

MARINE

Demcon multiphysics

Moving simulation for uncrewed surface vessels in house to save €10,000 per simulation per design iteration

Product

Simcenter

Business challenges

Leverage aviation knowledge in the maritime industry

Optimize the design of a new USV that can be used at sea

Simulate complex operating conditions such as wave interactions at sea

Keys to success

Leverage multiphysics simulation to represent real-life operating conditions

Use Simcenter STAR-CCM+ to speed up setup and simulation

Use visualization tools to have meaningful conversations with nontechnical personnel

Results

Completed simulation for each design iteration in under two weeks

Saved €10,000 per simulation per design iteration by conducting simulation in-house

Achieved significant improvements in vessel efficiency and sustainability

Reduced new hire ramp-up time due to comprehensive documentation and software capabilities

Demcon multiphysics uses Simcenter STAR-CCM+ to reduce simulation time for each design iteration to under two weeks

Using advanced simulation for strategic innovation

Demcon multiphysics, which is part of the Demcon group, is an engineering consultancy firm focused on using simulations to tackle complex engineering challenges. Demcon multiphysics supports a wide range of projects, from large initiatives requiring multiple engineers to smaller ones. In today's rapidly evolving engineering landscape, accurately and efficiently simulating complex systems has become a vital competitive advantage. "Our projects are truly multiphysics, as we need to

account for flow, thermal, structural mechanics, electromagnetics and acoustics," says Ivor Cleine-Koopmans, a senior engineer. "It's the combination of all these factors that enables our expertise to stand out."

"We use Simcenter STAR-CCM+ to tackle complex computational fluid dynamics problems, such as simulating boats in waves, dam simulations and reacting flows," says Marijn Kalter, a multiphysics engineer. "After a short trial period, we found it beneficial for fluid-structure interactions and discrete elements. We now apply Simcenter STAR-CCM+ to more advanced CFD simulations, including two-phase and reacting flows, for many more projects than we initially anticipated."





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Multiphysics Engineer
Demcon multiphysics

Bridging the sky and sea

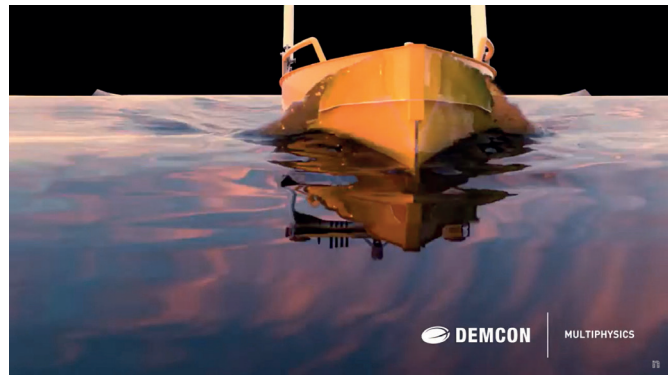
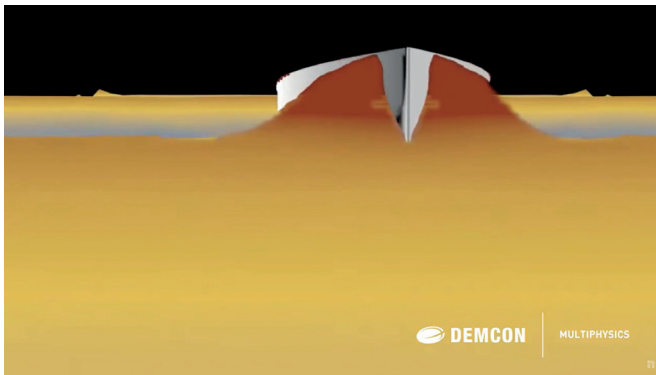
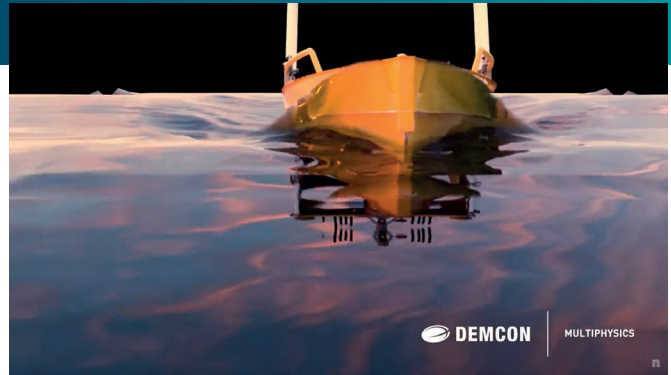
One project that greatly benefited from computational fluid dynamics (CFD) simulation involved developing an offshore uncrewed vessel. This project was a collaboration with Demcon unmanned systems, also a part of the Demcon group. The collaboration centered around optimizing the design. Demcon unmanned systems is a leading name in electric autonomous uncrewed vessels.

The organization’s portfolio includes uncrewed vessel design and build, autonomous navigation software and platform development. “Although we didn’t have a track record in the maritime domain when we started, we had years of uncrewed

system development experience in the aviation sector, and our process was based on systems engineering,” says Fedor Ester, one of the company’s founders. “Therefore, we guide our customers through every development and engineering stage, validate every step with concrete results and build trust using documentation and a robust quality process. That gives us a unique edge.”

What also gave Demcon unmanned systems a unique edge was the collaboration with Demcon multiphysics. They used Simcenter™ STAR-CCM+™ software – part of the Siemens Xcelerator business platform of software, hardware and services – for seakeeping and stability simulations of the unmanned vessels.





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The seakeeping simulations were a crucial part of the process. “There are many unknowns in vessel design; for example, can we determine how the thrusters perform when impacted by a certain wave?” says Ester. “How does a vessel perform in specific weather conditions? To answer these questions, we set up a replicable simulation environment for extensive testing. That’s where our collaboration with Demcon multiphysics simulation came into play.”

When considering new vessel designs, the team needed to account for multiple factors: turbulence detection, air-water interaction, stability and the overall performance of the vessel under different conditions. This is where computer-aided engineering (CAE), particularly CFD software, proved helpful. “Simulation enables us to make quick design iterations for any new vessel or payload integration we’re developing,” says Ester.

“When the software is user friendly, we can train new users efficiently, allowing them to focus on their tasks rather than struggling with the software. Simcenter STAR-CCM+ adds value to our projects in this way.”

Ivor Cleine-Koopmans
Senior Engineer
Demcon multiphysics



The vessels, equipped with sensors on the bottom, must maintain constant contact with water, as air could impact underwater sound signals and affect accurate measurements. This was assessed for different wave types with CFD simulations. Furthermore, the vessel needed to operate in open sea conditions, which involved exposure to larger waves and disturbances, unlike its counterparts that mainly stayed in inland waters. Assessing its seaworthiness with CFD simulations was essential.

“The extensive example database in Simcenter STAR-CCM+ and the ability to exploit symmetry significantly sped up our setup and simulation time,” says Kalter, who set up the simulation for this project. Cleine-Koopmans concurred, highlighting the importance of having access to the right solutions while guiding junior engineers: “Marijn joined us after completing his master’s degree, and this was his first

venture into the maritime field. We had to explain the critical factors in vessel design to him. When the software is user friendly, we can train new users efficiently, allowing them to focus on their tasks rather than struggling with the software. Simcenter STAR-CCM+ adds value to our projects in this way.

“When we started on the project, we had specific questions regarding the sensor package and air entrapment. We wanted to visualize the results, so we plotted the average volume fraction of air and water beneath the sensor package at specific locations, which provided valuable insights. We then generated a short animation from the vessel’s underside to illustrate what was happening. The team from Demcon unmanned systems requested two or three different conditions, and we quickly ran through them, exploring several other scenarios as well.

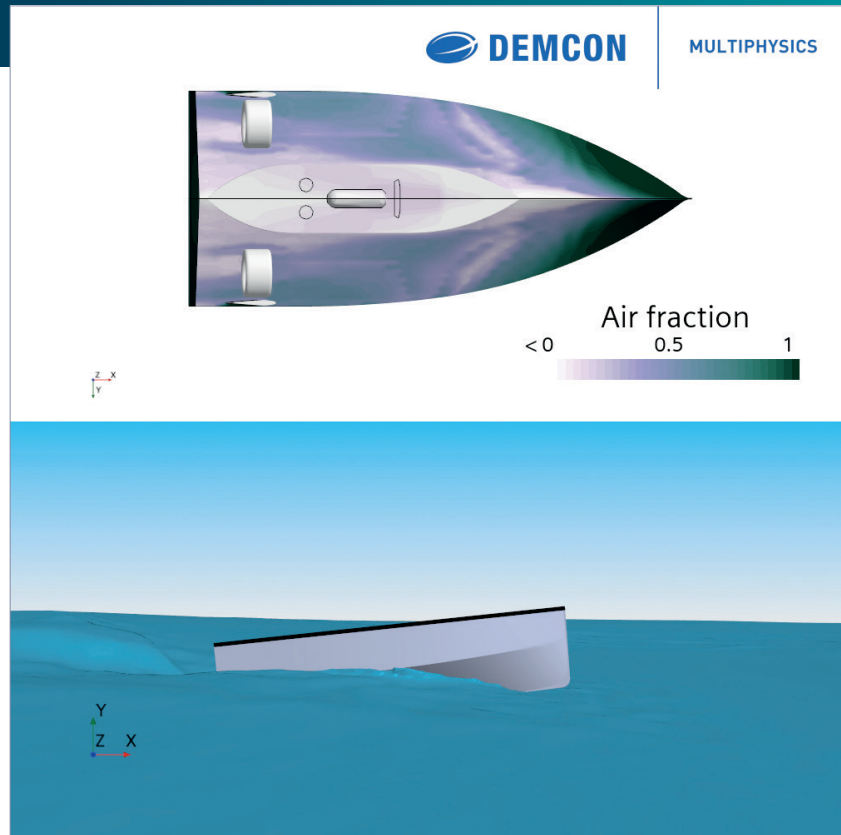
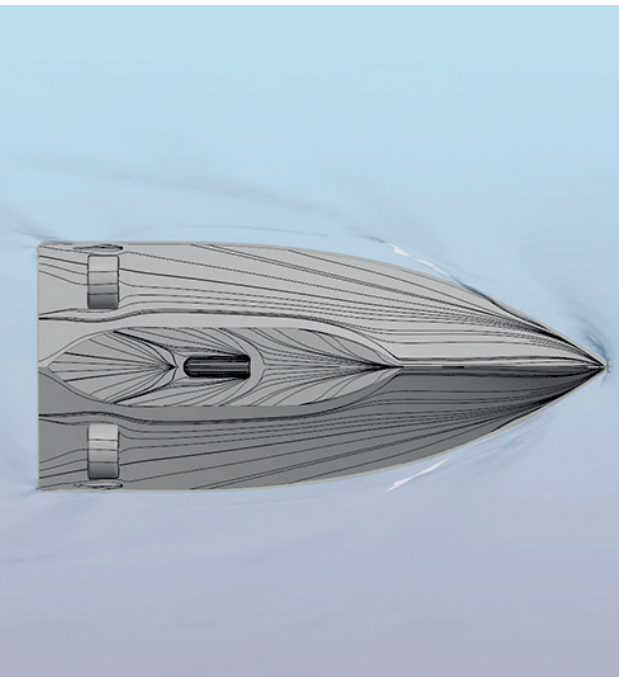


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They had a relatively small vessel facing large waves, and it sailed smoothly over them without any issues. However, when we examined very short waves that passed beneath the vessel's length, we encountered challenges. This analysis allowed us to understand the operational limits of the vessel."

Kalter has discovered several Simcenter STAR-CCM+ tools that have enabled the team to rapidly start testing wave configurations: one with a short wavelength and small amplitude, and another with a large wavelength and amplitude. For example, initializing the wave was straightforward, allowing the team to set the wave height within a day and begin the simulation. The various options for wave initialization and boundary conditions helped optimize the simulation run time. "We shared movies, images and plots showing the pitch and heave of the boat with the naval architect," says Kalter. "By using Simcenter STAR-CCM+, we were able to advise them on moving the sensor package and suggested some other design changes," adds Cleine-Koopmans.



The design was further refined, and the team provided additional insights into the keel design. The naval architect from Demcon unmanned systems also inquired whether it was possible to determine the vessel's roll decay or coefficient to support his stability calculations. "We started by positioning the vessel in a steady state of water inclined at the angle, releasing it and letting the roll decay naturally," says Cleine-Koopmans. "We obtained a clear plot that illustrated the roll decay over time. This information was then used by the naval architect for their calculations to further optimize the design."

"We spent about two weeks on each design iteration to investigate and resolve various issues," says Kalter. The client company, which excavates shoals from the seabed to accommodate larger boats, uses these inspection vessels in their operations. Currently, multiple uncrewed vehicles are in operation, with the Demcon team optimizing the design of the latest and largest vessel for open sea conditions. The team envisions future simulations in

Solutions/Services

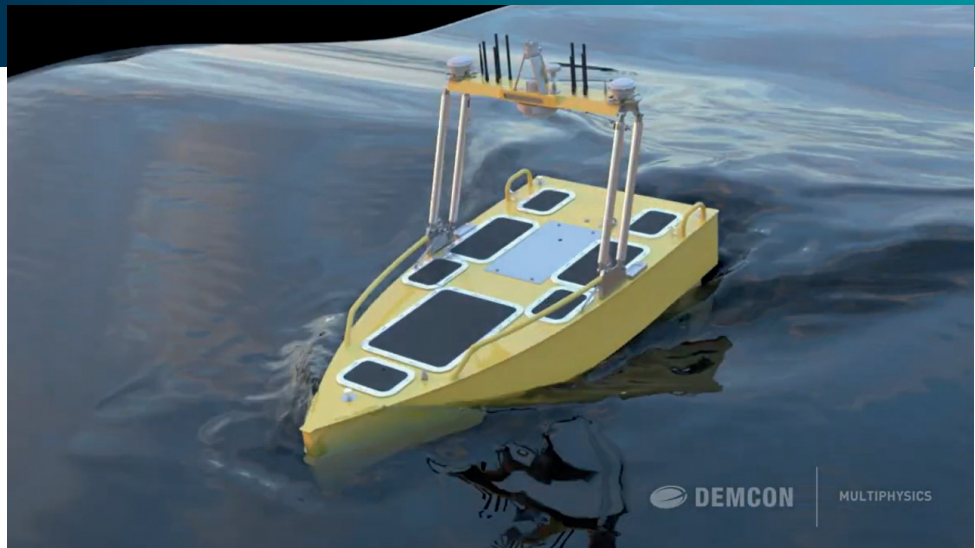
Simcenter STAR-CCM+
siemens.com/simcenterccm

Customer's primary business

Demcon multiphysics provides advanced simulation services, powering the development of groundbreaking products and complex systems. By applying physics expertise in diverse markets – from the food industry to nuclear fusion and anything in between – Demcon multiphysics crafts innovative engineering solutions that push boundaries.
<https://multiphysics.demcon.com>

Customer location

Enschede
The Netherlands



which the boat follows specific trajectories, leveraging the many available options to make appropriate choices based on the vessel's needs.

"We completed an entire performance iteration before testing in water, which is generally reserved for large investments and not typically done for smaller vessels," says Ester. "However, we do it for small vessels to ensure high-quality designs. Having our colleagues from Demcon multiphysics conducting the simulations allows for fast iterations. That way, we achieve results very fast," Ester noted.



This approach also enables material optimization, resulting in smaller systems and an overall better design. Using simulations to optimize the design reduces material usage and enhances environmental sustainability too. Understanding the design's limitations allows for more precise safety margins, leading to more efficient and sustainable vessels. Improved sailing performance and reduced fuel or power consumption are additional benefits of this optimized design process.

Together, Demcon multiphysics and Demcon unmanned systems continue to improve maritime automation, combining technological innovation with practical applications. Their success story demonstrates how their expertise has enhanced maritime technology, creating safer, more sustainable and more efficient operations. "This represents a new way of working that requires a new design philosophy," says Ester, who says simulation-driven design and cross-industry expertise will shape the next generation of maritime technology.

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