



CAPEHORN ENGINEERING

CFD SPECIALISTS & MARINE TECHNOLOGY SOLUTIONS

SHIP & YACHT OPTIMISATION

YACHT RACING DESIGN

RENEWABLE ENERGY



Welcome to Cape Horn Engineering

Cape Horn Engineering is a UK based company, best-in-class independent CFD (Computational Fluid Dynamics) consultancy with clients all over the world. Industry leaders in CFD and marine technology solutions, specialising in performance prediction of cargo ships, renewable energy structures, racing sailing yachts, superyachts, motor boats and more.

Our CFD methods cover a large variety of flow behaviours and includes free-surface flow, viscous flow, full-scale performance prediction, fluid-structure-interaction, dynamic behaviour and design optimisation.

Cape Horn Engineering was founded in 2007 by Dr.-Ing. Rodrigo Azcueta with the vision of providing world-class expertise in marine CFD to support the design of racing yachts. We have since been involved in four America's Cup campaigns and the yachts designed with our technology have dominated the Around-the-World Volvo Ocean Race for almost a decade, winning three times in a row.

Our technology and experience, grown in this competitive sport environment, has trickled down to other sectors like the recreational and maritime industry. Our flow analyses have been proven time and again in a wide variety of other marine applications including power boats, fully foiling and foil assisted high speed vessels, advanced and unconventional vessels, commercial cargo ships, and offshore platforms for renewable energy.

Working for the America's Cup requires rigorous testing and validation to remain competitive at the highest level. It also means access to large resources, working in a team and benefiting from other disciplines. R&D and validation has always remained a corner stone in the development of our methodologies and experience.



SHIP & YACHT OPTIMISATION

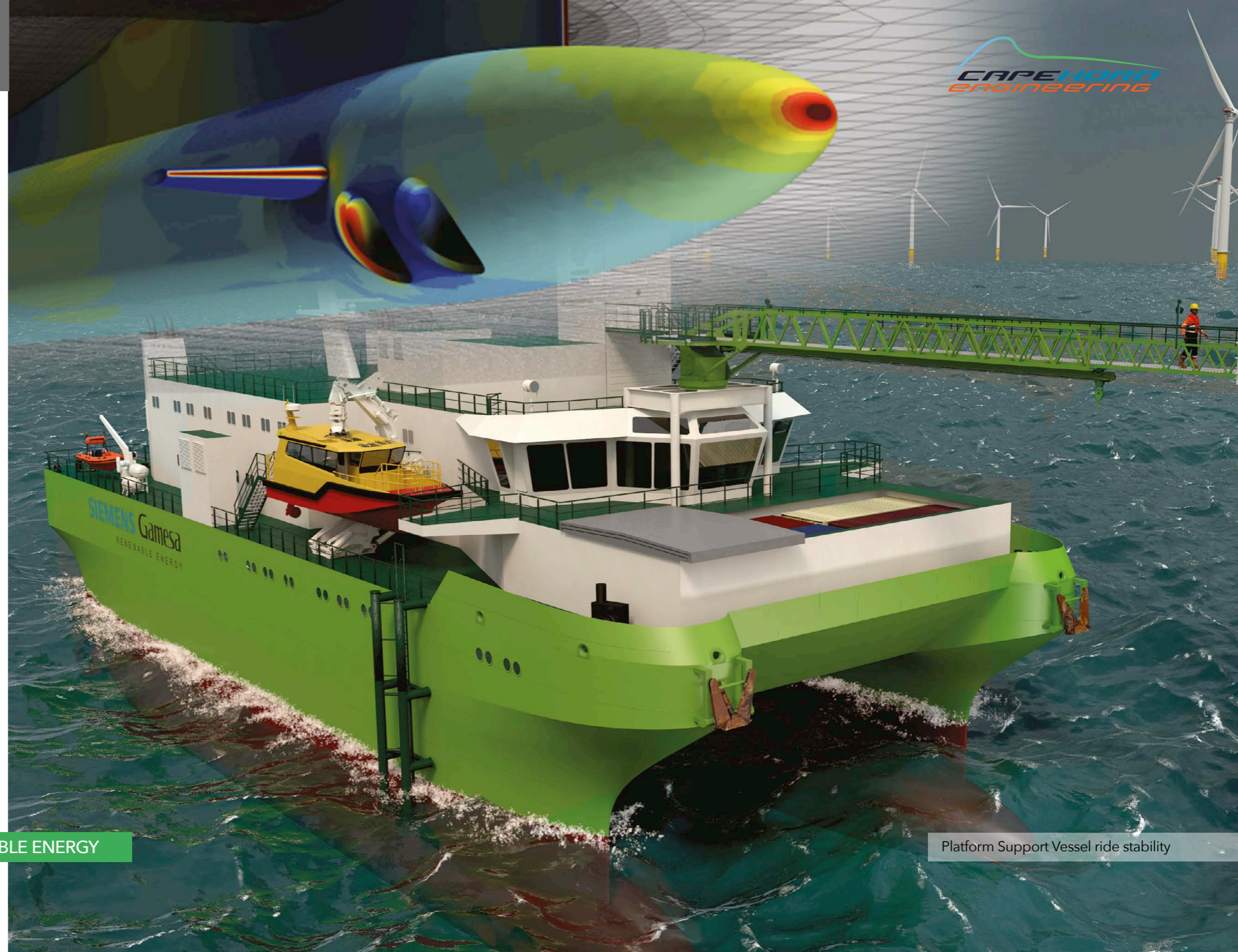
YACHT RACING DESIGN

RENEWABLE ENERGY

America's Cup design optimisation

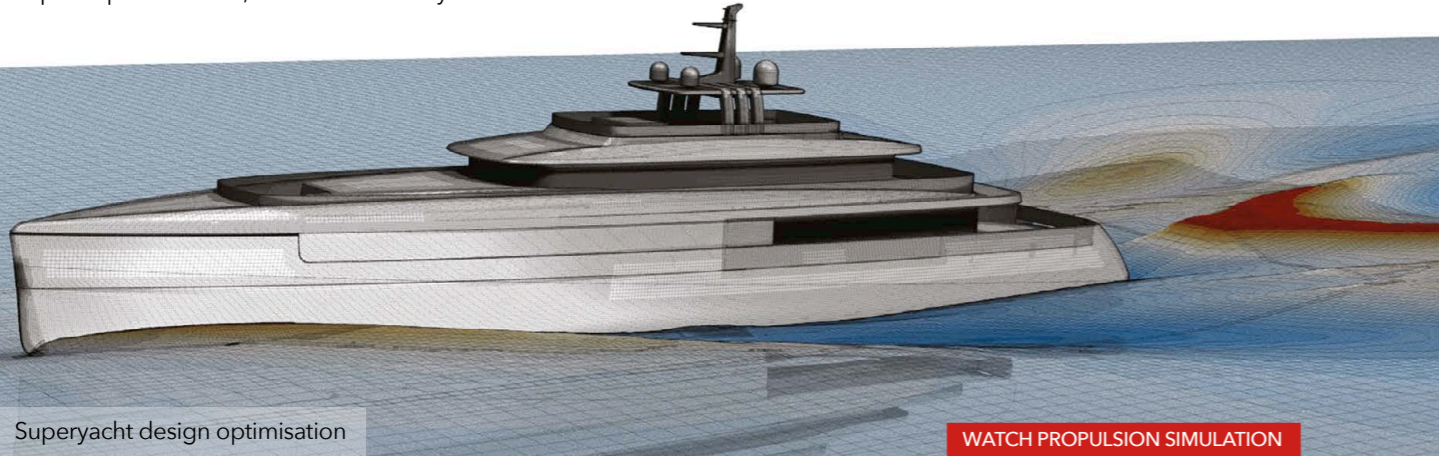
What are the main features of our simulations?

- * Years of verification and validation with towing tank, wind tunnel tests and in some cases with full scale sea trials
- * No compromise on software quality, we use the best CFD package on the market, STAR-CCM+ from Siemens PLM
- * Our work flow is highly automated, which allows us to run hundreds of simulations per day
- * We have access to large High Performance Computing clusters and large amounts of software licenses
- * Hydrodynamic simulations are run at full scale including all appendages and details. No need for extrapolation from model scale
- * The simulations include the free surface deformation and the dynamic sailing attitude of the vessel
- * They can include complex physical phenomena when present, like cavitation, transition laminar/turbulent flow, ventilation, sprays, etc
- * We simulate ship motions in incoming waves of any direction, also surfing down a wave is possible
- * There is no restriction on the amplitude of the motion, even capsize events are possible
- * Fluid Structure Interaction for hydrofoils and other structures
- * Aerodynamic simulations in steady state or transient flow, coupled to FEA model for deformation of sails
- * Slamming loads, sloshing, water entry, wave piercing, water on deck and any associated dynamic phenomena
- * Any detail of the superstructure can be taken into account in aerodynamic simulations
- * We can perform simulations of manoeuvres according to ITTC procedures
- * Propulsion simulations using different levels of fidelity, from virtual discs to rotating propellers



Platform Support Vessel ride stability

Cape Horn Engineering have pioneered RANSE based CFD since its very beginning and continues its research work on a daily basis. Due to our proven expertise in the America's Cup, Volvo Ocean Racing and other high profile sporting events, we can apply this cutting edge technology to a wide variety of other marine applications including commercial cargo ships, power boats, fully foiling and foil assisted high speed vessels, advanced and unconventional vessels, to save fuel and to improve performance, comfort and safety.



Superyacht design optimisation

[WATCH PROPULSION SIMULATION](#)

Using CFD technology

We use advanced visualisation techniques to understand the flow features and to share that knowledge with clients. We post-process the simulations in a way that the designers obtain load cases and internal forces and moments for dimensioning the appendages of their designs. We carry out Fluid Structure interaction for appendages and sails. We assess cavitation in the appendages of all high speed craft. We have developed foil section optimisation loops that take into account transition and cavitation. For extensive design campaigns we optimise hull and appendage shapes using modern optimisation techniques like neural networks response surface models and optimisation algorithms.

CFD technology is a huge benefit for naval architects when optimising any vessel. Historically, designers have used more traditional technology, such as towing tank tests for their final designs to make sure they meet their clients' requirements. But the force similarities between the model at scale and the real ship cannot be achieved in a towing tank, which makes testing complex, based on assumptions and empirical formulations.

Today, using CFD eliminates this problem, since it models the vessel at full size, and captures the stern wake and boundary layer effects directly at full size. Other advantages of CFD compared to tank testing is that realistic moments of inertia and VCG are easily achievable in simulations as well as the decomposition of forces and moments by components like hull and appendages, and by physical origin like friction and pressure. Moreover, CFD offers a greater insight into the details of the flow through images, video animations or interactive visualisation files. Even virtual and augmented reality is starting to make an impact today. CFD also offers substantial reductions in time and costs compared to physical models.

[SEE CASE STUDIES](#)

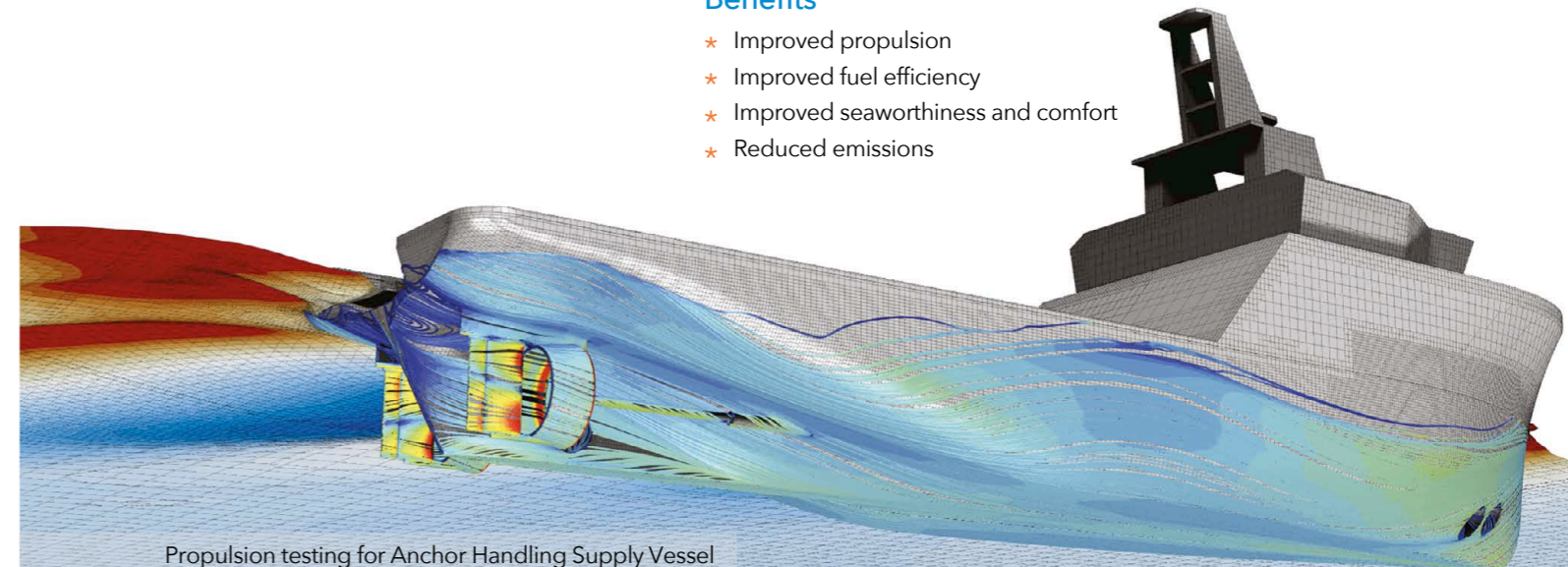
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Advantages of CFD compared to tank testing

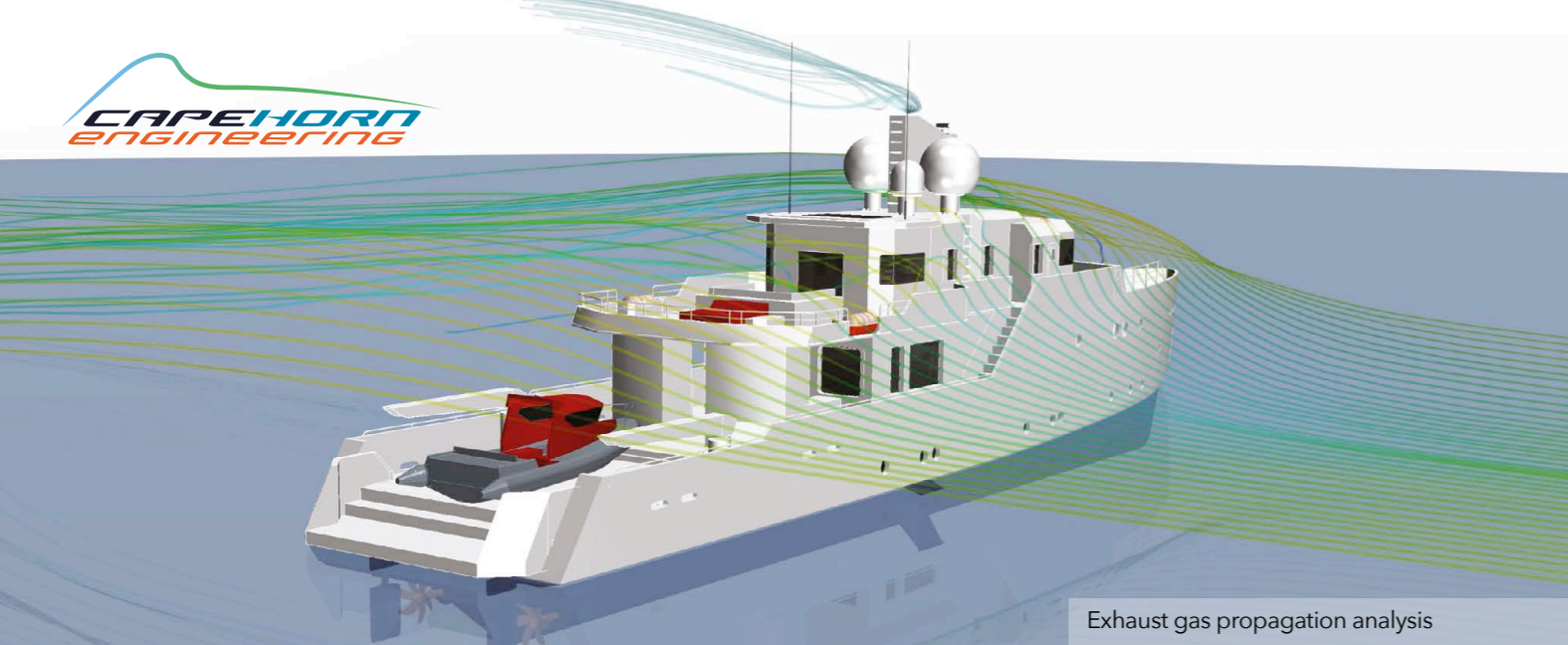
- * All simulations are at full scale
- * Simulations use realistic inertias and centres of gravity (something not feasible in tank testing)
- * Oblique incident waves coming from any direction can be simulated, tank testing is usually limited to head waves
- * Decomposition of individual forces and moments for the hull and each appendage
- * Precise analysis of motion velocities, accelerations and trajectories of the body
- * Flow visualisation and animation to gain insight and understanding about differences between designs
- * Simulations are 100% reproducible
- * Hull or appendage shapes can be easily changed without building new models
- * It is easy to test many design configurations i.e. to swap appendages
- * Easily test in a variety of sailing conditions (speed, wave characteristics) to compare performance
- * Time and cost reduction

Benefits

- * Improved propulsion
- * Improved fuel efficiency
- * Improved seaworthiness and comfort
- * Reduced emissions



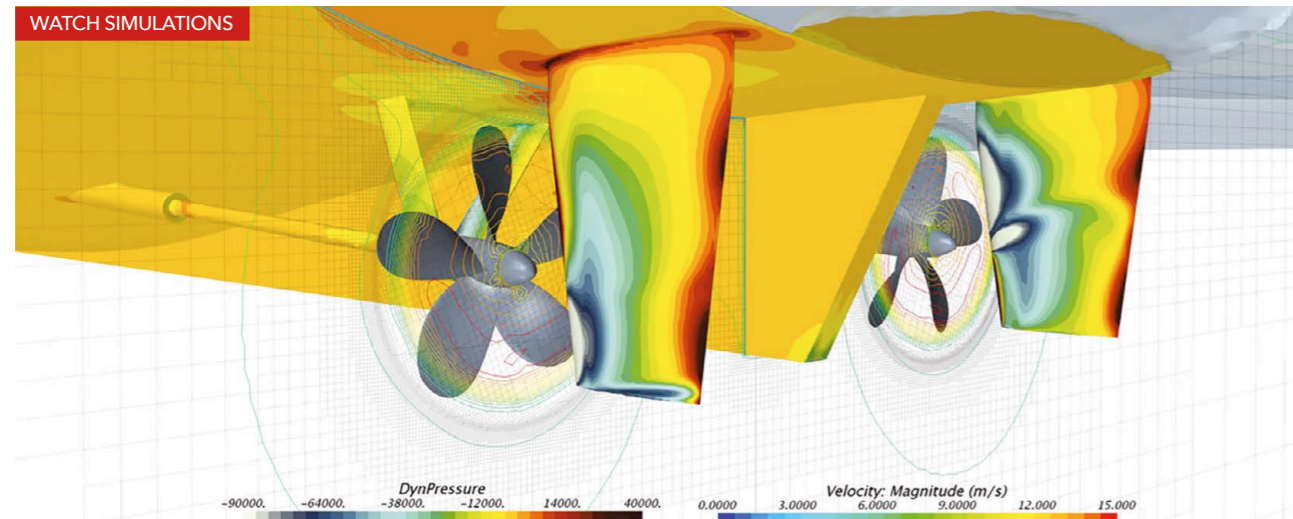
Propulsion testing for Anchor Handling Supply Vessel



Exhaust gas propagation analysis

A good design process involves investigating the hull with its appendages and propellers simultaneously, as there is no isolated engineering component without an effect on the whole system. CFD allows us to perform calculations on the system as a whole, so the design process can be steered for fuel efficiency, comfort and safety.

CFD technology can also be used for aerodynamic simulations to capture wind effects around exhaust vents in order to investigate where the smoke will travel for passenger comfort.



WATCH SIMULATIONS

SHIP & YACHT OPTIMISATION

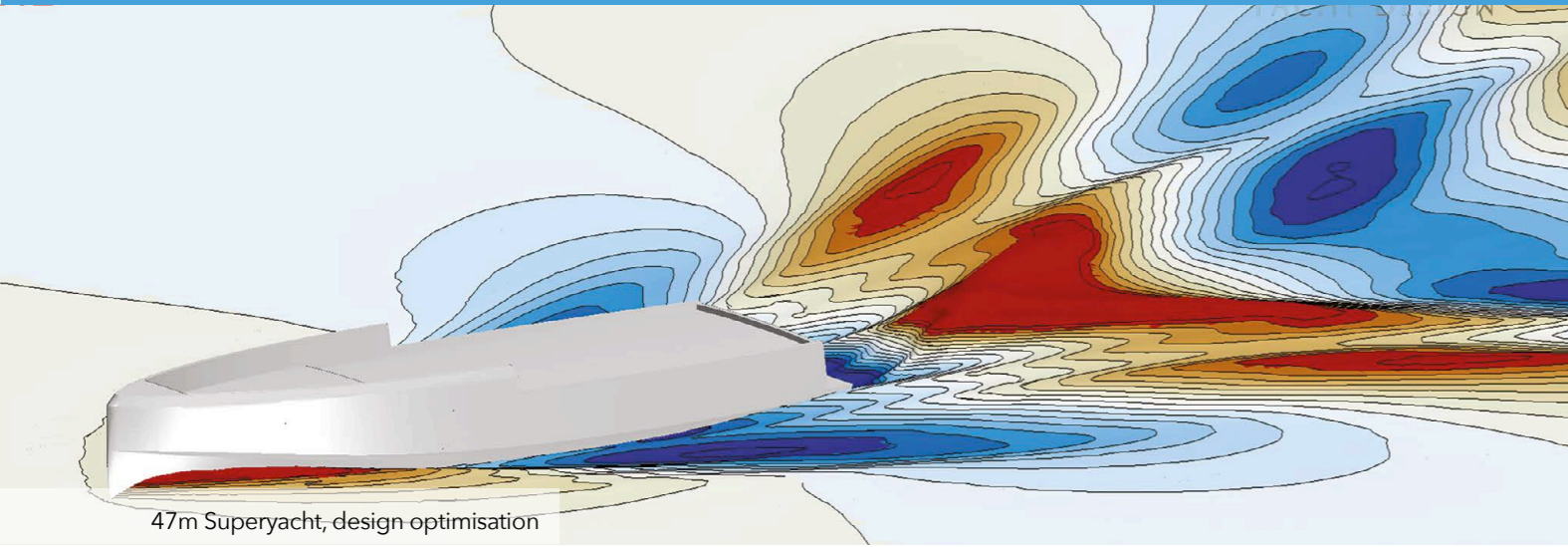


CFD validation for Fleming 58

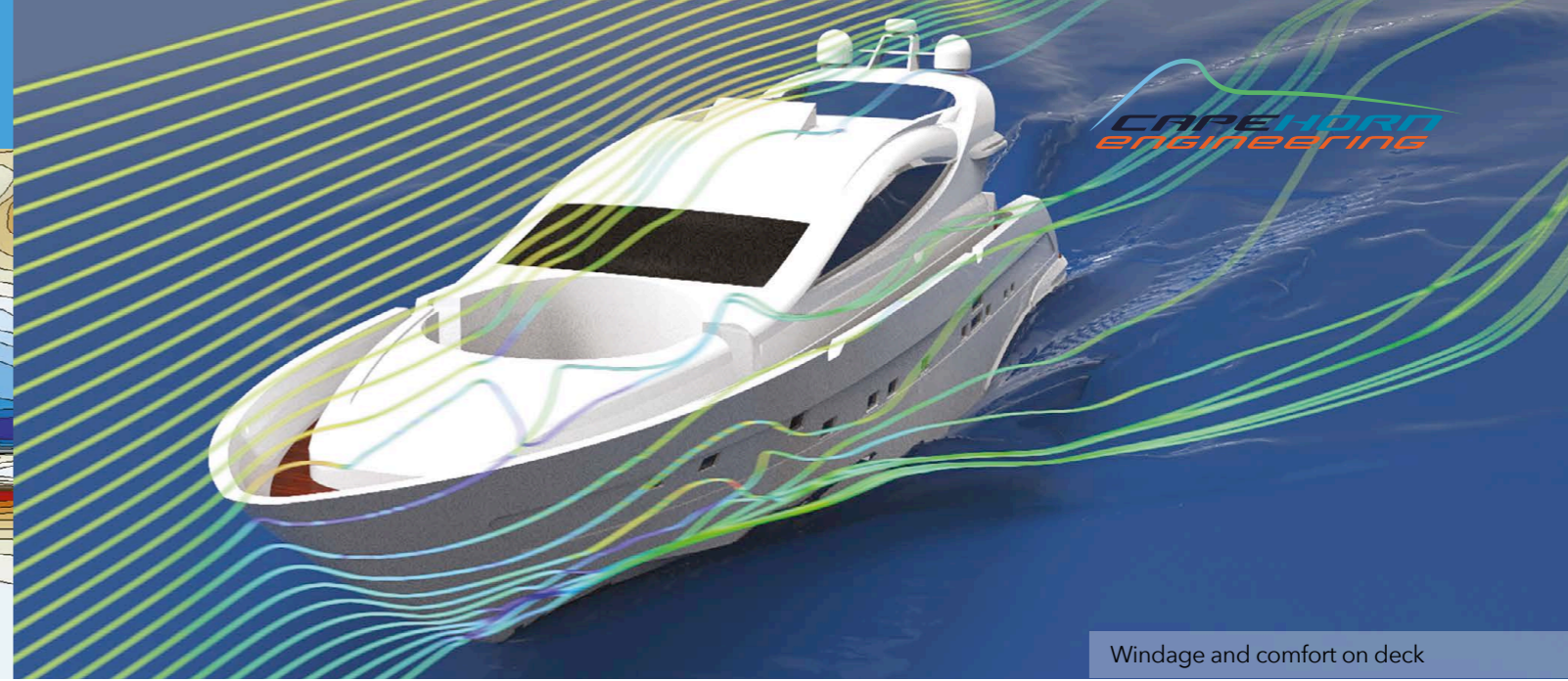
SEE CASE STUDY

Areas where we can help...

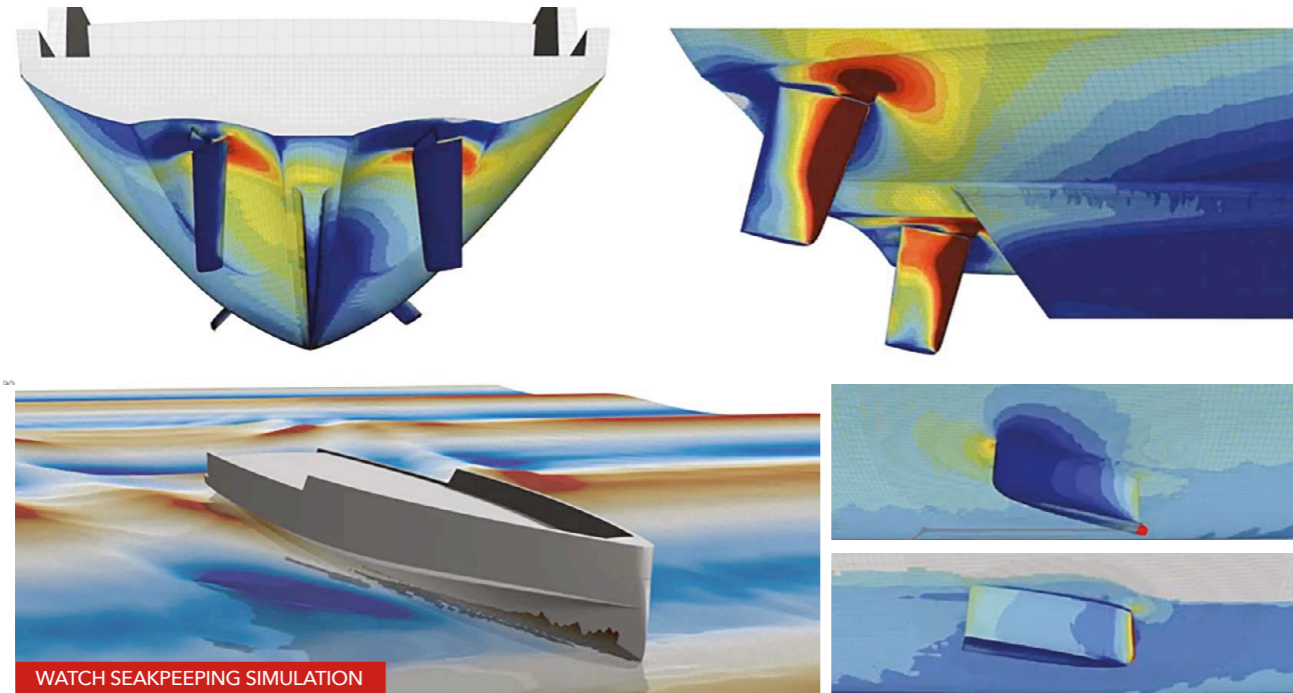
- * Hull and appendages performance and optimisation
- * Propulsion, propeller selection, fuel consumption and delivered power
- * Cavitation on propellers and Energy Saving Devices (ESD)
- * Energy Efficiency Design Index (EEDI)
- * Manoeuvres according to ITTC procedures
- * Appendage torque and bending moments and load cases
- * Seakeeping, added resistance, motions and accelerations
- * Slamming loads, water on deck and sloshing
- * Global ship bending moments in waves
- * Damage stability, ship launching and life boat launching
- * Roll damping, performance of fin stabilisers, trim tabs and interceptors
- * Fully foiling and foil assisted vessels
- * Cavitation on hydrofoils and 2D foil section optimisation
- * Fluid Structure Interaction (FSI) of appendages
- * Occupant safety and comfort including local wind effects and exhaust gas
- * Windage and structural wind loads on superstructures
- * Ship Helicopter Operating Limits (SHOL)
- * Engine room and cargo hold and cabin ventilation



47m Superyacht, design optimisation

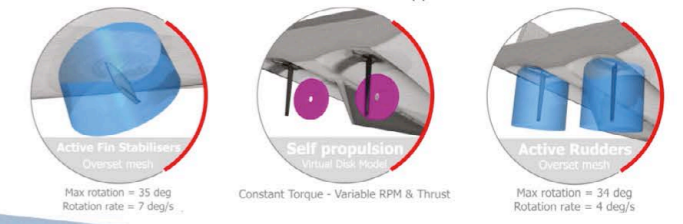
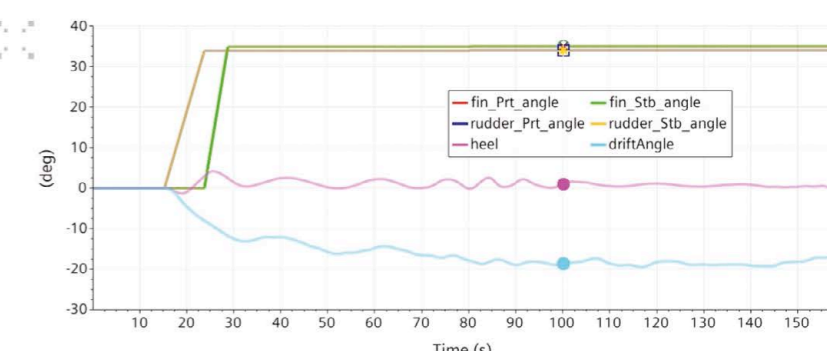
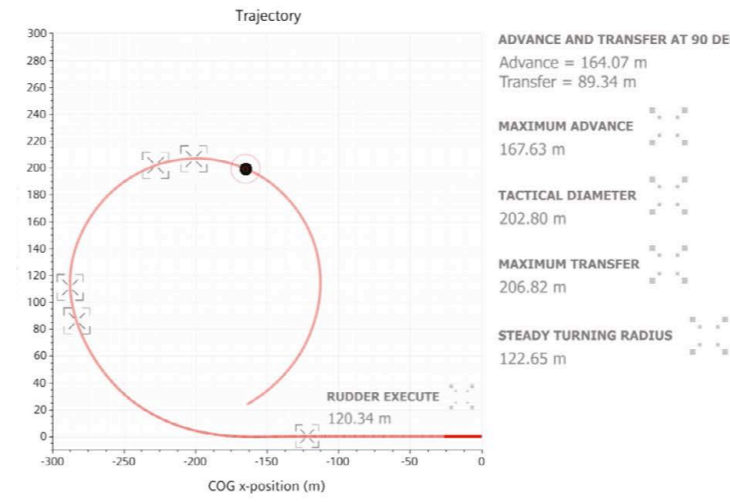


Windage and comfort on deck

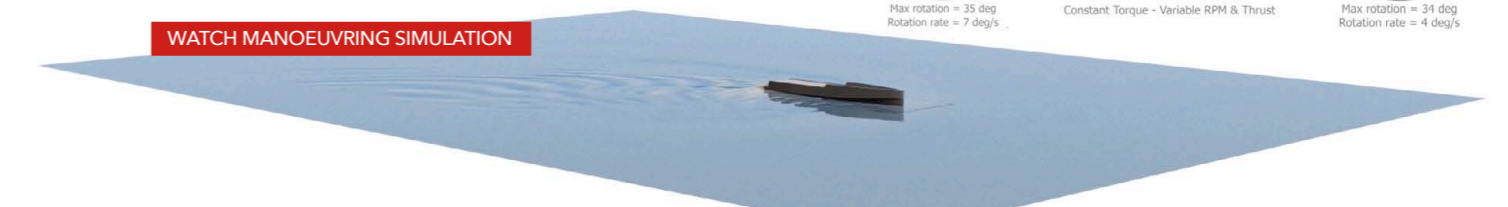


WATCH SEAKEEPING SIMULATION

Some examples of recent projects: 47m Superyacht design optimisation, windage and comfort on deck assessment, standard manoeuvring (turning circle) analysis according to ITTC standards, motor yacht seakeeping analysis.



WATCH MANOEUVRING SIMULATION



Dr.-Ing. Rodrigo Azcueta has been at the core of simulation based America's Cup and Volvo Ocean Race design campaigns for 15 years, always pushing the boundaries. Our designs and engineering solutions have helped three sailing teams win the famous Around-the-World Volvo Ocean Race: ABN Amro in 2005/06, Ericsson Racing Team in 2008/09 and Groupama Sailing Team in 2011/12. We have been involved in 4 America's Cup Campaigns: the 32nd with BMW Oracle Racing, the 33rd with Team Origin, the 34th with Artemis Racing, the 35th with Land Rover BAR.

After our successful involvement in the design of the foils of the previous HUGO BOSS, without doubt the fastest boat in the fleet during Vendee Globe 2016-2017, we were proudly commissioned again by Alex Thomson Racing to assist in the design of the new foil system for the recently launched, next generation IMOCA Open60 HUGO BOSS.

How can we help you win races?

- ★ Running simulations to help design the sails, hull and appendages of your boats
- ★ Running Velocity Prediction Programs to assess the yacht performance and optimising your design for a given handicap system
- ★ Using state-of-the-art optimisation methods and algorithms to come up with the best design for a given condition or multiple conditions in yacht racing
- ★ Obtaining accurate load cases for reliability or for designing structures to the edge when it matters



WATCH AERODYNAMIC SIMULATION

HUGO BOSS, CFD airflow



WATCH HYDRO YACHTS SIMULATION

HUGO BOSS, designed for Vendee Globe 2021

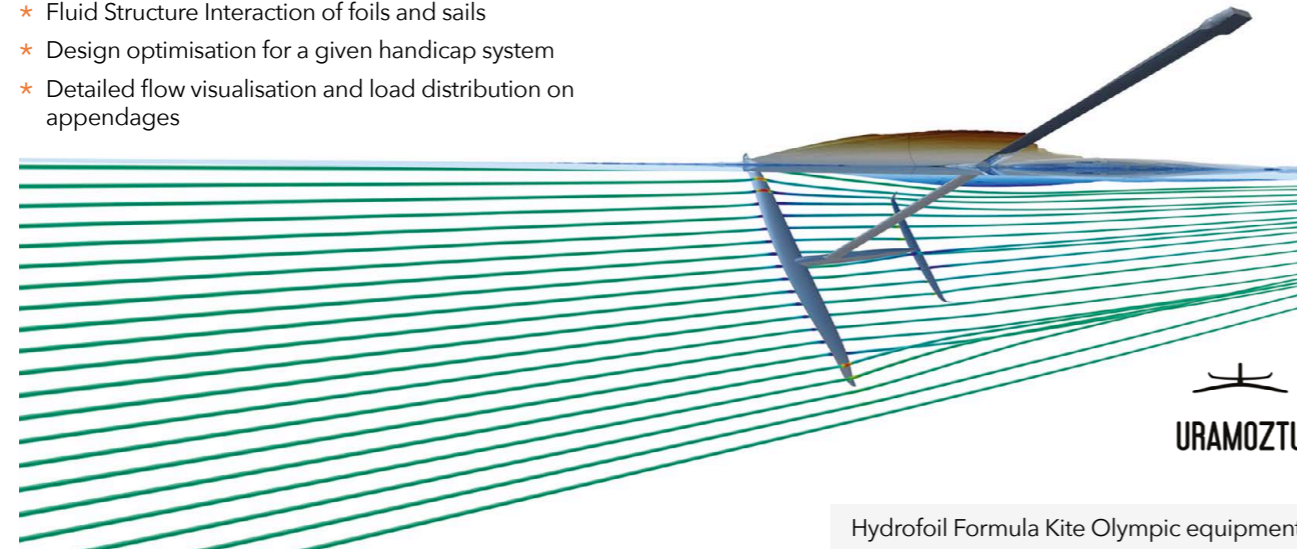
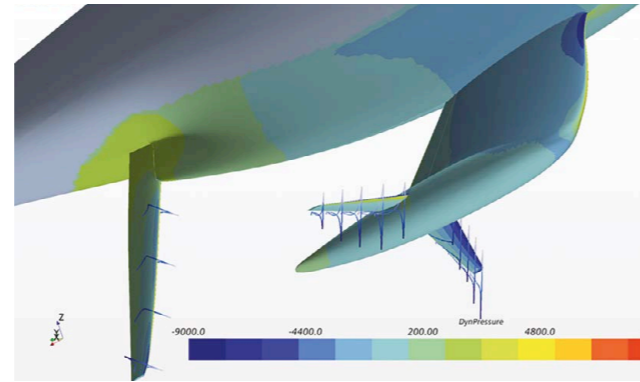
Making a difference...

Cape Horn Engineering's methodologies have been developed and rigorously tested in a highly competitive environment, where the slimmest of margins can make the difference between winning and losing a race.

Besides America's Cup, VOR70 and Open60 we have helped design winning yachts for ORC, IRC, Superyacht class, 12 and 6mR, Olympic classes including Formula Kite hydrofoils, TP52s, Mini Maxis, classic yachts, production boats, the list is endless.

You may be interested in...

- * VPP and Polar curve
- * Hull and appendages performance and optimisation
- * Yaw balance, appendage torques and bending moments, load cases
- * Seakeeping, added drag, motions and accelerations, slamming loads
- * Sail design and sail coefficients
- * Windage of hull, deck and rigging
- * Cavitation on hydrofoils
- * 2D foil section optimisation, laminar sections free of cavitation
- * Fluid Structure Interaction of foils and sails
- * Design optimisation for a given handicap system
- * Detailed flow visualisation and load distribution on appendages

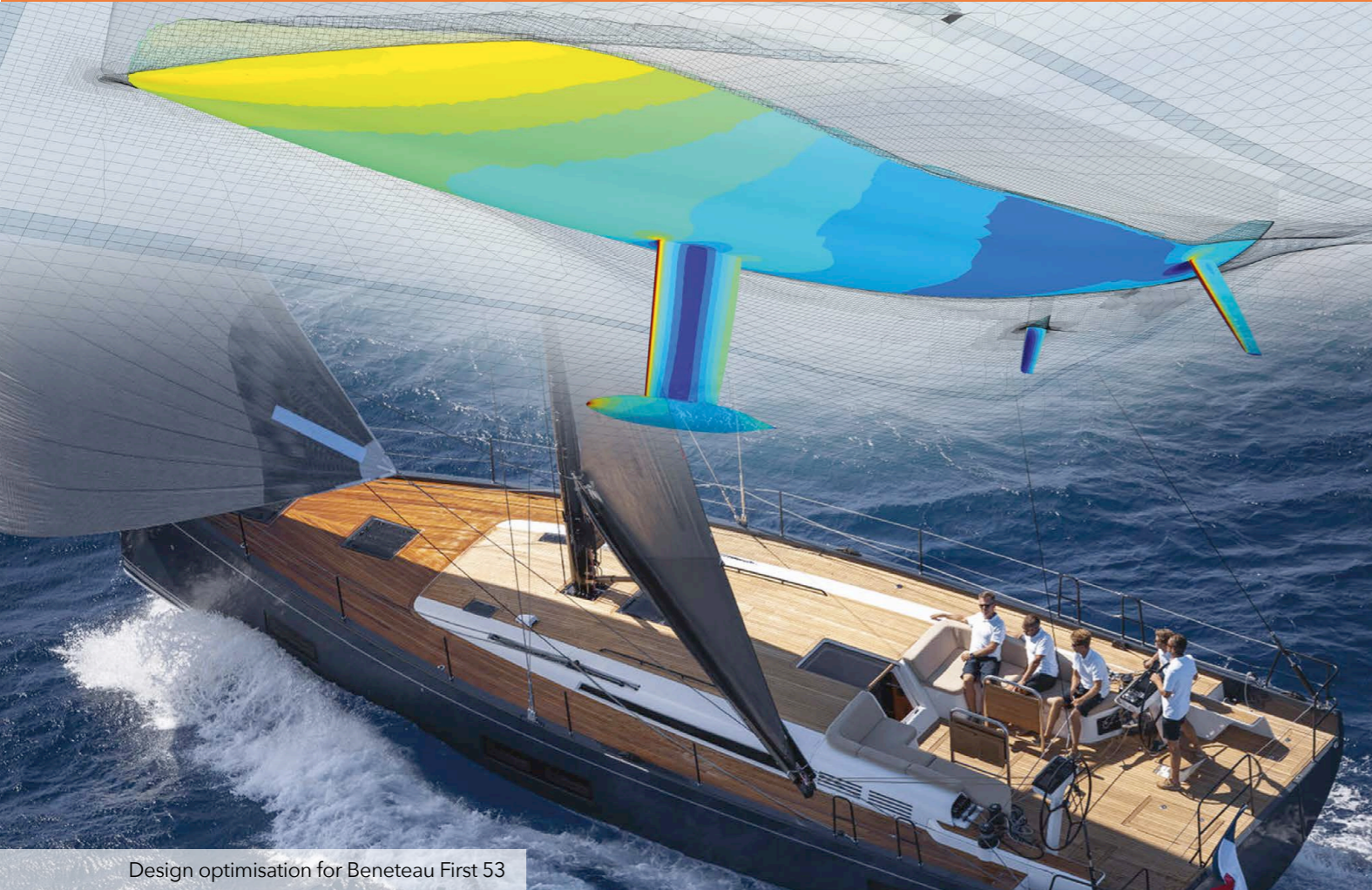


URAMOZTU

Hydrofoil Formula Kite Olympic equipment



Racing yacht technology, Malcolm McKeon, Baltic Yacht 112m LIARA



Design optimisation for Beneteau First 53

CFD analysis is increasingly being used to optimise the design of production yachts. Our involvement with international yacht designer, Roberto Biscontini to optimise the design of the new Beneteau First 53 has proved to be a winner for Europe's largest boat builder. Rigorous testing with Computational Fluid Dynamics (CFD) was carried out on 25 different hull designs, plus keel bulb, rudder and displacement investigations in a very wide range of wind and sea conditions. Extensive work on weight analysis, precisely positioning the boat's centre of gravity, centre of effort and centre of buoyancy helped to achieve the desired result... a well balanced, powerful hull with high speed potential but also a good level of sailing comfort.

[READ NEWS](#)



Online sail design service - for sail makers, naval architects and yacht designers

The AeroSim Portal offers a very cost-effective solution for a complex task. It has been designed and engineered to offer a cloud-based sail design tool to boost sailing yacht performance.

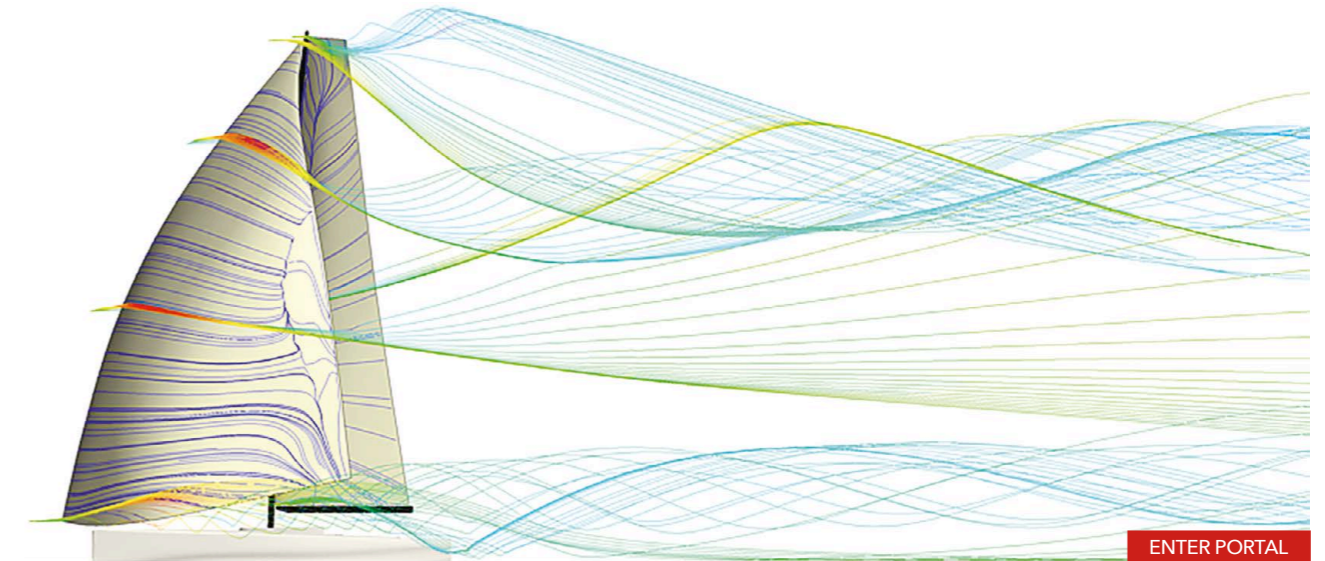
The service is developed with technology originating from Volvo Ocean Race and America's Cup campaigns and is truly state-of-the-art. Applied simulation methodologies are rigorously examined and validated. Accurate results of your sail geometries plus efficient visualisation of the sail loads are available in just less than 1 hour. With this service you will be able to efficiently analyse and evaluate the performance of single or multiple sail configurations in different weather and race course conditions.

Increase your sail performance...

- * Submit a single sail design to multiple geometries
- * Specify weather conditions / racecourse conditions
- * Purchase tokens through a secure payment system
- * Run simulations in just less than 1 hour

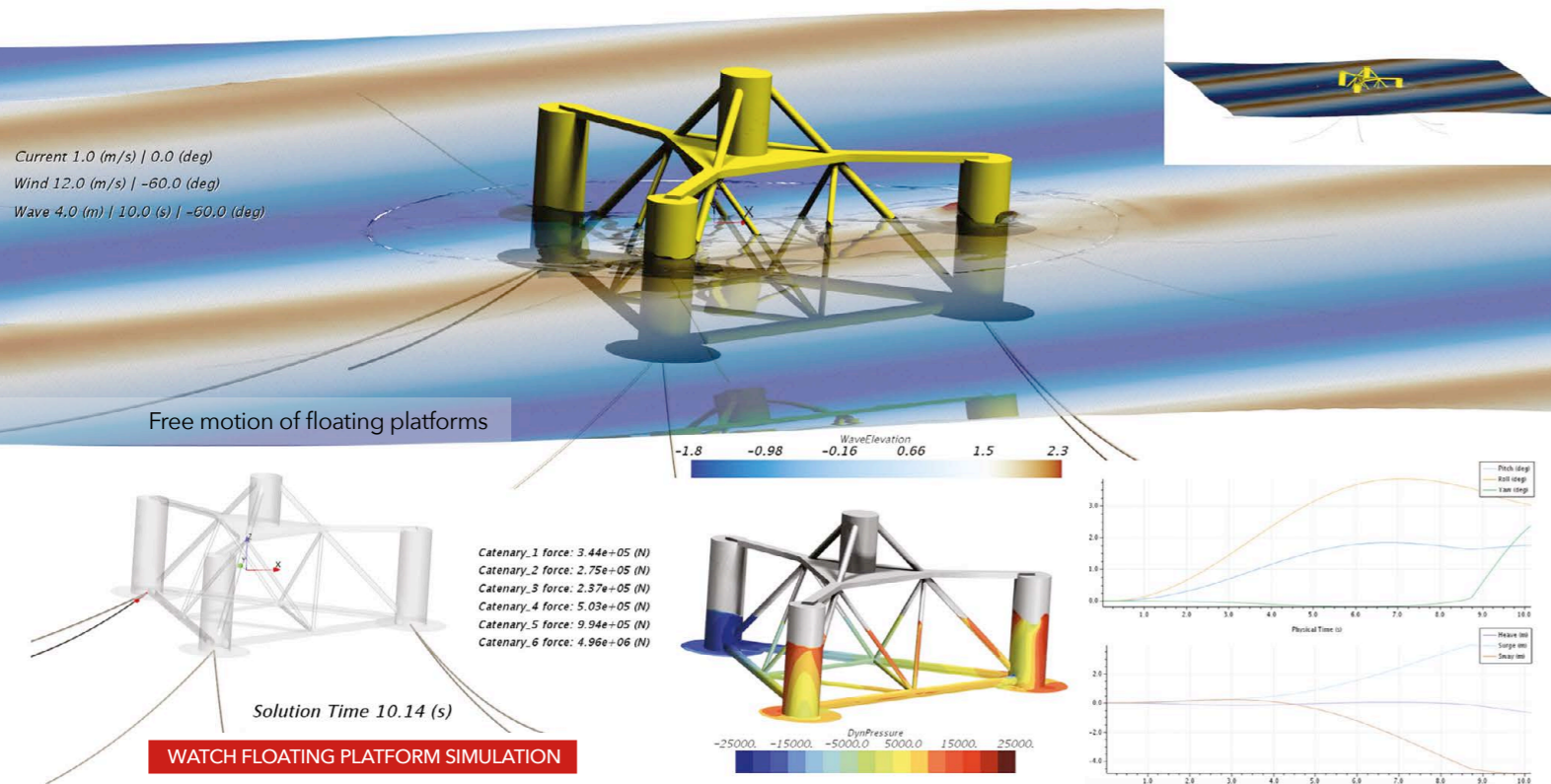
See the results...

- * High fidelity simulations
- * Evaluates the performance of the sails
- * Efficient visualisation of the sail loads
- * Accurate results of the best possible sail geometry



[ENTER PORTAL](#)

RENEWABLE ENERGY



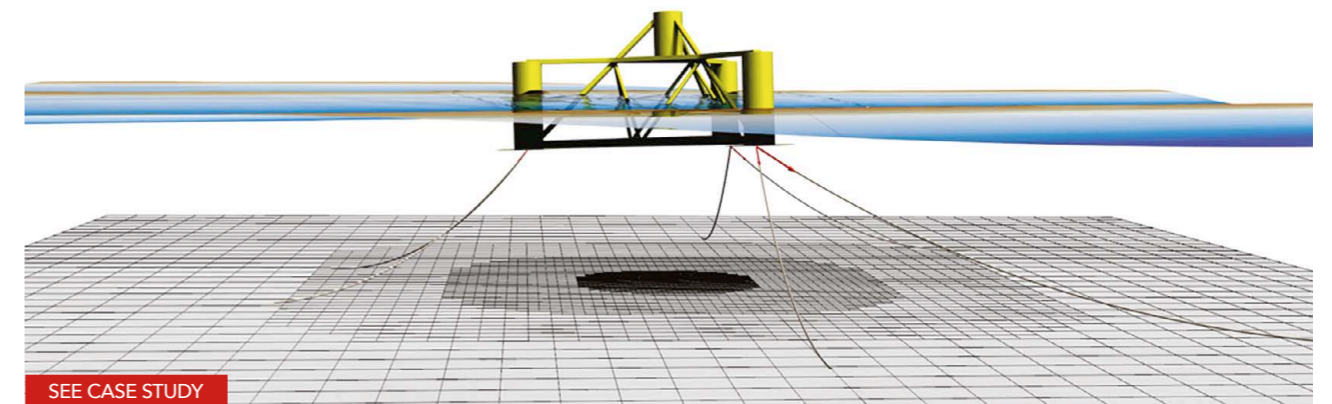
Using CFD technology

With our expertise in aerodynamics and hydrodynamics we can assess and compare the performance of different types of renewable energy structures. We have experience in high-fidelity modelling of Offshore Wind Platform motions under the effect of waves, current and wind to investigate high fatigue load cases, extreme load events, meeting stringent reliability and safety standards.

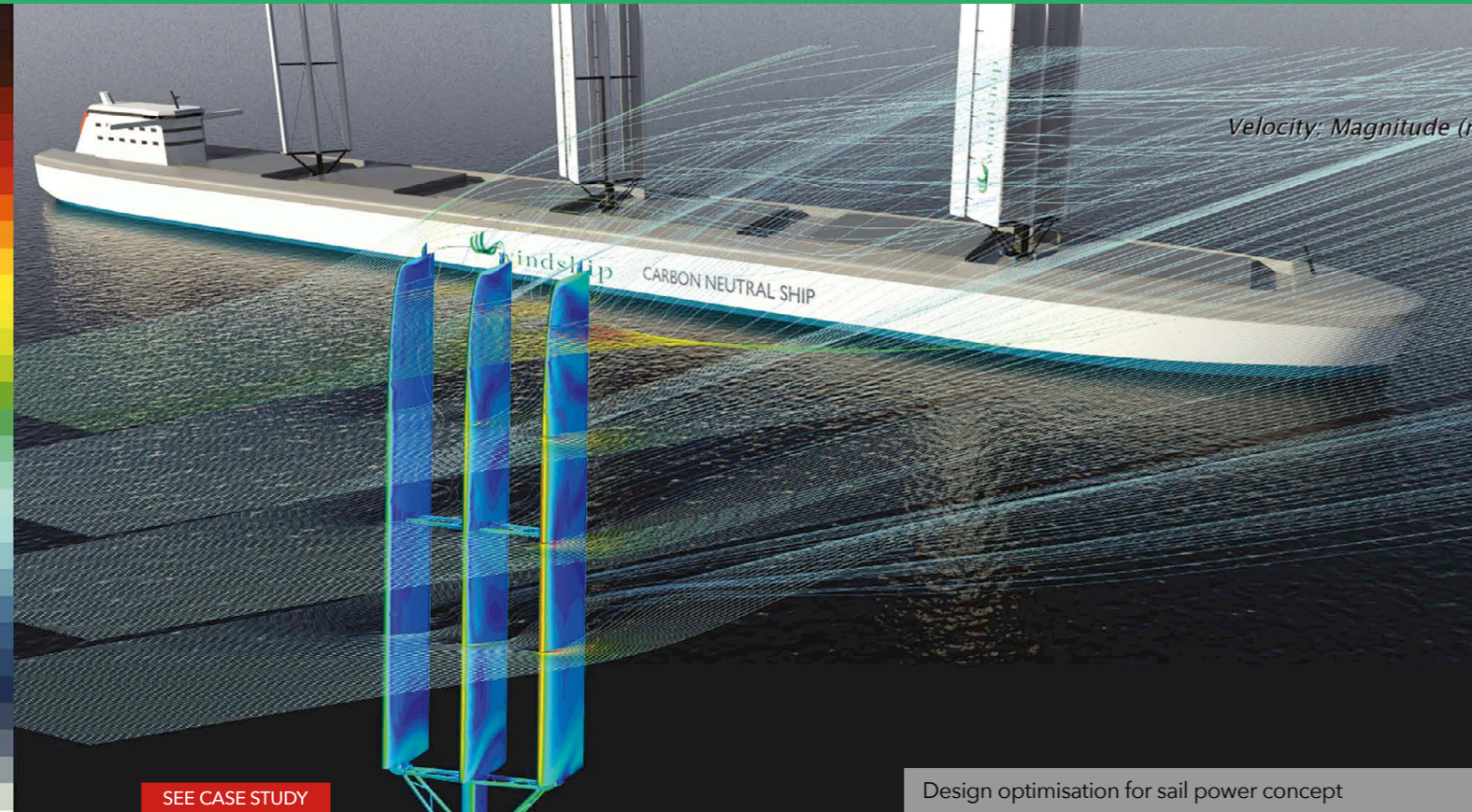
We care passionately about the environment and firmly believe the world needs to concentrate its efforts in developing efficient solutions for producing renewable energies. We have a strong desire to apply our skills and technology to contribute to this development and improve the performance of wind or ocean energy structures using renewables. We are keen on partnering in regional or global R&D efforts for developing novel and improved renewable energy structures and reduce the cost of energy and increase safety and reliability. Our simulations can be applied to any type of offshore platform, including different types of mooring systems, for offshore wind, ocean waves and tidal energy.

We can support your project

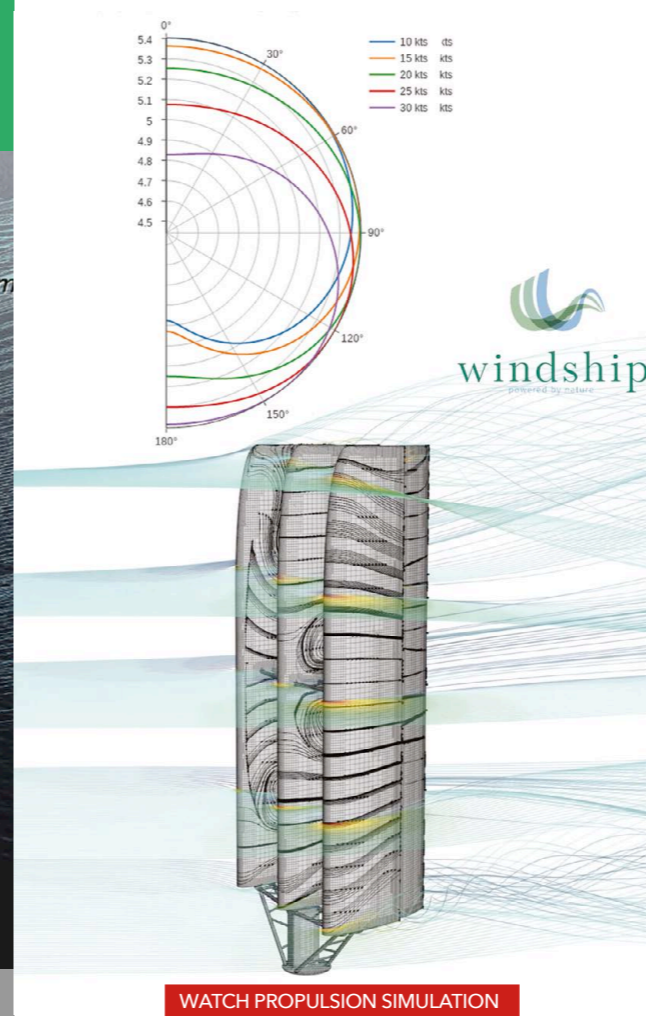
- * Improve rotor blade performance including section profile
- * Motions and extreme loads of offshore floating platforms
- * Investigate mooring systems
- * Investigate wave energy structures
- * Investigate tidal turbine structures
- * Reduce noise emissions and vibrations
- * Reduce high fatigue load
- * Meet stringent safety standards
- * High fidelity, CFD-based wind and tidal forecast embedded in global models



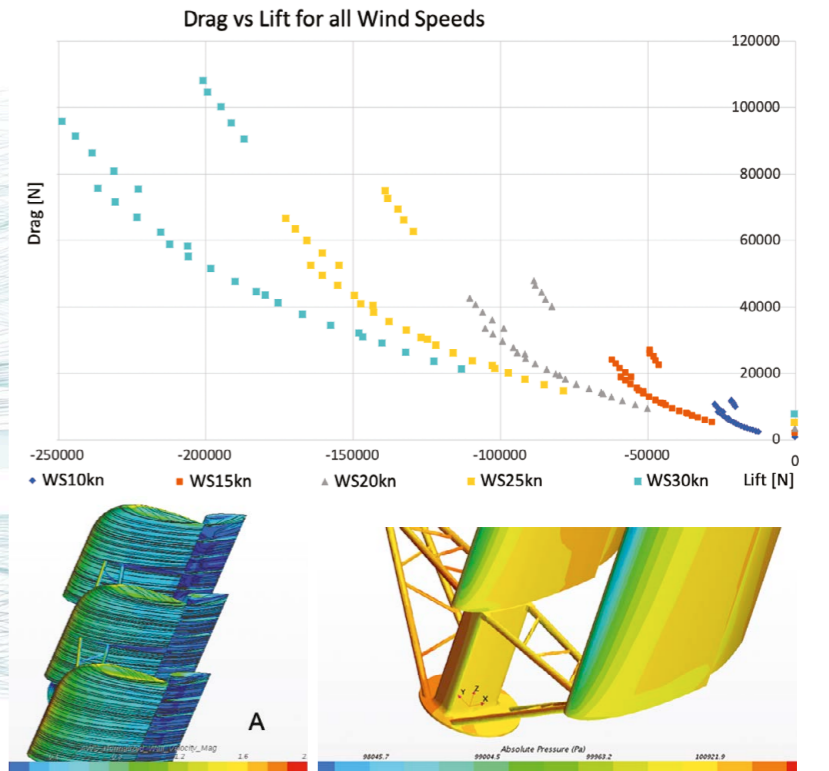
RENEWABLE ENERGY



Design optimisation for sail power concept



Extensive CFD testing to further improve the design of the solid wings



Environmental concerns are influencing a greater need for renewable and sustainable energy across the world, with specialist technologies being at the forefront of new designs and solutions. As maritime industries begin to tackle climate change issues, ports and shipping companies are looking for carbon-free alternatives by testing potential solutions for vessels. The requirement to make a move toward greener shipping is imminent.

Wind Propulsion Technology (WPT)

To address the problem of global commercial shipping, the introduction of WPT (Wind Propulsion Technology) has been evaluated. According to some recent studies, wind-assisted ship propulsion using rigid wings, sails, kites, Magnus rotors or other novel devices on some specific vessel types such as bulk carriers and tankers, have the potential of fuel savings and emission reductions around 10-30%.

Due to our renowned experience and specialist technology, we are able to offer a holistic analysis of the benefits of WPT.

Working with Windship Technology on their sail power concept, the latest advancements in wind turbine blade design and high performance solutions can achieve a high emission reduction of 30% on average. The design could revolutionise the way tomorrow's vessels carry goods across the world's oceans. In order for the shipping industry to adopt these new technologies, the accurate analysis of the potential savings and performance results were required, taking into account factors such as the aerodynamics of the thrust producing devices, the vessel hydrodynamics, propulsion system and the optimal routing.

CFD Technology

A multitude of wing assembly shape configurations were tested in varying wind conditions. Thousands of high-fidelity CFD simulations were performed and analysed. The simulations were used to set up force models needed to describe the vessel's hydrodynamic and aerodynamic behaviour. Extreme wind load cases were delivered to structural experts for assuring optimum weight and safety of the structures.



Why outsource CFD?

Many naval architects and racing teams invest in their own in-house CFD capabilities but when performance is crucial, it pays to outsource to specialists. If you're serious about winning or achieving the highest performance and keen to avoid expensive mistakes, you need the best CFD team for the best results.

In-house CFD can be very costly in the longer term. Software vendors will present potential clients with an optimistic view of what is achievable, which may lead to disappointment. Resources and software licenses may not get used efficiently or effectively, adding unnecessary overhead. CFD experts within the industry are rarely available for hiring. Resorting to less experienced juniors may lead to poor quality results and delayed delivery. A specialist dedicated CFD company will have relevant expertise and larger resources, allowing them to deliver the highest quality results in a shorter time frame, at a reduced cost.

Choosing a CFD provider

Today, there are many new so-called CFD experts who claim to predict performance within 1% precision. The main concern with choosing a CFD provider is that it has now become very easy to produce some sort of results and nice flow visualisations, which can look impressive. The CFD provider should have the relevant expertise, disciplines, experience and software to run simulations and analysis to the exacting standards required. For this reason and to ensure you receive the best results, it is crucial to choose a CFD provider carefully, based on resources and expertise.

Why choose Cape Horn Engineering?

With new guidelines and regulations to reduce emissions and improve air pollution, the demand for yacht and ship optimisation is rapidly increasing and becoming a key requirement with yacht designers and naval architects. We are specialists within the marine industry and leaders in flow analysis with an expertise in aerodynamic and hydrodynamic performance. Our CFD analysis will support designs to improve efficiency and performance, including aerodynamic simulations for innovative solutions such as wind propulsion technology. We use the best CFD package on the market, STAR-CCM+ from Siemens PLM and we are renowned for providing best in class services to many international clients around the world.





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