

Joint Industry Projects as a cornerstone for research

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Introduction

In the dynamic realm of maritime engineering, collaboration stands as a cornerstone for innovation and progress. It's a synergy of minds and resources that propels industry standards forward, setting new benchmarks and unlocking potential previously untapped. At Damen, this ethos is not just a philosophy but a guiding principle, driving initiatives that redefine excellence in shipbuilding. This white paper delves into the culmination of several Joint Industry Projects (JIPs) Damen has contributed to within the field of hydromechanics. In our efforts on hydromechanics research, we witness the evolution from traditional methodologies to cutting-edge innovations, all aimed at enhancing ship design and performance, propeller design and methodology validation. Participating in JIPs not only bolster Damen's position as a leading maritime solution provider but also foster an environment of collective advancement within the industry.

The value of JIP participation

Damen has a well-established RD&I department, so a reasonable question would be to ask why does Damen even need to join these JIPs? The answer to this is multifaceted. Joint Industry Projects bring together industry expertise within a partnership. Typically, JIPs address common challenges within the industry that are often too big, complex or costly to be tackled by one company alone or require specific knowledge or equipment that is not available at a single company. In joint industry projects it is all about cooperation between partners while sharing costs and benefits. With a modest investment by a larger group of partners, there is a significant leverage on the total value of the project outcome. The risk for a company in joining a project of this size is significantly smaller than if it was to undertake this by itself. Besides, endeavouring common technical industry challenges individually would not lead to an industry agreed approach. Damen RD&I actively pursues working in joint industry projects. Especially within the field of hydromechanics, partnering with academia, suppliers, competitors, operators and other businesses is highly valued and have proven to significantly contribute to the research ambitions at Damen RD&I. This paper reviews some prime examples of JIPs and the relevance for Damen.

F & FC series

<https://www.marin.nl/en/jips/wageningen-f-series>

<https://www.marin.nl/en/jips/wageningen-fc-series>



The F and FC series JIPs investigate propeller performance, an essential factor in the performance of all ships. Although Damen is not a propeller designer, by participating in the project, we gain valuable insights from propeller manufacturers while contributing with our own expertise to work toward a unified solution of state of art propellers design suiting our typical application and thus resulting in better performing ships for our customers.

Since its inception in the 1960s, the Wageningen B series has long been regarded as the industry standard in propeller design. However, with the rapid advancements in technology, it has become apparent that the B series is no longer representing modern propeller designs. Modern vessels that Damen builds are designed for higher speeds, increased fuel efficiency and reduced underwater noise impact, which require advanced hydrodynamic profiles beyond what the original B series offers. Additionally, with the development of computational fluid dynamics (CFD) and advanced testing facilities, enabling designers to optimise propeller shape and size for specific vessel types and operating conditions, propeller design has evolved significantly. Recognising this gap, the F series JIP was initiated, aiming to redefine the baseline for propeller performance and efficiency.

Central to the F series' ethos is the pursuit of defining highly efficient propeller designs, at the start of the JIP Damen sat with the other members, who consisted of propeller manufactures, ship operators and other ship yards, to explore the design space by being engaged in this process we managed to shift the tight focus on large container type vessel to a broader range which included smaller workboats, high speed craft, OPVs, yachts and research vessels, a core part of the Damen product range.



From this it was clear that the F series which was focussed on highly efficient propellers, possibly at the cost of cavitation and noise, could not provide the solution for the boarder range of vessels, which often had the stronger requirements for reduced noise.



Therefore, the FC series was created, with the aim of maintaining high standard in energy efficiency but focussing on noise emissions. The FC-Series aims to address the unique geometric characteristics and performance requirements of propellers used in ships where comfort is a priority. With both series finalised, Damen RD&I is actively integrating these advancements into our design processes. This integration ensures that future Damen vessels will benefit from significantly improved propeller performance, characterised by enhanced efficiency and reduced noise emissions depending on design considerations. The project allowed the partners to align on the definition of state of art modern propeller design aspects. The resulted propeller series are a new benchmark that allows Damen to discuss vessel performance with propeller designers and research institutes in the developments of our vessels. This highly benefits the process as the series are recognized as the industry benchmark easing the collaboration between Damen and our suppliers.

JoRes

<https://www.jores.net/>



The JoRes JIP strived to increase confidence in numerical methods and create a basis to further ship performance improvement. It aims to develop an industry recognised benchmark by collecting validation cases both on model

and on ship scale. Building upon prior international workshops on numerical methods in ship flows, the JoRes JIP represented a concerted effort to bridge the gap between theoretical modelling and full-scale results. Included in the list of participants are research institutions, universities, ship builders, operators and the companies that provide the industry with their CFD software.

Traditional ship design practices rely on model tests and in recent years scaled CFD calculations, yet these methods are limited by inherent scale effects and viscous complexities. Scale effects refer to the difference in the behaviour and modelling of the flow around a vessel around a model 1/10th the size of it or smaller. In ship hydromechanics there are two main non dimensional properties that we want to maintain while scaling; the Reynolds number, which describes the change from laminar to turbulent flow, effectively the viscous resistance and secondly; the Froude number which describes the length of the waves the vessel produces in relation to its own length, essential the wave making resistance. These two resistance components when combined account for more than 95% of the total resistance of the vessel. However, when scaling the vessel down geometrically the two do not scale at the same rate, often meaning that model tests focus on one over the detriment of the other. The benefit of using full scale CFD simulations is that this is not a factor of concern. Damen has recognised this and been actively undertaking these simulations over many years, however within the industry the lack of public validation tethers its acceptance.

For every ship that was tested at full scale in the project a full set of Sea Trial Acceptance Tests (SATs) were undertaken using state of art measurement technologies. The input for those cases were provided to all project participants to undertake a blind numerical exercise using their CFD capabilities without sharing the results. Each participant's result was consolidated and plotted against the SAT result, showing the spread the current approach resulted in. Damen also undertook this work and consistently predicted an accurate result for the SAT often within the centre of the spread of the participants, showing that our early adoption of CFD has been successful.

Within the project several different areas were investigated. One of these topics was the effect of roughness at full scale. This has led to several more collaborative research projects on the topic starting as well as Damen's own internal investigation.



The JoRes JIP has now reached its conclusion, delivering 6 ship scale validation cases. Furthermore, ongoing initiatives, such as the blind CFD cases in workshops organised by Chalmers University of Technology and next year's CFD workshop 2025 at MARIN, underscore the industry's commitment to continuous improvement and collaboration. The project has helped bring across the importance of using full scale references to validate CFD within our industry, being fully in line with Damen's vision and future RD&I efforts.

Tripping JIP

<https://www.marin.nl/en/jips/tripping>



This JIP is all about understanding the limitations of scale corrections for marine propellers. While it is well known that model scale tests inadequately capture full scale physics, the utilisation of state-of-the-art methodologies in the F & FC series JIPs identified critical disparity between model test results and full-scale computational simulations concerning fluid flow dynamics around propellers. Consequently, there arose a necessity to enhance model testing methodologies to better mirror real-world conditions. Thus, the conception of turbulators, designed to induce a transition from laminar to turbulent flow, emerged as a promising solution. A notable departure from conventional approaches characterises the methodology of the Tripping JIP. Rather than striving to validate CFD against model tests, this project endeavours to invert the paradigm. By leveraging turbulators to induce a transition from laminar to turbulent flow in model scale tests, the focus shifts towards adapting the model scale tests to align with CFD simulations and thus full-scale reality. While the prior two JIPs on propeller design concluded recently, the Tripping JIP has just started this year, embarking on a three-year journey aimed at refining the insights garnered from

the F & FC series JIPs. Damen is already contributing by taking part in the first two case studies, submitting more than 200 simulations for comparison.

This project is a prime example of how JIPs influence industry as upon successful implementation and validation. Looking forward, the inception of the Tripping JIP heralds a new chapter in methodology refinement towards enhanced performance modelling. This pioneering methodology will be proposed to the International Towing Tank Committee (ITTC) as a superior alternative to the current practices and should be adopted as the new standard. Therefore, it is imperative that Damen is at the table when such a fundamental aspect of performance prediction is changed on such a far-reaching level.

Conclusion: Top of Form

The importance and value of the F & FC series JIPs, as well as the JoRes and Tripping JIPs, cannot be overstated. These initiatives have collectively spearheaded a transformative era in propeller design and ship performance validation, setting new benchmarks and pioneering novel methodologies. By addressing critical issues such as noise reduction, scale correction, and the utilization of full-scale CFD simulations, these projects have significantly enhanced our understanding and capabilities within the maritime industry. The collaborative efforts and shared insights among industry stakeholders have not only propelled technological advancements but have also fostered a spirit of collective progress and innovation.

It is through such dedicated efforts and partnerships that we continue to push the boundaries of what is possible in maritime engineering. Damen with its ship design and building activities holds a strong position in the maritime sector and is often sought for participation in JIPs. We are often involved in the early proposal stages of JIPs to provide feedback. This has come about due to our proven track record of participation and engagement, a legacy we seek to continue. The collaborative nature of the joint industry projects has served Damen needs and research ambitions, and we continue to shape further projects and the direction that the industry is moving in. 🏠