn to improve safety, also at the level of IMO rules on passenger ship safety.

HSVA-Rolls has been used to simulate the coupled behavior of the damaged ship with the flooding of the vehicle deck and further compartments below for the early phase of the sinking process (until capsize). The later phase of the sinking process (capsize to seabed) was investigated by HSVA's partner, Prof. Hendrik Dankowski at Kiel University of Applied Science, using E4-Flood.

A given natural sea state can be modelled with an unlimited number of distinctive combinations of discrete wave components. During complex, time-dependent maneuvers, the sinking process can change with the selection of a particular representation ▶

Figure 1. MV Estonia (copyright – ESIB)

Figure 2. Location of the newly found side damages marked in red on the starboard side (copyright – ESIB)



of the sea state. This is also true for the influence of details of the opening and damage configurations of the ship, and thus a problem for the reliable assessment of an accident. In order to overcome this problem, a novel statistical approach was applied, allowing for a more robust prediction of a damaged ship's behavior in irregular random seas.

By simulating thousands of possible combinations of sea state parameters, damage configurations and conditions for the center casing doors, whose exact condition during the accident remains unknown to this day, robust predictions of the likelihood of certain damage scenarios could be derived. The significance of such results exceeds those of single computations as they add valuable depth, allowing to quantify the answer to questions of possibility and probability. An example of such results is given in Figure 3, showing the roll angle over time for 100 different representations of one sea state for one ship configuration (loss of visor and open bow ramp, center casing doors partly open) on a fixed track. For this configuration only 50 out of a 100 simulations see the ship capsizing within the first 40 min after the loss of the bow visor.

Moreover, two distinct modes of capsize can be observed, either around 500s or between 1000s and 1500s after the loss of the visor.

By analysing the overall response trends, it can be concluded that the likelihood of the NSD being present while the MV Estonia was still afloat, either in combination with loss of the bow visor and bow ramp or as single cause of the sinking, is a very unlikely damage scenario. The most likely damage scenario remains the loss of the bow visor and ramp with the ship following a track based on the location of debris found on the seabed, making a port side turn. Any modelled assumptions regarding the center casing doors, do not change this general result.

The study further provides insights into how different course and speed actions could have affected the survivability or time until capsize of the vessel on a statistical level. This offers valuable information for future assessment of ship safety and emergency maneuvers.

Overall, it is encouraging to see how an initially modest research program, starting with Rolls by one good professor and a small group of graduate students following the MV Estonia accident in 1994, has evolved into significant contributions to ship safety through continued development over the years. HSVA is proud to have played a key role in this work.

We would like to sincerely express our gratitude to Prof. Hendrik Dankowski for performing the simulations of the later sinking phases using E4-Flood and Dr. Petri Valanto for his contribution to HSVA-Rolls and the Estonia investigation over the past decades. Finally, we acknowledge the Estonian Safety Investigation Bureau (ESIB) team—Kaidi Katus and Tauri Roosipuu—for their excellent support and trust throughout the project.

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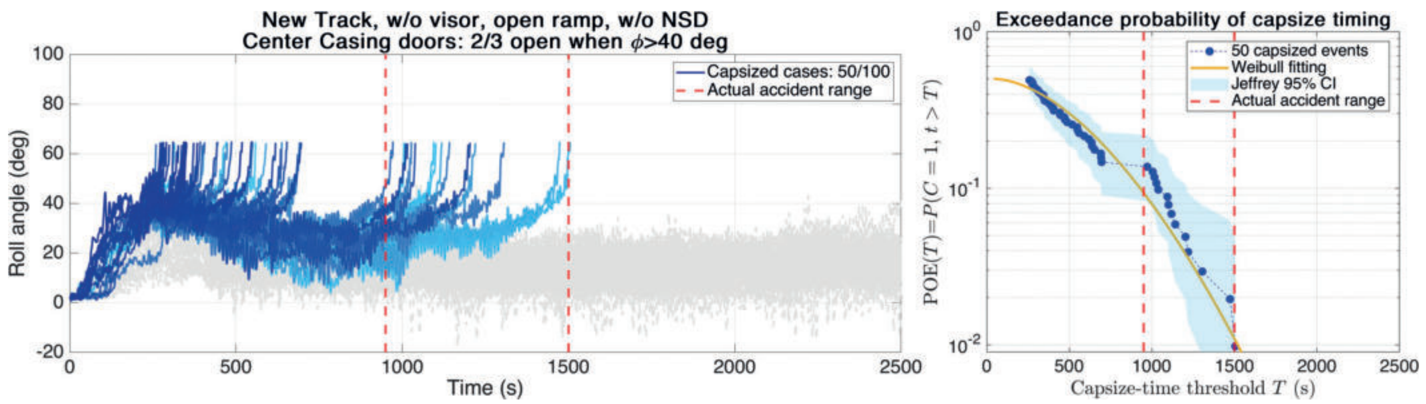
Figure 3. Example of numerical simulations without NSD under 100 different wave sequences



Hull Roughness in the Scaling Procedure

by Jan Richter

The condition of the hull surface has a notable impact on the performance of a vessel. It is well known that the fuel consumption increases in the course of time and that regular cleaning of the hull is a feasible means for returning to the expected power levels. Fouling effects are typically evaluated from on-board performance monitoring data to identify suitable cleaning intervals. Although studies exist that estimate the effect of fouling on the resistance, model tests and numerical predictions typically are conducted for the ideal contract condition – namely a clean, new hull and propeller. In recent years, especially driven by improved manufacturing tolerances of shipyards and the application of low-friction paint, the standard roughness that is applied for the performance prediction is often part of discussions. This article summarises different definitions that are commonly used and describes the effect of roughness on the resistance, especially within the ITTC 1978 and the HSVA scaling procedures.

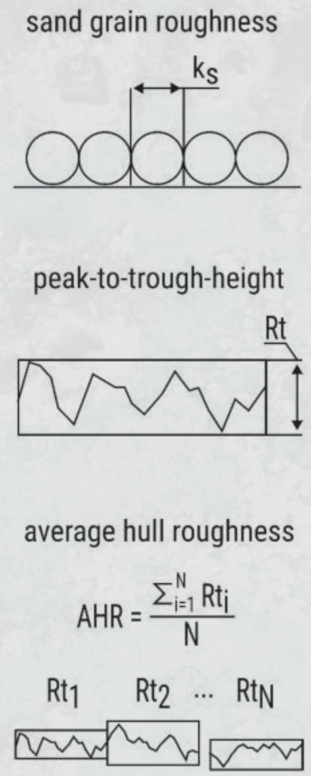


Figure 1: Different roughness definitions

Definition of Roughness

Roughness describes the unevenness of a surface which affects the shear forces between an object and the water and thereby contributes to the total resistance. Depending on the field of application, this roughness may be differently defined (Figure 1). In theoretic investigations or fundamental research, sand grain roughness k_s is typically chosen whereas practical applications often revert to other definitions, such as the average peak-to-trough height or envelope curves. The equivalent sand grain roughness describes the sand grain size of equally distributed particles on a surface and is normally only encountered in theory, strict laboratory condition or in CFD calculations. The peak-to-trough height *Rt* is obtained from tactile measurement of the final surface and is the difference between the highest peak and deepest trough within the evaluation length. It is normally larger than k_s as it not only incorporates ▶

the roughness of the surface finishing (such as paint), but also inadequacies in the manufacturing and application process. In naval architecture, roughness assessment is typically described through the term "average hull roughness" *AHR*, which corresponds to the arithmetic mean of multiple systematic peak-to-trough measurements, each over a distance of 50 mm, on both sides of a hull's underwater surface, including more complex regions at bow and stern.

The standard average hull roughness assumed by ITTC is $AHR = 150\mu m$ and it relates to only about one fifth in sand grain roughness. This relationship between the different definitions is not linear and the ratio changes for larger as well as smaller roughness values. It should further be noted that additional factors, such as waviness of the plates, zinc anodes, welding seams, fouling, etc. are normally not part of a ship's average hull roughness measurement procedure, even though they may be major contributors to resistance increase. Fouling is an additional resistance component that can be subtracted from long-term on-board measurements between docking/cleaning periods, for example by linear trend removal. The remaining factors can be summarised as manufacturing challenges and industry tolerances, which are typically accounted for by the correlation allowance.

Roughness in the prediction process

The ITTC recognised early that an additional friction component describing the full-scale hull roughness needs to be added to the scaling process to provide realistic results. The original friction term has been introduced by Bowden and Davison and is based on a comparison to a set of sea trials in the early 1970s:

$$\Delta C_F = \left[105 \cdot \left(\frac{AHR}{L}\right)^{1/3} - 0.64\right] \cdot 10^{-3}$$

With the aim of incorporating an additional correlation allowance, which describes correlation effects other than roughness, and to correctly include a speed dependence in the friction allowance, the re-formulation of Townsin has later been introduced as ITTC standard:

$$\Delta C_F = 0.044 \cdot \left[\left(\frac{AHR}{L}\right)^{\frac{1}{3}} - 10 \cdot Rn^{-\frac{1}{3}}\right] + 0.000125$$

The formulation depends on the roughness height and the Reynold number, providing a straightforward method for determining the roughness effects, even though it may not be all-encompassing for modern manufacturing technologies and coatings. The topic has been exhaustively discussed on the 29th International Towing Tank Conference and ITTC strives to further improve the roughness function model. The challenge lies in finding a universal function that includes different types of coatings and surface finishes.

In the standard scaling procedure, HSVA does not explicitly include a hull roughness and instead only applies a correlation allowance. This term implicitly incorporates the industry standard hull roughness. In its present state the implicit AHR is generally assumed to be in line with the ITTC value of $150\mu m$. Applying off-standard roughness in a performance prediction is realised by introducing a friction coefficient offset ΔC_F between the requested roughness $C_{F.R.AHR}$ and the industry standard $C_{F.R.150}$:

$$\Delta C_F = C_{F.R.AHR} - C_{F.R.150}$$

With the empiric equation:

$$C_{F.R} = 0.075 / \left[\log\left(\frac{Rn}{1 + 0.0011 \cdot \frac{AHR}{L} \cdot Rn}\right) - 2\right]^2$$

This definition incorporates a stronger Reynolds Number dependence when compared to relative changes of the ITTC formulation with slightly lower effect at low speeds and steepening slopes with increasing speeds (see. Figure. 2).

Concluding Remarks

The roughness contribution to total resistance in the scaling process is difficult to assess and generalise without reliable information on the full-scale roughness. For this reason, HSVA correlation allowance currently incorporates the industry standard roughness implicitly and additionally allows adding corrections for off-standard surface qualities in a comparable order of magnitude as implemented in the ITTC recommended procedures. In

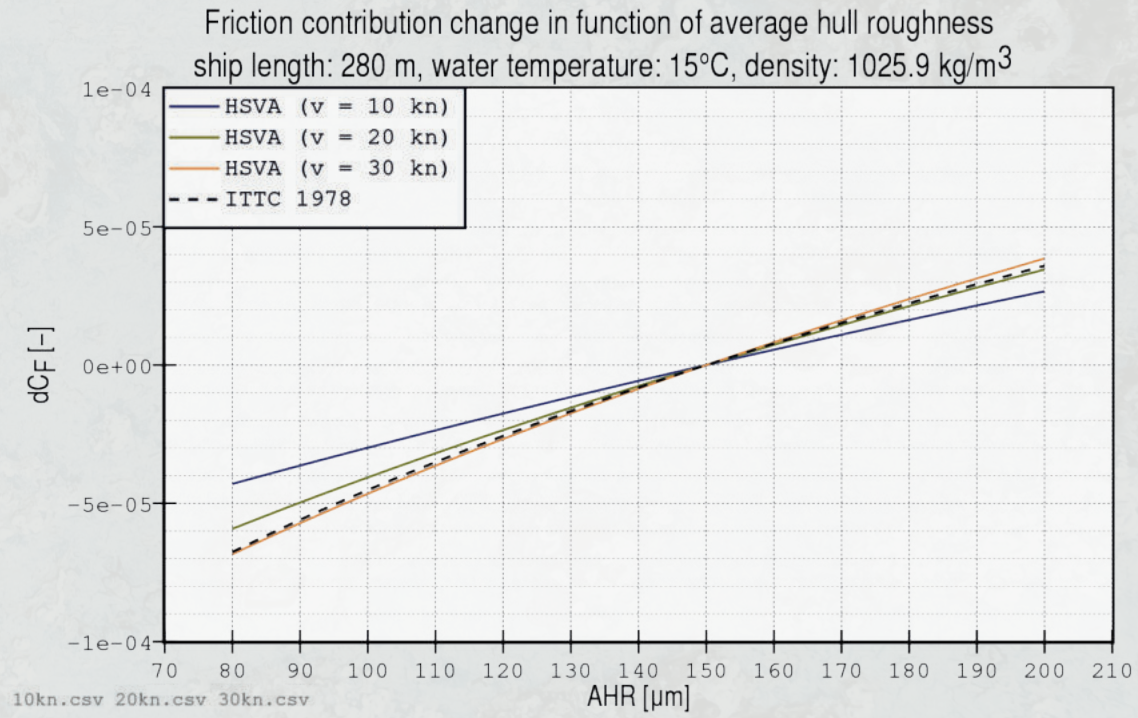


Figure 2: Effect of average hull roughness on friction coefficient

order to correctly account for advances in surface finishing due to reduced manufacturing tolerances and improved coatings, the correlation allowance is regularly checked against (and prospectively adjusted for) recent speed trial feedback. As an alternative approach and similar to the ITTC procedures, the hull roughness (even the standard AHR value) could be excluded from the correlation allowance and considered through a separate function during scaling. This is only reliably possible, when sufficient speed trial recordings that include AHR measurement reports have been collected to establish a relationship between changes in resistance (and corresponding power demand) and average hull roughness. While monitoring the correlation allowance can, strictly speaking, be done without roughness measurements, that information is still valuable to identify and report the current state of the industrial standard and to appropriately include off-standard roughness effects.

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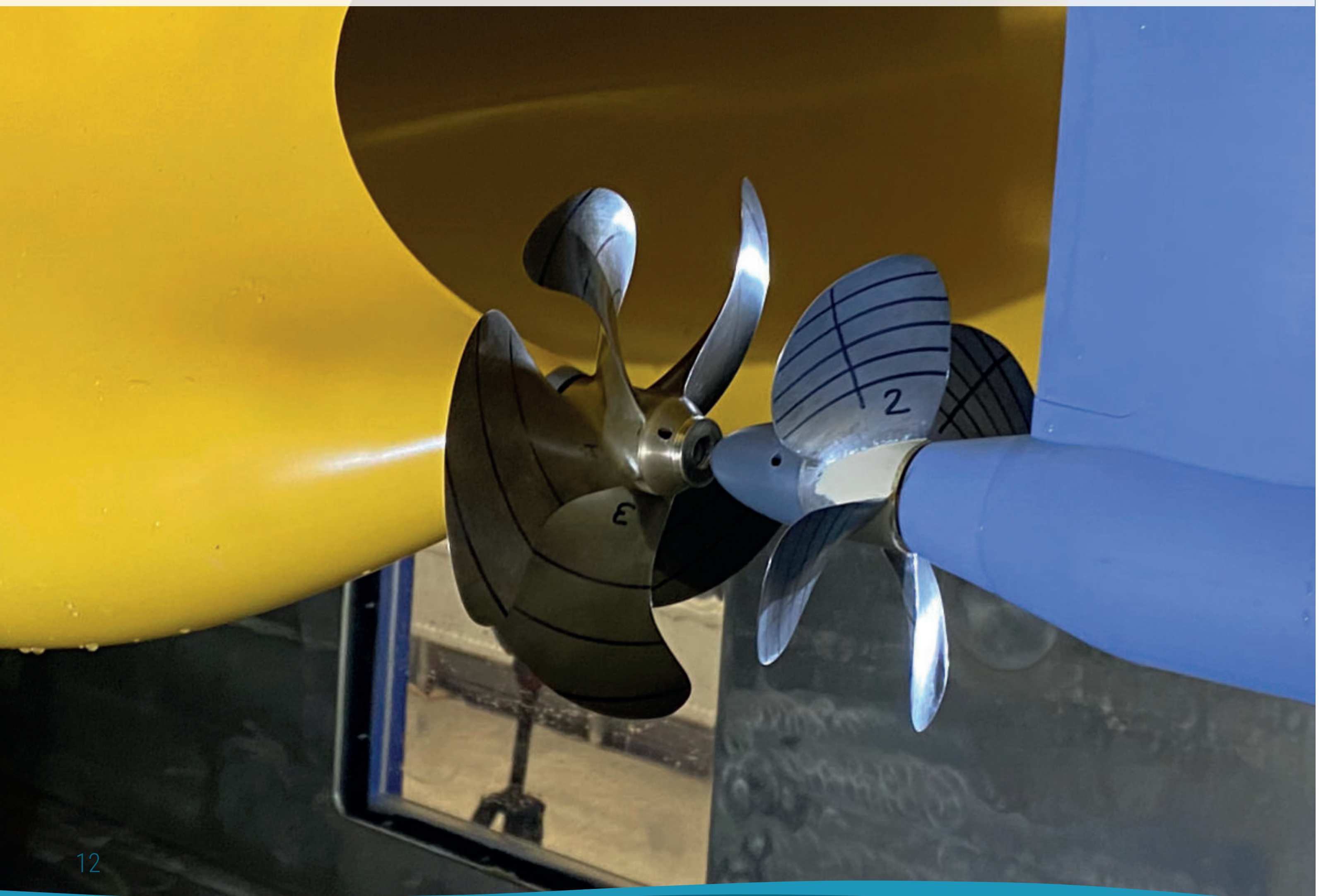
Contra-Rotating Propulsion Devices in Model Testing

Contra-rotating propellers (CRP) are high-efficient propulsion systems in which two propellers with opposite senses of rotation are mounted behind one another. The forward propeller acts similar to a conventional single-screw setup while the aft propeller is designed to take advantage of the wake of the first.



by Jan Richter and Sören Brüns

A contra-rotating arrangement is typically realised by fitting a second propeller shaft into the shaft of the forward propeller (Figure 1, case B), bringing along challenges in manufacturing and fitting processes. Another common way for realising CRP setups comprise of an azimuth drive mounted aft of a conventional single-screw arrangement (Figure 1, case F) or two contra-rotating propellers on the leading and trailing edge of a POD housing (CR-POD; Figure 1, case C). The entire HSVA service catalogue for conventional propulsion setups is also available for CR configurations.

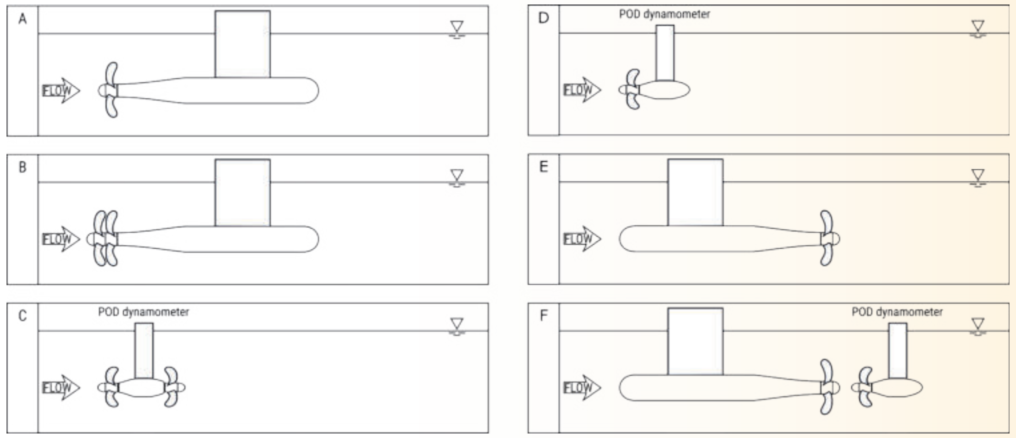
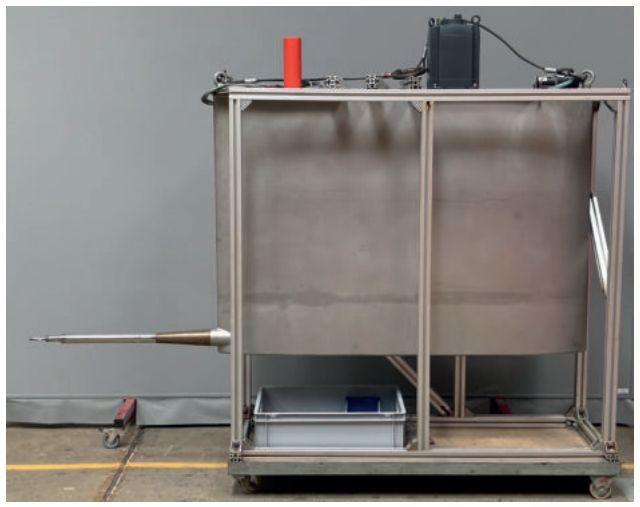


Figure 1: Relevant Propeller Open Water Arrangements

With regards for propulsion tests for conventional CR arrangements on shaft lines, a dedicated CR dynamometer with one inner and one outer shaft is available (Figure 2).



This setup allows thrust and torque to be measured individually for each propeller, while the rpm ratio can be adjusted independently. The propeller open water tests (POW) are carried out as a complete system and with the same scope of measurement values as for the propulsion tests. The contra-rotating system is mounted on the open ▶

Figure 2: HSVA CR-Propeller Open Water Dynamometer

water test device and thrust, torque and revolutions of each propeller are measured directly, implicitly including the interactions between the forward and aft propellers for the given rotational speed ratio. Separate POW tests for the forward and aft propeller alone are optional because they are not explicitly required for the evaluation, but can offer a wider picture of the hydrodynamic behavior of the propellers. Commonly, a CRP configuration is treated as a propulsion unit and is normalised to the dimensions and revolutions of the forward propeller. In the HSVA procedure for CRP system evaluation, the system characteristic (index $_{sys}$) is combined by normalising the measured propulsion characteristics – revolutions *n*, thrust *T* and torque *Q* – of the aft (index $_2$) to the forward propeller (index $_1$):

$$J_{sys} = \frac{V_a}{n_1 \cdot d_1}$$

$$K_{T.sys} = \frac{T_1 + T_2}{\rho \cdot n_1^2 \cdot d_1^4}$$

$$K_{Q.sys} = \frac{(n_1 \cdot Q_1 + n_2 \cdot Q_2)}{\rho \cdot n_1^3 \cdot d_1^5}$$

In addition to the previously defined variables, the speed of advance V_a, water density ρ and propeller diameter *d* are used in the equations above. The remaining analysis follows HSVA's standard procedure. But it is also possible to evaluate the forward and aft propeller separately based on the open water characteristics of the combined propeller open water tests. The test setup and scope are the same as described in the system evaluation and each propeller is evaluated separately and in line with the HSVA standard procedure. Using this approach provides more detailed information about the propulsion characteristics of the individual propellers instead of only the system.

As shown in Figure 4, the hybrid combination of a shaft-driven propeller and a POD drive (Figure 1, case F) is also part of HSVA's testing capabilities. For propulsion tests, standard propeller dynamometers are combined with a POD drive. Again, the rpm ratio can be selected freely and thrust and torque are measured individually for each propeller (with system thrust being measured in the case of the POD drive). Within the research project Twin-CRP-POD ULCS (grant number 03SX520A), HSVA developed a test set-up that also enables propeller open water testing for this type of configuration, where a POD is located downstream of a propeller (Figure 3). The analysis of a CRP setup with an azimuth drive is analogous to the approaches described above but requires additional open water tests, as the POW dynamometer must be installed in reverse for this arrangement. In order to remove the effect of the propeller open water test device in this arrangement (Figure 1, case F), at least two additional open water tests with the forward propeller in normal (case A) and in reversed position (case E) need to be carried out.

For the third common configuration, the CR-POD unit (Figure 5 and Figure 1, case C), HSVA uses especially developed gearboxes designed to fit into the POD housing. In this setup, the rpm ratio is fixed, while torque is still measured individually for each propeller. The overall system thrust of the complete unit is measured. Propeller open water tests are conducted in the same manner as for single-propeller POD configurations, in which the POD housing is included for the open water tests and its resistance is part of the system thrust. Resistance tests consequently are carried out without the POD housing installed. The CR-POD is always treated as a system of forward and aft propeller as well as POD housing resistance and a separation of the individual propellers is not done.

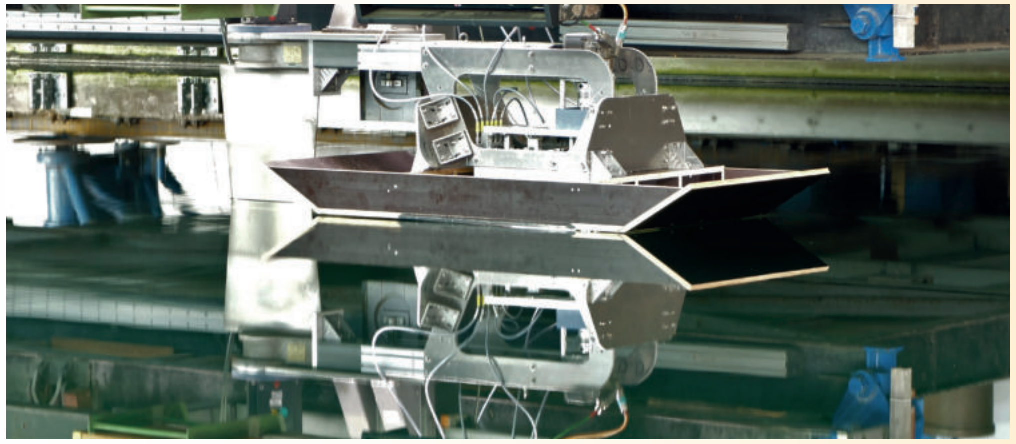


Figure 3: POW Test Set-Up for Shaft Propeller and POD in Hybrid-CR-Combination

It is also possible to test CRP setups in HSVA's HYKAT. In addition to conventional cavitation tests, propeller open water tests and propulsion tests without surface effects (e.g. for underwater vehicles) can be investigated. The advantage of these tests in comparison to the model basin equivalent are the large Reynolds numbers than can be reached, in some cases even allowing tests close to full-scale condition.

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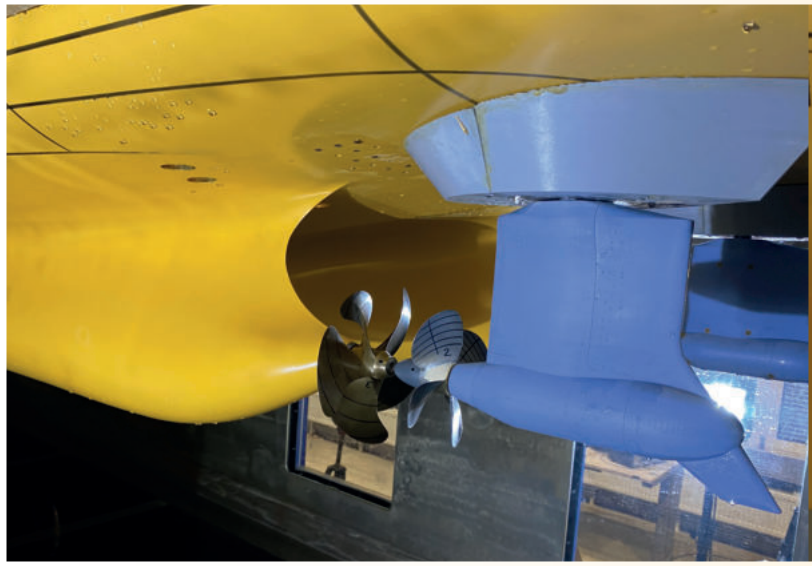


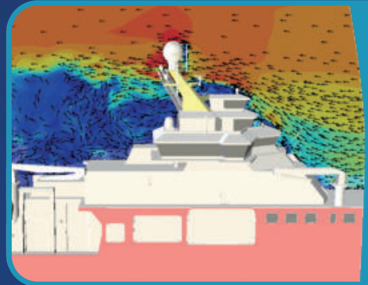
Figure 4: Hybrid-CR-Arrangement from the Research Project: Twin CRP-POD ULCS

Figure 5: CR-POD from Model Tests with DLR - DiLaR Research Vessel

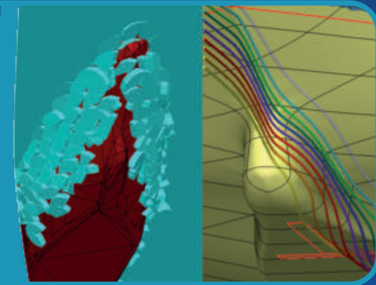
Design Assistance for Complex Ice Breaking Vessels

A successful design is usually the result of a combination of well-thought-out small components. This is very true for multi-mission ice breaking ships: from the thickest plating of the bow to the sharp edge of the ice knife, every component must be designed with care to ensure that the vessel will fulfil its diverse missions.

by Quentin Hisette



HSVA's virtual wind tunnel uses CFD to simulate the air flow around the ship superstructure, for example to optimize the smoke dispersion or verify helideck safety.



Typical hull lines optimization usually involves fine tuning of the bow shoulder area in order to find a compromise between ice and open-water performance.

An efficient propulsion system requires finely tailored appendages: whether it is an icebreaking headbox, an ice knife or shaft line brackets, all need to be carefully designed with respect to their interaction with ice.

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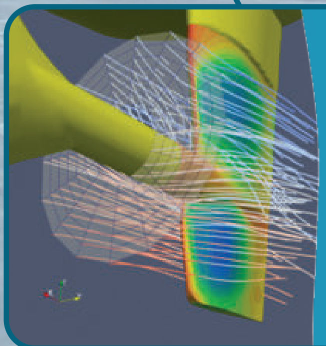
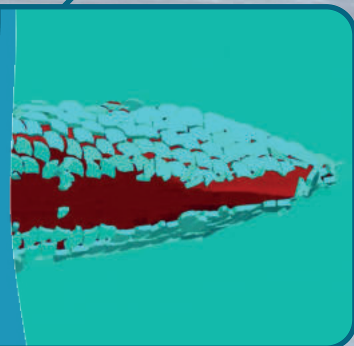
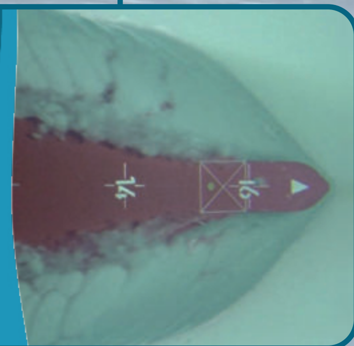


Ice class propulsion systems are designed as a compromise: the objective is typically to optimize the operations at low speed during icebreaking (large thrust, low cavitation, minimum vibration), while still offering low fuel consumption at larger speeds in ice-free conditions.

Besides conventional sea trials, HSVA also provides assistance during ice trials, e.g. for test planning & conduction, but also with on-board and on-ice measurements.



Ice clearing simulations are used to optimize the hull shape for low ice coverage, aiming to reduce ice frictional resistance, keep specific instruments ice-free (e.g. sonar, moon pool), and minimize propeller -ice interactions levels.



During ice model tests, underwater video footage is used to assess the icebreaking at the bow. Ice failure mode, as well as size, shape and motion of the broken ice fragments are evaluated in detail to develop an efficient icebreaking bow.

Disclaimer: inset images for illustrative purposes only. No direct link to the vessel depicted in the central image.

Integrating Wind-Assisted Propulsion into Multi-Purpose Vessel Design: Insights from the FlettnerFLEET Project

In the German Federal Ministry of Economy and Energy-funded research project FlettnerFLEET, advanced aerodynamic and hydrodynamic optimisation studies were conducted for a tanker vessel using Computational Fluid Dynamics (CFD). In addition, performance predictions were carried out with HSVA's in-house tool EcoLibrium. The modular fast and extensible simulation environment can capture up to six degrees of freedom in ship motion while accounting for all relevant aerodynamic and hydrodynamic forces. This work has already been reported in earlier issues (see NewsWave 1-25 and 2-25). In this issue we focus on integrating wind-assisted propulsion into a multi-purpose vessel (MPV) design.

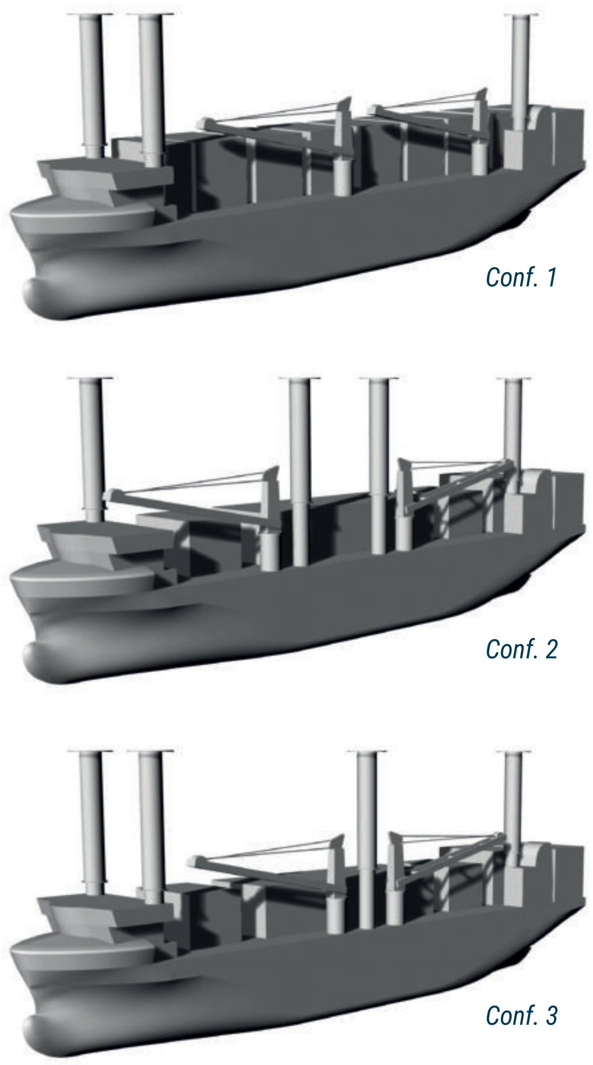


Figure 1: 3D Geometry of three configurations for the Flettner rotor installation on a MPV Vessel

by Yan Xing-Kaeding

First of all, the general arrangement for the MPV has been provided by the project partner HB Hunte Engineering GmbH. In contrast to the tanker vessel, there is very limited space suitable for Flettner rotor installations due to cargo load and crane operation on a Multi-Purpose Vessel. However, three configurations have been identified to be feasible and these were explored using our Eulerian CFD approach accordingly. Figure 1 illustrates the 3D geometries of these three configurations. The CFD mesh for Eulerian approach is shown in Figure 2 for the first configuration as an example. The Eulerian CFD approach is described in detail in NewsWave 1-25. The method is extremely fast compared to Reynolds-Averaged Navier-Stokes (RANS) or scale-resolving Large-Eddy (LES) based simulation methods. Therefore, it is suitable for large design space exploration. Further advantage of the method is its ability to predict the interaction effect between the Flettner rotors themselves as well as between the Flettner rotor and other cargo/crane or superstructure with sufficient accuracy for early design stages. Finally, it can also be used for evaluation of the relative total performance of different rotor configurations as well as the ranking of all Flettner Rotors within the investigated configurations. Figure 3 shows for example the best and the worst performed Flettner Rotor found in this study.

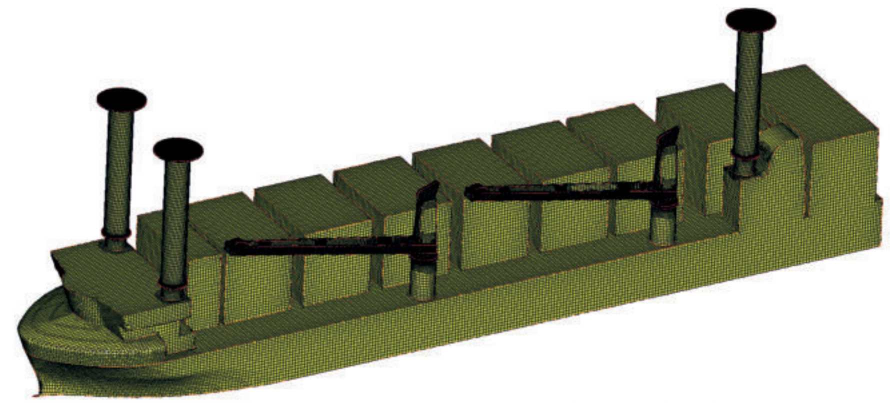


Figure 2: CFD Mesh of the Conf 1 of the MPV Vessel

EcoLibrium evaluation revealed then the polar diagram of the required delivered power for different configurations, showing that almost 20% power savings can be achieved by the best configuration at a moderate wind of Beaufort 3 and the true wind angle around 110°/250°. Other important parameters such as the rudder and drift angles are also computed by EcoLibrium for this specific ship, shown in Figure 4 for all wind direction (TWA between 0° and 360°). This finally build the data basis for the decision-making of selecting the best configuration for the project ship – MPV. Note that a vessel equipped with a wind propulsion system can behave quite differently in terms of rudder angle or drift motion depending on its hydrodynamic coefficients, therefore each vessel needs to be individually evaluated and optimised in terms of total energy consumption for a given operational profile.

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Bundesministerium für Wirtschaft und Energie

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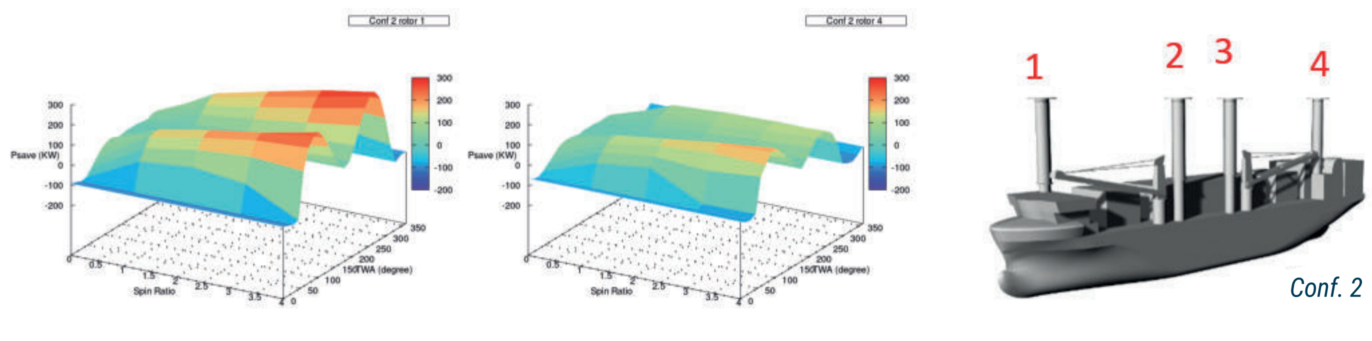

Figure 3: The performance of the best (conf 2 - rotor 1) (left) and worst (conf 2 - rotor 4) (middle) performed Flettner Rotor and its corresponding position (right)

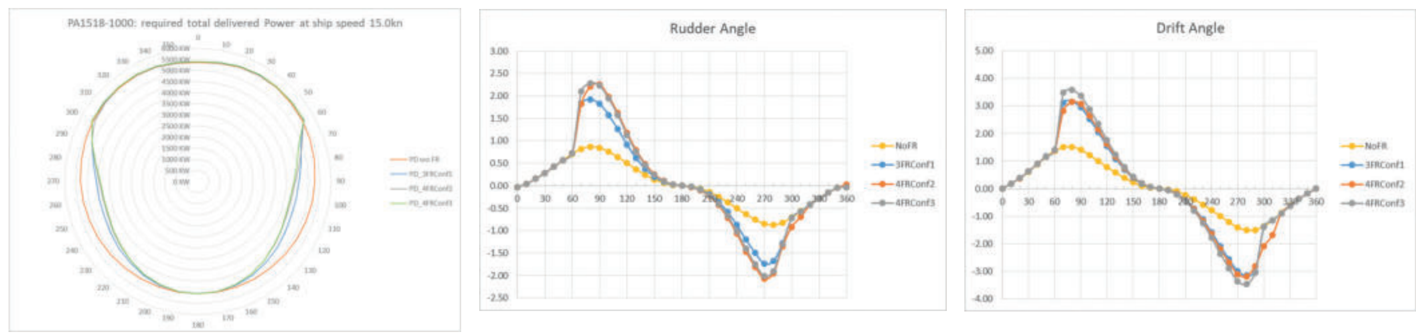

Figure 4: EcoLibrium results of polar diagram of required delivered power (left), rudder (middle) and drift (right) angles for the MPV