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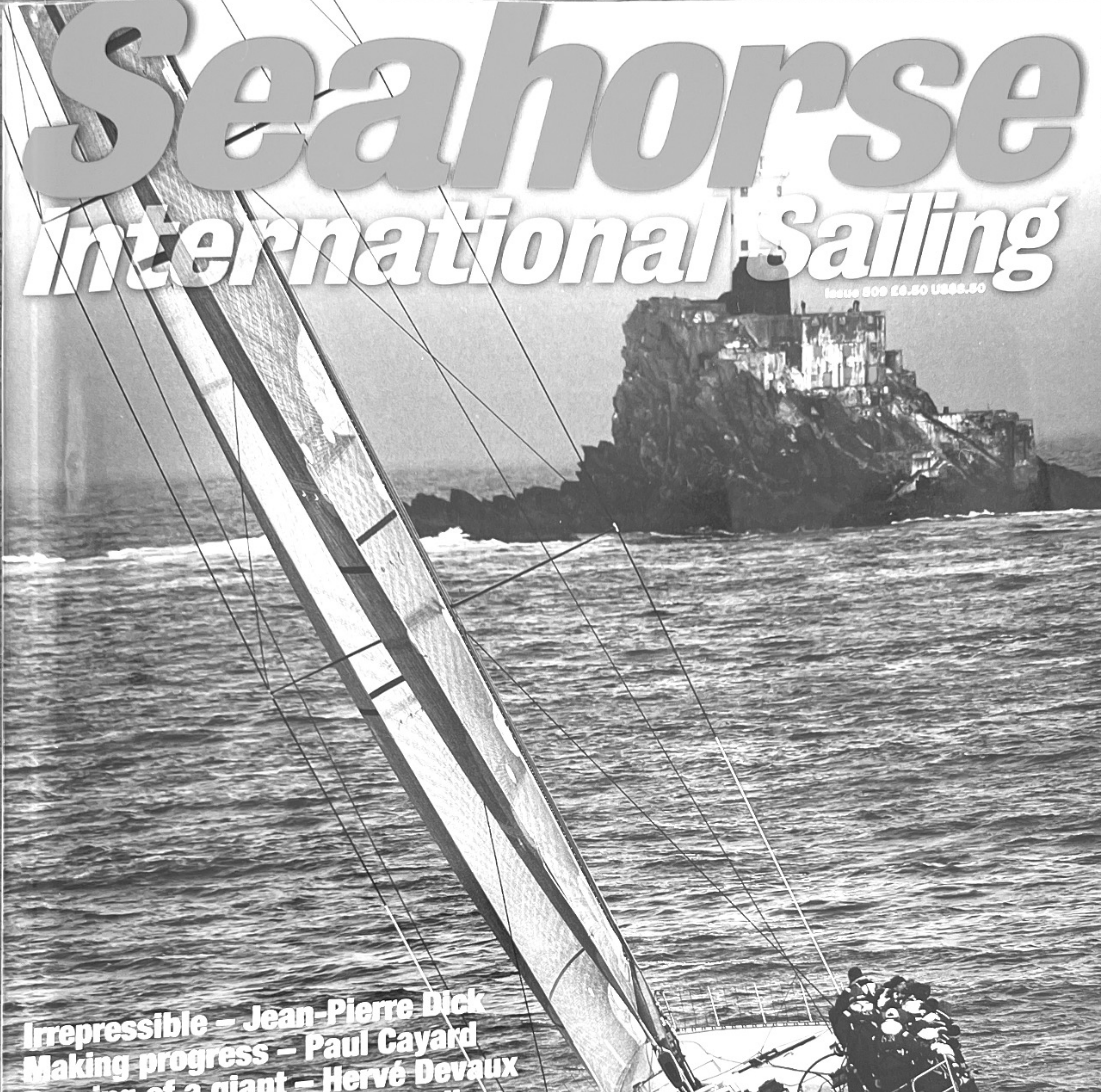

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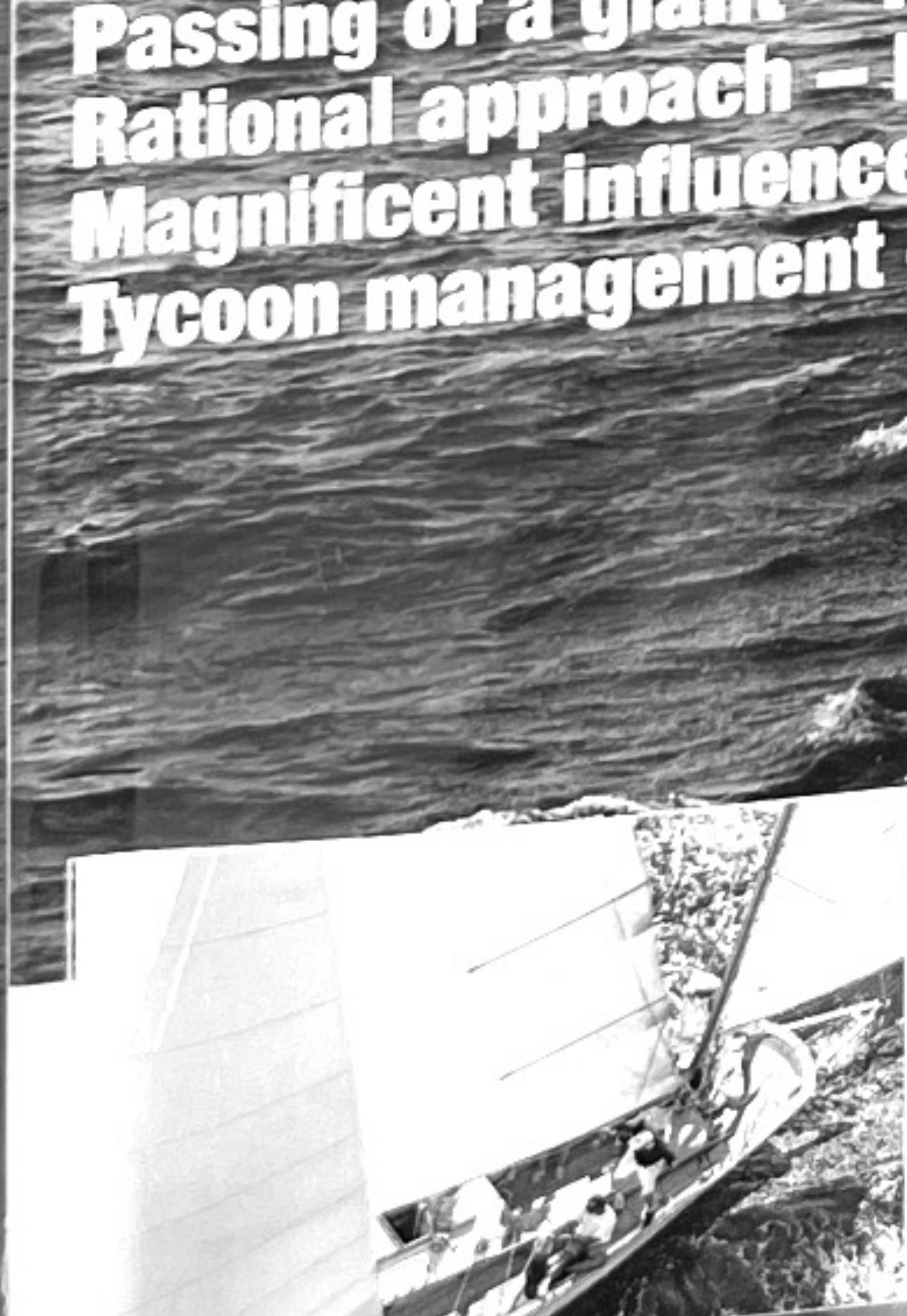

Meeting the master

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One of two new 5.5 Metres built by Peter Morton last winter, the Hollom-designed *Jean Genie* is seen during an early outing on the Solent. The crisp chine (*opposite*) also defines the point above the waterline where maximum beam is measured.

At this stage *Jean Genie* was sailing with an experimental runner-less rig but by the time she arrived in Italy the team had reverted to a conventional set-up which allowed a more slender topmast section; the narrow upper girths on the design's high-aspect mainsail meant that the fatter tube section necessary to dispense with the use of runners cost too much in terms of efficiency in the top half of the sail

Champion!

Dave Hollom, once best known for his winning glider foils, is on a roll with championship titles in sailing in everything from OK and International 14 dinghies through to the highest echelons of model yachting. Then in May his first 5.5 Metre, *Jean Genie*, put on a dominant performance on its competitive debut on Italy's Lake Garda…

In 2019, in time for the 2020 Worlds, I produced a prospectus for a proposed new 5.5 Metre. It contained a number of new avenues of possible progress in the design of 5.5 Metre boats and it was hoped that the Australian David Hayter, who very successfully sails one of my International 14 dinghies, would perhaps be able to contact prospective owners during those Worlds in Australia. As it turned out Peter Morton, otherwise known as Morty, a British owner new to the class and keen to have his own 5.5, decided to take matters further.

It all started in February of 2020 with a visit to Cowes to discuss the project with Steve Quigley, an Australian naval architect and trusted advisor of Morty. During the design study in the prospectus I had produced a number of VPPs to test various areas within the allowed rule space – Steve seemed duly impressed that the VPP that was closest to Morty's existing boat agreed extremely well with the boat's recorded sailing performance.

A few weeks later Morty decided to push the go-button, with me designing the boat and Steve running CFD tests on each design.

To add to the strength of the team Tom Schnackenberg, of *Australia II* and New Zealand America's Cup fame, and a close friend of Morty's, was recruited to oversee the performance predictions. Dave Lenz, Ruairidh Scott and Sam Haines looked after sail design and Suzy Russell of Orca Consulting took care of the boat's structure.

The boat was to be built by Gavin Tappenden of Composite Craft in Cowes, with whom I have had a long relationship that spans a fair few successful boats. Andrew Palfrey, aka Dog, took on the role of project manager and also looked after the rig and general control systems.

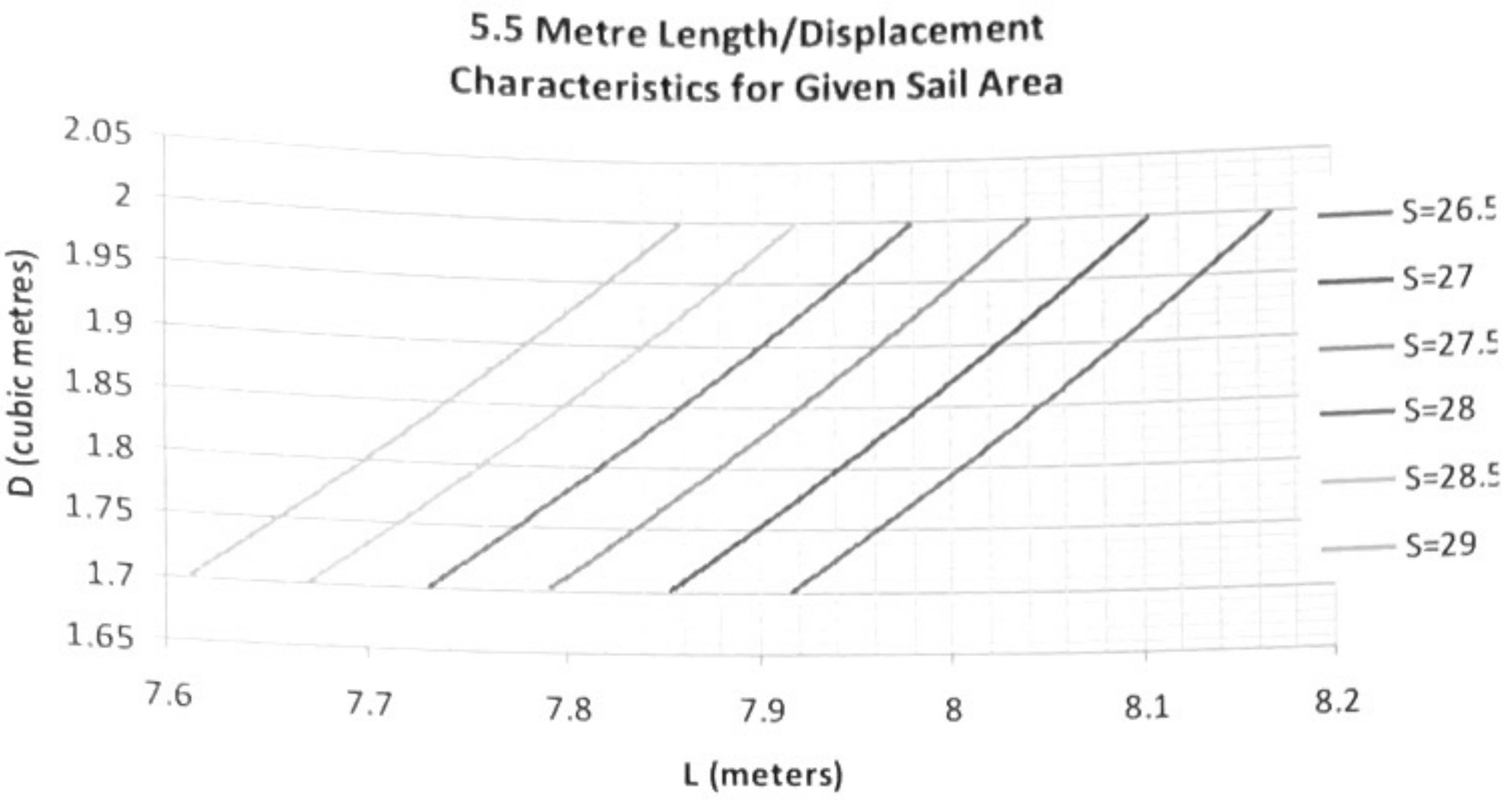
History

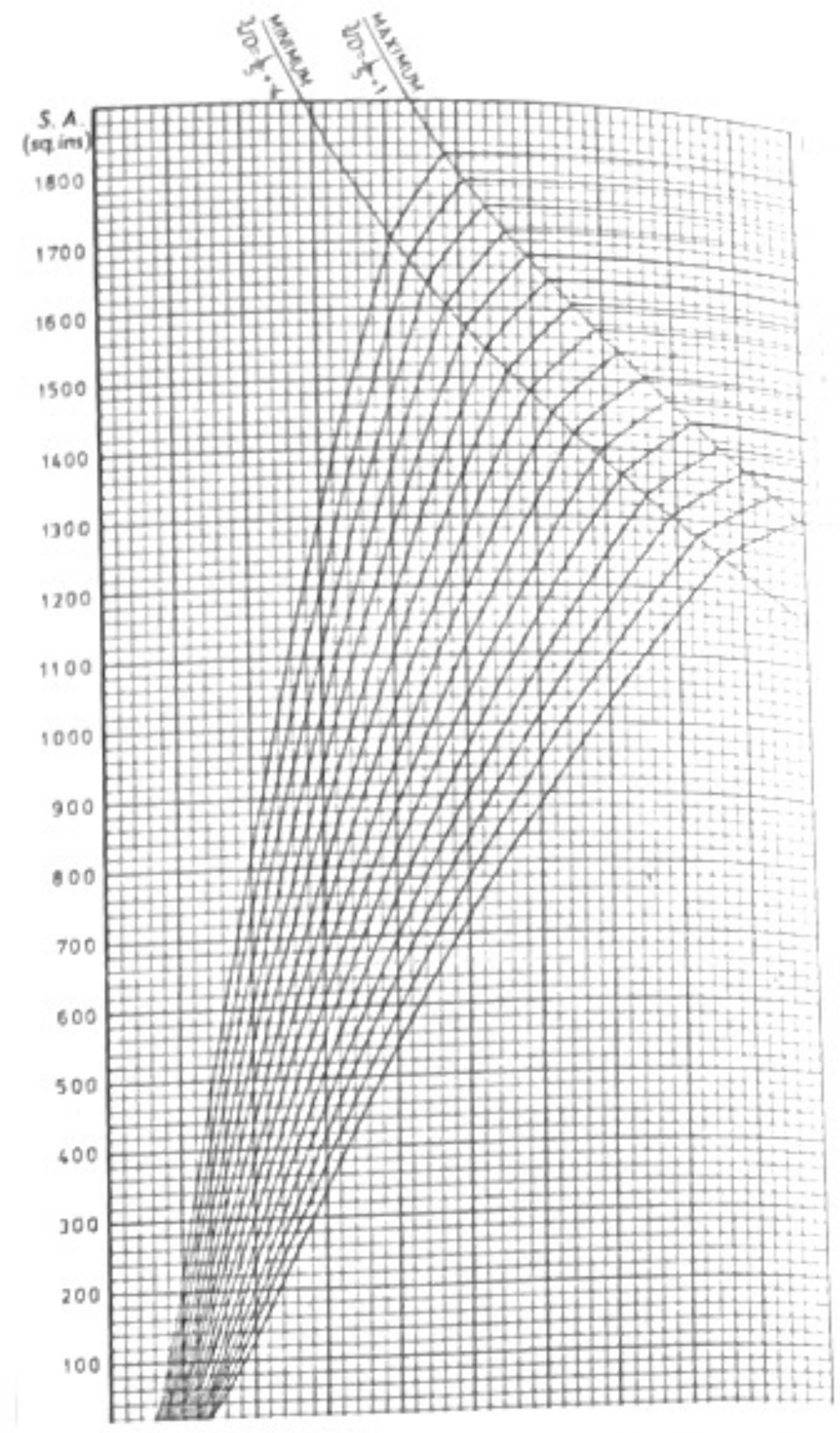
The 5.5 Metre class has its origins in a devised in 1914 for the Boat Racing Asso tion (BRA) by Malden Heckstall-Smith, then editor of the *Yachting Monthly* ma zine and brother of Brooke Heckstall-Sm yachting correspondent of *The Field* and first secretary of the International Y Racing Union (IYRU).

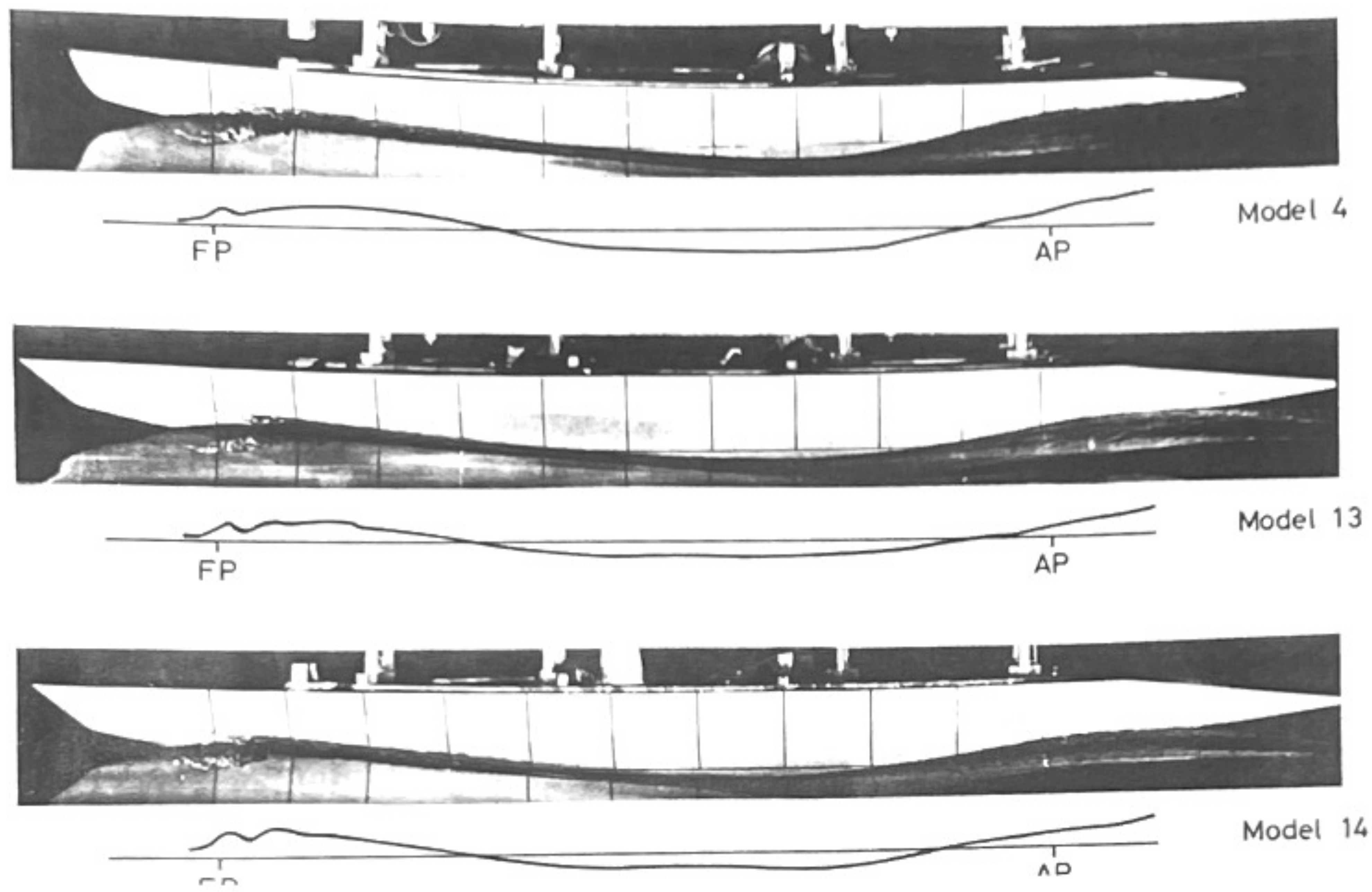
The BRA was formed by a group members of the Yacht Racing Associati (YRA), the forerunner of the Royal Yacht ing Association (RYA), who were dissati fied with the type of yachts that the YR was promoting and instead wanted a r that produced the type of yacht that t were more interested in racing. The rule th Malden came up with became known as 'BRA Eighteen Foot Rule'.

At the time there were two major ya racing rules: the Universal Rule, devised Nathanael Herreshoff and used in t USA, and the International Rule, used Europe.

The International Rule was in es length and sail area rule (see last n Charles Sibbick profile). It was b the old Seawanhaka Rule with a for freeboard, plus a 'd' measure encourage deep canoe bodies; a there was a minimum displaceme







Clockwise from top left*: graph showing the overall limits of length, sail area and displacement within the 5.5 Metre Rule; graph showing the relationship of sail area, length and displacement within the model A-Class Rule, the rule from which the 5.5 Metre Rule evolved; theoretical and actual wave profiles for three 12 Metres at 9kt. Model 4 (*top*) is an Ian Howlett take-off of Ben Lexcen's history-making Cup winner *Australia II*; model 13 (*centre*) is one of Hollom's own development models and model 14 *Crusader 2* – her flat aft run was widely considered (too) radical at the time but the design philosophy turned out to be similar to the 5.5 Metre *Jean Genie

International A Class (1926...)

Rating in inches = $\frac{L + S^{0.5}}{4} + \frac{L*S^{0.5}}{12D^{0.333}}$

+ Penalties = 39.37 inches

Where L is waterline length in inches plus half any excess in quarter-beam measurement, S is the sail area in square inches and D is displacement in cubic inches. There are maximums of draught, and quarter beam length, which vary with waterline length, and which incur penalties if exceeded and also a maximum displacement, which also varies with waterline length, and above which sail area ceases to increase. There is also a minimum freeboard, based on waterline length, below which penalties accrue and a minimum displacement, also based on waterline length, below which sail area falls more rapidly with reducing displacement.

International 5.5 Metre (1950...)

Rating in metres:
$0.9*[\{(L*S^{0.5})/12D^{0.333}\}+\{(L+S^{0.5})/4\}] = 5.5$

Where L is length measured at a height of 82.5mm above LWL plus the bow girth difference plus one third of the stern girth difference, the girth differences being measured at the ends of measured length. There are hard maximums and minimums for displacement and sail area, a maximum draught and a minimum beam and freeboard plus other restrictions. (The 0.9 in the formula is only there to make it a 5.5 Metre and avoid confusion with the existing 6 Metre. Without it, it would be a 6.11 Metre).

The playing field

The two graphs (*above*), showing the relationship between length, sail area and displacement, define the playing field, the area where trades between these factors can be made. As can be seen, this is much more restrictive for the 5.5 Metre Rule than for the A Class Rule.

The task of the rulemaker is to devise a formula that allows boats to be designed to almost any area of the rule and still be competitive. But no rule is that good so the first task of the designer is to find the weaknesses, the area within the rule that produces the fastest boat, otherwise known as the sweet spot.

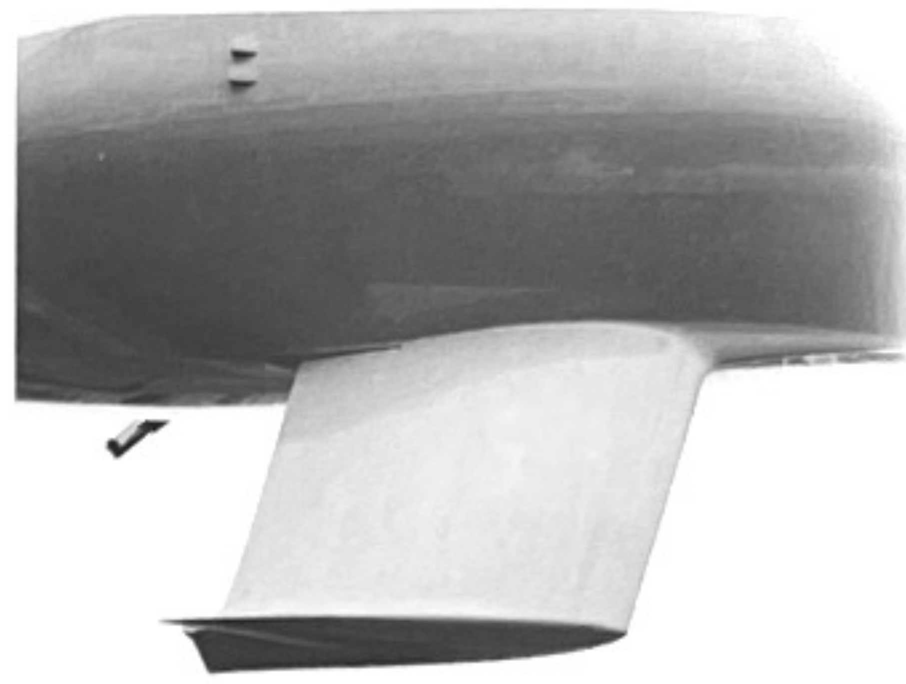
This is not necessarily as easy as it seems. Boats sitting in different parts of the rule may be dominant in a particular weather condition, so some judgment is required to produce a boat that will win multiple championships in different parts of the world across a variety of conditions.

Designing boats to the four corners of the 5.5 Metre Rule, effectively clones of each other so that variations in shape do not influence the result, and then running them through a reliable VPP, will find the sweet spot in various conditions. It is then up to the designer to come up with a successful judgment.

The problem with the 5.5 Metre Rule is that like most other rules it treats all upwind sail area as being equally efficient whereas in practice it is not. As sail area reduces, because rig height remains constant, the aspect ratio and thus its upwind efficiency improves. It produces a smaller force for the same lift coefficient (Cl) but because, due to the higher aspect ratio, induced drag (drag due to lift) is reduced, the force vector is angled more forward so that more of its force is available to drive the boat forward and less is pushing the boat sideways. The effect of this is that upwind the higher the aspect ratio the more each square metre of sail area is worth.

Downwind it is different. Once the apparent wind is abaft the beam any drag has a component of force working in the direction in which we are sailing and adds driving force.

A good VPP takes all of this into account and will predict which is the area of the rule to be in. As we expected it predicts a short boat to be in lighter airs and a long boat to be



a breeze. There is also a slight leaning towards the lighter boats being a little faster but there is not that much in it.

An insight into which way to go can also be had by looking at what has happened in similar classes. The trend in the A Class, which uses the same formula, has been for boats to become lighter, even to the extent of going into the penalty area of displacement – that results in sail area being lost at a greater rate with reductions of displacement than it is within the no penalty area. I believe also that the overall trend in IOR was for the boats to become ever lighter. Perhaps there is a clue there?

The concepts

Four concepts appear to fit our rule:
(1) An overhang at each end.
(2) A plumb or almost plumb bow with a stern overhang.
(3) A double-cranked short bow overhang plus a stern overhang, as pioneered by Laurie Davidson with his America's Cup ACC design, *NZL-60*.
(4) A plumb bow and a plumb transom with no overhangs at either end.

In conversation with the late Britton Chance many years ago, he maintained that there was nothing to choose between concepts one and two and that boats to both concepts had won championships.

Theoretically, the plumb bow has the advantage that the static waterline length is greater than with a bow overhang, thus for any given displacement and prismatic the frontal area will be less.

If the frontal area is less the water has to accelerate less to pass the hull. Lower accelerations mean lower drops in pressure and, bearing in mind that the wave system around a boat is mainly a consequence of the pressure distribution around that boat, lower drops in pressure mean a lower and less draggy wave system. Also, as viscous drag is approximately V^2 dependent, lower local velocities mean lower viscous drag.

Technically, such a boat has a lower Volume coefficient $(Volume*1000/Length^3)$ or, in old-fashioned terms, a lower Displ/Length ratio $(Displ/(0.01*Length)^3$. Generally speaking boats with lower volume coefficients have less drag for the reasons given.

The argument for concept one is that once moving the static waterline extends, but of course the frontal area is still greater than for concept two.

The old America's Cup (ACC) Rule that followed on from the 12 Metre Rule, although using a different formula to trade length, sail area and displacement used a very similar means to determine length, ie it was measured a certain distance above the waterline and combined with girths, so that similar concepts were possible under that rule as well.

Concepts one and two were tried but concept three, the Davidson cranked bow overhang, finally dominated. It is, in essence, a cross between concepts one and two. For a given measured length it has a longer waterline than concept one but a shorter waterline than concept two.

Concept four gives the greatest waterline length for any given measured length and thus the lowest volume coefficient and frontal area for any given displacement and length. It does, however, not increase sailing length with speed, as does a boat with overhangs.

The shape

Throughout the history of yacht design sectional shapes have swung back and forth between V and U-sections. Sometimes this has been influenced by the rating rule in operation at the time.

For instance, at the turn of the century the Dixon Kemp Length and Sail Area Rule favoured flat scow sections, because, as only waterline length was measured they better extended sailing length beyond the waterline endings with heel. Meanwhile, the International Rule favoured deep V-sections.

However, there have been many class where there would appear to be no stron reasons, dictated by a rating rule, th would favour either type of section a yet, at various intervals, sections ha switched from U to V and back again.

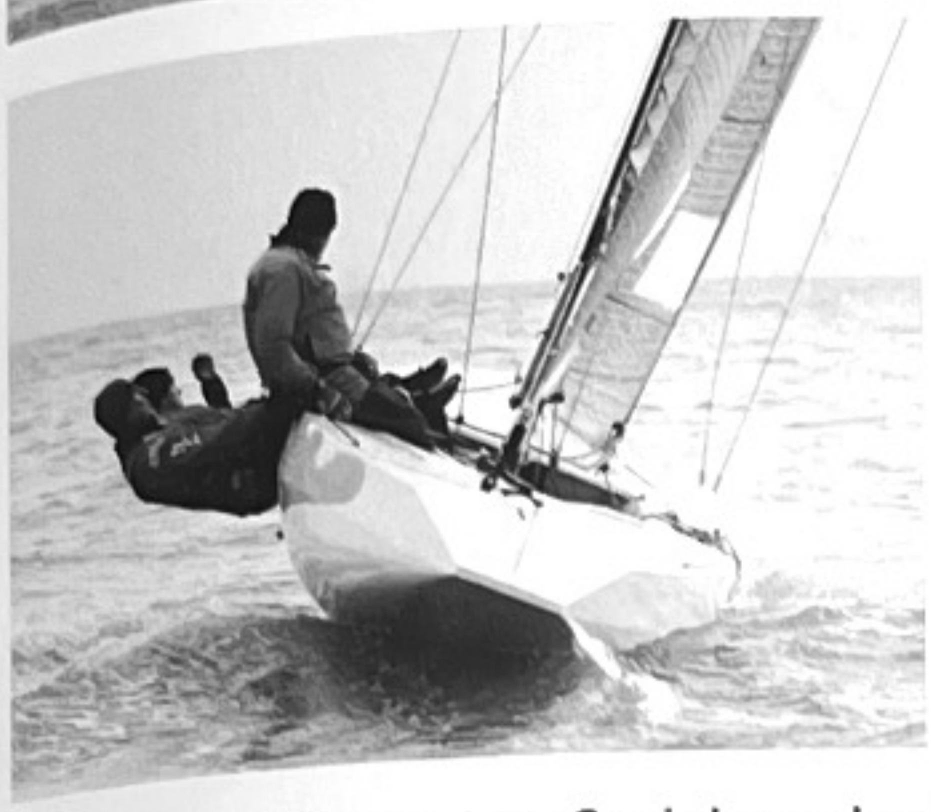
Uffa Fox in his book *Sailing Boats* te the story of the early development of t International 14 dinghy. Before 1927 a boats in the class were designed wi U-sections. However, in 1927 Uffa design and built *Avenger* with V-sections – in h first season, 1928, out of 57 starts she wo 52 times, came second twice and thi three times. A convincing display of superiority and not entirely due to Uffa's sk as a sailor for he had previously sailed h own U-section designs with nothing li the same success.

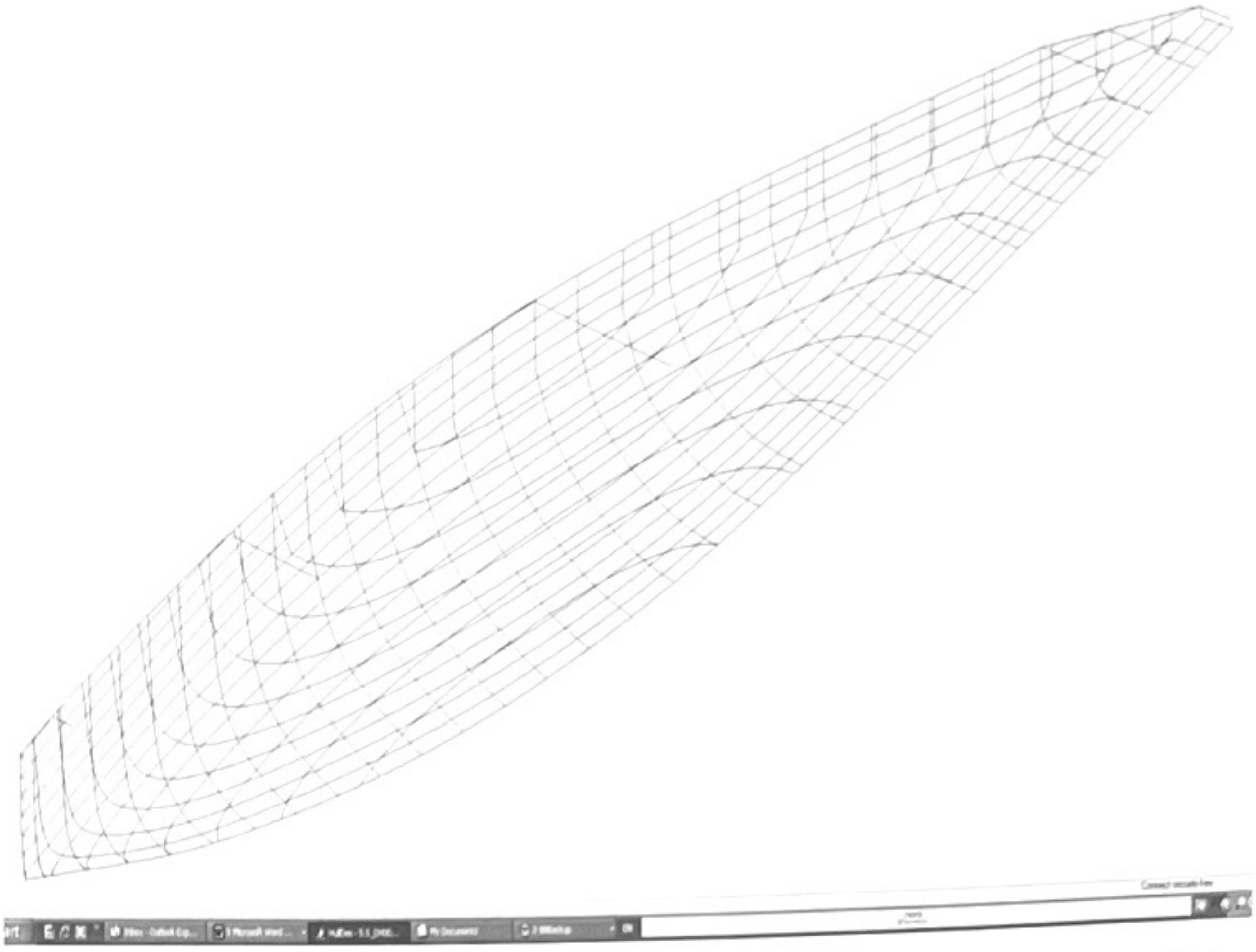
Predictably, from then on all dinghies o a similar type were of V-section until, about the mid-1970s, a U-sectioned dev opment class design again won convincingly (it was, I believe, the National 1 *March Hare*, designed by Mike Jackson From then until the present day U-sections have remained supreme but appear to be as we speak, in the process of change.

By the way, the story is much the same in both model racing yacht design and ful sized keelboat design – with one or two exceptions, most model and full-sized keel boats are now of U or similar section.

Proponents of the U-section argue th such a shape gives less wetted surface are for a given volume, and thus viscous dra will be reduced. However, U-sections on definitely minimise wetted surface area i the beam/depth ratio (B/T) is the same for both the U and the V-section and this m or may not be true when stability is tak into account. Also, wave drag might b different for the two types of section that it might not be all that obvious wh is the favoured section type.

Froude, in his famous experime discovered that to minimise wave d volume should be placed as far away fr





Opposite clockwise: ***Jean Genie*** **here clearly using all of that long aft overhang – note the narrow upper girths of the mainsail which compromised the use of a thicker upper mast section to do away with runners; the clean and modern cockpit co-designed by Andrew Palfrey and builder Gavin Tappenden incorporates thoughtful Star-style handholds for today's mini-hiked 5.5 crews; IRC-style thick fin keel with a subtle reverse taper, leading-edge 'wedge', large trim tab and small delta-wing endplate... but no wings or ballast bulb.**
Top: **Steve Quigley's own new 5.5 Metre shows a rounded stern while Hollom typically goes all-in with the board-flat approach (*left*).**
Right: ***Jean Genie...*** **showing a smooth-flowing transition from bow U-sections to V-sectioned mid-body and a completely flat run aft**

the water surface as possible, at the bow, and that at the stern the volume should be as near the water surface as possible. He then reasoned that the shape that best achieved this was a U-section at the bow and a V-section amidships running to a flat stern. We pretty much came to agree with this when we used a potential flow wave drag program during the Crusader America's Cup challenge in 12 Metres. Indeed, the shape of *Crusader 2* was heavily influenced by this work and she was a very fast boat.

Bearing all this in mind, and as V-sections seemed to be competitive in classes where both types of section were used, it seemed worthwhile investigating the pros and cons of the two types of section, and at the same time looking at the effect of U-shaped bow sections linked to V-shaped midsections. In the early 1990s we therefore conducted a computer experiment to try to determine the effect of sectional shape on wetted surface area and, as far as was possible, look also at the effect of sectional shape on wave drag.

Boats were designed using U, V, a flat scow section and a U to V-section à la Froude. Great care was taken to ensure that the length, displacement and metacentric height and thus the stability of all the boats were identical. Furthermore, other parameters such as lateral area coefficient (Clat), waterplane area coefficient (Cwp) and prismatic (Cp) were held constant or, where one of them had to change in order to look at the effect of changing that parameter, they were changed one at a time holding the other parameters constant.

The results were very interesting and the shape of *Jean Genie* is very much influenced by this work and, as mentioned, the original work on wave drag undertaken nearly 40 years ago during the Crusader Cup challenge – using one of the earliest potential flow wave drag programs written by Dr George Gadd of the National Physical Laboratories (NPL).

A visual output of the program for three 12 Metre hull forms, showing actual and computed wave shapes, is the example shown on page 52. Model 4 is *Australia II*, Model 13 is a development model and Model 14 is *Crusader 2*.

Optimisation

In the brief for his new 5.5 Metre Morty specified that the boat should be optimised for true windspeeds of 8 to 18kt. He reasoned that below 8kt sail trim and going the right way were perhaps more important than pure boatspeed, and that above 18kt boat handling became the dominant factor. This somewhat simplified the optimisation process.

With the help of Steve Quigley's CFD analysis, which determined canoe body drag, Tom Schnackenberg ran the data through my own VPP to obtain a full performance analysis for each boat.

Firstly, we analysed boats designed to the four candidate concepts, all fitting the same part of the rule, ie all having the same measured length, displacement and sail area, to remove those variables; although it was not necessarily the fastest concept, we chose, for a number of reasons, concept one.

We then looked at boats to that concept, designed to fit various parts of the rule, and eventually settled on a boat having maximum measured length, minimum displacement and *minimum* sail area, in other words a boat at the bottom right of the graph on page 52.

It is very dangerous, in a rule with hard edges, to be in any corner because if there is a small inaccuracy in displacement or length the sail area might come out less than the minimum allowed and then you have nowhere to go to correct the problem other than major surgery, or the boat will not be a 5.5 Metre. We thus positioned the boat a little above minimum displacement to avoid any possible problem.

The isometric of the Jean Genie hull shape that is shown above clearly shows the progression from the U bow sections to the V-sections in the mid-body and the flat scow sections at the stern.

The boat was built in a female mould taken from a CNC-cut plug by Composite Craft of Cowes using S-Glass and foam with some finishing work by David Heritage.

My VPP gave it an advantage, in the mid-wind range, of about one minute over a two-mile windward and a two-mile leeward course, and this seems to have been borne out in competition.

The really pleasing thing, however, is that below 8kt true we seem to be no slower than the opposition upwind... and downwind we are still quicker.

Most sporting success results from a group effort and this is no different – largely down to Morty's own skills in putting together a great team in which every member has contributed to that success.

As a matter of interest, and as pointed out by Morty, according to Douglas Adams' *Hitchhiker's Guide to the Galaxy*, in which the mega-computer Deep Thought, after seven and a half million years of brooding calculation, intones with 'infinite majesty and calm', the answer to 'Life, the Universe and everything' is 42. Perhaps it's a lucky number?

Dave Hollom, Yorkshire ❑