Build no. 2 and 3 of the 34 m semi-custom motor yacht series, built by Cyrus Yachts in Turkey (under the management of Vitters Shipyard) for which Van Oossanen & Associates carried out all of the naval architecture. The hull of these yachts is an early version of the FDHF development. Their maximum speed is 24 knots.

Computer beats the testing tank

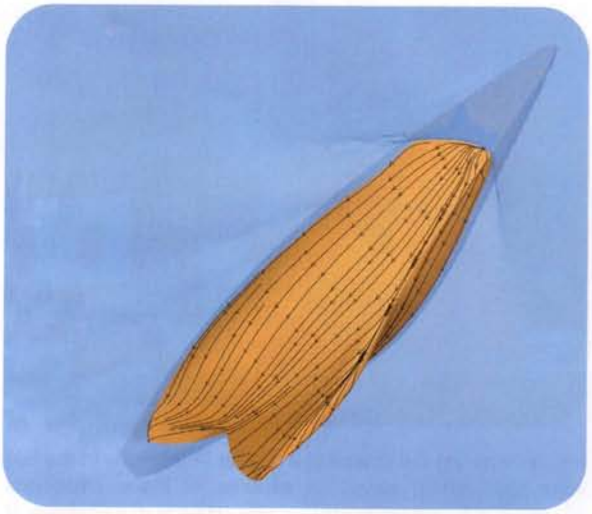
Piet van Oossanen at Van Oossanen & Associates

Known as 'the keelmaster' since the 1983 America's Cup, Piet van Oossanen is a hydrodynamics specialist. The winged keel he designed for Australia's AC boat was revolutionary. He now foresees a new revolution with the Fast Displacement Hull Form as co-developed by the next generation Van Oossanen.

"I received a telephone call from the project manager at the Wolfson Unit towing tank," van Oossanen smiles. "He said he could not believe the results of the tank tests they performed with the scale model of the new hull form we have developed. So he would do the tank tests again, to check". Those repeat tests showed the same results as the first: and those results exactly duplicated what had been previously calculated with the Computational Fluid Dynamics (CFD) software in use at the Van Oossanen design office. "The new hull form we have developed for fast passage-making motor yachts has at least 40 percent less drag than hard-chine hull forms throughout the speed range up to 40 knots. At some speeds, it even has 70 percent less resistance. And this comparison is not with old fashioned hull forms, but with the best results for the one thousands models that have been tested by the Wolfson Unit over the years". It is indeed hard to believe that between 40 to 70 per cent reduction in resistance is possible with a displacement hull form over the speed range of 15 to 40 knots, as a result of clever design and optimization. But this shows what can be achieved with CFD these days. The test in the large tank of the Qinetiq facilities at Haslar in England proved this without a doubt. "We have created a displacement hull that reaches speeds that until today are only reached by planing or semi-displacement hulls, and even at the highest speeds our Fast Displacement Hull Form (FDHF) has less drag."

Mr Peter van Oossanen

The FDHF hull is the result of the more than 30 year experience Van Oossanen has accumulated and the diligent application of CFD. This design addresses the disadvantages of hulls that are designed to be able to go fast, but at the expense of unfavourable hydrodynamics at lower speeds as a result.



Most high-speed yachts adopt low cruising speeds and only occasionally go full speed. Yet, to be able to operate at high speeds these yachts are given a hard-chine hull form, with the consequence that at the lower cruising speeds a huge resistance penalty is incurred. The less-than optimal hydrodynamics at low and moderate speeds manifest themselves during most of the life of the yacht. The FDHF hull breaks with this pattern and has good characteristics over the total speed range. All-round performance is a known advantage of displacement yachts, but the standard hull form usually adopted is unable to exceed the so-called hull speed because of the steep resistance curve in that speed region. The FDHF hull shape cleverly combines a number of innovations in hydrodynamics that reduce drag. By repeated analysis and optimization superior performance has been attained.

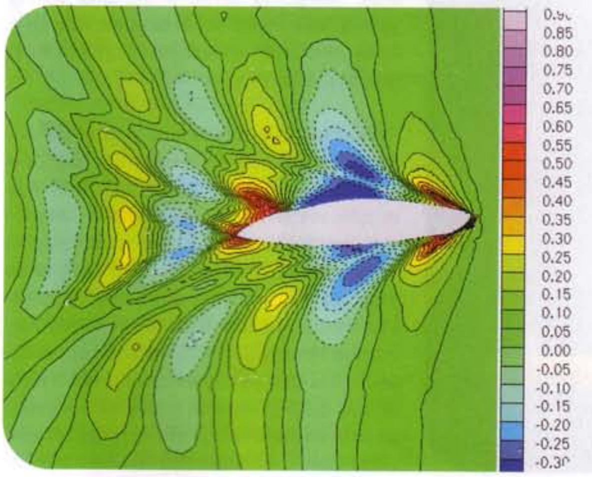
The bow has a slender type of bulb, there are spray rails in the bow region to deflect the spray at high speed.

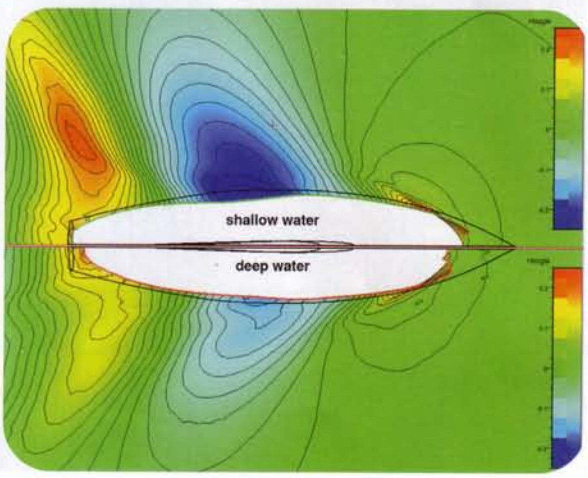
'Tank testing of FDHF led to unbelievable results'

The hull form itself is of the round-bilge type, but with a special distribution of the volume over the length. The aim thereof is to seriously reduce wave resistance at the higher speeds, while maintaining comfortable motions in waves. The FDHF hull has been tested for speeds up to 44 knots. The behaviour over the entire speed range is that of a displacement hull with little or no running trim, although it will rise from the water a little bit at higher speeds, but not as much as a planing or even semi-displacement hull will. "As drag has a linear relationship with fuel consumption, the green impact of this hull form is evident," van Oossanen underlines. The first yacht with this hull form is being engineered to be built at a well-known Dutch yard. The yard will soon publicize this project and the innovative impact of Van Oossanen's FDHF design will then be explained and celebrated.

The scientific approach Van Oossanen embraces is evident in all of the projects carried out at Van Oossanen & Associates, in Wageningen. Extensive CFD calculations and model testing is carried out to produce data that is able to indicate the favourability (or otherwise) of proposed design changes to the vessel's performance. This is particularly the case in the hydrodynamics area of design. This scientific working method remains unchanged over the years.

The computing capability of the company has increased dramatically with the adaptation of CFD software some 6 years ago. "We live in interesting days for naval architects. It is now possible to create a grid with 10 million cells in the virtual water around a hull in the computer, showing water movement, pressure distributions, wave formation, etc, caused by the passage of the hull, more then hundred metres in front, to the sides and aft of the hull. This results in an accurate calculation of the actual drag this hull experiences at various speeds. Five years ago, a grid this big for a complex hull form fitted with all of its appendages, would require a super computer. "We have had to make considerable investments in computer hardware to gain the calculating capacity needed for such predictions. Even with the computing power we now have calculations for a single speed still take two to three days, running on 50% of the processors in our computer cluster. But the results are accurate and reliable, providing data not only on the resistance of the hull and the appendages but also on the alignment of the appendages (such as bilge keels, shaft brackets, rudders,





etc), the back-pressure at engine exhausts, the wake field at the propeller, etc."

Design at Van Oossanen & Associates starts in the 3D Maxsurf suite, followed by further detailing in "Rhino". Preliminary estimates of performance characteristics are then calculated using in-house developed software and finally by CFD. The CFD suite used is that developed by the University of Nantes, in France. "We use the automatic mesh software developed by Numeca in Brussels, which is efficient and saves time compared to a manual meshing procedure. It strikes me that the development and design time required for our projects has not gotten any shorter. When everything had to be calculated by hand, a long time ago, stability and performance predictions were calculated just once during the course of a project. Alterations to the hull were then made, based on experience. These alterations would typically not lead to the re-calculation and re-analyses of the whole design. Nowadays, we perform calculations to see the impact of changes and improvements continuously. In this way the improved calculating capacity has led to improved designs and better performance and better fuel economy. We take the same time to carry out projects as a long time ago, but now deliver much better designs. We are finding that big steps can still be made."

'The green impact is evident'

In efforts to maximise the benefits of computer-aided design, Van Oossanen has linked their CFD tools to special optimization-software developed by the German company Friendship Systems. The so-called "Friendship Framework" in combination with CFD is able to evaluate the hydrodynamic results of an initial design and then determine hull form alterations that may lead to better performance by modifying certain design parameters. These changes to a design are then automatically generated by the software and again analysed by CFD. This process is repeated over and over until no further improvements can be found. This, in part, was one of the keys to the creation of the FDHF. "We are the only naval architecture office in the Netherlands that has made this link between 3D hull form design software, CFD and optimization programs. It is clear that this extra step in optimizing a design is delivering enormous benefits. We are about to also apply this technique to the design of other vessels such as inland water transport vessels, sea-going cargo ships and sailing yachts. We could be seeing an industry-wide revolution in hull form optimization during the coming years."

"We can now also make better predictions of a vessel's resistance and the associated hydrodynamic characteristics in calm water using CFD than we can predict these aspects by means of tests in towing tanks. In doing towing tank tests with scale models there are always scale-effects to be accounted for in extrapolating the results to the full scale. For resistance this problem has been reasonably solved but for aspects involving the wake pattern at the location of the propeller and other flow properties this remains a prob-

SUI59 designed by Van Oossanen & Associates in collaberation with Philippe Briand for the Swiss America's Cup contender in 2000 lem. The current methods of converting the test results to real-life scale introduces margins of inaccuracy. Using CFD, we calculate everything on a life-size scale. The difference is that in CFD everything is virtual."

"Simulating dynamic effects such as those associated with motions in waves is the only advantage towing tank testing still has over CFD. Although also in that area CFD is making major strides. Today's computer models cannot yet simulate breaking waves and a disturbed seaway around a hull form. But this will be possible in the future. That is why we still need towing tank – to evaluate future numerical models and to fill-in while these developments take place. Designs need to be evaluated in all possible sea environments, not just only for their characteristics in still water. The Marin research institute, for example, is constantly providing experimental data about dynamic effects in rough water for the benefit of software developers so that these are able to correlate their results with experimental data and learn from the differences in further developing their programs."

The 'Maasvogel' one of 3 16.7 m Lemsteraak yachts designed by Van Oossanen & Associates

CFD can be applied in more areas then only in hull optimization for yachts. Van Oossanen & Associates often calculate the wind flow around the superstructure of large motor yachts, to be able to identify the necessary locations for windshields or changes to the design to avoid wind hinder in recreational areas on deck. In this case, a grid is laid out around the virtual surroundings of the digital design, containing up to 20 million cells, to determine the air flow around the superstructure.

Van Oossanen & associates run a full-service design office, but also do a lot of calculation work for other design offices. For Hoek Design, all of the existing lines plans of J-class yachts were studied and their hydrodynamic performance determined. The office determined which designs would be theoretically fastest in different wind conditions. The preferred design was identified and clients wanting to build a replica of a J-class yacht were given advise as to which of the designs were superior. In the development of new yacht designs, Van Oossanen's office often cooperates with Omega Architects in Druten, The Netherlands. "Together with Frank Laupman's artistic approach of what a super yacht could look like, we reach a synergy - where the input we both deliver adds up to more than the sum of the two separate efforts. Together with Omega we are responsible for most of the designs built by Heesen Yacht Builders in Oss. We are presently working together on a number of different design concepts for other yards as well. We also carry out hydrodynamic design analyses work for ship owners and shipyards such as Wagenborg and IHC, for various types of cargo vessels and dredgers".

'I hope to see a revolution in hull form optimisation'

"The design process is not only improving at a fast pace in the field of hull design and hydrodynamics – it is also making a lot of progress in the design of equipment, engines, and installations on board. Holland has a realm of top-of-the-market suppliers. Engines are getting lighter and outputting more power. Would a durable marine engine typically be a heavyweight 10 years or more ago, it is now possible to build this engine much lighter. This is also the case for other items of equipment. Although the hull shape is crucial in reducing resistance through the water, reducing displacement adds to that considerably. There is presently considerable demand for eco-friendly design. Designers and yards that miss out on this market shift, will lose market share in the years to come."