Good science needs good research

Two important elements contribute to ORC's improving rating technology: research and observation. Just as designers remain abreast of the latest performance developments, the International Technical Committee (ITC) must keep up their understanding of the science behind these developments. ORC makes a big investment each year in pursuing this research so that the aerodynamic and hydrodynamic modelling is accurate and relevant to the fleet. The task of the ITC is to maintain a VPP-based, transparent handicapping system that both provides equitable racing for a wide range of boat types and encourages sailing yacht development, while at the same time protecting the fleet from unusual designs that exploit the system. The ITC's research agenda for 2013 shows how we try to discharge our responsibilities.

Firstly, the aerodynamic force coefficients. The ORC fleet is moving more and more towards asymmetric downwind sails, and it is several years since the offwind sail force coefficients were examined in detail. This year a short wind tunnel test programme is planned to check sail force coefficients for contemporary sail designs; two mainsails, one with a 'normal' roach and one with a square top, will be used in conjunction with three asymmetric spinnakers tacked on centreline. One spinnaker will be at the maximum dimension for the rig, and two will be smaller.

Simples… sailboats are getting faster. The first man to exceed 100kph under sail, kitesurfer Alex Caizergues, chats with Class40 skipper Sébastien Rogues. Length remains the most powerful driver of sailing craft performance… except for kites of course!

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These tests will be useful to better assess sails set from a bowsprit versus those set from a pole, since current coefficients do not seem to match observations. It may be that the coefficients have overstated the relative benefit of being able to square the pole now that asymmetric spinnakers have improved so much in design. These tests will give only a snapshot of the performance differences but will provide valuable data to make sure that any VPP changes are relevant to real sails.

For the upwind sail force coefficients two areas are under investigation:

1) In light air we feel the aerodynamic force model is not acknowledging the poorer performance of fractional rigs. This may be due to the wake effect of the mast when you don't want to twist the sail because you are looking for maximum power. In fact, the flow over the spar and mainsail behind the jib is better than over the bare topmast. Fractional rigs may be suffering because they cannot adopt the ideal mainsail twist profile.

2) The linear reduction in induced drag as the sails are flattened is certainly an over-simplification of the real behaviour of the sails. The nuances of the depowering process could be improved at both ends of the True Wind Speed range; it is necessary to find a way of modelling the max power condition where the max force is associated with some extra flow separation.

Here our best tool is the CFD Virtual Wind Tunnel set up by the Wolfson Unit using the OpenFOAM code running on the University of Southampton's IRIDIS 3 computer. The CFD research will study a range of flying shapes, and compare these with existing wind tunnel data to try to develop a new sail depowering methodology.

Also, the depowering formulation will be redesigned taking into account that boats now only rarely reef their mainsails; the REEF parameter might be replaced by a TWIST parameter, keeping the full mainsail area but adjusting the centre of effort height and induced drag. Some will say this work is long overdue.

Last year's magnum opus of revising the residuary resistance formulation is now under test by the racing fleet. One of the factors highlighted was the effect of wetted area on hull resistance. Static wetted area is easily calculated but this differs from the sailing wetted area. The concept of a Dynamic Wetted Area will be assessed with a view to desensitising the measured wetted surface area using existing CFD data to get surface friction results.

The new Residuary Resistance formulation will also be fine-tuned when we have some meaningful field observations.

The efforts of the ITC are not driven by blue sky thinking. The engine of our research agenda is the submissions made by member authorities to the annual ORC meeting; one 2012 submission suggested that small boats remain unfavoured compared to larger rivals. Some potential sources were identified:

a) Sail forces are affected by pitch motion, which small boats have more of. The ITC will study the introduction of a degradation factor of sail shape (hence of coefficients) due to boat dimensions. Small boats have relatively more pitch motion than larger boats, so this instability of sail shapes with waves may in some way correlate with the efficiency of the aerodynamic forces.

b) Wind gradient. A study will be performed to verify if there is a local modification to the vertical wind profile close to the water surface due to the wave profile that affects small, low-freeboard boats more than larger yachts.

c) Low Reynolds numbers – influencing lift. The lower Reynolds number for small boat sails and keels could restrict the maximum lift available. This will be checked.

d) Added resistance revision for smaller boats. Some years ago ITC reduced the wave spectrum and hence the added resistance in waves, so this could have disadvantaged small and light boats. This too will be checked.

e) The Default Righting Moment (RM) was successfully introduced to limit the rating credit/debit available for very low and very high-stability yachts. Now it is generally seen that smaller boats have lower RM than the default, the opposite of larger boats. This is in some way penalising small boats, so the default RM formulation is under review.

Looking at this in closer detail, a revised default Righting Moment will be studied to improve formulation by calculating an assumed Vertical Centre of Gravity (VCG) based on a simple categorising of boat types. Existing design data will be used to estimate weight and CG of each of the canoe body, deck, internal structure and fit-out, control systems and rig weight. Ballast weight will be deduced from displacement less the sum of the above weights. The aim is to return a better estimation of the default RM to maintain the trend away from tender yachts without unduly penalising small yachts which are by definition more tender.

Equally important to these research programmes are accurate observations of the performance of boats relative to their ratings. This is not as easy as it may seem: simply looking at corrected time results is not enough. Just as a coach analyses numerous details to assess a team's skills, a rating analyst needs to understand the subtleties of the wind conditions, course layout, tactical situation, crew ability and other factors. Filters are often needed to qualify observations before laying blame on faults in the rating system. But because the ORC system offers a diverse array of rating types, this process can be easier to isolate than with a global single-number system, where there are just too many variables to distil into meaningful conclusions.

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