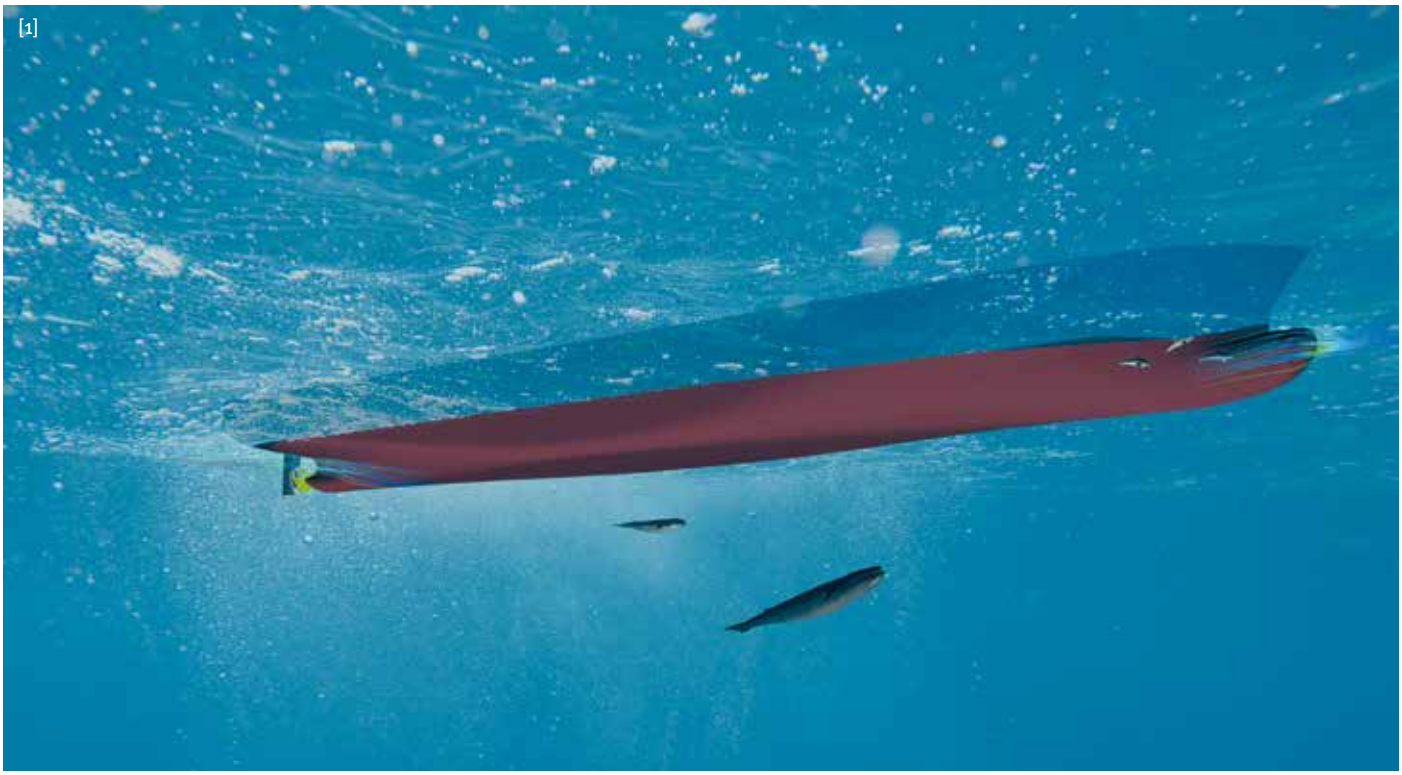
MMG NEWS
Research and Innovation
MMG The Propeller
Efficiency by MMG | Mecklenburger Metallguß GmbH | **August 2016**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Closer to reality

Following the trend to a more detailed observation of ship operating conditions, the design and calculation methods have the potential to close the gap between simplified model assumptions and real ship operation. Big data and maritime 4.0 services are nearly state of the art at most of the shipping companies. Nevertheless, the question is how to handle this big amount of data with included well known measuring and observation inaccuracies. In order to draw the right conclusions from these data collections it is essential to perform smart analyses of the data. The necessary methods have to be based on existing experience of scaling effects and, with increasing priority, on state of the art simulation methods.

As MMG continuously enhances the in-house capabilities of simulating propulsion performance, cavitation behaviour, constructible reliability and underwater noise impact of the designed propellers it is nowadays the logical step to bring this virtuality into consequent combination with full scale measurements. The comparison between filtered operational data and numerical propulsion simulations already demonstrates the potential of modern CFD methods. It is time to step forward from big data to smart data in order to get full access to the right and unclouded story the data wants to tell us.

How often should I polish my propeller? Is it worth to think about a re-design or performance enhancement by applying propulsion improving devices? What is the performance baseline of my vessel as I see discrepancies between the original model test result and on-board observations? Do I need a new propeller after underwater collision or can it be accepted to repair the propeller with respect of remaining propeller efficiency?

All these questions are the key to a continuous economically improved ship management and cannot be answered from more or less unfiltered big data. Only smart data will give us smart answers.

The concept of life cycle management is mentioned in various applications and for different products. But it can be seen that this topic is not fully covered or mentioned for ship propellers. MMG started very early to register all significant incidences in a propeller's lifetime. This "patient file" is recorded at MMG's database and can be combined with performance observations in order to get the full picture and give ship owners a well-grounded all-over consulting package.

Ensuring a high-level performance of the propeller cannot stop right after delivery. That is why MMG concentrated its recent research on building the bridge between the theoretical world of fluid dynamics and design application and the clear but complex feedback from vessels sailing round the globe. We design propellers according to real scale requirements.

[1] Simulation of a Complex Environment

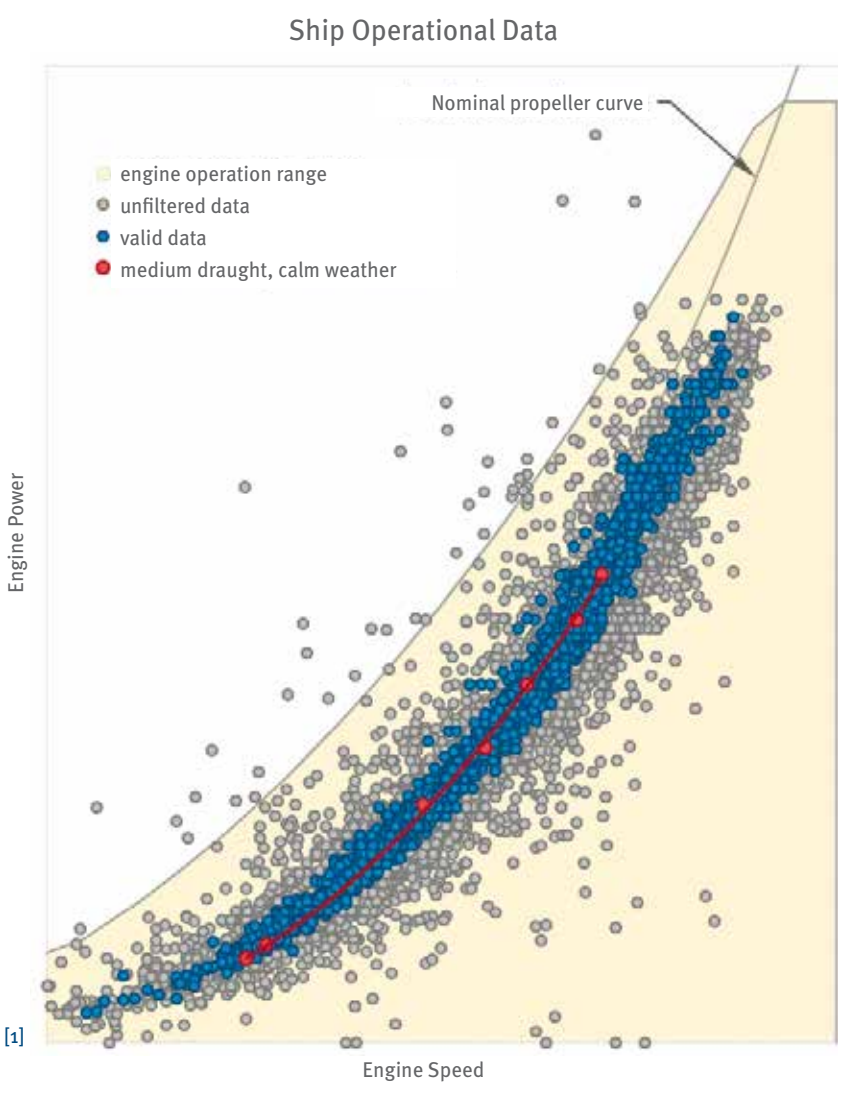
Continuous Care – Lifetime Performance

MMG is among the top suppliers for marine propulsion components. With more than sixty five years' experience MMG provides its customers with propellers which are well known for their outstanding performance and reliability in ship operation. MMG not only designs and manufactures its own propellers, but also offers its production capabilities to other propeller designers. But MMG has a lot more to offer. Design and construction of shaft lines, torsional vibration calculations are just a few examples. MMG has long been strong in after sales and customer service which include maintenance, damage analysis and repair.

During the past years slow steaming has changed the shipping industry significantly. The fleet in service is not just sailing slower but ships are operating on a profile that covers a wide range of loading conditions and vessel speeds. Optimizing the design to a specific operational profile is not only the task in retrofit projects but has also found its way into the newbuilding business. The changes in vessel operations led to many ship conversions where propellers have been retrofitted. Up to now MMG has equipped more than 190 vessels with re-design propellers specifically optimized to their new operational requirements. Thereby fuel savings of up to 14 per cent could be achieved. By increasing competition the requirements on the performance of modern propeller designs grow and the accuracy of predictions is gaining importance.

In this context MMG's designers have thus increasingly engaged in the real ship operation. To obtain the maximum possible efficiency with a propeller design the detailed review and analysis of a vessel's present or planned operation plays an important role. Sometimes the limited availability of operational data poses a challenge or the reported data can be of poor quality. The engineer has to identify the actually relevant data to identify the actual propeller operation conditions. Consequently MMG has developed analysis techniques for ship operational data which allow such evaluations and eliminate faulty elements. As an example figure 1 shows raw operational data together with results of our analysis plotted in the respective engine diagram. Following, we can also derive operational profiles from raw report data. The combination of sophisticated CFD methods included in our 5D-Propulsion standard with these techniques for full scale performance predictions ensures consistent results. Building upon this wealth of experience MMG extends its ongoing support by offering performance analysis services.

Having these tools available we can also utilize them for condition monitoring and fleet analysis. Possible applications are comparison of sister vessels sailing on equal or different routes, correlation of actual operation and predictions and verification of commonly applied sea trial analysis methods. They enable us to identify performance decay, irregularities in fuel consumption and possibly even damage incidents. From the results of such analyses we can draw conclusions on appropriate measures to restore of even improve a ship's operation. The options range from maintenance operations such as cleaning and polishing to modification or repair to replacement or re-design of the propeller. In case of propeller damage, MMG analyses the damage, develops proposals for temporary or permanent repair and an MMG service team executes the repair as convenient for the customer as possible. If major modifications of a damaged propeller are necessary, we assess the resulting impact on the propeller efficiency to support our clients in their decision. Together with our customers we contemplate cost and benefit of each option and find the individual optimum solution. All investigations and actions undertaken are stored in "patient records" for easy access and a full picture of the propeller's history.



[1] Big data versus Smart Data

Numerical Propulsion Simulation – A well-proven tool

Numerical Propulsion Simulations (NPS) as an advanced Propeller Design Tool was applied at MMG about 2 years ago. Since RANSE CFD became applicable in daily processes, MMG gained experience in many calculation cases and constantly improves the quality and speed of the method as well as in-house hardware until now.

MMG NPS can be summarized as a process starting with complete ship hull generation in 3D from constructional documentation ending up with a numerical model test result including performance predictions following internationally accepted procedures.

Improving quality and speed of the method: What can be expected from NPS?

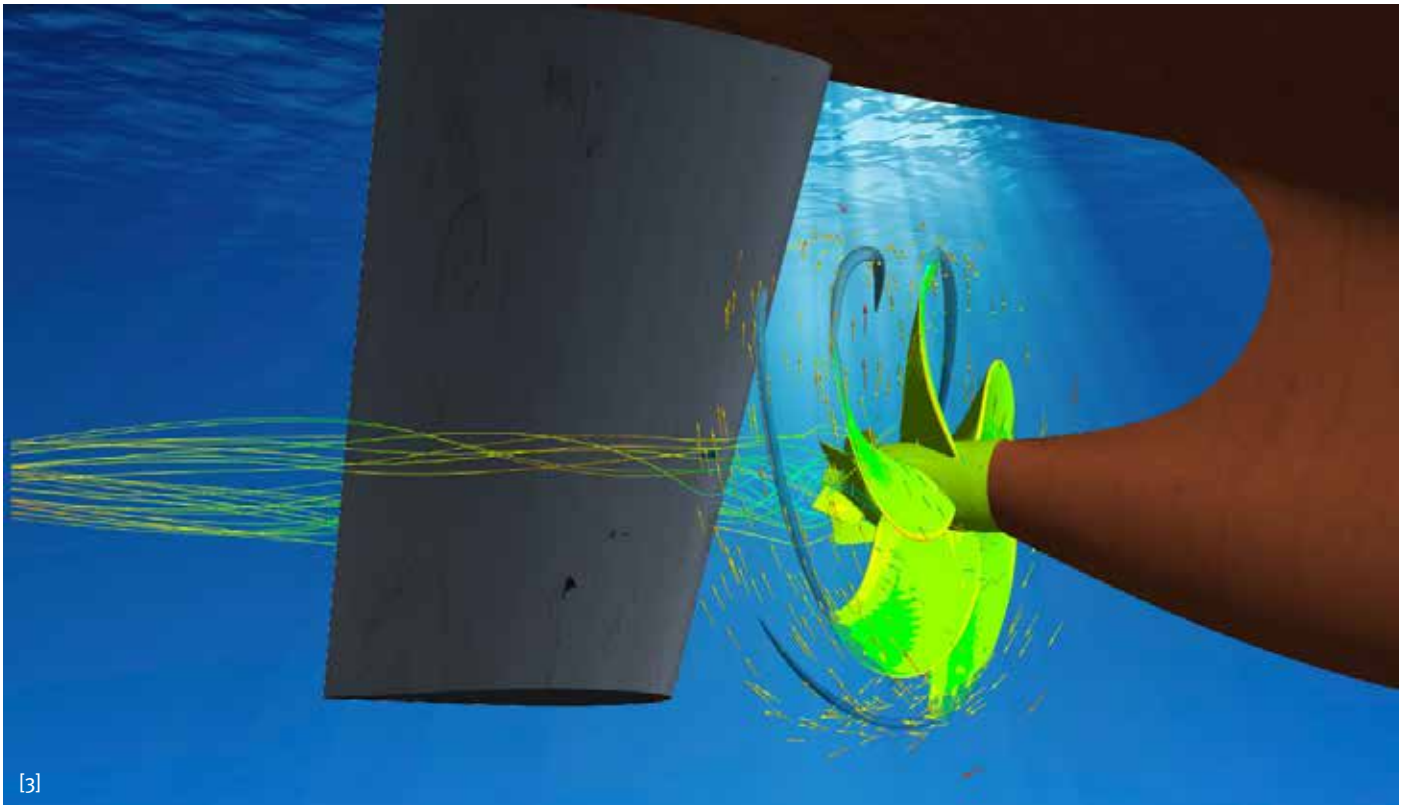
Continuous validation of the numerical procedure is one of the major duties to ensure best quality of the results. Dozens of calculation cases being validated in model basins all over the world took us to the point where we can reproduce model tests within an error range of 2 per cent in measured forces, which might be close to an error range of measuring devices.

Speed of NPS is a very crucial factor, since project schedules in many cases are extremely tight and an advanced method that adopts RANSE CFD is required to deliver best performance and reliability of the product. MMG's investment in high performance computing ensures very reasonable calculation periods using the viscous flow codes ANSYS CFX® and OpenFOAM®. Increasing automatization of the process combined with high performance hardware leads to periods of 2 weeks for an average re-design project comparing 2 propeller designs.

Current targets

Especially comparing devices like propellers, rudders or energy saving devices of any kind is an increasingly demanding task in test facilities depending on model scale factors and thus scaling procedures. Studying scale effects up to full scale, RANSE CFD is object of the current work at MMG's CFD department.

Furthermore we are stepping into procedures to simulate ships in service conditions, investigate altering conditions and sea loads to combine NPS and real life vessel operation.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[3] Numerical Propulsion Simulation

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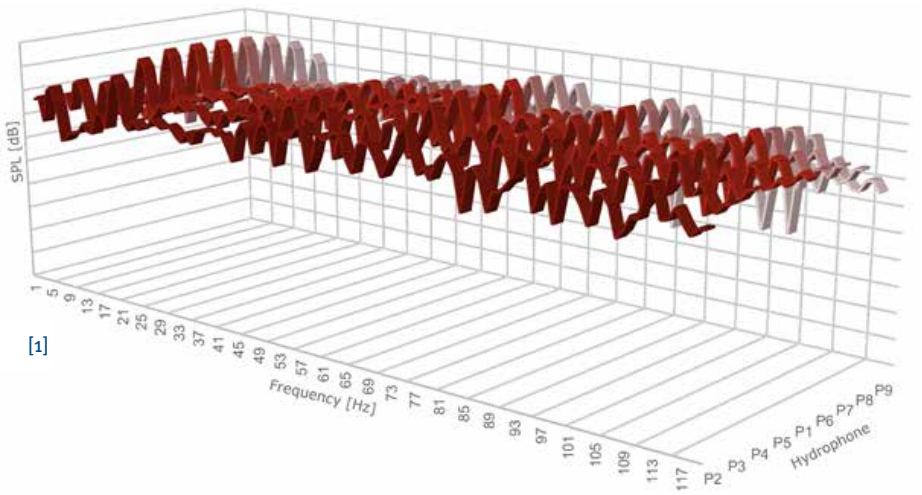
Underwater noise – research for noise less propeller

Due to the increasing traffic volume of sea transportation the level of emitted underwater noise strongly increased within the last decades. Its impact to marine life is turning into major focus of international organisations and governments. Thus regulations for the reduction of underwater noise are in permanent discussion and might come into force in the future. MMG feels a strong responsibility for the marine environment, therefore we contribute to a reduction of propeller-borne noise by ongoing research activities since 2014.



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Current research projects on underwater noise at MMG focus on the numerical prediction of propeller-borne noise and vibration. Consequently, we extend our in-house potential flow and RANSE solvers by modern methods to determine radiated noise of the propeller in the far field (see Figure 1). The calculated sound pressure level is validated by extensive cavitation tunnel tests and full scale measurements (see Figure 2) during these joint research projects. Additionally, we establish best practice procedures in order to reliably predict the emitted propeller noise. The enhancements in understanding of the sources of propeller-borne noise as well as their prediction are used to develop advanced design methods, which allow a propeller design optimized towards multiple criteria: high efficiency and low noise. Our research on noise is done in strong collaboration with national and international partners.

Research and development at MMG has a long tradition. Besides topics on noise prediction MMG's R&D activities currently cover a broad range of technical aspects, starting from loads on propeller in ice up to propeller hull interaction and its scale effects – always with the focus on the ongoing improvement of our products.


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Publications

Damages and Repairs at Marine Propellers
Dock Day, Hamburg, Germany

Development of hub caps fitted with PBCF
SMP, Austin, USA

Propeller im Vergleich
SVA Forschungsforum, Potsdam, Germany

Numerical Towing Tank versus Noon Data
HullPIC Conference, Cortona, Italy

[1] Noise Foot Print · [2] Full Scale Measurement