Catalyst

Journal of the Amateur Yacht Research Society

Number 36 October 2009

How to supply information for publication in Catalyst:

The Best way to send us information:- an electronic (ascii) text tile (*.txt created in Notepad, or Word, with no formatting at all, we format in Catalyst styles). Images (logically named please!) picture files (*.jpg, gif, or *.tif). If you are sending line drawings, then please send them in the format in which they were created, or if scanned as *.tif (never as JPEGs because it blurs all the lines)

Any scanned image should be scanned at a resolution of at least 300 ppi at the final size and assume most pictures in Catalyst are 100 by 150mm (6 by 4 inches). A digital photograph should be the file that was created by the camera. A file from a mobile phone camera may be useful. Leave them in colour, and save them as example *clear_and_complete_title.jpg* with just a bit of compression. If you are sending a CD, then you can be more generous with the file sizes (less compression), than if emailing, and you can then use *.tif LZW-compressed or uncompressed format.

For complex mathematical expressions send us hardcopy or scan of text with any mathematical characters handwritten (we can typeset them), but add copious notes in a different colour to make sure that we understand. WE can also process MS Equation and its derivatives. Include notes or instructions (or anything else you want us to note) in the text file, preferably in angle brackets such as <new heading>, or <greek rho>, or <refers to *image_of_jib_set_badly.jpg*>.

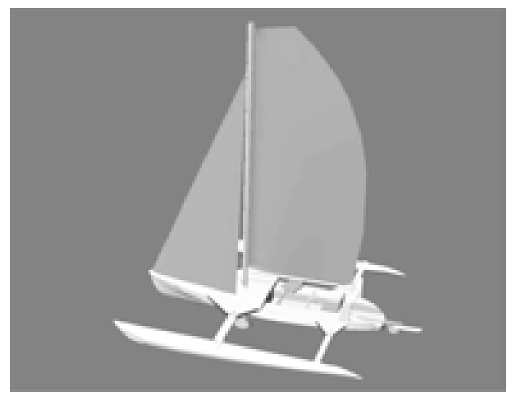
Otherwise: — If you write in longhand, and sketch or include photographic prints, and trust to snail mail (a copy, never the original) then all can and will be dealt with in due course. If you have trouble understanding anything in this section, email to ask.

As examples, the polar diagram p16 of *Catalyst 28* was re-created from a second generation photocopy, photos of shunting in the Champion article in *Catalyst 27* (pp 19-21) were screen grabs from a video supplied on DVD. The rest of the images in that article were scanned from photographs, and the text was OCRed (Optical Character Recognition software) or keyboarded.

Send a copy of your work (copyshops can scan to file and email for you):

by email: catalyst@ayrs.org,
by fax: +44 (8700) 526657, or
by post: Catalyst, BCM AYRS, London, WCIN 3XX

Features



Others

Katherine Knight exits the Weymouth Speedweek course on her International Moth (photo: Nick Povey)

Catalyst

Journal of the
Amateur Yacht Research Society

Catalyst is a quarterly journal of yacht research, design, and technology published by the Amateur Yacht Research Society, BCM AYRS, London WC1N 3XX, UK. Opinions expressed are the author's, and not those of AYRS. AYRS also publishes related booklets.

Contributions are welcome from all. Email them to **Catalyst@ayrs.org**, or send (at your risk) disks or typed copy with illustrations to the Society's office. AYRS can take no responsibility for loss or damage in the mail.

AYRS subscribers receive both *Catalyst* and the booklets. Subscription is UK£20 or US$30 per annum for a Paper Member, £10 or $15 for Electronic and retired members. Subscription requests and all other queries to be sent to the AYRS Office, BCM AYRS, London WC1N 3XX UK, email: **office@ayrs.org**

AYRS is a UK Registered Educational Charity (No 234081) for the furthering of yacht science.

Website: http://www.ayrs.org

ISSN 1469-6754

I'm just back from Speedweek where I had a most enjoyable time in spite of pleasant sunny calm weather for several days; time was not wasted however as we were able to tow Charlie Coish's rendering of Bob Downhill's "Garage Door" I hope that Bob will write a report of this and its sailing trials, especially as the AYRS prize for Innovation and Endeavour was awarded to Charlie.

We were also able to fly Slade Penoyre's Catapult under Roger Glencross' parafoil maybe there is hope for the wind powered seaplane!

Unfortunately it did mean that Fred's Folly did not get to sail down the course under kite power, but was able to do so using a standard Laser rig, faster than last year but not fast enough to win a prize.

My return home task was to help Julian lower the mast on his boat while afloat before passing under a low bridge for his laying up recovery (bigger boat can't come home on a trailer)

Arrangements for the January 30th AYRS meeting and AGM are in hand but I must remind you that it is on a SATURDAY this year; if you come a day late we won't be there!

If you can't come, the other thing for me to say is "Tell us what you are doing" and to write a few words about your project to ensure that Catalyst keeps arriving and also to ask for potential exhibits at the London Boat Show, if only a photograph and a few words about what is happening in the photo.

Fred Ball
AYRS Chairman

Hydroptere takes three speed records and may have hit the "Cavitation Barrier"

Photo: Hydroptere

On 4th September, l'Hydroptere broke both the 50m and 1 mile speed records to become "the fastest sailing boat on the planet".

The new recorsds, ratified by WSSRC, are:

- ♣ 500m – Outright and D Class world records – 51.36 knots (previous holders were : Outright – Alexandre Caizergues (kiteboard) at 50.57 knots, and D Class - l'Hydropere 46.88 knots).
- ♣ 1 mile – (Outright) – 48.74 knots (previous holder l'Hydroptere at 43.09 knots).

Both of these records were set in winds of 30 knots, at La Seyne sur Mer in France.

Not satisified with these, Hydroptere achieved another record run over one nautical mile to set another record on 4th November, ratified at 50.17 knots, thus becoming the first sailcraft to break the 50 knot "barrier" over this distance. This was again in wind of 30-35 kts.

Interestingly, one of her crew, Anders Bringdal, was at Weymouth Speedweek and spoke of his experiences on l'Hydroptere at the evening AYRS meeting.

It would seem from his talk that speedsailing record breakers may now be facing a real barrier rather than the artificial "50 knot" one – a "cavitation barrier" as serious to foil-borne boats as the sound barrier was to aircraft.

For all of her record runs, l'Hydroptere's crew carefully control her speed so as not to exceed about 56 knots. Once they go over that speed, they run a risk of loss of lift from the foils followed by a "crash". This has happened on more than one occasion and suggests to us that at those speeds they are running very close to the limits achievable with sub-cavitating foils. As the foils move through the water, the pressure over their curved top surfaces is lowered. It is this reduction in pressure that is responsible for much of the lift that the foil generates. At "cavitation speed", the water pressure over the curved top surface of the foil is reduced so much that the water literally boils at normal temperatures, resulting in a dramatic loss of lift and the boat simply crashes back into the water at 55 knots!

The exact speed at which a foil cavitates depends on the foil shape; more curvature means more lift at low speeds, but also a lower cavitation speed. Super-cavitating foils tend to have flat top surfaces and are essentially wedge-shaped, developing all their lift from their bottom surfaces. They are effective at high speeds, but develop a lot of drag at lower speeds. Whether super-cavitating lifting foils can be used effectively on a sail-powered craft remains to be seen.

Other foil-borne, and foil-stabilised sailcraft, e.g. Sailrocket, are going to come up against the same problem at the same sort of speeds, so it may be that l'Hydroptere's records will stand for some time.

AYRS understands that l'Hydroptere has now returned to base in Brittany and is to be reconfigured for more offshore, longer distance, record setting; for which development work has been quietly underway at their facility on Lake Geneva.

Sailrocket flips again

The Hydroptere team has not been the only one pursuing records this back end of 2009. Sailrocket returned to Namibia for a month of record attempts in September-October. Unfortunately no records were set, although early in the period, on 7th October, Sailrocket executed another spectacular, and damaging, flip.

Paul Larsen reported: "Yesterday we did a run in gusty conditions with recorded winds during the run ranging from 18.6 to 26.3 knots. The run started slow and peaked at 52.8 knots going past the timing hut... with no main flap on (approx. 4 knots still up our sleeve)... I got the flap on and pushed on trying to make this run count. At the end of the course we hit a small freak wave (a last remnant of the North bound Atlantic swell that wraps around the distant Pelican point and rolls back up the bay). The front end got 'boosted' and it appears that the main foil failed at the top inboard tip due to the centre of effort moving rapidly down with the boat fully loaded at around 48-50 knots. It didn't go as high as last time and turned 90 degrees to leeward... but it did the full flip and inverted landing."

There was a fair amount of damage, but nothing irreparable (and none to Paul), and the team were able to repair things and continue record runs. Although they got close to record speeds, with several run recording peak speeds around 52 knots,

At this point, a few seconds later, Sailrocket is very much a glider without a tailplane. The wing is still lifting the bow, but there is no lifting area aft to balance it. Now there is no way out of the flip.

This is the beginning of the first flip, in Oct 08. The bow has just lifted off, the foil is out of the water, and there is nothing to counteract the lift of the sail/wing except weight (Both photos by Helena Darvelid)

the winds were not sufficiently steady to maintain that sort of speed over the whole 500m. So they have returned to UK to regroup ready for the next session.

How close Sailrocket is to hitting her cavitation speed (see l'Hydroptere story) is not known. It is apparently clear from the videotape that this accident was caused by hitting a wave, which threw Sailrocket's, bow upward out of the water. What is also clear to us though, is that just like Donald Campbell's Bluebird, Sailrocket, although stable on the water, is NOT stable when in the air, and the team may need to reconsider the relationship between the centre of gravity and the wing, or even fit a "tailplane" (which could be horizontal) to ensure that when she takes off she comes down right way up and under a degree of control.

Kite- ands sail-boarders are inherently aerodynamically stable as their centres of gravity are close to the lines of the forces developed by their sails; they have to be to maintain stability and control while on the water. The "glider-hapa" projects of Jon Howes and Stephen Bourn are similarly constrained. Craft with foils, rudders and more than one point of support on the water are not necessarily so constrained. Such craft may well have to consider and test for what will happen when they lift off. Whilst they will not gain speed when airborne (just as a kiteboarder slows down and moves rapidly to leeward when they jump), the ease with which they can land and continue a speed run may be a significant safety feature to be considered. Donald Campbell died when his boat flipped backwards at 320 mph; one would not want anyone else to follow.

Weymouth Speedweek Results

Speedweek this year suffered from a lack of wind. Your editor was able to be there only for a couple of days, and on those days there was so little wind that Jonathan Barton was able to launch his craft (a fragile construction at the best of times) and sail it without damage.

There were, however, a few days when the wind did blow, and although no records were set respectable speeds were recorded. The fastest results were as follows:

Kite Fleet	Jason McCaffrey	31.56
Novices	Richard Fabbri (kite)	30.40
Pro Fleet	Patrick Van Hoof	30.13
Gold Fleet	Stephen Corps	29.54
Masters	Robin Penna	29.47
Amateurs	Lance Newbery	28.55
Women	Zara Davis	27.30
Juniors	Ryan Dunkling	25.00
Boat Fleet	Nigel Leeming (Trifoiler)	19.07
	Katherine Knight (Intl Moth)	18.35
	Torix Bennett (own design)	12.35

Craft are sailboards unless otherwise indicated.

Photo: Nick Povey

Nigel Leeming's Trifoiler

This year, the Speedweek organisers tried out a timing system using GPS recorders attached to competitors. These recorded positions at frequent intervals – frequent enough to determine when competitors enter the speedsailing course and when they exit, hence the speed. For reasons of cost and logistics (the recorders have to be downloaded at the end of each day) this was restricted to the Pro Fleet.

Nick Povey reports:

Despite many years effort we have not been able to reliably progress beyond visually sighting competitors. Unfortunately that requires that we can read every sail

Photo: David Tuttlebee

Jonathan Barton tries out his craft

number and that competitors cross the start and finish line well spaced so we can enter the data from a keypad. It is inevitable that runs are lost due to not being able to read numbers and due to competitors crossing the line simultaneously. On Sunday we had periods when the throughput was in excess of 12 competitors per minute. Three times the rate at which we ask competitors to enter the course to enable accurate timing!

The good news is that we trialled the use of GT31 GPS units with the Pro Fleet. A comparison of the data that these units produced was very interesting. Firstly we were really pleased to see that our visual timing was very good indeed. In general producing times within 0.25kt of that produced by GPS. Secondly we were able to confirm that we lose a small percentage of runs - something that we deeply regret.

After many hours comparing the data, we decided to use the GPS as the master data set for the Pro fleet

There are still many challenges - such as the logistics of downloading 100 data sets each day. 10 units took 30 minutes - 100 equals 5 hours!

It is our intention to work with the results software experts with the intention of developing the analysis process so that we can use GPS based timing in the future. This will be used to time competitors on a designated 500m course, set for the conditions prevailing on the day.

Photo: Nick Povey

Icarus came back for a day but recorded no fast runs

From Table-top to Sea: A New Design of Downwind Sail

Michael Simons

Overview:

Existing types of downwind sail have various drawbacks for the cruising sailor. This paper describes a project to find a more convenient design of sail starting with small-scale fan-blown models, followed by the scale-up of the design to dinghy and cruising yacht scale. The resulting full size sail has now had many hours of testing at sea. It provides good downwind performance with easy handling and a self-gybing capability, requiring no gybing manoeuvre as the wind crosses the stern of the boat.

Introduction

Modern sailing boats are generally sloop rigged. These rigs are efficient when sailing upwind or across the wind, but often do not provide enough sail area when sailing downwind in light or moderate breezes, when a dedicated downwind sail may be used to increase boat speed.

Existing types of downwind sail have various drawbacks, especially for the short-handed sailor. Thus spinnakers are very effective, but require a strong spinnaker pole with two or three pole control lines, and are complicated to set up. In use, they need careful trimming and attention, and gybing requires transfer of the pole to the other side of the mast and sail. They are suitable for fully crewed racing boats, but less so for a cruising yacht with limited crew.

Asymmetric spinnakers are used on fast racing vessels, and are also used as "cruising chutes" on cruising yachts. They are less effective when the wind is substantially astern, when they need poling out with a long pole, and gybing requires transfer of the sail, and pole if used, from one side of the boat to the other.

Twin foresails poled out on opposite sides can be used when the wind is astern, but need poles to be set up and are not effective when the wind comes over the quarter or more abeam.

Traction kites have recently been tried for downwind power, but whatever their merits, ease of use would not seem to be among them – especially on a busy Saturday in the Solent.

Square sails set on spars have been used since ancient times and provide stable and versatile downwind performance. However the spar extends the full width of the sail, and must be substantially rigid, which makes it too long, bulky and heavy for convenient use on a modern sailing vessel. Although square-riggers girdled the world before the age of steam, handling the rigs could be dangerous work needing a large and skilled crew.

The aim of the work described here was to devise a new form of downwind sail which would be fully versatile downwind, but simpler to deploy and handle than a spinnaker, particularly with the short-handed or cruising yachtsman in mind. Ideally, this might be a sail which could fly out in front of the boat and be set more or less square to the wind, without support poles, complicated rigging lines or frameworks. To give enough sail area, without use of over-long spars or battens, parts of the sail should be essentially self-supporting, extended by the action of the wind itself.

Experimental Approach: Model Tests

The approach was a practical one, testing possible sail designs using model rigs to allow quick trialling of ideas. Any promising design would be further developed with a view to scaling up for boat tests.

The main model rig had a 72 cm (28 inch) mast made of wooden dowel, representing a 1:15 (2cm to 1 ft) scale model of a 30ft cruising yacht. Test sails were made from 0.013 mm polythene sheet, using Scotch ® Magic Tape to make the seams. Spars for the sails were made of thin split cane (as used for plant supports) or thin plastic-coated garden wire, or even drinking straws. Light cord (1 to 1.5 mm dia.) was used for standing and running rigging, and the wind was provided by a domestic electric fan (12 inch dia. blades) positioned 2 – 2.5 m from the test rig. The test rig was placed either on a table top or on the floor, usually indoors. Most tests were run with a model mainsail in place. See Figure 1.

Figure 1. Smaller model rig, "wind" coming over port quarter. The dark chiffon strips are wind tell-tales.

Although the thin polythene sheet used was very flexible, to check that results were not being influenced by "rigidity" of this material over short distances, a second rig at twice the scale (144 cm mast) was used with sails of twice the size but using the same 0.013 mm material. These were done using two fans, and confirmed that the test sails were indeed being extended by the airflow and not helped by any stiffness of the material itself. An example is shown in Figure 2.

Figure 2. Larger model rig, wind abeam. The brick is to prevent capsize.

The test sails were raised on the rig and the fan turned on. The model was turned to give varying wind angles, from dead astern and round to the beam, then as far ahead of the beam as the sail would take without collapsing. A successful sail filled well and would fly and draw as the wind varied from astern round to the beam, and preferably ahead of the beam. No attempt was made to measure drive at this stage, this was done during sea tests, described below.

Findings from Model Tests

The starting point of the study was the square sail: might it be possible to have a sail set between two spars but having wings extending well outside the spars which are filled by the wind and restrained by sheets fixed to their extremities, thus providing sail area well beyond the relatively short spars? The spars would be of a length that could be handled on the foredeck of a boat, perhaps equivalent to 10 or 12 ft for a 30 ft boat.

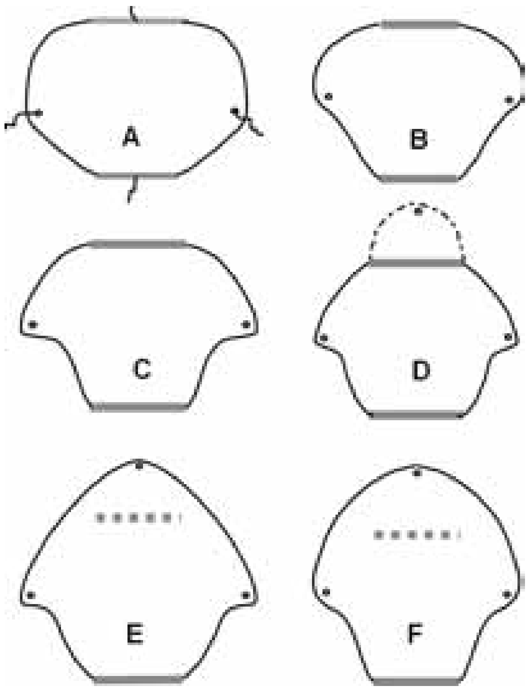


Figure 3. Some sail shapes. Spars are the wider grey lines, dotted ones are optional. Halyard, strop and sheets are indicated for sail A only.

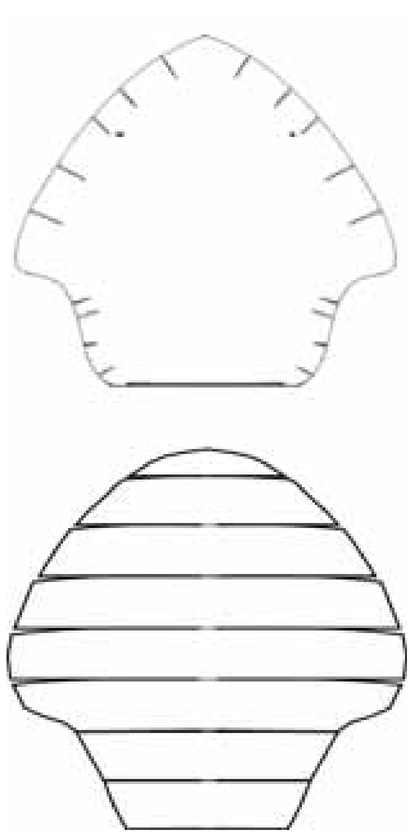


Figure 4. Examples of building 3D curvature perpendicular to main plane of sail by means of darts, above, and tapered seams, below

Some of the shapes tested are shown in plan form in Figure 3. All designs needed shaping to give curvature in the direction perpendicular to the plane shown, giving cup-like sections to catch the wind. This was done by taking in darts around the perimeter, as illustrated in Figure 4, and examples of the flying shapes appear in Figures 1 and 2.

The middle of the lower spar of each sail was fastened to a downhaul or strop which was attached to the bow of the model rig, the middle of the upper spar or the head of the sail if above the spar was attached to a halyard leading to the top of the mast. Port and starboard sheets, leading to hooks on the stern quarters of the model rig, were attached to the wings of the sails at points indicated by the schematic eyelets on the diagrams. All four lines were readily adjustable and could be secured in position, and their lengths were optimised for each test setting. The sail was set ahead of the forestay, and the sheets led outboard of the shrouds. These arrangements may be seen in Figures 1 and 2.

Sail A (Fig 3) filled nicely with wind when the wind was dead astern, but the wing sections of unsupported sail outside the ends of the spars collapsed as the wind came forward. Experiments showed that cutaways in the lower parts of the wing sections greatly helped the wing sections to fly (explanation later). Sail B is an early example, and Sail C with more pronounced cutaways flew better. Sail D flew well, and also flew well when a top section, shown by dotted lines, was taped on, and the halyard attached to the peak of the top section rather than the spar.

Sail E evolved from D, and would fly with the wind 10 degrees ahead of the beam. This sail was scaled up for sailing dinghy trials as described below. Sail F would fly with the wind 20 degrees ahead of the beam, and represents the best performing design described in this paper. This sail was scaled up for full size sea trials on a 30ft yacht; see below.

Both sails E and F were also found to fly well when the upper spars were removed, although in model tests the sparred versions were perhaps more tolerant and stable. However the full-scale boat tests showed that they perform perfectly well without an upper spar, which is a very welcome simplification, and upper spars do not now feature in the yacht sail designs. There might though be a place for an upper spar in designs for other applications.

Several variants of the designs shown were also tested, to map out the boundaries of possible designs, but are beyond the scope of this paper.

Model sails similar to E were tested on a small radio-controlled model yacht (20 in / 50 cm loa) on a lake, but lack of on-board sheet winches and the model's susceptibility to wind and wave made it difficult to draw conclusions other than that the sail could pull the boat along rather quickly at times.

The next phase was to scale up to sailing dinghy size.

Dinghy Tests

Sail E of Fig 3 was scaled up to suit a 14 ft (4.2 m) dinghy. Approximate measurements were width 11 ft, height, 10 ft, spar length 4 ft, area 78 sq ft (7.2 sq m). It was built from a decorator's polythene dust sheet (film thickness 0.03 mm) and Duck ® brand glass-fibre reinforced strapping tape. The two spars were of lightweight glass fibre tube from telescopic fishing (or flag) poles. Figure 5 shows the clew area of the sail and how the edge reinforcement and clew load-bearing reinforcements were made. The tape running perpendicular to the edge holds one of the sail-shaping darts in place. This simple and cheap structure was quite strong and adequate for testing, if short on long-term robustness.

In the event it was tested on a 16 ft dinghy (Laser 16) in light (about f3) wind conditions.

Without the mainsail raised, the sail flew well with wind from 180 to 90 degrees (aft to abeam). The boat sailed well on both gybes with a beam wind, as well as with the wind further aft, including dead astern. The sail flew stably, without flapping, fluttering or rolling, and without needing detailed trimming. Gybing was effortless, merely requiring the sheets to be trimmed as the wind went from one side to the other. With mainsail up, the sail flew well with a beam wind, but less well with the wind astern.

The only pictures of this test were taken on a mobile phone; figure 6 shows the sail flying with the wind astern.

Further tests with variants of the sail were also carried out with a 12 ft Otter dinghy.

Conclusions from the dinghy test were that the sail had scaled up well from the small-scale static models, that it flew well and provided drive for the boat with winds from astern to abeam. The next stage was to build a full size sail for thorough evaluation on the author's 30 ft yacht, which would provide a larger and more stable platform with proper instrumentation.

Figure 5. Clew area of dinghy sail.

Figure 6. Dinghy sail flying out in front of Laser 16 dinghy.

Sailing Yacht Trials

Figures 7, above and 8, below.. *Large sail flying out in front of yacht Julanda in Hayling Bay*

The author is most grateful to Ivan Bole, of Arun and Rockall Sails, for advice and guidance up to this point, and then for the crucial role played by him and his staff in this large-scale part of the project, in building and modifying the full size sail, and also in introducing the author to the art of proper sailmaking.

The sail was based on design F of Figure 3, with a width and a height of 25 ft (7.6 m) and an area of about 440 sq ft or 41 sq m. This equals the combined jib and mainsail area of the test boat (the author's Dufour 30 Classic, Julanda) and is approximately the same area as a cruising 'chute for the boat, and about two thirds the 650 sq ft area of a 30 Classic's spinnaker. It was thought prudent to size the sail cautiously, in view of its novel and largely untried character.

The sail was built of horizontal panels of nylon spinnaker fabric, similar to the layout in Figure 4, lower design. Polyester edge tape was sewn round the edges, and conventional reinforcing patches with pressed stainless steel eyes were fitted at the five load-bearing points, i.e. the sail's peak, two clews, and at each end of the foot where it was lashed to the spar. Smaller patches with eyes were mounted in the upper part to take the ends of an upper spar, and additional small patches with eyes were fitted later to take retrieval lines.

The lower spar was found to carry a substantial load, and after trying various options, an old sailboard mast, cut down to 10 ft length and provided with a joint in the middle, was found to be very suitable. Its weight was less than 5 lb, about 2 kg. For the upper spar, lightweight fibreglass tubing as described above was suitable, but the sail was soon found to work well without it.

The sail was raised with a spinnaker halyard running through an articulated masthead turning block. Sheets were tied to the clews and run back to turning blocks on the quarters, the blocks having cam-cleat beckets to secure the sheets, which could also be led to winches if required. The strop or downhaul was tied to the centre of the lower spar and was run through a turning block mounted on the bow roller, with provision to vary its length using the bow cleats and a snatch block and purchase mounted on the toe rail. A strop length of about 5 ft (1.5 m) was often used.

The sail can be seen in action in Figures 7 and 8.

This sail has been tested during the 2008 season (limited opportunities because of consistently poor weather) and during 2009. It has been flown for a total of about 18 hours in about 20 separate testing sessions, covering some 60nm in the process. Wind speeds (true) ranged from 5 to 17 knots (kt). Tests have taken place in Chichester Harbour, Hayling Bay and out to the Isle of Wight, the Solent, and the sea off Dartmouth.

During testing, apparent windspeeds were recorded from the boat's anemometer. True windspeeds as recorded for the test period by nearby met stations, Chimet or Bramblemet, were also noted and compared against the boat's wind and water speed data – agreement was good (www.chimet.co.uk/search.asp or www.bramblemet.co.uk/search.asp). The boat's water speed was measured with its rotating paddle speed log, and this was calibrated against GPS speed, due precautions being taken to factor out tidal flow from the GPS speed.

Results

After some initial adjustments to the sail's 3D shaping with additional darts, it was found to fly well: the upper portion filled and spread well beyond the width of the lower spar, and the sail held its shape in wind directions from astern to perhaps 10 degrees ahead of the beam if the sheets were trimmed suitably. The flying shape was inherently stable: if a partial collapse occurred due to a wind fluke, it would snap back into its flying shape within two or three seconds.

Trimming of the sail was found to be forgiving, it continued to draw through substantial changes in wind angle without adjusting the sheets, and on a run the sail simply swung across the front of the boat as the wind passed from one side of the stern to the other with no adjustment needed.

As can be seen from Figures 7 and 8, the sail flies out from the boat on relatively long lines: the shortest is the strop to the bow roller at about 5 ft, there is perhaps 12 ft of halyard between the sail head and the spinnaker halyard block, and the sheets lead back to the stern. No part of the sail is closely attached to the boat. This means the flying sail can swing around somewhat in front of the boat, but this did not impart any rolling or swaying action to the boat, possibly because of its well articulated connection.

The sail could be used with or without the mainsail raised. With wind astern or on the quarter, better boatspeed, by perhaps half to one knot, was obtained when the downwind sail was used without the mainsail. This does have the benefit, when running downwind, of removing all risk of unintended mainsail gybes, and making downwind progress remarkably relaxing. With a beam wind, performance was similar in either case.

A plot of boatspeed against apparent windspeed is shown in Figure 9. This shows every valid test run done with the test sail only (no mainsail), for three wind angles: astern (around 180 deg), on the quarter (around 135 deg), and abeam (around 90 deg). Best downwind performance is about 5 kt in 7 kt of apparent wind (12 kt true if wind astern and no significant tidal current), or 6 kt in 10 kt apparent wind. Boatspeeds with stern or quartering wind were substantially greater than the speeds reached by the boat under main and jib – these are represented by the dotted line, which was taken from data in Julanda's log book of boatspeed under the three wind directions. (Interestingly, provided the downwind speed was with goosewinged jib, boatspeed under main and jib for a similar apparent windspeed was similar for all three wind directions).

Boatspeed with a beam wind was less than when the wind was further astern. Nevertheless, the sail gave similar boatspeeds to the main and jib together, and as their combined area is about the same as the test sail, we draw the perhaps surprising conclusion that on a beam reach the test sail was as efficient in those wind conditions as Julanda's sloop rig (which is in good condition). With the wind further aft, the test sail was more efficient.

It should be possible to improve further on these results as there is ample space to fly a larger sail, and Julanda never felt over-pressed under the test sail and conditions reported.

However, the present sail has given a significant improvement in downwind performance, and in ease of sailing downwind, and the author readily uses the sail for downwind passages including when family and grandchildren are aboard. It has even been found that the sail will continue to fly with engine assistance, when more speed was needed going downwind to beat the tide (downwind motorsailing).

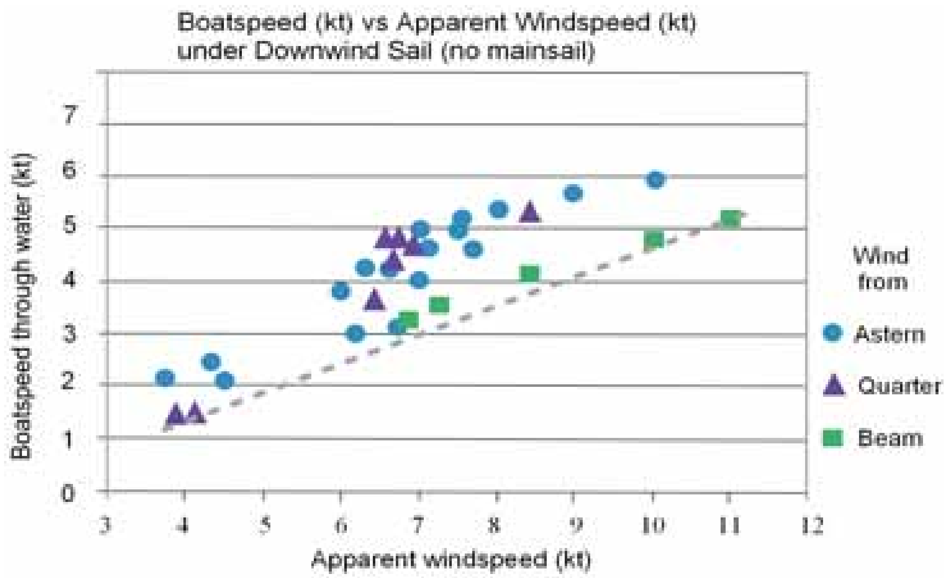


Figure 9. See text for explanation of dotted line.

Handling the Sail

It has been found quite easy to raise and lower the sail while sailing singlehanded, with the help of a long sailbag secured to the lower guardrail on the foredeck. The sail, attached to its spar, is kept in the closed bag until needed. The spar may be pulled apart into sections and the sail in the bag folded up for stowage in a locker if required. To raise the sail, the boat is steered so the bag on its rail is to leeward and the wind somewhere aft of the mast, the bag is opened and the whole sail and spar assembly, including attached sheets and strop, is pulled out and up with the halyard.(See Figure 10).

To lower the sail, it has been helpful to fit retrieval lines which collapse and restrain the sail when pulled. Then spar and sail can be pulled in over the lee guardrail, pushed into the bag and the bag closed. The retrieval line may be led back to the cockpit to allow rapid de-powering of the sail if required. Since fitting modified retrieval lines, the sail has never gone into the water during raising or lowering.

Alternatively, a normal spinnaker sock or squeezer could be used.

The main driving loads appear to be transmitted to the boat via the strop to the bow roller and the halyard to the top of the mast. The loadings on the sheets are such that they may be trimmed by (gloved) hand and secured by the cam-cleats in winds up to high f4. Above this, or for a significantly larger sail, they would need to be handled with winches.

Figure 10. Raising the sail. The sailbag shown was made from Polytarp and adhesive tape

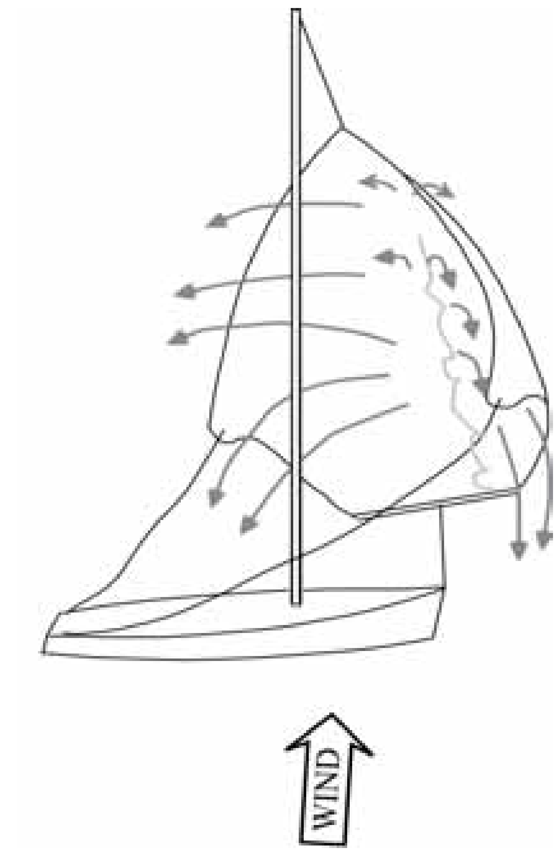
How it works

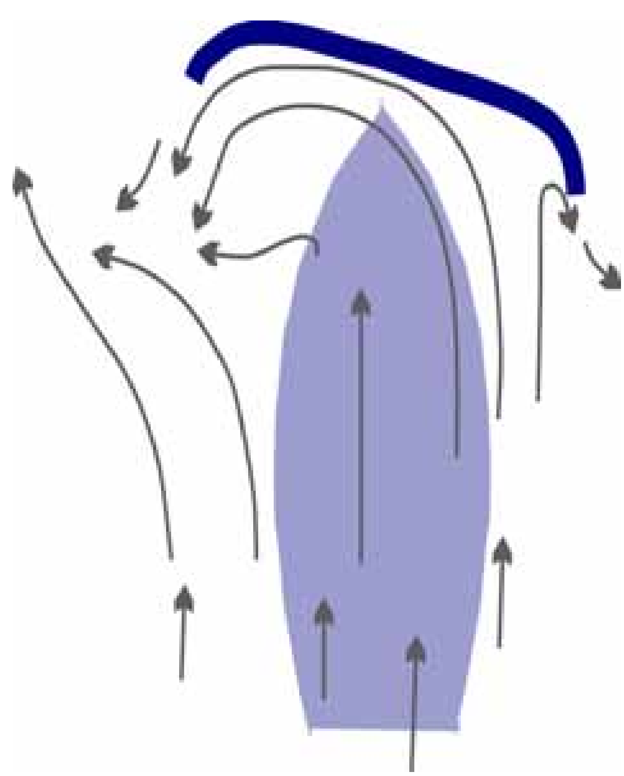
Wind flow around the sail has been qualitatively mapped with sails on the fan-blown model rig using a chiffon streamer on a long wand. These results are also consistent with the behaviour of the full size sail on Julanda. The wind flows allow us to understand the action of the sail by reference to Newton's first and third laws of motion. (No change in motion without an applied force, action and reaction are equal and opposite).

In Figure 11, a schematic diagram is given of boat, sail and running rigging, standing rigging is omitted. The wavy line represents a separation zone whose position across the sail varies with its angle to the wind, that shown is typical with the wind on the beam. The key point is that some of the wind is channeled downwards from the head of the sail through the area of the cutaways. It is the reaction to this downward deflection of air that gives the uplift that allows the head and wings of the sail to fly out as they do. Wind is also deflected by the sail rearwards and to leeward of the separating zone to give forward drive.

Figure 12 represents a view from above with the sail (thick curved line) correctly aligned to run downwind, at a height about a third of the way between the clews and the head. The sail, depending on the trim of sheets and halyard, can be relatively flat in the middle as shown, with the curvature near the edges. The wind is deflected along the face of the sail, in this case from right to left, which gives drive, then deflected rearwards by the edge, giving more drive. The backwards-flowing airstream meets the oncoming wind, which is deflected out to the left, giving more drive.

The significant downward deflection of wind, together with the general geometry of the flying sail, probably also generates uplift of the boat's bow.





Figures 11, above, and 12, below. Arrows represent wind.

Current status of the project

British and European patent applications for the design were published on November 18th 2009 (GB2460036, EP2119625, inventor Michael Simons).

A suggested name for the design as described here is the Pentasail, which reflects its unusual pentagonal underlying geometry, and the five main load points, which are the head, the two clews, and the two ends of the foot which attach to the spar.

An improved prototype full size sail is planned for further testing.

The studies are mainly aimed at cruising yacht application as explained, but other applications and developments of this new class of sail may well be possible. As well as racing possibilities, the potential for a low aspect ratio (i.e. squat) sail, together with its self-lifting capability, could open up applications for motor vessels, as auxiliary or emergency wind power which might not need a conventional mast.

Acknowledgements

Ivan Bole, of Arun and Rockall Sails, kindly responded to the author's request when the model stage was showing promise, and has given invaluable guidance throughout. He has also given essential practical help in the building of the full size prototype sail, and involving the author in its construction. Thanks also to Gavin (sailmaker) and Brenda (machinist, who actually sews it all together), and other staff at Arun and Rockall, for their cheerful help and patience.

The author's wife, Mariel, has shown great patience when parts of the house temporarily became wind tunnels or sail lofts, as well as accompanying the author on many test sails, and for this he is most grateful.

Bibliography

No specific references are given in the text, but general background information that underlies this work may be found in

"Sails and the way they work", 2nd edition, by Derek Harvey, publ. Adlard Coles Nautical, London, 2002 (good overview of known types of sail)

"Small boat sails" by Jeremy Howard-Williams, 3rd edition, publ. Adlard Coles Limited, London, 1987

Ancient designs of sail may be found in "Ships and Seafaring in ancient times" by Lionel Casson, publ. British Museum Press, London, 1994, and a number of classic types of sail are shown in "The Eternal Sail" by Camil Busquets, publ. Edimat Books, London, 2004.

Catalyst 34 Errata

Page 22, Equation 1 should read:

$$\sin(\gamma)\cdot\sin(\beta)\cdot\left(\frac{\sin\left(\beta/2\right)}{\sin(\gamma-\beta}\right)^2 = V_T\cdot\eta$$

Note the exponent on the big brackets, and that the multiply operator has been inserted on the right hand side. Our apologies go to the author and readers.

We also have better information about Greenbird's record run (page 26, footnote) in that the windspeed was apparently 30-35 mph, a little higher than previously reported.

Editor..

Free Spirit, an amphibious trimaran suitable for both disabled and able-bodied sailors

Charles Magnan

Free Spirit was originally conceived as a fast open amphibious trimaran daysailer capable of being launched, recovered and folded, as well as being sailed, by disabled sailors without the need for assistance. The amphibious capability of the boat is achieved by means of a retractable undercarriage powered by electric motors powerful enough to allow her to be driven down a slipway (and back up again!) with the crew aboard. Fore-and-aft folding allows the beam to be reduced sufficiently for trailering as well as reducing hardstanding storage space.

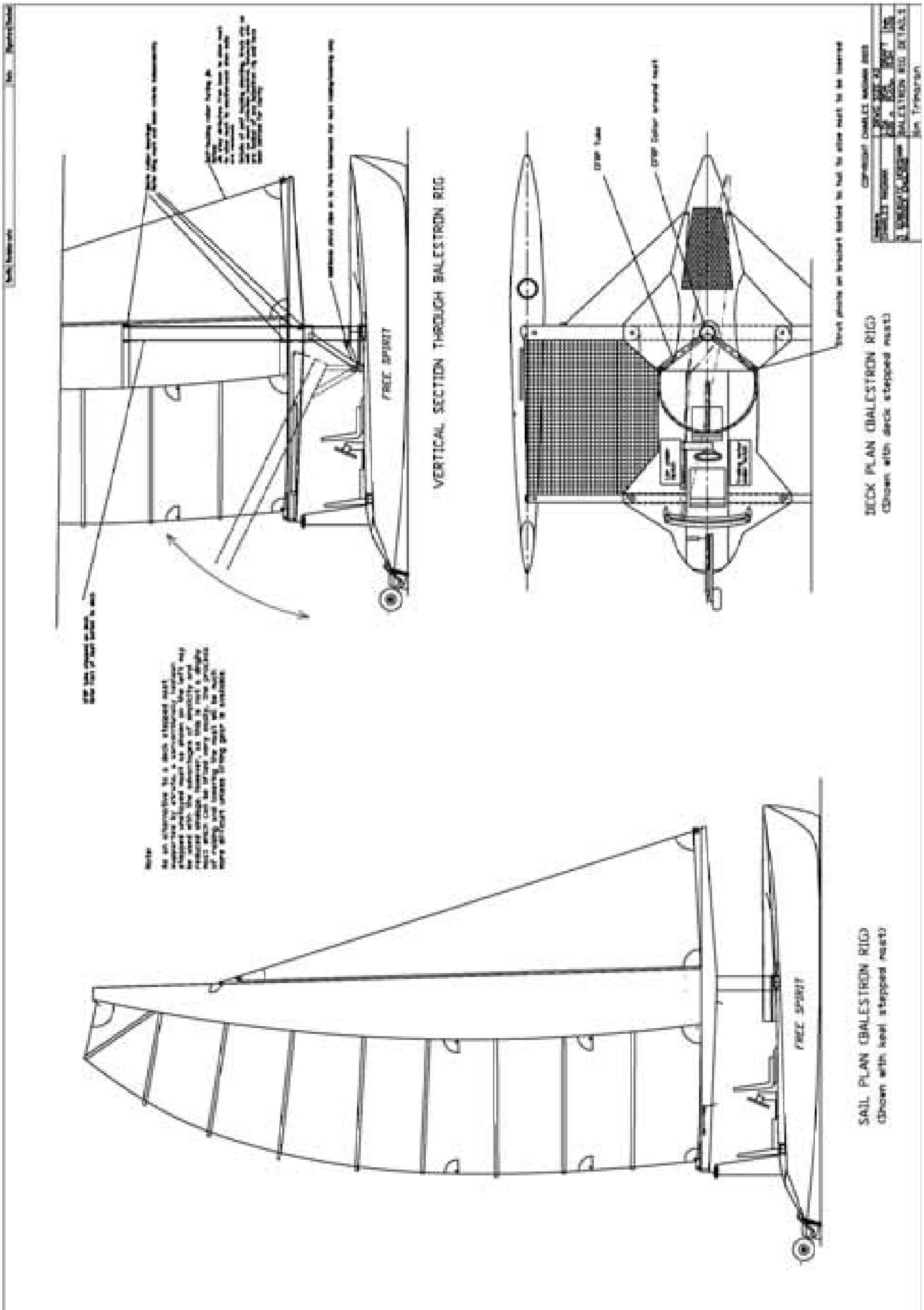
Additionally, as a roughly Tornado sized performance oriented trimaran, Free Spirit is likely to make a good platform for experimental rigs, hydrofoils etc. She will also appeal to all sailors who enjoy the sensation of fast beachcat sailing, but would prefer to achieve similar performance without needing to be suspended on the end of a trapeze wire and who may not be athletic enough to launch and recover a boat of this size unaided.

As a result of correspondence with disabled sailors the existing design will be modified to provide increased stowage space for wheelchairs etc in the forepeak. The possibility of utilising this as a cuddy/cabin will also be explored, with a view to seeing if a pocket cruiser version can be made without significantly increasing weight or windage.

At the present time Free Spirit exists as a design and 3D computer model (illustrated) and a start has been made on a prototype based on Tornado hulls.

The designer has made an approach to a potential corporate sponsor, but this has not brought any results, possibly another victim of the infamous 'credit crunch' and funding via the Howard Fund is being sought for the purpose of assisting with the building of a prototype and budgetary estimates are given (based on a "shoestring" approach making use of existing components as far as possible).

It is the designer's intention that the design be made available to charities and other bona fide non-profit organisations on a royalty free basis provided that the primary beneficiaries are disabled sailors themselves. It is the designer's intention to also make the design available to AYRS members on a royalty free basis as a standard hull design. The same principle will apply to the taking of a mould off the completed prototype hull to produce additional hulls if there is sufficient demand.


VERTICAL SECTION THROUGH BALESTRON RIG
DECK PLAN (BALESTRON RIG)
(Shown with deck stepped mast)
SAIL PLAN (BALESTRON RIG)
(Shown with keel stepped mast)
FREE SPIRIT

CONCEPT

Most able-bodied sailors take it for granted that they can travel to the place where they keep their boat, get on board if she is kept afloat, or if kept ashore, first rig her and then launch down a beach or slipway, park the launching trolley ashore and then get aboard and sail off. Returning from a sailing trip is the reverse of the above, except that considerably more athletic ability may be required to haul a large dinghy or catamaran back up the beach or slipway.

For a disabled person, of the above items only travelling to and from the place where the boat is stored is possible unaided. While boats have been either specifically designed or adapted for use by disabled sailors, this is still only possible with the help of a keen "ground crew" of dedicated helpers to launch and recover the boat and to get the disabled person in and out of the boat. Even larger boats kept in marinas or on moorings can be quite daunting for a disabled person to get to, never mind climb on board.

Free Spirit is intended to address this issue by enabling a disabled person to be able to drive to a dinghy park or other area of hard standing, park their car, decant themselves in to a wheelchair, travel in the wheelchair to the boat, climb into the boat, then rig and launch the boat down a suitable slipway and go sailing just like the rest of us would like to do, without being tied to the availability of other people to help. Naturally this is only practical if the recovery operation after sailing can be similarly managed unaided.

Additionally, this boat addresses another problem for performance oriented disabled sailors in that most boats designed to be easily sailed by disabled people have to sacrifice much of their potential performance. This was brought home to the designer some years ago at the London Boat show when he met a young lady who was a member of the Disabled Water-Skiing Association and who sailed Hobie cats because she had found the boats currently being used for disabled sailing were much too tame. Free Spirit aims to provide performance on a par with the best of the beach catamarans without requiring the sailor(s) to have the same degree of athleticism.

To achieve this, Free Spirit has been designed to meet the following criteria:

- Truly amphibious, i.e. capable of being launched and recovered from a slipway using retractable launching wheels which are attached to the boat and which remain part of the boat while sailing.
- Self propelled and steerable both on land and water.
- Capable of being boarded unaided by a person in a wheelchair while parked on hard standing ashore.
- Capable of being safely sailed by an unaided disabled person.
- Capable of being stored ashore with a relatively small footprint to minimise storage costs and trailable with a minimum of preparation.
- A speed potential under sail in the region of 20 knots.

Free Spirit has been designed as a folding trimaran with a retractable powered undercarriage. A retractable tail wheel is attached to the rudder and is thus steerable, although steering can also be done by independently powering each main wheel. Batteries supply the electric power and a trolling motor (also retractable) for auxiliary propulsion while afloat. Battery charging is by means of solar panels on the deck, which could be augmented by a portable petrol generator if an extended range under power is required. She is also capable of being used as a camping cruiser with the addition of a boom tent.

Undercarriage

Initially, the undercarriage design was based on using the legs of small outboard motors with wheels attached in place of propellers and driven by electric winch motors attached to the top of their propeller shafts. This is the system described in a previous (2003) John Hogg Prize entry (in which the Free Spirit project was a runner-up) and illustrated in the 2-D engineering drawings produced at the time. Subsequently, a modified system based on commercially available submersible electric motors driving the wheels directly by means of gritted rollers clamped to the tyres (Powrlaunch™) which also has the advantage of not requiring brakes as a worm and gear has been selected, with the effect that the boat will stop (on land!) as soon as the power is switched off. This system is illustrated in the views of the 3-D model shown in this document.

Sailing

Under sail, the long buoyant floats and wide beam (features proven in racing trimarans) allow a powerful rig to be carried which when coupled with careful attention to the aero/hydrodynamic cleanliness of the whole boat should give the potential for an exhilarating performance. As a capsize or major gear failure such as dismasting, or even a chafed halyard, can have very serious consequences for a disabled crew on their own, Free Spirit is designed to be as safe as practicable. A mainsail similar in size to that of a Tornado catamaran allows a standard Tornado mast and mainsail to be used if desired.

She has a self-draining cockpit and auxiliary propulsion to get home without requiring paddling. Resistance to capsize is provided by the high stability due to the wide beam and the combination of large floats with buoyant bows and rounded tops providing resistance to a diagonal capsize induced over the lee bow.

All lines and other controls are led to cockpit so as to be within reach of a relatively immobile crew. The mainsheet is located above the rear of the cockpit thus allowing unobstructed crew movement between rudder and the forward end of the cockpit. The folding system is designed to allow crossbeams to be able to fold aft of 90° to the hull centreline, but not any further forward, and folding is prevented by a line from the forward beam to the main hull bow, from where it is led aft to the cockpit and secured. It is recommended that this system be supplemented by a short detachable pole acting as a strut from the aft beam to the aft end of the cockpit (not shown in the drawings and other illustrations), thus providing a second and entirely independent means of ensuring that the beams do not fold accidentally while sailing.

Adaptations for Use by Disabled Sailors

A pull-out shelf at the stern just above the height of the seat of a wheelchair can extend over the rudder allowing boarding over the stern from a wheelchair "parked" beside the rudder. There is stowage space on board for a collapsible wheelchair to be carried aboard if desired.

The crew sit in seats equipped with lap seat belts (not shown in drawings or 3-D model) with quick release buckles. The seats are adjustable – fore and aft in a manner similar to a car seat in the case of the helmsman, and from side to side in an arc of a circle in the case of the crew. In this case rotation is about a central spindle mounted in the cockpit floor and running to the keel of the main hull. Rotation is controlled by means of spring loaded click stops similar to those commonly used in jibsheet cars or multigym machines. This can be implemented either by mounting the seat on a circular track as illustrated in the 2-D CAD drawings based on the initial concept or by dispensing with the track and cantilevering the seat directly from the spindle, as is illustrated in the 3-D model. The latter has the advantage of an uncluttered cockpit, greatly improving access for disabled persons, but has the disadvantage of requiring a much stronger supporting spindle and seat support framework. In this case, the click stop system would need to be mounted on the spindle itself, controlled by a cable release mounted on the seat frame. The crew, assisted by strategically placed handholds, would in either case rotate the seat manually.

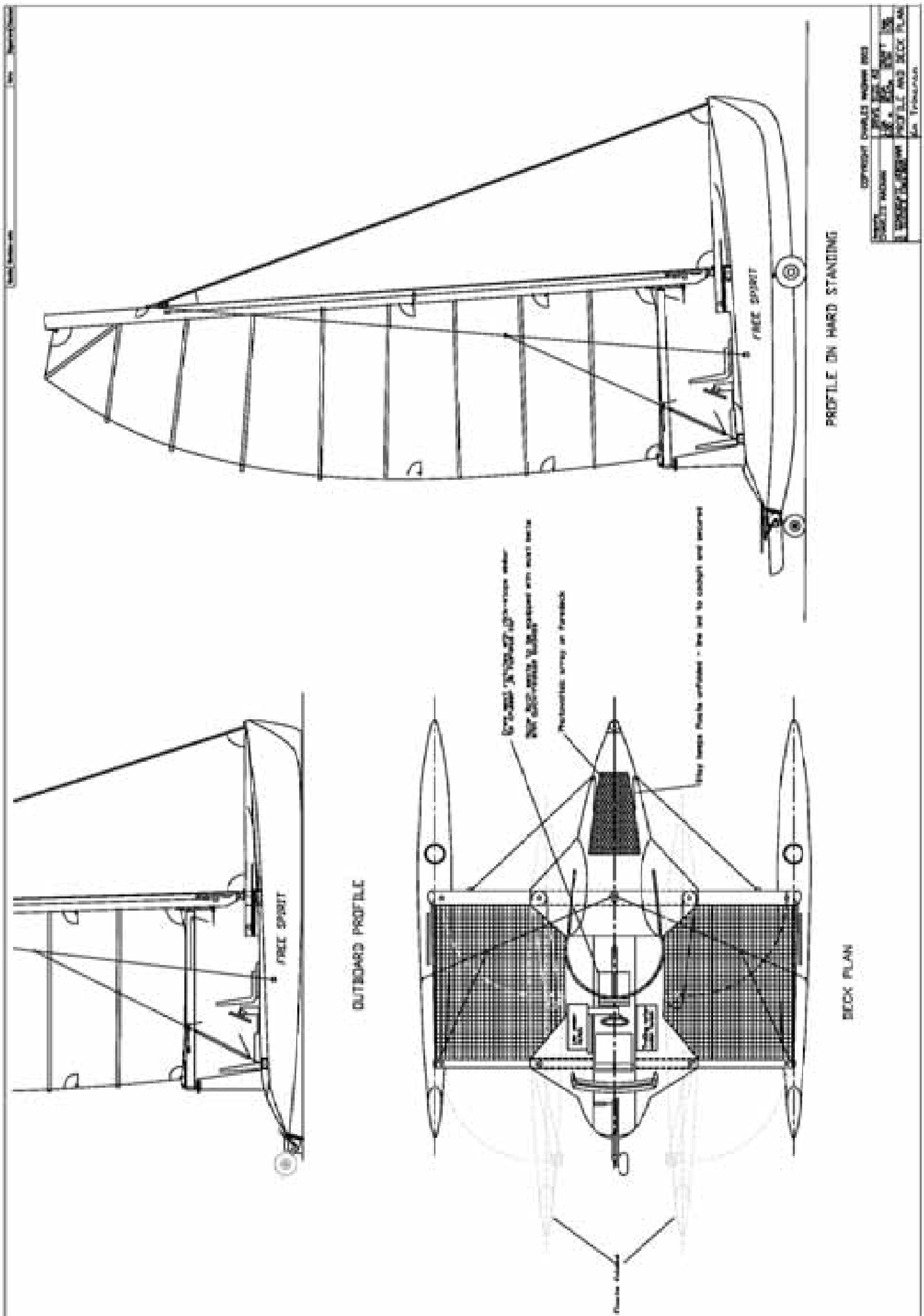
Use by Able-Bodied Sailors

Additionally, to increase the usefulness of the design to a wider public, the basic boat is able to be built without special motors etc. required for self propelled launch and recovery, should these items be deemed unnecessary in particular circumstances. Thus able-bodied crews or clubs/associations with plenty of helpers available for assisting disabled sailors may choose to save the weight and cost of batteries and motors and still have a fully functional high performance boat.

Similarly all special equipment specifically aimed at disabled crews can be omitted/removed if the boat is to be used by able-bodied sailors. Thus windsurfers or beachcat sailors who are used to the exhilaration of high speed sailing, but who are not as young as they once were, may find a high performance boat that does not require either trapezing or musclepower for launching and recovery to be very useful.

Mk II Design with Enlarged Forepeak

As a result of correspondence with disabled sailors the existing design will be modified to provide increased stowage space for wheelchairs etc in the forepeak. The concept is based on a disabled crew being able to launch unaided as described above and being able to take their (folding) wheelchairs aboard with them if there was no one available to look after them ashore and the standard NHS folding wheelchair is larger when folded than the designer


FREE SPIRIT
PROFILE ON HARD STANDING
OUTBOARD PROFILE
DECK PLAN

had originally assumed. Thus the main hull will be wider and with a higher deck profile than in the original version illustrated. In both versions of the design, the mast is deck stepped and supported by a ring bulkhead acting as an arch. This avoids having the narrow space in the forepeak being bisected by a strut or keel stepped mast and thus allows maximum use of the available space to be made.

The possibility of utilising this increased space as a cuddy/cabin will also be explored, with a view to seeing if a pocket cruiser version can be made without significantly increasing weight or windage. At the very least, the camping cruiser role could be considerably enhanced if an enclosed 'head' compartment can be provide, containing a portable toilet, since the traditional "bucket and chuck it" approach is increasingly frowned upon, especially in harbours and inland waterways.

NOTES ON DETAILED DESIGN

Propulsion - Land

Electric winch motors were initially chosen for propulsion ashore as they are standard off-the-shelf items, which are easily available, designed for a marine environment and designed for low sped/high torque operation. A hydraulic drive system would also work well, but is likely to be prohibitively expensive.

An alternative system is illustrated in the views of the 3-D model, based on the use of an alternative system based on commercially available submersible electric motors.

Propulsion – Water

Once an electrically powered system with its requisite batteries has been selected as the means of getting the boat up and down a slipway, the use of an electric outboard such as the commercially available Torquedo motor is an obvious choice for auxiliary propulsion afloat. Should there be fears of a long journey back to the slipway under power draining the batteries to the point where there is insufficient energy left to successfully recover the boat up the slipway, it is possible to carry a small portable generator and operate under power in a manner similar to a diesel – electric train. Under normal circumstances charging is done by means of solar cells on the foredeck, which keep the battery charged up when not in use.

Transmission System Options: Winch Motors

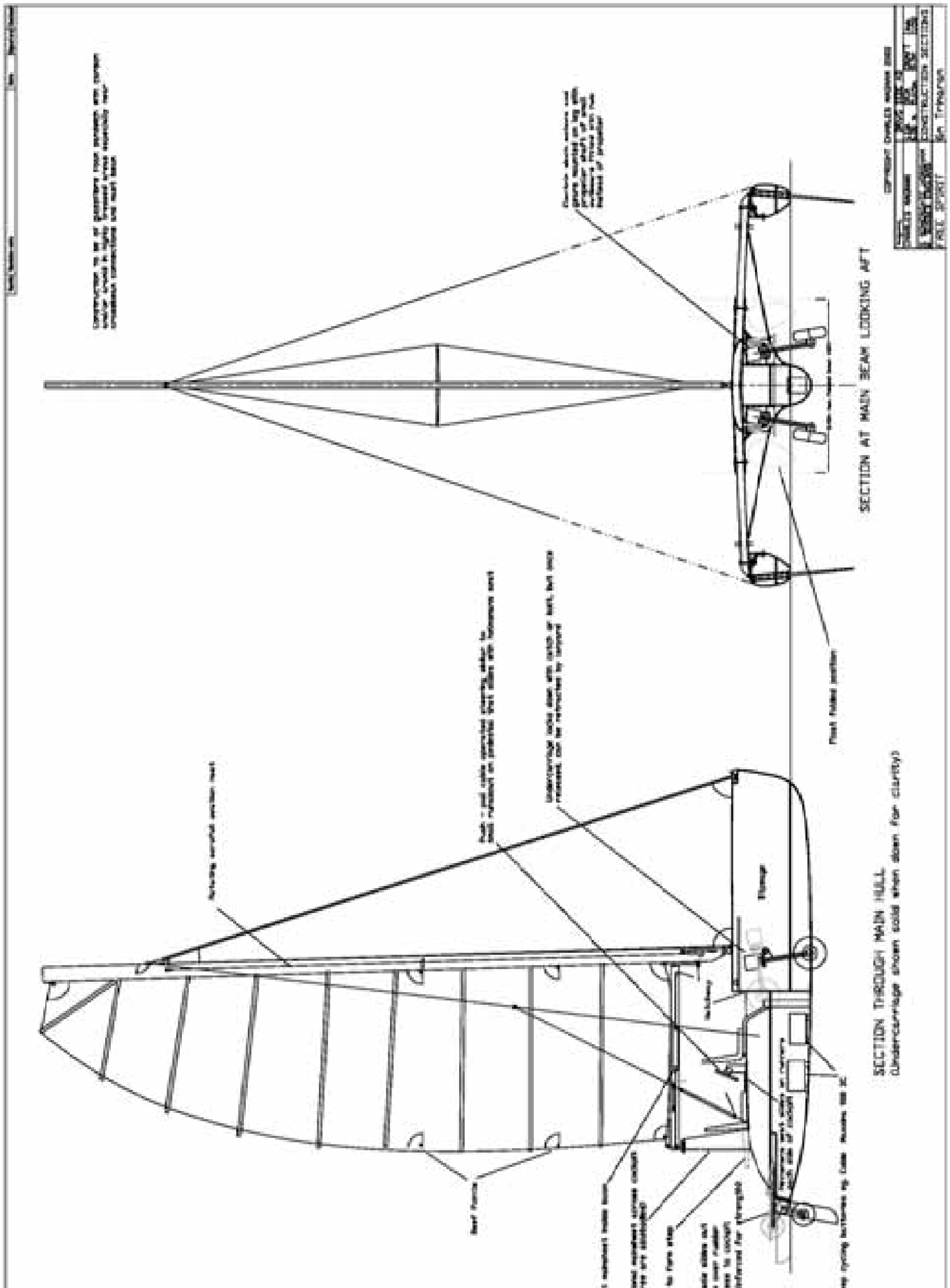
The driven wheels are located amidships, just forward of the centre of gravity of the loaded boat where they take the majority of the craft's weight and are complemented by a steerable, retractable tail wheel attached to the rudder and thus able to be steered by the normal system used when afloat. The driven wheels are connected (welded) to a vertical outboard motor drive shaft within the leg of a small outboard motor, (again a standard off-the-shelf item available at a reasonable cost) which also acts as a column to take the weight of the boat when ashore and is built of marine grade materials. The skeg below the gearbox will need to be removed. The bevel gears in the outboard motor leg provide a horizontal drive to the propeller shaft, which is connected to a hub mounted with a suitable wheel such as a boat trailer wheel. The outboard motor legs pivot up into bays under the cockpit seats and above the waterline.

Transmission System Options: Powrlaunch™ Submersible Motors

This involves driving the wheels directly by means of gritted rollers clamped to the tyres. This also has the advantage that brakes are not required, as a worm and gear is used, with the effect that the boat will stop rolling as soon as the power is switched off. It is however a less mechanically efficient means of propulsion, although it does allow for very low gearing. Because the overall system is much simpler (no brakes required) and uses tested commercially available components, this is the recommended drivetrain system.

Wheels

People wishing to launch from open beaches may need to use larger wheels (e.g. Cat Trax™ launching trolley wheels which have aluminium hubs and balloon tyres or aluminium ATV/quadbike wheels – competition models tend to use aluminium for lightness, which also gives improved corrosion


SECTION AT MAIN BEAM LOOKING AFT
SECTION THROUGH MAIN HULL
(Undercarriage shown solid when down for clarity)

resistance for marine use) may need to modify the design to accommodate the larger tyres. This can be done by allowing the shafts and wheels to rotate axially for stowage or by increasing the height of the wells, by raising the cockpit seats.

It should be noted that to launch from open beaches is not advisable for unaided disabled crews because of the risk of putting a wheel in a soft spot (e.g. an area of rotting seaweed covered by sand), which may require the crew to get out and push. However it may be very useful for ablebodied crews who could motor over longer distances than they would want to have to push a boat on a trolley, thus allowing launching/recovery at low tide and allowing a larger and heavier boat to be beach launched than is normally the case.

Brakes

Low speed (walking pace) bearings and brakes only are required if winch motors are used, with no braking system being needed if submersible motors with worm and gear drive are used. The use of mountain bike style cable operated disc brakes (with aluminium or stainless steel discs) on the top of the vertical drive/propeller shafts as illustrated are one possible solution which will prevent the boat careering out of control while descending a steep ramp.

Choice of Rigs

The basic boat uses a conventional stayed sloop rig with a rotating mast Tornado style, but with the added efficiency of a tighter forestay due to a more rigid staying base and of a jib which closes the gap between its foot and the foredeck has been illustrated as this is likely to meet the performance criteria while still being within the capability of a disabled crew.

An optional bowsprit with an asymmetrical spinnaker or reacher may be used, depending on crew ability and if this is provided with roller furling its use should be within the capability of an experienced disabled crew.

Alternatively, a balestron boomed rig similar to the AeroRig™ may be used. While likely to be more expensive and heavier, it is very easy to handle. It should still be possible to use an optional bowsprit with an asymmetrical spinnaker or reacher as in the case of a more conventional rig, if a masthead spinnaker set from a swivel is used. The designer also intends to use the boat as a platform for experimental wing sail rigs.

Additionally, Amateur Yacht Research Society (AYRS) experimenters and other like-minded people may wish to try flying a traction kite from the vicinity of the lee bow, as this would generate additional driving force without significantly increasing the heeling moment and the lift from the kite would also reduce the effective displacement of the boat.

As illustrated, the boat has been designed/set up for use by a crew who are disabled in the sense of being wheelchair bound (i.e. not having full use of their legs), but who are assumed to have sufficient upper body strength to operate a conventionally sheeted rig. Various AYRS members are involved in experiments aimed at developing rigs that are self-tending or are controllable by joysticks in a manner similar to a radio controlled model, and Free Spirit is likely to provide a suitable platform for these, potentially opening sailing up to a much wider range of disabilities.

STATUS OF THE PROJECT

At the present time Free Spirit exists as a design and 3D computer model (illustrated) and a start has been made on a prototype based on fibreglass Tornado hulls, both as floats and as part of the skin of the lower part (principally below the waterline) as well as an existing Tornado rig. The intention is to use an opened out Tornado hull (with deck and centreboard case removed, which has already been done) as a moulding surface that also forms the outer layer of the hull laminate. The hull will then be split longitudinally at the keel line to provide a greater width than is likely to be feasible without an additional fillet being inserted between the two halves of the hull.

Tornado hulls will be used intact as floats and crossbeams will be based on existing aluminium mast sections that had originally formed part of an earlier AYRS project.

The designer is in the process of finalising details of the revised design, primarily involving undercarriage mounting and locking mechanisms and laminate schedules for the hulls as well as details of access hatches and exploration of the feasibility and modifications required for removable modular accommodation and disabled persons' modifications. It is intended to structurally design the hull laminates to allow for the flexibility of both stayed and unstayed rigs being used in various incarnations. Initially the rig from the "donor" Tornado belonging to the designer will be used, possibly with the addition of a larger jib, because it is the simplest and lowest cost option for getting basic working prototype on the water.

Prototype Construction Programme

The next stage of the project is for a prototype to be built and tested, which can itself be used by disabled sailors as well as experimenters and also from which moulds could be made should it be desired to produce more boats in the future.

The process is probably best approached in stages, first producing a structurally complete boat that can be test sailed and once this has been satisfactorily achieved, adding the powered undercarriage and then the disabled persons' modifications.

During 2009, the aim is to complete the main hull and ideally the folding system, enabling a sailing prototype to be used at the beginning of 2010.

A description of each phase is given below.

Phase 1:

Construct main hull for "basic" open dayboat with forepeak based on opened out Tornado hull as described above.

Approximate budgetary material cost £2,500 for hull materials (mainly glassfibre and epoxy resin, but with local strengthening/stiffening with aramid and carbon fibres) and corecell foam core for sandwich structures (This figure excludes the value of the Tornado that is already owned.)

It is anticipated that construction will begin in earnest in the spring of 2009 and continuing through the summer.

Phase 2:

Construct folding beam system for "basic" open dayboat and assemble completed trimaran using two more Tornado hulls, centreboards, rudder and rig already in the designers possession.

It is anticipated that construction of the folding beams will begin in the summer of 2009 and continue through the autumn with the idea of assembly and test sail of completed basic boat in the autumn of 2009.

Approximate budgetary material/machine shop cost £300 for machining, stays and fastenings for crossbeams, most materials including the additional Tornado hulls being already available. An additional £300 for a jib suitable for the larger foretriangle of the trimaran is also desirable.

Phase 3:

Purchase of undercarriage and associated systems – principally submersible electric motors with battery and controls and suitable wheels. Construct undercarriage legs and assemble completed undercarriage in trimaran and test powered launching system.

Approximate budgetary material/machine shop cost of £500 for wheels and other materials, machining, fittings and fastenings for undercarriage in addition to £1400 the submersible motor system including battery and controls.

Phase 4:

It is anticipated that construction/installation of the modifications specifically aimed at making the boat suitable for disabled persons will begin in the spring of 2010 and be followed by thorough testing of the amphibious prototype both in terms of sailing qualities/performance and its capability for amphibious launching and recovery. Initially this will be undertaken by the designer (and other able-bodied persons if volunteers can be found!) Once the these trials have been satisfactory, testing of the boat by disabled people will then follow with the intention of making modifications if required in the light of experience by disabled crews.

Approximate budgetary material/machine shop cost £500 for materials, machining, fittings and fastenings for modifications.

SUMMARY OF THE CASE FOR FUNDING

Funding is being sought for:

- Provision of materials, or replenishment of materials, already purchased and earmarked for another project which has been delayed to accommodate this one, for the construction of the main hull and folding system. The materials principally consist of corecell foam, fibre reinforcement (glass, carbon and/or aramid as appropriate) and epoxy resin) for the hull and fittings for the folding aluminium beams as described above.
- Purchase of undercarriage and associated systems – principally submersible electric motors with

battery and controls and suitable wheels.

- Financing of modifications specifically aimed at making the boat suitable for disabled persons, such as sliding/rotating seating and wheel steering systems.
- The main benefits of funding are:
- To enable a higher standard of construction of the main hull, resulting in a safer, better performing and more durable boat than would be the case if a throwaway proof-of-concept prototype was built at minimum possible cost, as would most probably be the case if the designer is reliant entirely on his own resources. In particular it is likely to mean the difference between plywood and vacuum bagged foam sandwich construction for the greater part of the main hull.
- To enable a higher standard of construction of the folding system, particularly with respect to paying for professional metalworking and custom fittings as against an entirely DIY job using handheld tools.
- To pay for modifications specifically aimed at making the boat suitable for disabled persons, which are of no direct benefit of the designer himself.

Benefits of the Project for the Less Able-bodied

Benefits for the less able-bodied (disabled as well as elderly or otherwise) stem from the development of a boat that is:

- Truly amphibious, i.e. capable of being launched and recovered from a slipway using retractable launching wheels which are attached to the boat and which remain part of the boat while sailing.
- Self propelled and steerable both on land and water.
- Capable of being boarded unaided by a person in a wheelchair while parked on hard standing ashore.
- Capable of being safely sailed by an unaided disabled person.
- A speed potential under sail in the order of 20 knots, providing exhilarating sailing without the need for trapezing.

It is the designer's intention that the design be made available to charities and other bona fide non-profit organisations on a royalty free basis provided that the primary beneficiaries are disabled sailors themselves.

Benefits of the Project for the AYRS

Apart from the obvious benefit of being involved in expanding the options available for disabled sailors in the UK and hopefully worldwide, there are other benefits that should be considered:

- A very significant potential for raising the profile of the AYRS as a whole as this has the potential to revolutionise sailing for people with disabilities and thus has the potential for the sort of positive publicity that would be very good for AYRS.
- The boat can be made available as a stable and relatively comfortable committee boat/rescue boat for use at AYRS events and possibly Speedweek as well as a testbed for rigs, hydrofoils etc. that AYRS experimenters may wish to try out.
- The more of the financial cost of the project that can be met by funding assistance, the more inclined the designer will be to donate the finished boat to either the AYRS itself or to another suitable charity, once it has served its purpose as a prototype and testbed for his and other AYRS experimenters' ideas.
- Funding will enable the main hull to be built of durable lightweight materials including glassfibre reinforced epoxy foam sandwich, rather than a much more cheap/quick and dirty approach to building a very basic proof of concept prototype which risks sacrificing the quality and durability of the finished product.

It is the designer's intention to also make the design available to AYRS members on a royalty free basis as a standard hull design. The same principle will apply to the taking of a mould off the completed prototype hull to produce additional hulls if there is sufficient demand.

Benefits for the Advancement of Nautical Science

Experimental projects that the designer intends to use the completed prototype include:

- Exploring the practicality of the amphibious launching system and disabled persons' modifications in conjunction with disabled sailors themselves.
- Extending the above concept to cater for a wider range of disabilities, involving ideas such as the use of servos and intelligent controls to make the process of controlling a sailing boat as simple and physically easy as possible.
- Adaptation of the amphibious launching system to allow powered beach launching (by able-bodied sailors), probably by using ATV wheels. This in

conjunction with the folding system are aimed at producing a boat capable of being stored ashore with a relatively small footprint to minimise storage costs, but is larger than is normally practical for beach launching/recovery. The advantages of high performance without the need for trapezing or even having to move from one hull to another are largely due to the superior stability inherent in the wider beam possible with the trimaran planform, but there is an obvious disadvantage in that three hulls are almost inevitably going to be significantly heavier than the two hulls of a catamaran (particularly noticeable during launching and recovery).

- Exploring the practical implications of adaptation of the amphibious launching system to allow it to function as an integral road trailer to make the boat trailable with a minimum of preparation and solve the problem of trailer storage when it is not being used. (Think of a trailer that can be stored ashore in the boot of a car).
- Exploring the practical implications of using a "picklefork" configuration in which the floats in (unfolded) sailing trim extend significantly forward of the main hull. This has advantages in terms of diagonal stability (resistance to overturning over the lee bow) and in making a more compact boat when the floats are folded aft, but may have a significant effect on tacking performance.
- Exploring the practical and performance implications of rigging the craft with unstayed wing sails. (Potential increase in drive and aerodynamic efficiency if Little America's Cup style slotted wing is used, but there are many hurdles to be overcome if a practical rig that does not need a hangar for storage is to be developed.)
- Exploring the practical and performance implications of rigging the craft with a traction kite rig (possibly in combination with a more conventional rig).
- The addition of variable incidence hydrofoils as a removable addition, and doing comparative performance evaluation of them, by doing timed runs (Speedweek?) with and without hydrofoils in similar conditions.
- Exploring the practical implications of using a (large) bulbous bow. Conventional wisdom is that they are not effective in boats of this size, but ship bows are designed on the basis of towing tank tests models of a roughly similar size and this implies that such a bow could provide a significant reduction in hull resistance. Preliminary calculations indicate that the Froude Number of this boat is likely to be in the range where a bulbous bow is most effective. What is difficult to determine without actually building a trimaran with one is whether it would have a significant detrimental effect on tacking performance (due to the deeper forefoot etc.)
- Exploring the practicality of adding removable modular accommodation to an open boat design to create a pocket cruiser that can easily be converted back to the original concept of an open plan design with a large cockpit. (The inspiration came from various metal folding sportscar roof systems currently available)

Other AYRS experimenters are invited to collaborate in the above or to add their own projects to the list.

It should be noted that the above list is (loosely) arranged in terms subject areas and is not intended to imply a chronological order. (Judging by the length of the list, I may be gone a while...)

Funding is not at this time being sought for any of the above apart from the basic amphibious boat with modifications specifically aimed at making the boat suitable for disabled persons as described previously.

POTENTIAL PITFALLS

Potential problem areas include:

- Phase 1 (main hull construction) may take longer than programmed. This will delay the programme, but does not in itself threaten the viability of the project.
- Difficulties in tacking with float bows extending in front of the main hull bow. This may be resolved by altering the beam attachment points on the floats to bring their bows in line with the main hull bow.
- Difficulties in powered beach launching. This is a desirable outcome, but not essential. One of the aims of the project is to explore the practicality of doing this and attempting to overcome any difficulties encountered. The submersible motors are proven product for launching and recovering RIB powerboats of greater weight from slipways, so this capability at least should not be in doubt.

"Fred's Folly" an experimental boat

Fred Ball

The centre hull was built at least 25 years ago to try to build as cheaply and easily as possible when there had been some competitions based on a sailing boat built for £100; however at the time I never developed a rig although I did make some asymmetric floats for her. But never built the beams to fit them!

Having had several attempts at kite sailing from a 13' dory, a 16' catamaran and a 10' RIB, I felt that the centre hull would lend itself to making a kite boat with the addition of floats allowing me to sit in the centre hull and steer with foot controls leaving my hands free for kite flying.

My original attempts at kite sailing made me realise that the need to concentrate on the kite meant that practice at sailing the boat with a conventional rig would be a good idea so I initially installed the mast and sail from a Topper using wooden brackets behind the forward beam to hold the mast foot.

This worked reasonably well and I won third fastest boat at Speedweek 2008: by default I am sure as there were at least two other boats that should have been faster than F's Folly.

However tacking was not easy as I had place dagger board slots forward of the beam as I felt that the kite rig would be acting at the level of the beam and as I wanted to try the effect of inclined boards I had made up a split dagger board box vertical slot to the inner edge and a 45 degree slot entered just below deck level on the outer side and exiting at the bottom of the vertical box; I now know that I should have built this behind the level of the forward beam.

My next thought was how to get a bigger rig placed further forward and chose to try a Laser rig stepped a little way forward of the front beam so I removed a portion of deck and fitted another partial bulkhead and a substantial block of wood to the bottom of the boat spread the loads from the mast foot between the new bulkhead and the original under the beam and similarly at deck level reinforcements were added to spread the loads and a piece of plastic drain pipe was built in to complete the mast socket arrangement. I didn't think that unsupported 4 mm ply would be strong enough! The arrangements have worked well just slipping the rigged mast into a socket is much easier than bolting bits and pieces on as I did to use the Topper rig and so far has accepted the loads involved without problems.

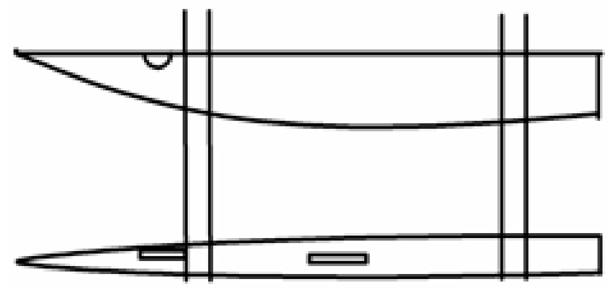
Sailing at Barton Turf Adventure Centre showed that the centre of lateral resistance was still too far forward for well mannered sailing, so for Weymouth May week I built in slots 0.6m behind the forward beam and also made up a pair of larger dagger boards to replace the ex sailboard ones that I had been using. While at Barton Turf I was also able to try flying kites from her, but while tethered to the rescue boat a sudden surge of power lifted her for a moment from the water. It was obvious the kite control system needs further work.

During the May week I found that sailing had become much more pleasant and she tacked easily.

I tried the original slots as well with the large boards and found things were much worse, obvious if you think about it, I also tried sailing without boards and was rewarded with virtually no directional control! Unfortunately winds were light so no more attempts were made at kite flying.

During Speedweek 2009 I avoided sailing on the Sunday, when I should have tried the kites, as it was quite windy and I didn't want to break my boat. Instead I drove my dory to perform towing trials etc.

Then the wind disappeared so I was able to try conventional sailing with some low aspect ratio keels I had made with what I felt was reasonable performance although spectators did remark that there was noticeable leeway. While it is very comfortable sitting in the cockpit of the centre hull and visibility ahead is excellent you cannot see the wake. Fickle winds remained



"Fred's Folly" half width sketch plan

loa 3.6m (12') oa beam 3m (10') weight 88kg (195lbs)

Standard Laser rig

so after removing the low aspect ratio boards I continued sailing with the bigger dagger boards in the aft slots and felt that they worked well.

However on the last day wind speeds improved and while kite sailing might have been best; time constraints and the fact that my support boat could usefully be used to help others meant that I chose to go sailing with the new dagger boards, and I was surprised to find that in a stronger wind the full dagger board made tacking difficult but half depth she handled well, and I was able to beat up to the harbour course that had been laid and put in several runs with the wind just abaft the beam my best speed over the 500 metre course was 6.6 knots; not bad for a 3.6m displacement boat, but not good enough for a prize.

What next? I think that I shall rebuild one of the floats with the combined slot unit behind the beam (for kite sailing) and an adjustable centre board behind that for normal sailing; the new float will probably have a simple V section bottom to reduce slamming instead of the current four chine arrangement.

While I've obviously got a lot to learn about the design of a multipurpose boat I am convinced that a small economically built boat which can easily be altered is a very good way of gaining useful experimental information and providing an enjoyable pastime.

Wind Powered Seaplane

Or Hagedoorn Revisited

Fred Ball

At Speedweek this year we were able to fly a Catapult inflatable catamaran from a ram air parascending kite, renewing Roger Glencross' enthusiasm for the boatless sailing as described by J G (Mendel) Hagedoorn in his monograph "Ultimate Sailing" (1971), later republished in part by Scientific American in March 1975.

The kite had its leading edge supported by a carbon fibre spar which was then suspended by a simple a frame across the boat (held near vertical by forward and back stays) the harness of the kite was attached near the centre of gravity of the boat, all the kite flying lines being behind the A frame.

On one of the calm days we towed this behind a dory powered by a 25hp outboard motor and at about 11 knots the whole catamaran and kite creation lifted clear of the water.

This infers that if instead of towing the catamaran/kite creation it was tethered to a suitable hapa (paravane) in a wind speed of about 15-16 knots it would take off carrying a pilot who with suitable controls would be able to remain airborne and manoeuvre across the wind or even upwind.

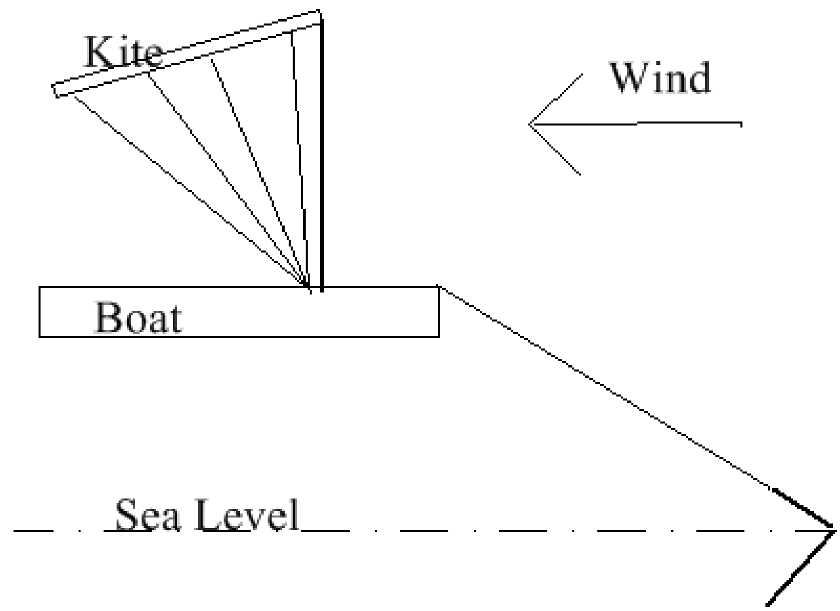
I believe that the most important problem to address is controlling the kite or wing as I think that full three-axis control is essential to maintain flying position and to regain control when it all goes wrong.

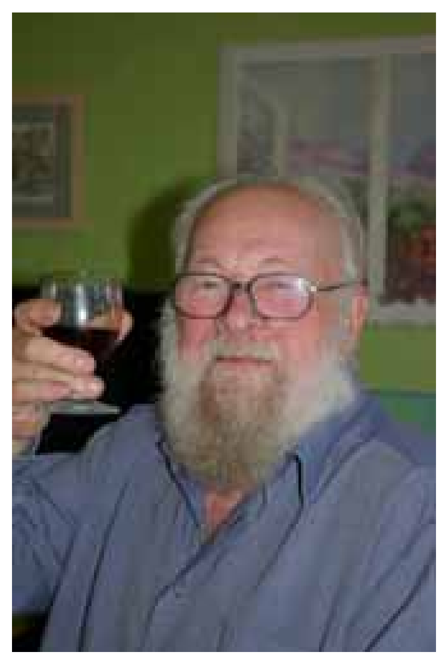
In the sketch all is well providing the apparent wind speed is maintained, however if the wind speed drops the wing attitude needs to alter to allow acceleration forwards to regain airspeed otherwise a stall will almost certainly occur with the airborne unit literally dropping out of the sky.

I think that to attain the necessary airborne control a lightweight glider with a full complement of control surfaces would be needed. The forward part of the fuselage would need to be transparent to ensure a good view for the pilot (ahead, above, below and to each side). The tow hitch would need to be near the centre of lift, so that the glider can move in all directions relative to the hapa's towline. Floats would be needed to enable take off and landing on the water, probably with adjustable struts to give a neutral at rest attitude and a take off angle of attack when needed.

I feel that a radio controlled model should be made to demonstrate how a tethered glider could be flown with control of its flying height and to either side of the wind direction from the point of tethering.

While the parascending kites have adequate flying controls for use as they are designed I feel that control by a brake at each wing tip will not be adequate to avoid catastrophic loss of control when tethered to a hapa as I have described.





“Sue” Lewis, 1920 - 2009

Owen Temple Lewis was born on March 16 1920 at Carluke, Lanarkshire, and was educated at Charterhouse. He learned to sail during childhood holidays at Kilmory Knap in Argyll, before going up to Trinity College, Cambridge, where he rowed. His lifelong nickname, Sue, dated from his schooldays.

After reading engineering at Cambridge, he was called up and joined the Royal Navy. He was involved in World War two as an engineer on warships doing convoy duty. After the war, he worked as a design engineer, taking jobs at Daniels, the Stroud chainsaw manufacturers, and at Miniature Electronic Components in Woking. Other employment followed: in a boatyard; as technician in a wind tunnel, “throwing frozen chickens at bits of Concorde”; and as quality control engineer on parts for a nuclear power station.

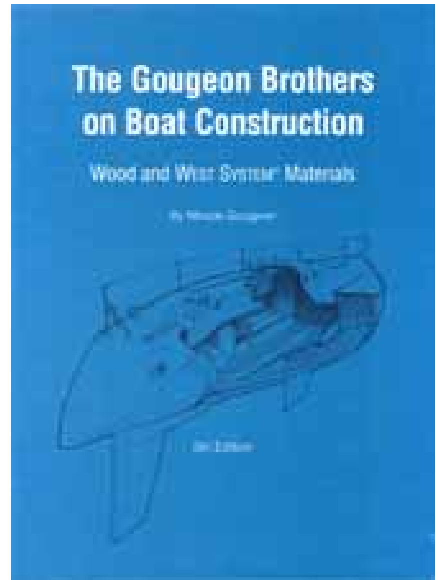
Sue was always an inventor, amongst other things he designed: a mechanical wool winder, which wasn’t adopted by the manufacturers, but its twin appeared mysteriously some time later; rowlocks: cunning gate handles: rose arches; and self steering gear for his boat. But his real interest was in boat design. He designed and made several over the years, and until the end, even in hospital, he continued to work on boat design.

His interests were many and various, he was actively involved in the restoration of the Kennet and Avon Canal, and he was an expert in knotting and splicing ropes. He was a dedicated member of the Amateur Yacht Research Society, took his place on the stand at the Boat Show every year, and was involved in the annual sailing speed trials at Weymouth.

Sue Lewis died on August 18 2009, and is survived by Sally and their five children. The world is a poorer place without him.

Books for after Christmas?

Something to spend those vouchers on



The Gougeon Brothers on Boat Construction, 5th edition, by Meade Gougeon,

400pp, pub: Gougeon Brothers Inc, Michigan, USA, 2008, ISBN 1-878207-50-4, £36.00.

This is *not* a book that one would normally read for pleasure, from cover to cover. That's not to say that it's unreadable, or that there are not chapters that one would read in one sitting. It's simply not that sort of book.

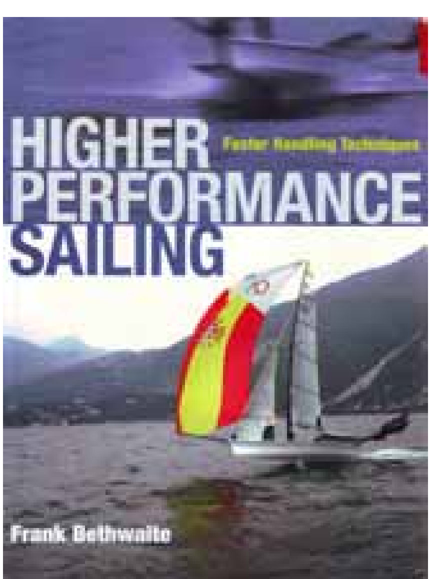
It's more like an encyclopaedia; an encyclopaedia of boat-building using modern adhesives and the techniques that they facilitate.

Meade Gougeon is of course a founder of Gougeon Brothers Inc, manufacturers of West epoxy resins. So there are quite naturally chapters on epoxy resins and the techniques of epoxy saturated timber construction, but these cover not just how to do it but also the research that has been carried out into the properties of the resulting composites. However, there are also great sections here on boat-building practices from lofting to building moulds to planking to painting. About the only thing I have not found here that I might expect to find is a chapter on vacuum-bagging techniques – but that Gougeon have covered in a separate publication.

Of course it doesn't deal with such things as caulking, but then one would not expect it to. The whole point of using epoxy resins is that they permit the construction of integral and monocoque structures that don't need bits of material stuffed between planks to keep the water out. Neither does it deal with selecting a design or any of the facets of the design process. Indeed it lays great stress on that designing a boat is a complex task best carried out by those with appropriate training. The only departure from it is a chapter towards the end that discusses "tortured plywood" construction, with the advice to use models because "that appears to be the only practical way to achieve accuracy".

This is the 5th edition, and claims to be a major reorganistion of the material in the previous edition (I haven't compared the two) and includes new chapters and updates reflecting developing practice.

In short, if you want a reference work, or a primer on wood-epoxy construction, then this is the book to look for. It's not cheap, at $40 or £36.00, and doesn't seem to be available through the normal cut-price outlets, but is well worth it.



Higher Performance Sailing, by Frank Bethwaite,

427pp, pub Adlard Coles Nautical, London, 2008, ISBN 978-1-4081-0126-1, £45.00.

By contrast, this *is* a book that I read from cover to cover, if not in one sitting, at over 400 pages it's too long for that, but over a couple of days.

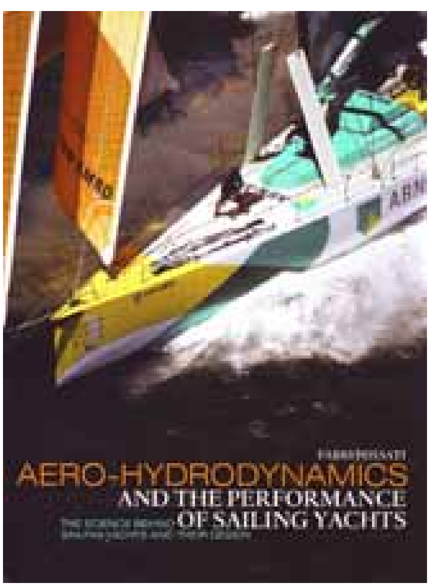
It builds on Bethwaite's earlier book (High Performance Sailing) and in essence tells the story of the 49er, 29er, etc family of dinghies, how they came about, what they can do, and how to make them do it. But it's not just a book for dinghy sailors, but for everyone interested in high performance sailing boats.

On the way to telling that story, it includes a number of diversions. There are chapters on the development of planing dinghies up to 1905 – long before Uffa Fox built *Avenger* (widely believed in UK, including by me, to be the first successful planing dinghy – a belief that is sadly wrong). It diverts into a review of extreme sailing craft, including a bit on foilers contributed by Ian Ward and the late George Chapman (both AYRS contributors). There is a lot on wind dynamics, explaining what a sailboat has to cope with, and a whole third of the book deals with Bethwaite's hull development including the tow tests he carried out at full scale with minimal resources.

Then comes the bit on how to sail them. As someone involved with teaching beginners to sail I was fascinated by the use he made of simulators, teaching not only the top end sailors, but also beginners, including schoolchildren. Unfortunately there seems to be only one of these simulators in UK, and as they are only built to order, they cost $Aus 30,000 to buy. So I'm not getting the sailing school one for Christmas, much though I would like to; but having read of the results that they can achieve, I do wonder why we don't make much more use of them. Maybe the RYA should order 10 and get the unit cost down to something more affordable.

To sum up, this book should be on the bookshelf of anybody who designs performance dinghies, and for that matter, on the shelf of anybody who designs performance multihulls.

It should also be on the bookshelves of anyone who sails these boats competitively, not only at grassroots level but also at national and international, even Olympic, levels. It really is that good.



Aero-Hydrodynamics and the Performance of Sailing Yachts, by Fabio Fossati,

English edition 2009, 350pp, pub: Adlard Coles Nautical, London, ISBN 978-1-4081-1338-7, £45.00.

Fabio Fossati is Professor of Mechanics at Milan Polyttechnic, and has been scientific coordinator for the testing of sailing yachts there since 2004. This book is an English translation of his 2007 work *Teoria dello yacht a vela*.

As one might expect given that background, it is very strong on the theory and mathematical modelling of yacht behaviour, dealing in detail with the various influences on yacht motion, not only as a steady state model, but also the dynamics, establishing the basis for velocity prediction programmes. (The author is also a consultant to the Offshore Racing Congress).

The last half of the book deals with the application of that theory to the testing of yacht models both in tanks and in wind tunnels. It discusses the problems of scaling, and the best approaches to dealing with them and the procedures that are typically followed as a result.

Multihulls get a brief mention, and there is even a photograph of one of Dave Culp's kites, but for the most part the book concerns itself solely with monohulls, although it includes those with canting keels (but not canting rigs).

Not I think a book for the amateur save for those who have a desire to understand those things, but for students intending to make a career in yacht design and testing, it is probably essential reading and maybe a useful purchase.

Simon Fishwick

Catalyst Calendar

This is a free listing of events organised by AYRS and others. Please send details of events for possible inclusion by post to Catalyst, BCM AYRS, London WC1N 3XX, UK, or email to **Catalyst@ayrs.org**

January 2010

8th - 17th London International Boat Show
EXCEL Exhibition Centre, London Docklands. AYRS will be there, in the North Hall. (Srtand N045R) Helpers are wanted to staff the stand, sell publications and recruit new members. If you would like to help (reward: free ticket!) please contact the Hon Secretary on 01727 862268 or email office@ayrs.org

NOTE CHANGE OF DATE FOR THE FOLLOWING

30th All-Day AYRS Meeting
9.30am-4pm, Thorpe Village Hall, Coldharbour Lane, Thorpe, Surrey TW20 6TE (off A320 between Staines and Chertsey – follow signs to Thorpe Park, then to the village). Details from Fred Ball, tel: +44 1344 843690; email frederick.ball@mypostoffice.co.uk

30th AYRS Annual General Meeting
4pm, Thorpe Village Hall, Coldharbour Lane, Thorpe, Surrey TW20 6TE (as above). Details from the AYRS Hon. Secretary tel: +44 (1727) 862 268; email: secretary@ayrs.org
Note: Items to be considered by the AGM, including nominations for the Committee MUST be received by the AYRS Secretary before 22nd December 2009 (post to AYRS, BCM AYRS, London WC1N 3XX, UK, or email: secretary@ayrs.org)

February 2010

27th AYRS Southwest UK Area Meeting
4pm 7 Cross Park Road, Wembury, PL9 0EU near Plymouth. As we did last year, we plan to hold a get-together of people interested in technical developments in sailing or boatbuilding. Wembury is a coastal village a few miles SE from Plymouth. We offer light refreshments at about 16:00, followed by presentations and discussions from about 17:00. We are reliant on at least one or two members coming prepared with some kind of presentation and maybe a few others bringing a few pictures to share, so do bring your pictures as prints or in a PC format such as CD, USB storage device etc. If you have a longer presentation in mind, it might be worth contacting me first so that we can fit it in.
As before, we propose an afternoon stroll for those who would like to join us prior to the evening meeting. This will start at 14:00 but we will try to think of a different route from last year and that may mean a different start point, so phone or email for details to John Perry, 01752 863730 j_perry@btinternet.com (note the underscore in that email address).

April 2010

25th Beaulieu Boat Jumble
The National Motor Museum, BEAULIEU, Hampshire, UK. AYRS will be there!

May 2010

10th—15th Boat trials, Weymouth
Location to be determined (not Castle Cove this time but somewhere else in Portland Harbour). Contact: Norman Phillips email: <wnorman.phillips@ntlworld.com>

28th – 31st *Broad Horizons* – AYRS Sailing Meeting
Barton Turf Adventure Centre, Norfolk UK, NR12 8AZ. Contact AYRS Secretary AYRS Secretary, BCM AYRS, London WC1N 3XX, UK; email: office@ayrs.org. Note: All boats limited to 1.2 metre max draft!

28th –31st UK Home Boat Builders Rally – Norfolk Broads
Barton Turf Adventure Centre, Norfolk UK NR12 8AZ. Joint with the above. For details see http://uk.groups.yahoo.com/group/uk-hbbr/

June 2010

4th – 6th Beale Park Boat Show
Beale Park, Pangbourne near Reading, UK. Open-air boat show with a number of boats available to try on the water. AYRS will be there again, selling publications. Contact: Fred Ball, tel: +44 1344 843690; email frederick.ball@mypostoffice.co.uk

30th - 1st July Innov'sail 2010
Second International Conference on Innovation in High Performance Sailing Yachts, Cité de la Voile Eric Tabarly in Lorient, Brittany, France. Organised by RINA, IRENAV and the Ecole Navale Francaise. See http://www.rina.org.uk/innovsail2010

How to find Thorpe Village Hall (AGM venue)

http://www.multimap.com/maps/?lat=51.40823&lon=-0.5285&redCircle=on

For your satnav, the postcode is TW20 8TE

Important Notice - AYRS AGM, Annual Report & Accounts

1. Due to the delay in publishing Catalyst 36, the 2008-9 Annual Report & Accounts will be published on the AYRS Website **http://www.ayrs.org**.

The printed copy will be circulated with Catalyst 37 (January 2010) which will most likely not be published until after the AGM.

The Editor tenders his apologies, and if wanted, his resignation.

2. The AGM will now be held on **30th January** (see Calendar)

Catalyst — *a person or thing acting as a stimulus in bringing about or hastening a result*

On the Horizon . . .

Split junk sails
More Howard Fund applications
Experimental platforms
More sources and resources: reviews, publications and Internet sites

Amateur Yacht Research Society
BCM AYRS, London WC1N 3XX, UK

Printed by Printflow, London EC1V 7JD