SCHRS

SMALL CATAMARAN HANDIPAP RATING SYSTEM

WORLD COUNCIL REVIEW 2012

(Updated 29/4/2012)

BACKGROUND

During 2011 we had some valuable feedback on technological developments that affect our formula, so significant changes are now required to keep it up to date.

The main sources of feedback come from:

1. The F16 fleet, which can now provide significant evidence that the cat boat version (single handed with no jib) is slower than the two handed version. As a class they race on a level rating basis, with an increasing number of top sailors. Our main information on this class has come from Greg Goodall, Wayne Richards and Simon Longstaff, based on experience at the last two F16 world championships
2. Jean-Claude Rouves (JCR) of the FFV who has done an extensive performance study of French results, and has identified some material anomalies. Of the main classes sailed there, the Hobie 16 is too harshly treated, and the F18 too generously.
3. This is also seen in the UK, where the Dart 15 and Dart 18 classes have virtually abandoned handicap racing because they feel it is so unfair.
4. The Texel Rating organizers, Geert Ruesink (GR) and Nico Boon, who run a rival rating system based on statistics drawn from many years of experience in the Round Texel Race. They have a better formula for dagger boards to SCHRS, which takes no notice of absolute size, only efficiency in the form of aspect ratio. Experience from the F18 fleet has shown a significant benefit from size.

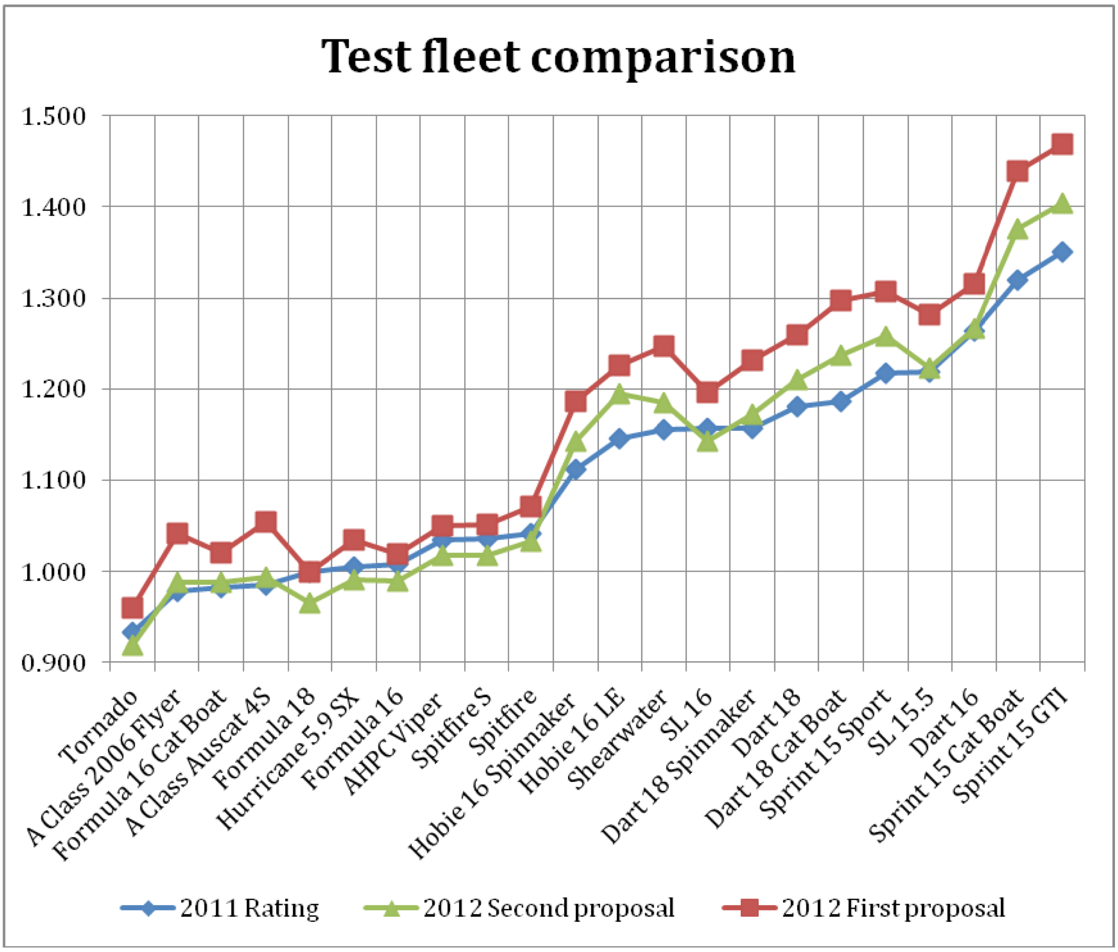
If SCHRS is to live up to its status as the ISAF recognized method for handicapping small catamarans, it needs to widely accepted and used. We are bringing the various rating systems closer together in the following ways:

- Addressing the small cat problems experienced by the French. In 2010 they started using different numbers to resolve the issue among older slower designs, based on performance experience, rather than the strict application of a formula, but with the benefit of their data this can be addressed by improving our formula.
- Co-operation with the Dutch, which is now into its third season. We are now using the same software and have adopted some of their specific formulae where they seem to model performance better.
- Opening communication with countries, where other systems also operate. Mark Schneider has joined the World Council in the United States, where US Portsmouth Yardstick (USPN) operates. A similar appointment is planned for Australia, where the Victoria Yardstick (VY) is used.

These are the principle developments on this project since last year.

- At Carnac JC Rouves of Federation Francaise de Voile (FFV) presented his statistical study of performance in France and explained the concerns which had led to FFV using different figures.
- There was a meeting in Paris in September, attended by Olivier Bovyn (President F18 and World Council member), JC Rouves, (FFV and Technical Committee), William Sunnucks (Chairman of the Technical Committee), Nick Dewhirst (Chairman UKCRA and President SCHRS) and Geert Ruesink (Ronde on Texel).
- Olivier Bovyn presented the Annual SCHRS Report to the 2011 ISAF Annual Meeting in Puerto Rico. Having completed its task, the Multihull Commission has been disbanded, so SCHRS now reports to the Equipment Committee.
- Over the autumn there were numerous e-mails between GR, JCR and WS to workout practical solutions to the issues discussed in Paris.
- A draft Report was distributed among the technical committee on 3rd January 2012. Modifications were incorporated into the final Report to the World Council which contained the recommendations discussed below.
- User testing of the recommended changes has been carried out on past results by JCR in France, MS in the US and both WS and ND in the UK.
- The World Council approved all recommended amendments and authorized publication of the revised rating numbers on 2nd March.

The agreed changes move much closer to reaching these objectives, but any formula is only the best practical approximation of reality. The agreed changes are not as extreme as new performance as the latter measure boats + sailors, whereas the SCHRS formula only measures boats.



METHODOLOGY

Step 1: Having looked at the empirical results we identified which parts of the formula might be adjusted to give the desired results. This was discussed at the meeting in Paris.

Step 2: A number of alternative approaches were then developed, and these were discussed in the e-mail correspondence during the autumn.

Step 3: The Technical Committee worked on test fleets, and tuned the formula to reduce the number of anomalies to a minimum.

Standard error analysis

To speed up the process of optimizing the formula 'standard error' approach has been adopted. Targets were set, using the empirical results, and then multiple versions of the formula tested to see which version most closely reflected experience. The targets were:

1. C3 boats – difference from JCR empirical figures
2. C1 boats – difference from JCR empirical figures
3. Average for C3 classes – Average for C1 classes = increase by 3%
4. F16 1 man – F16 2man = 2%
5. Dart 18 Cat Boat – Dart 18 = 2%
6. Dart 15 – Dart 15 Cat Boat = 2%

JCR empirical figures for C1

Bateaux	Ratings calculés sur performances	Table ratings FFV- SCHRS 2011	Ecarts	Ecarts en temps / h	Commentaires
Formule 18	0,950	1,000	-5,00%	00 :02 :59	Différence supérieure à 1%
Tornado New rigs	0,957	0,934	2,47%	00 :01 :28	Différence supérieure à 1%
Classe A	0,982	0,980	0,21%	00 :00 :07	
Groupe 104	1,035				Groupe de référence

JCR empirical figures for C3

Bateaux	Ratings sur performances	Table ratings SCHRS	Ecarts en %	Ecarts en temps/h	Commentaires
15.5	1,219	1,219	+0,00 %	00 :00 :00	Bateau de référence
SL16	1,145	1,157	-1,04 %	-00 :00 :38	Différence négative
HC16 Spi	1,146	1,112	+3,06 %	00 :01 :48	
DART 18	1,227	1,181	+3,90 %	00 :02 :11	Bateau sans spi – Cas particulier

Results of standard error analysis

Formula	**Standard Error from targets**
SCHRS 2011	3.04%
SCHRS 2012 (proposed)	1.38%
Texel	4.01%

This table shows that SCHRS 2012 fits more closely with the targets set than either SCHRS 2011 or Texel. Further discussions with Texel are planned for June. This method has proved a useful way to see quickly how far proposed changes move outcomes in the desired direction.

RESULTS

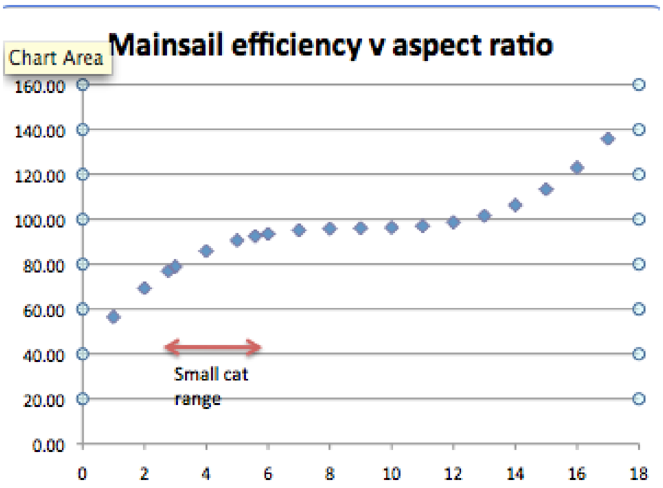
Class	SCHRS 2011	SCHRS 2012
Main C3 classes		
SL 15.5	1.219	1.223
Dart 18	1.181	1.210
SL 16	1.157	1.143
Hobie 16 Spi	1.112	1.143
Main C1 classes		
AHPC Viper Double	1.035	1.018
Formula 18	1.0003	0.966
A Class 2006 Flyer	0.978	0.988
Tornado New Rig	0.934	0.919
Other relevant classes		
Sprint 15 GTI	1.350	1.404
Sprint 15 Cat Boat	1.320	1.376
Dart 16	1.263	1.266
Sprint 15 Sport	1.218	1.259
Dart 18 Cat Boat	1.186	1.237
Dart 18 Spinnaker	1.157	1.172
Shearwater	1.156	1.185
Hobie 16 LE	1.145	1.195
Spitfire	1.041	1.033
Spitfire S	1.036	1.018
F16 two man	1.008	0.989
Hurricane 5.9 SX	1.006	0.991
A Class Auscat 4S	0.986	0.993
F16 Cat Boat	0.982	0.989

CHANGES TO THE FORMULA

1. Mainsail Efficiency – adjustment for square top added

	SCHRS 2011	Proposed SCHRS 2012
1. Mainsail efficiency (ME)[1]	$40.1+18.31xm-2.016xm^2+.07472xm^3$ $xm = aspect\,ratio = VLM^2 \div CM$	$OldME \times CTMS$ $CTMS = (1-(0.12538-RTMS))^{.8}$ $RTMS = \frac{LTM \times VLM \div 4}{CM}$

To date Mainsail Efficiency (ME) relies entirely on aspect ratio. The existing formula is thought to work satisfactorily, although its theoretical credibility is dented by the S curve which appears at higher values. See below.



The new formula also takes account of LTM or the Length of the Top of the Mainsail. See appendix 1 which shows how LTM is measured. LTM is quick to measure, and JCR has already collected data for most classes. There were concerns that the impact of the LTM penalty is too dramatic – some pinheads get a benefit of nearly 6% which may be too much. So the effect was scaled back using a 0.8 power factor on CTMS (CTMS ^ 0.8). The charts below show the impact of the changes on the test fleet. The Dart 15 cat boat benefits by 4.84%.

2. Length Calculation – reduced length penalty for older designs

	SCHRS 2011	SCHRS 2012
2. Length (L) pre 2007 designs[2]	$L = WL + 0.3 \times (AL - WL)$	$L = WL + 0.1 \times (AL - WL)$

[1] The quadratic equation for mainsail efficiency produces and S curve which isn't intuitively correct. But ignore as it is outside the likely range. LTM = the Length of the Top of the Main, CM is the area of the main, VLM is the vertical height of the Main

[2] AL = overall length. WL = Waterline length

There is a slight change to the Length calculation to benefit old designs such as the Dart 18, Hobie 16 and Tornado which are longer at deck level (AL) than at waterline (WL). At present 30% of the overhang is added to the waterline length. This will now be reduced to 10% as above. This makes a difference of up to 0.5% in favour of the old designs.

3. Board Correction – size taken into account as well as aspect ratio

	SCHRS 2011	Proposed SCHRS 2012
3. Board Correction Factor (BC)[3]	$BC = 15 - \frac{15}{XB^{.1045}} + 2$	$BC = 2\% + (CB \times XB/55)$ (If no board then BC = 0)

The 2011 formula relies entirely on aspect ratio (XB), and the Dutch have criticized our formula for this. We know that bigger dagger boards can be faster particularly in lighter winds, and we are seeing some extreme boards in the F18 class.

The 2012 formula takes into account the area of the board (CB) as well as aspect ratio (XB).

4. Power Factor – new quadratic formula

	SCHRS 2011	Proposed SCHRS 2012
4. Power Factor[4]	$PF = 1 - .04 \times ((RM/HM) - 1)$	$.0527 * (HM/RM)^2$ $-(.0602 * HM/RM)$ $+1.0147$ subject to maximum of 1.032

The power factor is needed to recognize that boats with wide beams will go faster. It is related to Heeling Moment (the heeling force generated by wind on the sails) and Righting Moment (the leverage exerted by the weight of the hull and crew).

The graph below shows that the present SCHRS power factor is much less significant than the Texel one. An extra crew member increases an F18 rating by 7% due to his weight. But the only recognition for the benefit of his extra righting power is 0.7% which comes into the rating through the Power Factor. This is causing a problem with cat boats (a.k.a. unarig), particularly the F16 where the extra man is a clear benefit.

There is also a problem with the shape of the curve. In smaller overpowered boats such as the Dart 15 the extra crewman has little benefit, but the shape of the curve suggests it should have more.

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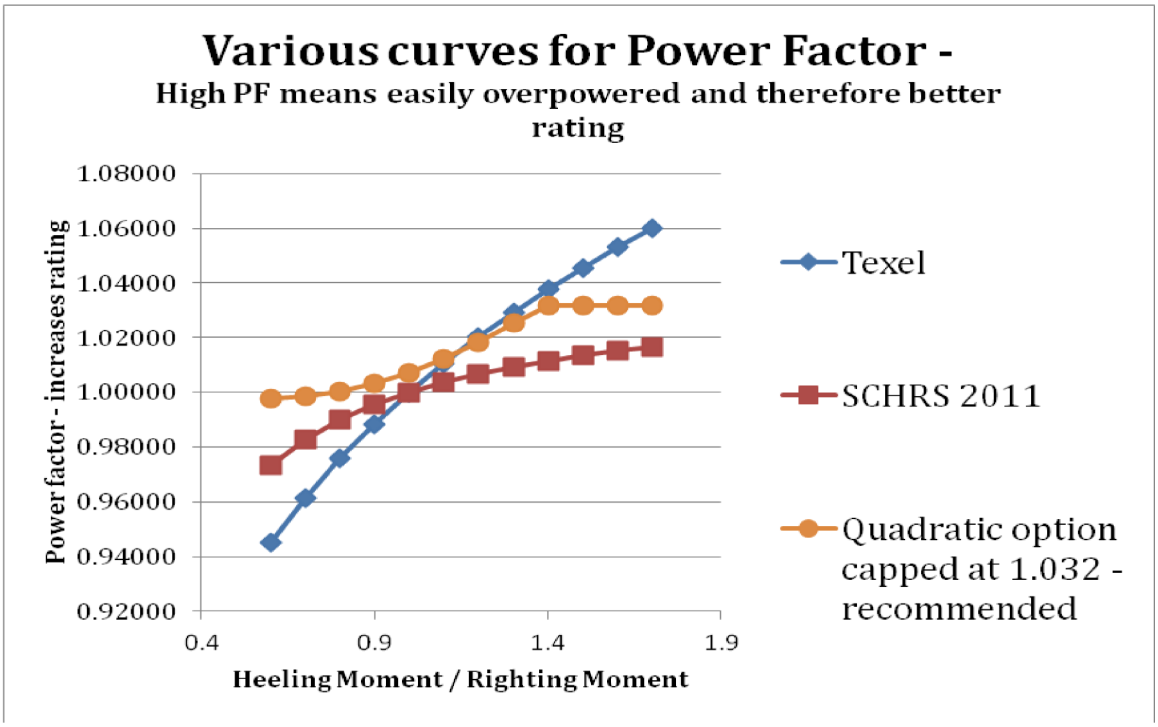
[3] BC = 0 if there is no board. XB is the aspect ratio of the board calculated as VLB^2/Area. VLB is the length of the board below the hull, measured round the circumference if curved.

[4] For ease of understanding an 8.565 factor is included in the HM definition not the PF one as in the strict SCHRS rule. It makes no difference. 8.565 is probably intended to be the dynamic wind pressure measured in kg/m^2. In the Texel formula the equivalent figure is 9.7 which assumes a windspeed of 14.8 knots.

We now use a quadratic equation, which gives a flat curve for the Dart 15 and other small boats, and steeper for the over-powered boats. A maximum value of 1.032 has been introduced to deal with the A class, which would otherwise have a far more favourable rating than is merited by its performance in practice.



5. Righting Moment – Texel formula adopted

	SCHRS 2011	Proposed SCHRS 2012
5. Righting Moment (RM)	$0.5 \times Beam \times (WS + WC) + Numtrap \times .93 \times 75$	$(0.5 \times Beam \times WS) + (Beam \times CW \times 75kgs) + (.93 \times Numtrap \times 75kgs)$

The existing righting moment formula is inappropriate for a small catamaran. The moment generated by the crew is only for 50% of the beam, not the full beam as would be expected with the crewmen sitting on the side. The new formula corrects this. Here SCHRS has adopted the Texel formula. Note that both formulae assume that sailors are all 75kgs and 1.86m tall (thus 0.93). CW is the number of crew.

6. Heeling Moment – Texel formula adopted

	SCHRS 2011	Proposed SCHRS 2012
6. Heeling Moment	$(0.4 \times VLM \times A - 0.02 \times CSPI \times VLM) \times 8.565$	$((.42 \times (VLM + 1) \times CM) + (.33 \times (VLJ + 1) \times CJ)) \times 9.7037$

The 2011 HM formula is a very rough approximation. It assumes that the foot of the mainsail is at water level. Also it assumes that the spinnaker contributes to heeling moment, when heeling is only normally a constraint upwind when the spinnaker is down.

In contrast this part of the Texel formula assumes that both jib and mainsail start at one metre above the water, and that the average wind speed is a little higher (thus 9.7037[5] rather than 8.565). This is logically better so has also been adopted by SCHRS.

7. Spinnaker Adjustment – simplification benefits single-handers

At present spinnakers are handicapped by deducting the jib area from the spinnaker area. This is unfair on cat boats which sail single handed without a jib, because they are assumed to have a bigger spinnaker than the two man version. The formula is now simplified so that CJ only appears once.

	SCHRS 2011	Proposed SCHRS 2012
7. Spinnaker Adjustment	$J = (CJ \times JE/100)$ $+((CSPI - CJ) * .1)$	$J = (CJ \times JE/100)$ $+(CSPI * .1)$

It is worth noting that the Texel formula does not deduct the jib area and has a bigger penalty – 15% of the area rather than 10%. It also has a complex default spinnaker size calculation for those boats where measurements are not available.

8. Sinking Hull Adjustment – something is better than nothing

SCHRS suffers from not having any measure of wetted surface in the formula. A given weight on a long thin hull creates more wetted surface than the same weight on a short wide hull. This is most apparent among 16 foot cats, when observing changes over time from the original HC16 with its deep V shape hulls to the latest Vipers, with much squarer hulls, so the older designs urgently need help.

In future after further research a modification may be introduced for HW/AL where HW is a measure of the maximum width of the hull as a proxy for wetted surface – the shorter and wider the hull the lower the wetted surface and the greater the speed.

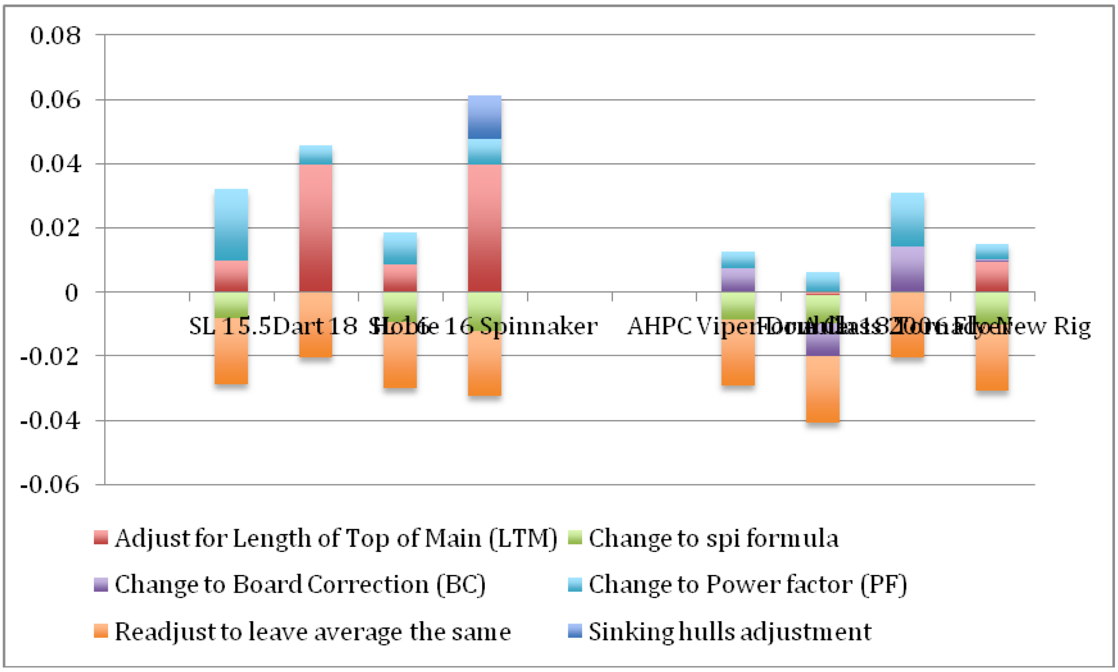
However its urgency requires that for the short term a constant factor will be introduced to benefit those boats with obvious extra wetted surface – those with sinking hulls such as the Hobie 14s and 16s, and some of the older Prindles. It is recognized that this does not meet our usual standards of mathematical rigor, but some adjustment is better than none.

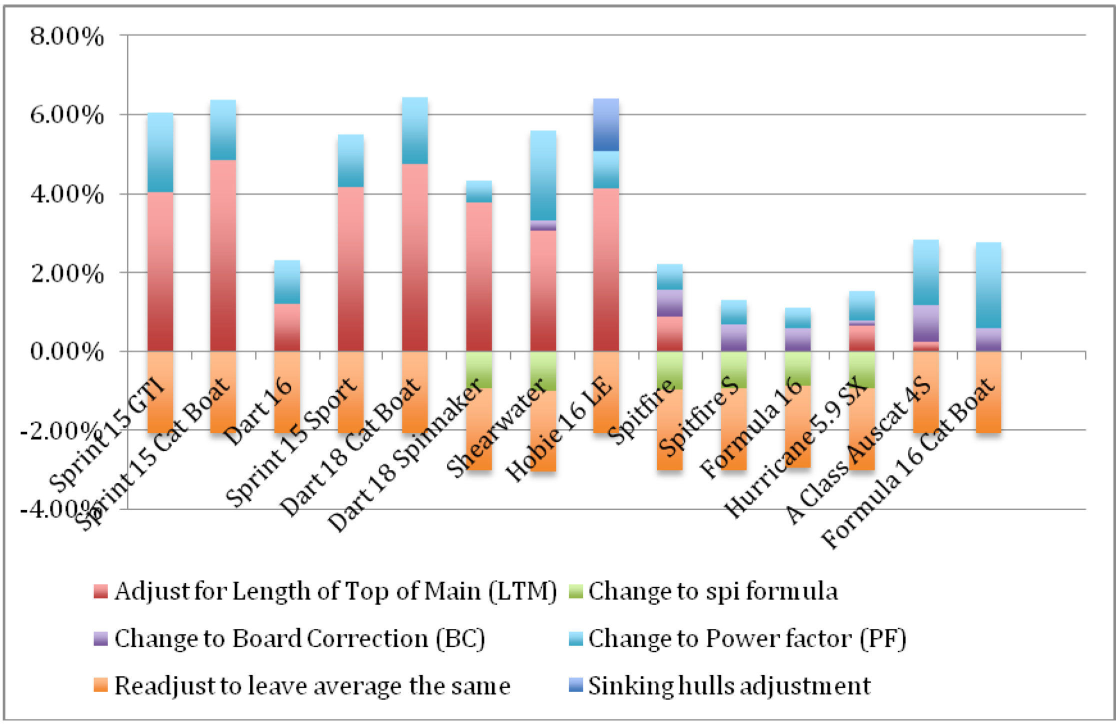
	SCHRS 2011	Proposed SCHRS 2012
8. Sinking Hull adjustment (proxy for wetted surface area)	No penalty or benefit	1.35% benefit for those boats with deep v hulls clearly designed to sink deep into the water

[5] The Texel formula calculates the Dynamic Wind Pressure in KG psm as 9.7037. This is the calculation: Dynamic Wind Pressure = (wind speed 7.6 metres per second) ^2 x wind co-efficient of .07 x 2.4

IMPACT ASSESSMENT

This analysis illustrates the impact each change has on each test fleet class. The bar charts below show the increase or decrease in rating attributable to each factor.





COMMENTARY

- The 1.35% sinking hull adjustment (dark blue) has only been applied to the Hobie 16, Hobie 14 and Prindle 15, which have very deep V hulls, and thus high wetted surface. Other designs may also be affected but to a lesser extend
- The power factor (light blue) is central to addressing the F16 problem. The new formula helps the A class, but not by as much as it would if it had not been limited

it at 1.032. It also helps the very underpowered boats such as the SL15.5 because of the shape of the curve.

- The change to the board correction factor (purple) penalizes the F18 which has very large boards. It helps classes such as the A class with small efficient boards.
- The change to the spi formula (green) penalizes all three sailed boats because the jib area is no longer deducted from the spi area.
- The biggest adjustment is for square heads or Length of the Top of the Main (LTM) – (red).

DISCUSSION

F18: The F18 will suffer a 3.4% penalty against some other boats. It is hit by the increased dagger-board penalty, its square top mainsail and the bigger spinnaker penalty. This is a significant change, but still smaller than the 5% change suggested by the French performance data. The F18 may lose a lot of top sailors to the new Olympic catamaran, in which case performance will fall. If this penalty is thought to be too high it can in future be reduced by scaling down the impact of dagger board length.

F16: With their lighter weight and wide hulls the latest designs such as Viper are often racing boat for boat with the F18s. If the 2012 formula increases the difference from 3.5% to 5.2% a lot more F16 handicap winners can be expected. It may be that a wetted surface adjustment in 2013 will remedy the problem.

Tornado: The Tornado has been hit a little harder than is justified by performance. Its rating will fall from .934 to .919. Its square top mainsail is penalized, as is its large centerboard area with low aspect ratio and wide beam. And it will have a bigger spi penalty. It has however been helped by reducing the rated length for boats designed before 2007 with bow overhangs. If further help is deemed appropriate, the impact of board area in the new formula can be scaled back in future.

F16: Feedback suggests that the single handed cat boat without jib is slower than the two handed version, whereas the formula now puts them both at .989. Nevertheless they are much better off than before, and a level rating is in line with their own class rules. This could be solved by upgrading the impact of the power factor, but that would create further problems with the A class at the top end of the curve, and the Dart 15 at the bottom end.

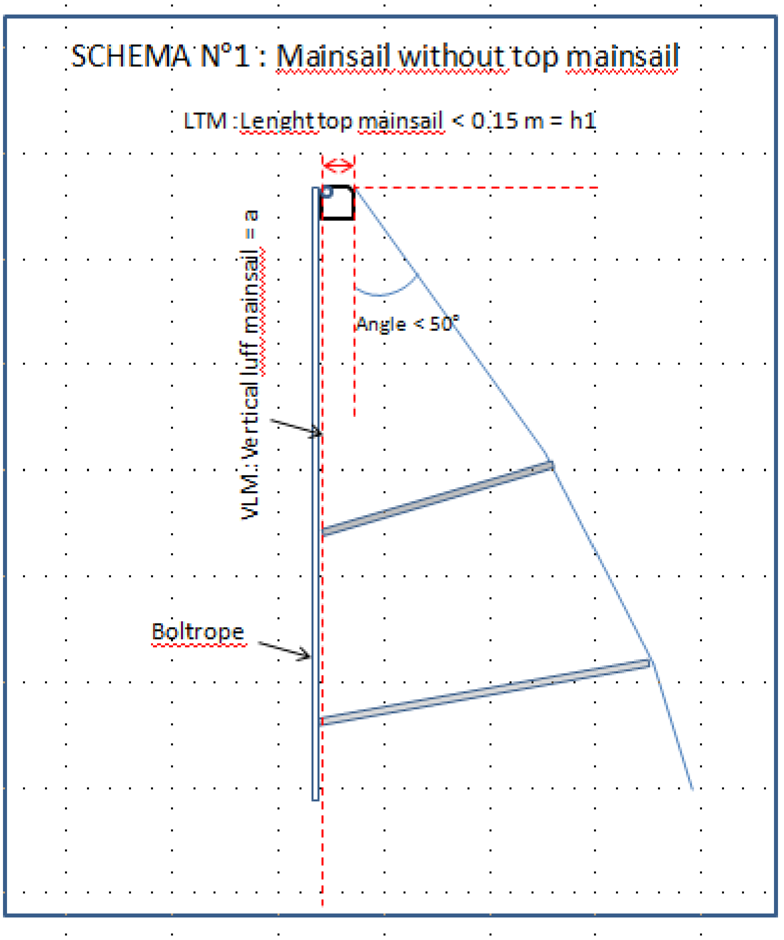
LTM adjustment: Feedback from one sailmaker (Peter Vink) suggests that a large square head or LTM adjustment would be wrong, and that sailmakers may try to find ways around it.

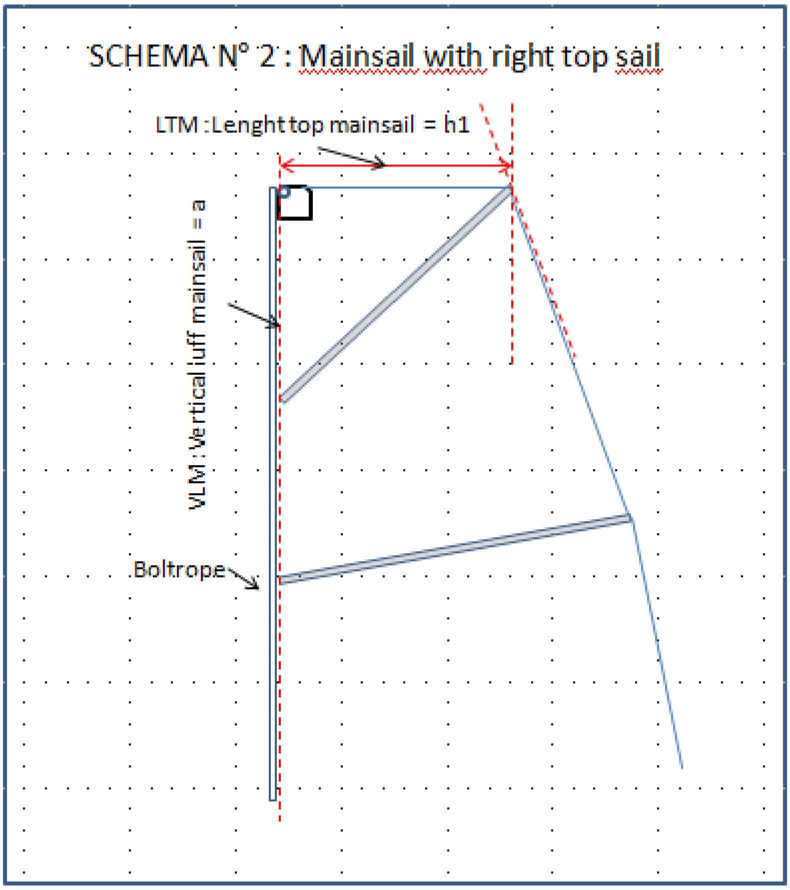
Purists: On occasion pragmatic proposals have been made which may seem arbitrary. The 1.35% benefit for sinking hulls is a rough fix for a real problem. Capping the power factor limit at 1.032 is an arbitrary limit intended to limit the benefit for very over-powered boats such as the A class.

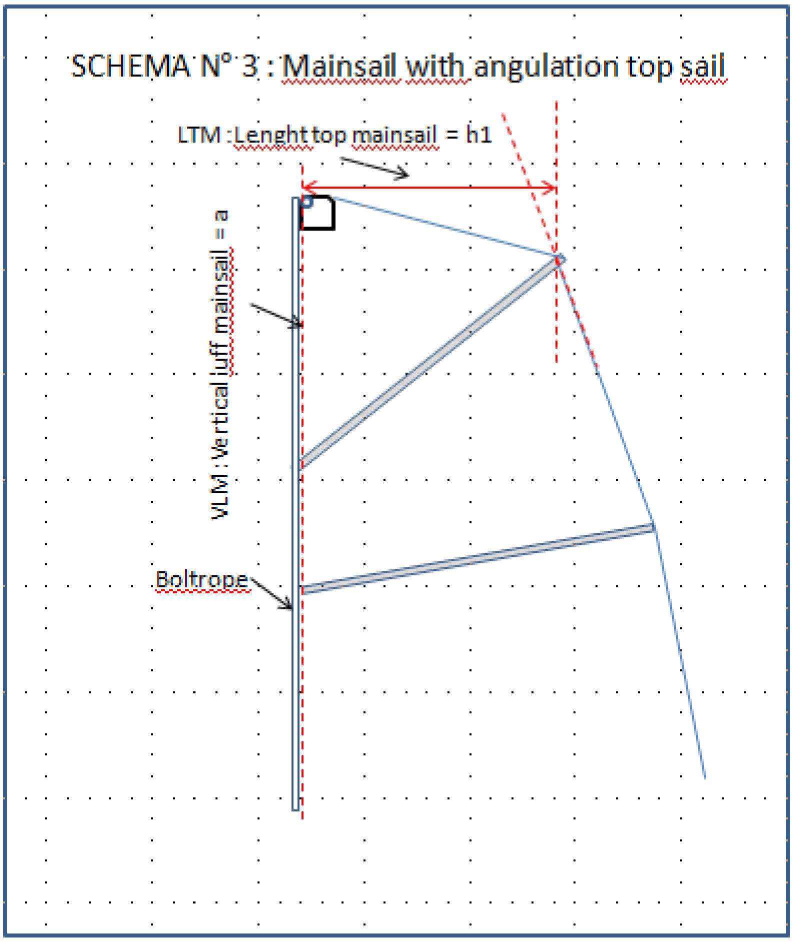
CONCLUSION

The huge benefit of SCHRS is its ability to rate 250 catamaran variants on a consistent and theoretically sound basis. But it also has to be recognized that perfection is not possible for any handicap system. Our job is to find the right balance between theoretical purity and a pragmatic approach which will increase participation. We believe that our 2012 proposal does this so far as is possible at this stage.

APPENDIX 1


SCHEMA N°1 : Mainsail without top mainsail
LTM : Lenght top mainsail < 0.15 m = h1
VLM: Vertical luff mainsail = a
Angle < 50°
Boltrope


SCHEMA N° 2 : Mainsail with right top sail
LTM : Lenght top mainsail = h1
VLM : Vertical luff mainsail = a
Boltrope


SCHEMA N° 3 : Mainsail with angulation top sail
LTM : Lenght top mainsail = h1
VLM : Vertical luff mainsail = a
Boltrope