ORC

Optimising for The Hague

My primary motivation for accepting an invitation to join ORC's international technical committee (ITC) in 2012 was to help move the type form of the ORC/IRC rules closer together so that boats could be sold into a global market and successfully raced by their owners anywhere in the world. I certainly never imagined that we would be facing a situation that the two rules would be used together for a combined ORCi/IRC World Championship event, but it's actually rather a fun idea and will put a spotlight on their differences to aid further improvement of both rules. Combining the results under the two rules may be more accurate than either individually, as to a some extent they mitigate against each other's shortcomings.

Designing to IRC is essentially a two-stage process. Firstly, define the box within the design space that might be attractive or otherwise advantageous, then design the fastest boat within that design space (just like a box rule). Fifteen years ago it was still possible to make massive gains by smart positioning of the boat within that box, and then minimising construction weight to lower the centre of gravity. Over the years the rule has gradually improved in general accuracy, offering increasingly smaller opportunities for design space exploitation so to a large extent our focus as designers has shifted towards ever-increasing sophistication of optimisation technology and engineering refinement with the emphasis back on hull shape.

ORCi (formerly IMS) offers a very different challenge, the rule being both transparent and complex. A designer can assess each algorithm within the VPP documentation and, with enough insight and/or technology+time+budget, he can try to exploit imperfections. As with IRC 15 years ago, designers could drive a bus through the holes in IMS and did so. At the time there was a purist approach to adjusting the rule algorithms so maximum exploitation usually meant extreme solutions and a sagging reputation for the rule.

A change in philosophy came with a change in name to ORCi and a subtle encouragement of designers to choose the 'faster' option when making their choices. The ITC focus has been in maintaining that philosophy while significantly improving the actual algorithms.

So, for 2018, the interesting challenge is simultaneously optimising to both rules for an event at a specific location. There are two sources of error/opportunity. Firstly, the real performance of the yacht will never perfectly match its rating so the racing yacht designers' job is to maximise any such difference in their favour. The second source of error is that the ratings can never be perfectly applied to the racing situation – for example, an IRC TCC is presumably based on a certain mix of conditions and courses, which will never be found in any one regatta.

Scoring opportunities

Venue characteristics – A good first step is to look into the specific characteristics of the event venue:

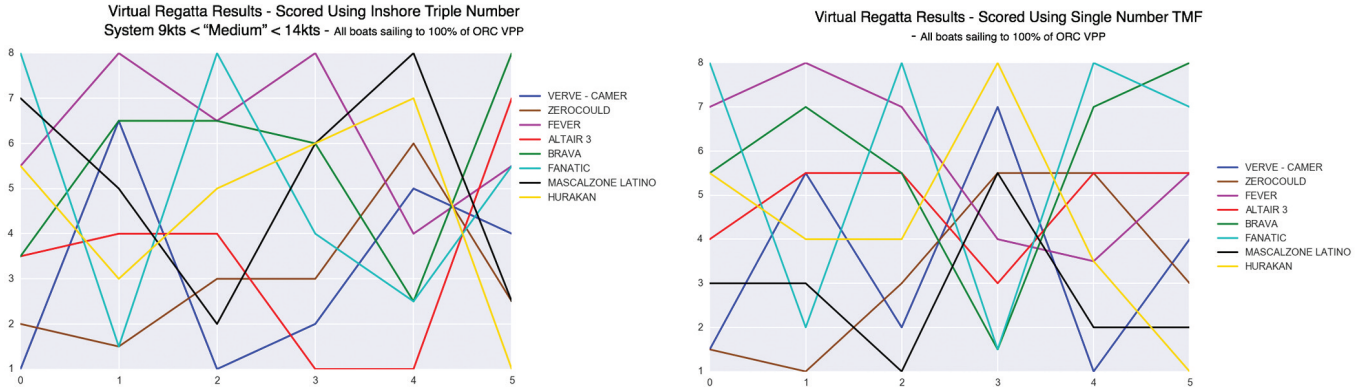
- Gradient wind strength and direction
- Sea breeze development and related shifts
- Tides and currents
- Wave state and how it varies with wind direction and tides

For IRC, being based on a single TCC, there are often significant opportunities to adjust (or choose, or design) the boat to suit the statistically likely conditions, but these opportunities are also available to some extent in ORCi, particularly if simpler scoring options are chosen.

Fleet entries – The result of a championship does not often match the cumulative corrective time, so avoiding high scoring results can be more important than winning more races. For example, if the

KURT ARRIGO

This year's Middle Sea Race enjoyed a well-supported division opting to be dual-scored under ORC within the IRC fleet and eligible for their own ORC trophy. The ORC winner was the Swan 53 *Music* which was runner-up in the race itself (the overall race winner was not entered in ORC). While some boats swapped position when they were re-scored under ORC the overall order remained similar



A comparison of results from the same ORCi-scored regatta run under the triple number (three wind-band) system, to be used for the inshore races at the 2018 worlds, and a single-number TMF – a windward-leeward adaptation of the IMS GPH single number system tailored for inshore courses and using time-on-time scoring. As you'd expect, application of the triple number system delivers a smoothing of each boat's results though whether the net result is a change in overall order is less clear. That's why we have regatta 'series'. The main conclusion is that in spite of our best efforts the combination of scoring system, weather and tide has an important effect on each result, even if everyone sails their boats to 100% potential and their ratings perfectly reflect the potential of the boats

fleet contains a cluster of well-sailed one-designs or similar types, then to avoid some high scores it could be important to avoid being too vulnerable against them in any of the likely conditions.

Scoring systems – Time-on-time or time-on-distance provide different results and even ORC's 'performance curve' scoring can produce different results depending on how it is applied. Many heated debates have been had around the world regarding the benefits and flaws of scoring options.

Race modelling – Building and running a basic 'race-model' allows various scenarios to be explored, taking into account variability in conditions, courses and fleet entries. 'RMS' files containing the rating polars of every yacht in the ORCi fleet can be downloaded from the ORC website and used for race modelling, identifying potential winners and losers in both IRC and ORCi, based on the likely conditions, scoring system and fleet at the event. Adding boat-to-boat interactions is attractive, but at this level it is impractical.

Rating opportunities

Now moving on to the rating vs design side of the problem, we have to find the biggest differences between real and rated performance. The possibilities are endless: measurement weight, ballast, rig height, fractionality, sail areas, roaches and draft are just some of the many variables that could be adjusted in either direction.

IRC optimisation – A limit of six IRC trial certificates per yacht makes it difficult to systematically probe the design space. At best one can approximately discern the local gradients of rating versus a parameter; for example, we could deduce that x metres of sail area cost 0.001 on a rating for a certain size and type of boat which then varies the further away from x we go. Sailmakers are often involved in IRC trials for many boats, so some become very knowledgeable about the IRC rating cost of sail areas. Over time a stock of IRC rule knowledge is built up but one cannot be too complacent about it as the IRC rule changes on an annual basis. Because of simple measurements, differences in shapes are unseen by the rule, so increasing performance versus rating in IRC can translate directly into an improvement in competitiveness.

ORC optimisation – ORCi's hydro-model upgrade in 2013 greatly desensitised the hydrodynamic model to subtleties of hull shape to encourage designers to focus on fast shapes rather than low ratings. Further hydro-model upgrades are in the works for the 2019 rule, but for 2018 it certainly retains a sensitivity to volume distribution in the ends that isn't matched by its accuracy.

Any physical change in ORCi will have some numerical effect on the measurement and rating, so finding weaknesses comes down to experience and observation, or by probing with powerful analysis tools. Potential opportunities may be found simply from a thorough read of the VPP documentation and perhaps by graphing some of the algorithms. Manual iteration of the VPP inputs can reveal trends, particularly where there is intentional typeforming built into the rule, such as spinnaker areas, pole lengths and keel draft.

For either rule, however, care should be taken to avoid drawing too many conclusions from one-dimensional changes; an example would be that after changes to ORCi's 'Power and Shape' spinnaker area factors in 2013, people found their ratings came down quite noticeably if they lowered spinnaker hoist (ISP), and so doing that became a trend. The underlying reason was that the background 'Power and Shape' factors were encouraging more cheap sail area within the supporting area, so a more thorough two-dimensional exploration by the rating optimisers would have revealed that increasing area while maintaining hoist height brought exactly the same discount while benefiting from a larger dose of cheap spinnaker area… IRC undoubtedly has similar multi-dimensional rule effects that due to secrecy and limited trials cannot be mapped.

Unrated effects – these are to be found in both rules and should be taken advantage of:

- Optimised shapes – Most of the 'design shape' choices in both IRC and ORCi today have minimal or no effect on rating.
- Optimised engineering – Under IRC saving weight in construction can allow the vertical centre of gravity to be lowered with a small rating effect or none at all. To actively encourage lowering VCG, ORCi uses a 'default righting moment' to mix with measured righting moment in a 1:2 ratio. Under both rules material choices for boat and rig have an effect, but within each category there are large variations and stiffness of structure is unrated.
- Sea conditions – Flat-water performance may be adequately captured by the rules, but the effects of waves or steep chop on the performance of a specific design are most certainly not.
- Off-design modes – Boat-to-boat tactics and shifts frequently require that a boat should sail differently from its optimal VMG targets. For example, holding a lane off the startline may require a high pointing mode, while being forced to overstand the top mark requires a fast mode; neither can be properly considered in the rating or scoring.
- Down-speed manoeuvres – The ratings do not reflect a boat's capability in accelerating out of tacks or gybes or startlines. For example, a boat that needs more lee-room to accelerate will be more difficult to consistently start well and unaffected by the boat to leeward. Often unrated situations can be improved by making changes that are rated. For example, increased keel fin area in ORCi will receive credit for the extra drag, but will improve low-speed manoeuvres as an unrated byproduct.

ORCi usually issues its beta VPP each November, along with an explanation of any significant changes so there can be time to optimise an existing boat (or even build a new one) to target a major event during the following summer.

The differences between the ORCi and IRC rules are reducing gradually over time, so converging the fleets into a single world championship is an exciting step. While some rule advocates may not be in favour of the move, for many it feels like a successful trade-deal between two worlds.

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