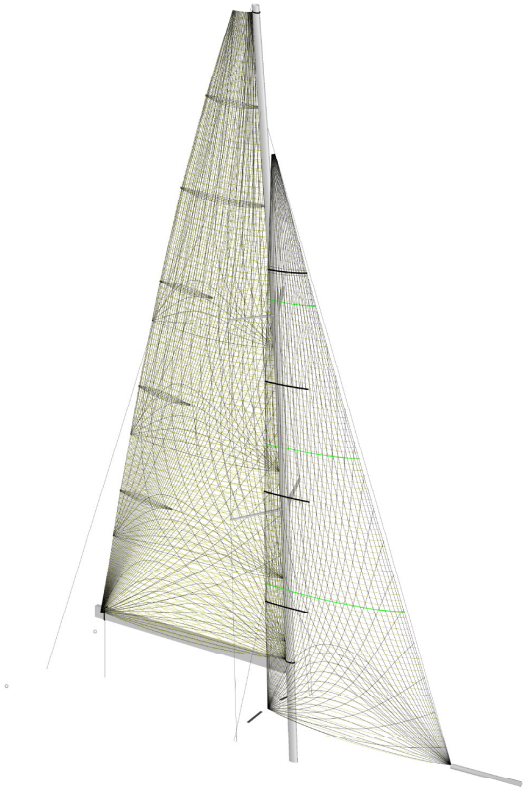
Ker46: Sail Shape Optimization



Sector

Sail

Project challenges

Optimise sail shapes

Fiber layout design

Provide target trim set for each sailing conditions

Keys to success

Capability to parametrically generate a wide range of sail geometries and compute MVLM flow code results for each, creating flow data for Ker Yacht Design's breakthrough "Sail-Optimizing VPP", that optimizes the sails to suit the needs of a yachts individual hydrodynamic characteristics, including full yaw balance optimisation.

Aeroelastic analysis to achieve optimized flying shapes with an efficient structural fibre layout.

Results

Significantly improved predicted sailing performance due to optimised sail shapes coefficients used by the VPP

Fiber layout design able to sustain the optimized sail-shapes in a wide range of sailing conditions

To assist the final customer to get the full performance out of his yacht, a table of target sail trims, target speeds, heel and rudder angles are provided for a range of wind speeds and angles.

INTRODUCTION

The goal of this project was to optimize the sail plan for a new Ker46 that was in production. Primary sail dimensions and shapes were to be optimized for the prevailing conditions and expected use of the boat as given by the client.

This project was carried out in collaboration with Ker Design and Hood Sail Sydney.

INITIAL INPUT

Initial sail designs were supplied by Ian Broad at Hood Sails Sydney. The target sailing conditions were then defined as mostly in the 10kt to 20kt range, but both above and below to be considered due to the intention of participation in offshore events.

ANALYSIS METHODS

The aerodynamic analysis technology developed by SMAR Azure Ltd makes it possible to run a significant numbers of aerodynamic analyses automatically. The system used allows for variations of up to 20 parameters at once for each analysis. This allows all boat trim settings, and sailing conditions to be included, (i.e. TWA, TWS, boat speed, heel, leeway, rudder angle and sail sheeting angles). It is also able to apply changes to sail shape and dimensions, this includes, camber, twist, draft position, luff length, roach, LP, head width and foot length. (It is also possible to modify I, J, P and E but these were not considered in this particular project).

For each parameter, a range is defined as a percentage variation from the initial input value set in the sail design used. For example camber maybe considered from -50% to + 100%, which is equivalent to the range of half the input value to double the initial value.

These dimensional inputs and the flow code results (forces and moments) are then used by Ker Designs' unique VPP system, which, using neural

"SMAR Azure impressed us with their capability and flexibility, adapting their MVLM aerodynamic code to provide multi-parameter input data to our new Sail-Optimising VPP technology."

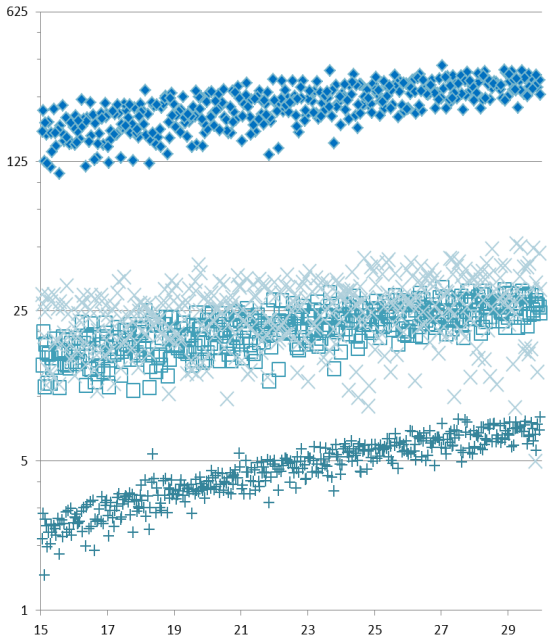
Jason Ker

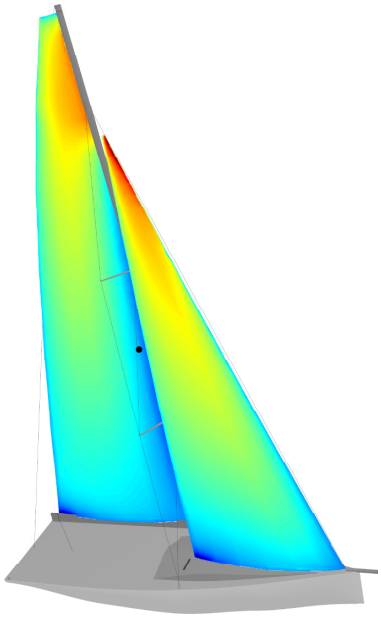
Ker Design S.L.

"We are excited to have had the opportunity to collaborate with KER DESIGN and SMAR Azure to provide our client with leading edge performance sails and look forward to seeing the results on the race course."

Ian Broad

Hood Sails SYD





Above a graph showing the sail coefficients produced for 1 sailset (J1+Main) by varying 20 parameters (geometry and trim).

On the right the pressure distribution on the J1+Main set in one sail/trim condition

technology for both the aerodynamic and hydrodynamic parts, searches for the combination of sail shape and trim that produces the highest speed at each TWA, TWS combination.

A further level of refinement was obtained by the use of RANS CFD, which allows the important effects of mast, boom, hull and turbulence to be considered. Due to computational cost, RANS studies are typically limited to downwind sails (where modeling turbulence is strictly necessary) and for upwind sails where budget and timescale allows.

For both upwind and downwind RANS CFD calculations, the initial sail geometry as defined by the sail designer was morphed using Ker Yacht Design's proprietary morphing technology to create a number of shape variations. The results of the RANS flow computations are used in the neural network for the aerodynamic model of the VPP in the same way the results from the MVLM were used for upwind conditions.

Results

Significantly improved boat speed

Millions of sail shape and trim combinations were evaluated to establish the fastest combinations following which a sensitivity study was carried out to establish the importance of certain trends. SMAR Azure and Ian Broad were then able to make informed sail design choices based on performance data.

Fiber layout design to improve the ability of the sail to hold an optimum shape across a wide range of sailing conditions

Once the optimal sail-shape was chosen, the SMAR Azure R&D team has developed a fiber layout that allows holding the fast shape in the given range of wind conditions. Compared with the initial proposed fiber layout, the manufactured sails are also lighter and more versatile.

Provision of the sail trim information to the final customer

Ker Design provides the sail use chart for all optimized sailing conditions.

Zero prototyping cost

The testing of millions of "virtual" prototypes leads straight to a result that could not be achieved from even decades of physical development. The final sail shapes and fiber layout are the result of a unique and fully analytical and engineered process.

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UK based and founded more than a decade ago today SMAR Azure features a multi-lingual team of dedicated professionals, a yachting-specific core technology, network modeling *and an array of software products that meet needs of sail, rig and yacht designers.*