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Squeezing out the box

Farr Yacht Design have been (successfully) exploring aero-hydro advances within the GP42 box rule...

The GP42 class has just concluded its third season, with close racing in a busy programme that mainly comprised the Audi MedCup series and the fleet's own Global Cup in Puerto Calero, Lanzarote. Races were more often than not won or lost by seconds over the typical five to eight-mile windward-leeward courses, and the MedCup was not decided until the last leg of the last race of a 29-race series. And while the frontrunners - Daniel Calero's Botín and Carkeek-designed Islas Canarias Puerto Calero and Filippo Faruffini's Farrdesigned Roma 2 - were at the top of the standings throughout the season, every other team won at least one race.

It's no coincidence that these two frontrunners were also among the most aggressive in pursuing upgrades within the fairly tight GP42 box, though ironically they moved in opposing directions in terms of profiling. *Calero* opted for trying to improve pace in breezy conditions, while *Roma* worked to be better in the light.

Did the changes work? Probably: Roma won the Global Cup, but Puerto Calero won the MedCup. Calero seemed to have a slight edge when the breeze was on, as intended, while the 'new' Roma 2, the only Farr design in the MedCup, seemed to have the edge in most other conditions.

So, with this backdrop in mind, the team at Farr Yacht Design (FYD) have been on the hunt for more pace in an allnew GP42 design for 2010 and think they have found it, primarily on the back of new innovations in hull and appendage design. Extensive CFD modelling and VPP work by FYD team members Britton Ward and Bryan Baker, both alumnae of the last BMW Oracle ACC programme, plus the experience of senior naval architect Jim Schmicker, have contributed to finding what they claim will be upwards of 11 boat lengths per race of additional speed over their baseline design ... which in Med-Cup terms is as good as over the horizon!

'FYD are fairly unusual in that we still complete all aspects of our CFD work inhouse,' says FYD president Patrick Shaughnessy. 'We own our own supercomputer cluster (420 CPU nodes), which is fully supported by us here in Annapolis.

'Every model we produce is meshed, run



and analysed by our team in-house. This direct oversight means that we can turn around meaningful work more quickly, and hopefully with a better understanding of the process, all of which has a significant bearing on the final product.'

FYD's direct control of their supercomputer cluster enables them to continue on design studies even without a client-funded research programme, an especially fortunate situation in these tough times when lavish research budgets are rarer than hen's teeth. With numerous VO70, Imoca 60, GP42 and other high-speed, immersedtransom projects over the past few years the Farr office have now invested considerable effort researching this style of boat. Recent efforts have yielded what are claimed to be 'new and fruitful development paths', which could prove relevant to the next generation among these fleets.

FYD's use of these sophisticated in-house computational tools is clearly a powerful asset, but alone they are unlikely to produce the 11-boatlength edge claimed for the company's newest GP42 design. This comes from being out there on the water in the thick of the competition; with Shaughnessy sailing with the Roma team for the past two years, the only naval architect in the Med-Cup arena to do so, he has been acquiring an intimate knowledge of the boats, the class and the more precise nature of the competition. So Shaughnessy's feedback has been an invaluable contributor to how FYD's array of design tools are applied for each component part of each GP42 project.

FYD can also claim the longest experience in GP42 design, being present and providing input in the first formulation of the rule in 2005, and designing the first GP42, *Roma* '06. Two subsequent designs were then commissioned for the 2008 season, Roma 2 and Near Miss.

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'Back for the second evolution in 2007,' said Shaughnessy, '*Roma 2* and *Near Miss* shared in a fresh study that investigated seven combinations of fins and bulbs to identify the best appendage solution. We've now extended that work to study the effects of both laminar and turbulent flow on the fin and bulb, and with some interesting results.'

'We have also examined 14 GP42 hull models,' explains Baker, the lead CFD engineer on the FYD team, 'in a new CFD study to examine more closely what happens at the air/water interface.

For this we're using a detailed test matrix of some 200 points/model to give us a detailed understanding of the hydrodynamic characteristics of each candidate design at various speed, heel, yaw and trim conditions. Some of the gains indicated in this study suggested a strong bias towards two particular models which traded some upwind speed for exceptional downwind performance.'

And while this would suggest a bias towards offwind performance, on a typical GP42 MedCup course the upwind leg lasts some 20 minutes, while the offwind legs rarely exceed eight minutes. This, therefore, underscores the importance of incremental increases in upwind performance as well as downwind, even though the two are often opposed in design: for example, more rocker in the hull with less transom immersion improves upwind pace, especially in waves, but is usually slower downhill. The challenge is to find the right balance given the course types and better knowledge of the venues.

'Our first-generation design, *Roma* '06, was designed to be a good all-rounder before the class plumped upon a bias to







windward-leeward courses, and is therefore a strongly built boat whose performance reflects a good average pace across all conditions,' says Schmicker.

'The newer *Roma* 2 and *Near Miss* have been better optimised for windwardleeward work, so we worked closely with their builders to produce the lightest boats in the fleet with the maximum allowed corrector weights. The challenge since has been to execute the refinements necessary for their respective racing niches.'

For *Roma 2* this ongoing optimisation meant trimming the girths in the aft 2m of the hull to raise the stern 15mm and thus increase the rocker while also adding a little more bow-down trim. Other changes included adding 40mm to the keel chord length for better lane-holding, particularly down-speed off the start, out of mark roundings or in light air, and a change to a low-drag chine-less bulb which is also a little shorter and thicker to improve offwind pace while not conceding too much in terms of VCG compared to its chined predecessor.

In contrast, *Near Miss* added a bowsprit and asymmetric sails for her non-MedCup programme during 2009, and found success in winning the Rolex Giraglia – their second victory there in two years.

In fact, much of the effort at FYD is spent looking for speed by simply (or not so simply) reducing hydrodynamic drag in all the component pieces of the GP42: hull, rudder, keel fin and bulb.

'We calculate that nearly 80% of the drag of the GP42 design is in the hull,' says Schmicker, 'so now we're trying to focus what we've learnt from our extensive immersed transom and bow shape work in the VO70s and then apply that to the GP42s. Far left: CFD shows how a subtle change in a (GP42) hull shape can have a dramatic effect on dynamic pressure (velocity) under the hull. At 9kt (near station 6.5) the Black model shows higher flow velocity over a greater surface area than Red. *Left*: CFD imagery can be useful to reduce drag in bulb and appendage design as well. This image shows the results of state-ofthe-art transition calculations at 8kt, where Pink is laminar and blue is turbulent flow across this GP42 bulb. Big picture... the pie chart (*left*) shows the dominance of hull drag on the total drag of the system

'We're looking at this both locally and through the volume distribution across the total design.'

Accordingly, Schmicker believes that a big effort on improving GP42 hull shaping in a new project will produce those bigger gains – perhaps in the order of eight lengths over a typical race. 'We believe that those gains would then easily be coupled with gains from appendage work of approximately two lengths,' says Baker, 'through a fresh study of fin, bulb and rudder options.'

Baker is confident in his office's CFD results in producing such specific estimates of improvement. 'We've learnt how to carefully fit the physics around the geometry of the design to create meaningful results that are no longer just within the uncertainty constraints of the process. This enables us to search for and find the very fine subtleties necessary to reduce drag in all of the various component parts of these designs.'

And lest we forget aerodynamics at the expense of hydro, FYD have ideas to improve efficiency here as well, with estimated gains in the order of one length over a MedCup course. The rather boxy appearances of the Roma and Near Miss coachroofs, for example, are a reflection of an emphasis on low windage and low centre of gravity, as well as weight saving through use of flat panels. Deck geometry is low-profile as well, with an increased radius in the hull-deck join forward also playing a part (further aft this radius decreases to force the crew weight as far outboard as possible!). Further gains are available in softer deck geometry as well as by moving more control systems below deck.

Crew righting moment is a crucial parameter in the GP42s as it is in TP52 design: the further aft the beam is carried, the greater the righting arm. But this carries hull volume and weight penalties with it as well. Like everywhere else... it is the final trade-off that will be most critical.

So what will be the shape of speed for the 2010 GP42 season? It's probably still too early to tell. There is plenty of talk of new boats, hulls, foils and new people, with at least one new team having recently committed to joining the circuit for next season. Meanwhile, there is other talk of downsizing TP52 teams and of IRC owners keen to go level racing in the Med. Come the spring we will find out... Dobbs Davis

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