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Challenging the algorithms

The ORC VPP works pretty well for predicting speeds of displacement and even planing boats when they are monohulls with a set of appendages oriented more or less vertically. The program's understanding of the lift and drag produced by the keel and rudder(s) combined with the hull form's lift and drag forces are the result of decades of study, starting with tank testing and reverting now to using digital tools – particularly extensive CFD studies. However, this year's adoption of the Offsets 2.0 VPP code now facilitates the defining of any appendage configuration, with ORC mathematicians confident that the contribution to performance of non-vertical appendages such as DSS and the curvilinear horizontal foils found on Imoca 60s and Figaro 3s can also be predicted… these predictions capturing the base effects of a vertical force that lifts the boat, and the augmented righting moment.

With the Mills-designed *Flying Nikka*, however, there is now a completely new issue: how to model performance when the hull lifts completely clear of the water. Davide Battistin is the ORC VPP programmer who has been working on this problem and explains the situation. 'When modelling performance of normal boats the challenge is identifying the elements of the force balances to find the equilibrium condition. With all the measurements provided of the boat, rig, sails, crew weight and so on, this is fed into the VPP to determine how at each wind speed and angle the forces are balanced, and thus the predicted performance of the boat in these varied conditions.

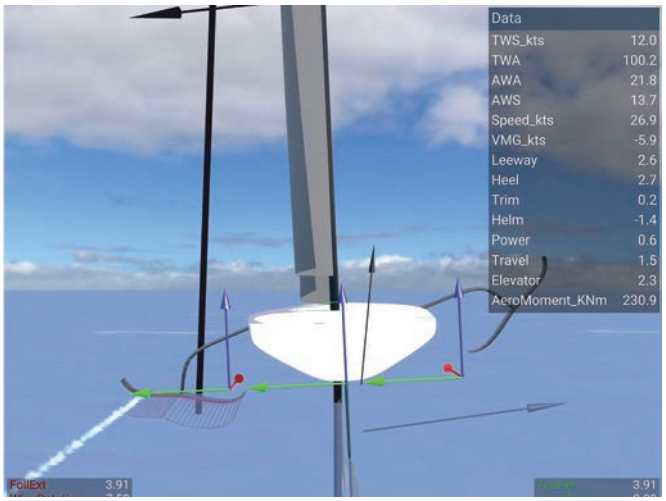
'Fully foiling boats have very different physics,' Battistin explains. 'While foiling the hull volume is no longer contributing to the force balance, so we obviously had to rework the VPP to account for this condition while the boat is foiling and at full power.'

A critical component in this modelling is to identify at what boat speed the amount of lift from the foils will equal the displacement of the boat, the so-called take-off speed. This of course is a concept familiar to America's Cup sailors, and spectators, as everyone saw those boats lift free of the water, maintain foiling speeds and then crash back down to displacement mode when the boat speed dropped for any reason.

In contrast with the AC75s, coastal racing demands that *Flying Nikka* also incorporates a deep fixed bulb keel, but otherwise Roberto Lacorte's flying machine has been designed to behave in exactly the same way as its purist AC counterpart. So the challenge has been in developing an accurate VPP that can account for these two conditions: semi-foiling where some hull is in the water (Battistin suggests that this is at about 50 per cent of the hull volume immersed) and fully foiling where the hull is completely airborne.

Yet it's not a simple switch between these two modes: there must also be recognition of the transition space in the polars from non-foiling to foiling, and once foiling the full span of wind speeds where foiling can be sustained.

And there are even more details to account for, such as when the wind forces are great enough to upset the equilibrium and depowering is needed. On a displacement-mode monohull it is simple enough to understand this with changes in heel angle, but



While some designers can only bring themselves to speak about measurers and rule managers through gritted teeth, Mark Mills is normally not among them, regularly sharing platforms with rule managers at design conferences. So he must have got out of bed on the wrong side the day he sat down with spirited owner-skipper Roberto Lacorte as together they dreamed up Lacorte's fabulous 60ft 'coastal racer' *Flying Nikka*, sending the rule managers away to wrestle with a whole new bunch of vectors (*above*). While Mills himself has had no direct experience of the AC75 Cup yachts, the same is not true of KND Performance with whom the Irish-based designer works closely – no doubt a primary reason why, to wide astonishment, *Flying Nikka* flew so steadily on her first day afloat

it's not so easy with a fully foiling boat for which bolt upright is always the default condition.

So the geometry of the lifting foils needs to be described and understood, including how angle of attack changes can affect lift and hence forward speed. Battistin admits this transition between modes is a performance zone that still needs a great deal more study, but at least now there is sufficient understanding of the foiling and semi-foiling modes that an ORC Club-level certificate can be issued so Lacorte's ambitious Mills design can race this summer season… and be scored.

Mark Mills himself has been working closely with Battistin and ORC International Technical Committee (ITC) chairman Andy Claughton to help in the process of identifying some initial provisional handicap polars for this boat. Mills is also now an ITC research associate, which means that, while not digging as deep into research projects as full ITC members, he is able to review the projects and provide direct feedback and advice from a designer and sailor perspective when needed.

'Working with the ORC team has been productive,' Mills said. 'I have not yet done an exact overlay of the polar data from our VPP with theirs, but they are using the same three-mode approach – displacement, flying and cross-over. And the numbers look broadly similar, which is interesting to me because I would have expected the ratings to have more handicap penalties built in.

'Our objective with *Flying Nikka* was to use our existing tools, then develop new tools to do our best to fairly rate this unusual design,' said Claughton. 'There may or may not be more boats coming like this, but in now at least having a template on the table we should be able to adapt and refine further as needed.'

As for rating penalties, Claughton says this is largely a political decision on whether ORC wants to add some factors that will speed up the ratings due, for example, to not understanding completely the ultimate potential of a fully foiling boat, and if it threatens the competitiveness of the existing fleet of offshore designs. That said, the ORC's VPP is set up to predict a highly optimised performance, because it always uses an idealised foil force model that is probably not achievable out there in the real world of wind and waves.

'Having a boat like this on a startline with conventional monohulls could be daunting,' admits Claughton. 'Yes, this team's objectives are to set course records, and not seek rating optimisations for corrected time victories as well, but at the ITC we will be keeping an eye on this while trying to provide as rational results as we can!'

Andy Claughton and Dobbs Davis ❑