Catalyst

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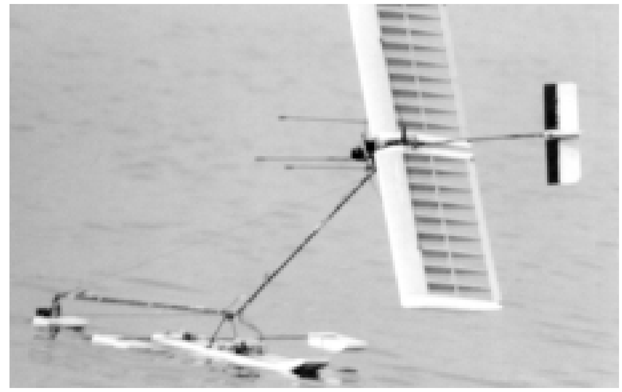

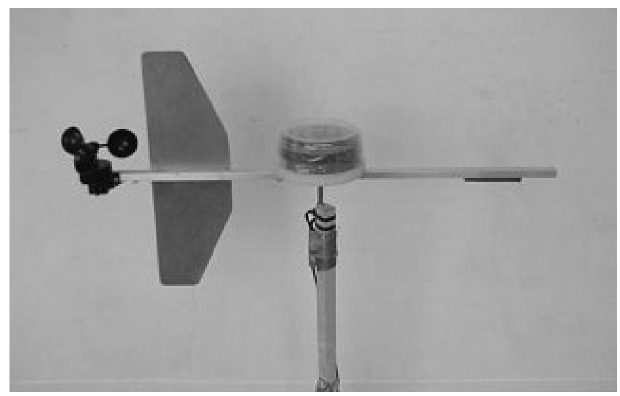

On the Cover —

David Duncan's Swing-Rigged Wayfarer

Photo: Alan Duncan
Enhanced by Paul Brierley, Firefly Design Ltd.

Catalyst

Journal of the
Amateur Yacht Research Society

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AYRS John Hogg Prize

2001 saw the launch of the AYRS John Hogg memorial prize, established in memory of one of AYRS distinguished early members, to be awarded for the most meritorious contribution to innovation in yacht science made by an amateur researcher. The prize has been donated by his family to celebrate John's life and work.

Six entries were received before the closing date, and one too late to be included, from which the judges selected a shortlist and the eventual winner. *Catalyst* congratulates them all. The winner will be presented with a cheque for £1000 on the AYRS stand at the 2001 London Boat Show on 3rd January by Rodney Hogg, John's son, and chairman of Spinlock Ltd.

The prize will be awarded again in 2002. The Rules have changed a little from 2001, but not in spirit, only in detail to eliminate some of the problems experienced during this year's judging. We look forward to seeing your entries.

Proa rules

The AYRS Proa Symposium on December 4th was a faciniating occasion pulling in proa devotees and detractors alike, albeit more of the former! It is clear that there is much more experience of proa sailing within AYRS than is generally realised. Not all of this is in sheltered waters with small dayboats – there is clearly a body of experience that would put the lie to the opinion expressed in a distinguished UK yachting magazine that proas are unfit for open ocean sailing, thereby writing off 1000 years of tradition!

It is however clear that there are no established design "norms" for modern proas in the way that there are for catamarans and trimarans. If proas are to take their place as the third kind of modern multihull, then they need such norms as a basis for sorting the safe designs from the way-out. AYRS members led the way in setting such norms for cats and tris. We need to do it again.

Simon Fishwick

AYRS - John Hogg Memorial Prize 2001.

Report of the Judges.

Six entries were received by the due date, of which three were short-listed. From them David Duncan has been selected as the winner of the £1000 prize.

The other two short listed entrants receive a year's free AYRS membership, and all three will receive certificates at the 2002 London Boat Show presentation.

David Duncan's novel Swing-Sail rig is best understood from the photos and drawings. It could be described as an 85 degree crab-claw sail hoisted on a freely rotating mast, with a point on the boom at the foot of the sail supported by a telescopic swing-boom goosenecked to the mast. A normal sheet controls the sail in use. The photo shows the sail afloat on Duncan's Wayfarer on Plymouth Sound. This sail exploits the lifting property of an inclined sail and additionally keeps full control, in particular of helm balance and for downwind sailing when it should be possible to minimise the risk of broaching.

David Duncan's swing rigged Wayfarer on Plymouth Sound

His modelled, but not yet full-size, scheme is the 'Twin-Surfer', which will seat the crew on a forward extension of the swing-boom. This should provide an interesting and exciting new way of sailing where one plays the sail with one's feet.

Stephen Bourn (Australia) submitted a paper "A Fundamental Theory of Sailing and its application to the design of a Hydrofoil Sail Craft". The paper "presents a general comprehensive but succinct theoretical framework for analysing the forces acting on a sail craft and the resultant sail craft performance" to quote the abstract. Much of this will be familiar to those who have read, for example, Edmond Bruce's and Harry Morss' works, but this paper carries their (and others') work forward with the clearest exposition yet of the need for the smallest possible apparent wind angle if you wish to sail fast, and the deleterious effect if you incline the sail (to gain lift upwards) too much. The paper as presently written concludes with a graphical presentation of the variation of the relevant parameters as the hydrofoil's angle of action relative to the horizontal is varied.

The second part of Bourn's entry is the design of a 'speed machine'. The way it will be operated is fully described in his November 1998 patent application, which was sent as part of the submission.

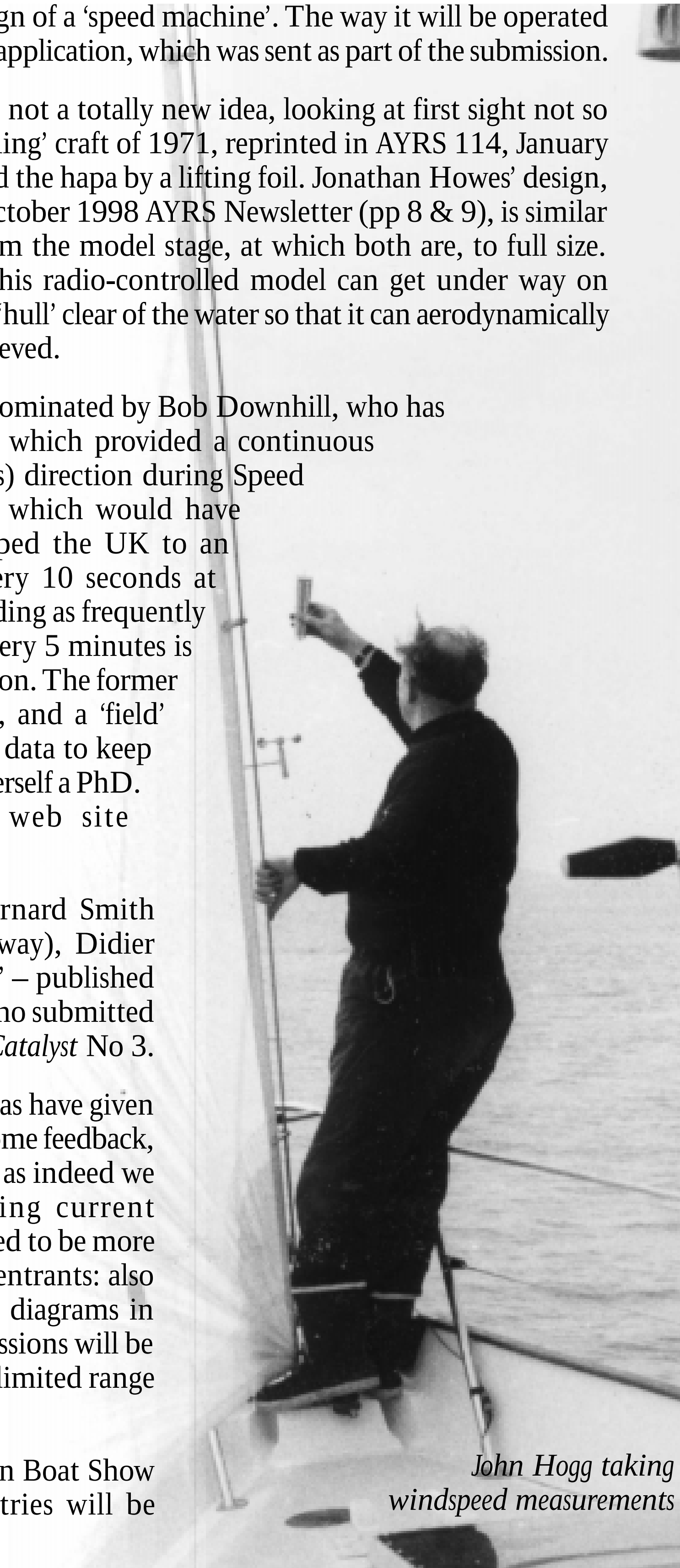
Bourn's scheme for a fast sailing machine is not a totally new idea, looking at first sight not so different from J.G.Hagedoorn's 'Ultimate Sailing' craft of 1971, reprinted in AYRS 114, January 1994. But the string is replaced by a beam, and the hapa by a lifting foil. Jonathan Howes' design, of which there is a conceptual sketch in the October 1998 AYRS Newsletter (pp 8 & 9), is similar so there is now an exciting race on to get from the model stage, at which both are, to full size. Bourn sent a short video which shows that his radio-controlled model can get under way on either tack, stop and tack, but so far 'flying' the 'hull' clear of the water so that it can aerodynamically weathercock does not seem to have been achieved.

Bob Spagnoletti's Wind Data Logger was nominated by Bob Downhill, who has been one of the beneficiaries of this device, which provided a continuous record of wind speed and (magnetic compass) direction during Speed Weeks 2000/1. This compact instrument - which would have brought joy to John Hogg and maybe helped the UK to an America's Cup win - recorded the data every 10 seconds at Weymouth for over 10 hours at a time. Recording as frequently as every quarter of a second, or up to once every 5 minutes is possible with an inversely proportionate duration. The former can show much more of the detail of wind, and a 'field' covered with such instruments could provide data to keep a meteorologist busy for weeks and earn him/herself a PhD. More detail is on the Speed Sailing web site http://www.speedsailing.org.

The other entrants were ("40 knot") Bernard Smith (USA), nominated by Robert Biegler (Norway), Didier Costes (France) who submitted 'Mes Bateaux' – published in *Catalyst* No 5 - and Peter A. Sharp (USA) who submitted his 'Power Alternating Sailing', described in *Catalyst* No 3.

We are grateful to all the entrants whose ideas have given us much food for thought. We have provided some feedback, which we hope will be useful for future work, as indeed we hope the prize itself will be in furthering current development. We have learnt that the rules need to be more closely specified to help both the judges and entrants: also that electronic transmission of words and of diagrams in particular has its hazards, so that future submissions will be called for in hard copy, by post, or in one of a limited range of formats.

The next award will be made at the London Boat Show in January 2003. The closing date for entries will be 15 October 2002.



John Hogg taking windspeed measurements

Introducing the Swing Sail-rig

David Duncan – Winner,
2001 John Hogg Prize

This new swinging sail rig is designed to reduce heeling moment and to produce a vertical lifting force. This helps to reduce a vessel's displacement, reduces water drag, and therefore increases the boat's speed.

The lifting force is obtained by tilting the sail vertically, as is the case with jib sails and spinnakers which both produce a vertical lift when inclined.

Tilting sails have been used successfully at varies times in the past but have not been easy to handle. The Arab dhow's lateen is an efficient sail that produces some vertical lifting force but is slow to tack about, and Kites produce lift but are not easy to control.

The unique arrangement of this rig, with its swinging boom, allows it to be easily controlled.

How it works

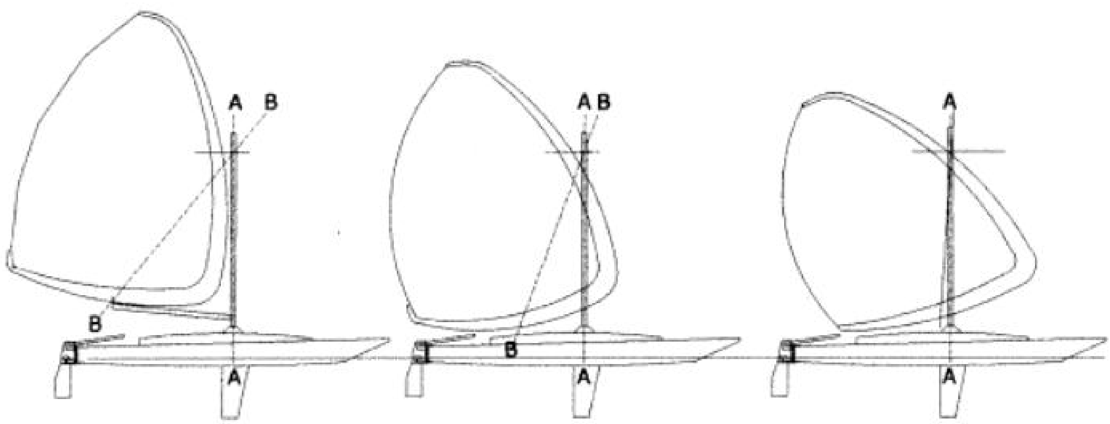
The rig consists of a wing sail assembly, which swings about a short mast with the aid of a swinging boom.

The boom is pivoted at the bottom of the mast so that it can swing horizontally about the mast.

There are two pivoting points on the Swing-sail rig, axis “A-A” and axis “B-B”.

The sail pivots about the mast axis, “A-A”, as in a conventional rig, and it also pivots about an inclined axis, “B-B”, between the top of the mast and the end of the swinging boom. This allows the sail to be tilted at an angle to the vertical as it moves with the swinging boom from one side of the vessel to the other. See drawings.

Changing from one tack to the other is easily achieved by moving the swing boom from side to side. As the swing boom moves aft the sail assembly becomes upright and automatically passes behind the mast and out onto the other tack.



The angle of attack of the sail is controlled by a mainsheet in the normal way and lee or weather helm can be easily adjusted by moving the sail fore and aft.

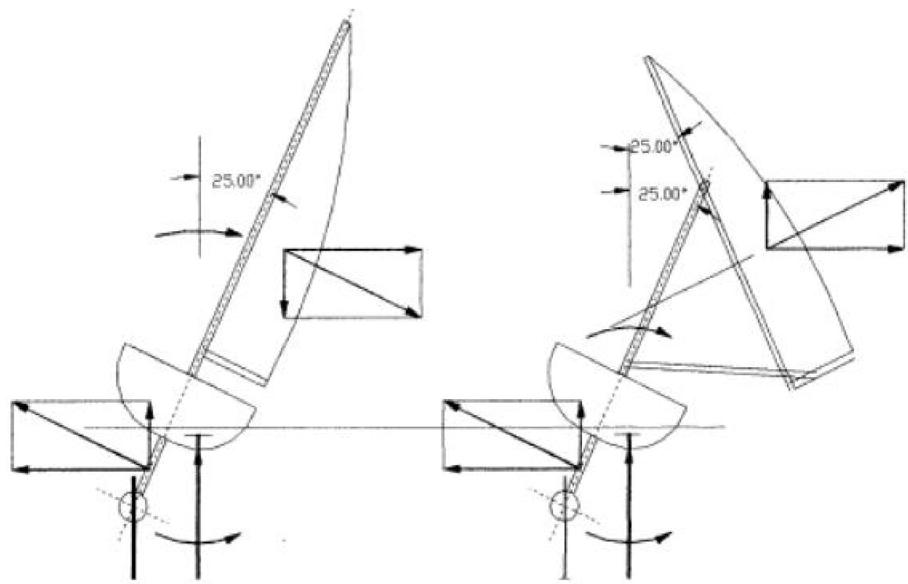
On a run the tendency to broach or to pitchpole is reduced by moving the sail assembly ahead of the mast. In this position the sail area is more evenly balanced side to side and the decreased heeling moment or lift helps prevent pitchpoling.

Raising, lowering or reefing the sail is achieved in the normal way while the sail is held in the upright position.

The photographs show a prototype version of the rig, mounted on a standard Wayfarer dinghy. The photographs were taken during trials in Plymouth Sound. The angle of tilt of the sail is less obvious in the pictures, but if a line is drawn from the top of the mast to the end of the swing boom, it becomes more apparent.

The boat has also been tested at a “Winds of Change” AYRS event at Harwich.

Apart from some teething problems the rig performed very well with a noticeable reduction in heeling moment.It also proved to be very easy to control.



Force Diagrams

The essential requirement of a sail is to produce a driving force component and it cannot do this (except on a dead run) without producing a heeling force. In a conventionally rigged yacht sailing close hauled the driving force is roughly one-fourth to one-third of the heeling force. In other words for every kilogram of driving force generated on the sail, three to four kilograms of heeling force are produced which have to be counteracted by the boat's stability.

A Keelboat has to heel for the keel to produce any righting moment. The following diagrams show the forces acting on sailing vessels in a typical heeling condition when sailing to windward with a conventional rig on the left and the new rig on the right.

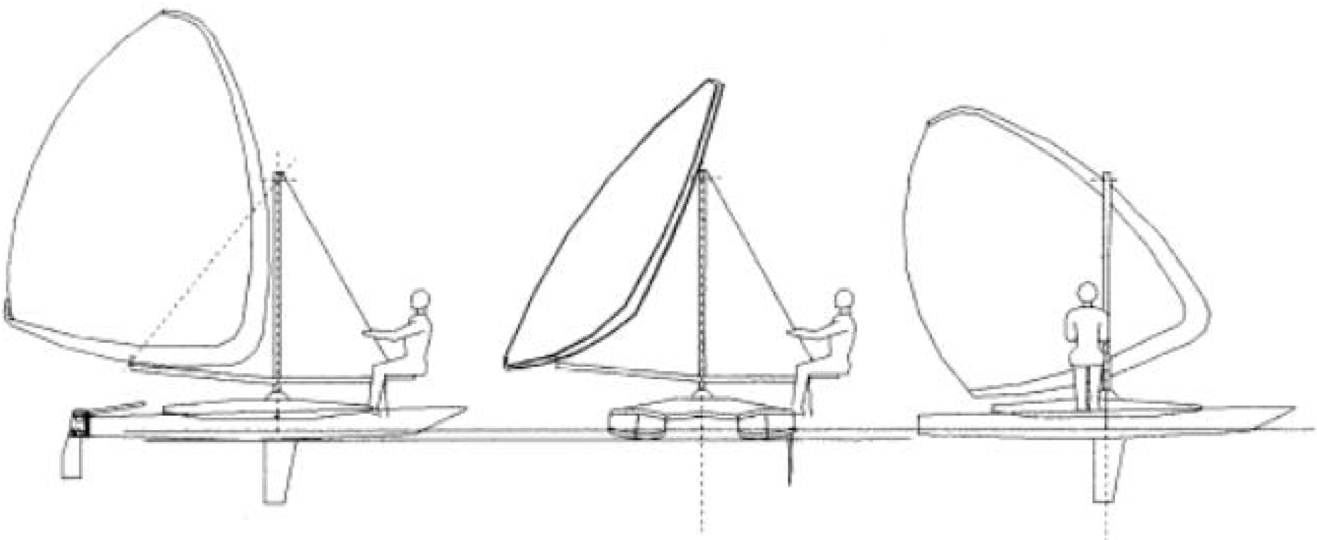
As can be seen in the two diagrams, the heel angle, sail area, keel area and driving forces are the same for each vessel. The underwater forces and the horizontal components of the sail forces are the same.

The vertical component of the sail force however is negative on the conventional rig and positive on the swing-sail rig. This reduces the heeling moment by about 50%.

The reduction in the heeling moment means the keel weight can be reduced; or, for the same keel weight, the sail area can be increased.

David Duncan

Introducing "TWIN-SURFER"



"Twin-surfers do it sitting down". In this version of a wind-surfer, the helmsman sails and steers the boat sitting on a seat. The surfer is twin hulled and is fitted with a "Swing-Sail" rig.

The seat is fitted on a swinging boom, which rotates about the mast and is suspended from the masthead.

The swinging boom extends out from both sides of the mast base with the bottom of the sail assembly attached at one end of the boom and the seat at the other end.

The seat can be moved in and out on the boom and also raised and lowered.

The sail assembly is rotated about the mast by the helmsman moving the boom with his feet. The boat can be steered in the same fashion.

The "Swing-Sail" pivots between the top of the mast and the end of the swingboom so that it moves from an upright position when tacking to a tilted position when sailing.

The boat can be sailed with one hull out of the water so that water drag need not be any greater than a standard wind-surfer.

The Twin-Surfer is easier to sail and offers several advantages over a standard wind-surfer.

Stability.

Because the surfer is twin hulled it is far more stable than a standard wind-surfer. The helmsman does not have to carefully and continually balance himself on a board but can relax and move about the twin-surfer.

Performance.

The boat is fitted with a "Swing-Sail" rig, which produces a vertical lift, reduces heeling moment, and allows a larger sail to be used.

Control.

The sail angle is controlled with a mainsheet but with less load than a conventional sailing dinghy. One sail is used so the boat can be sailed single-handed. Boat direction is controlled by rudders or by the helmsman moving the sail position using the swinging boom.

Comfort.

The helmsman can sail the Twin-Surfer sitting down comfortably on a raised seat. His raised position keeps him drier than many sailing dinghies.

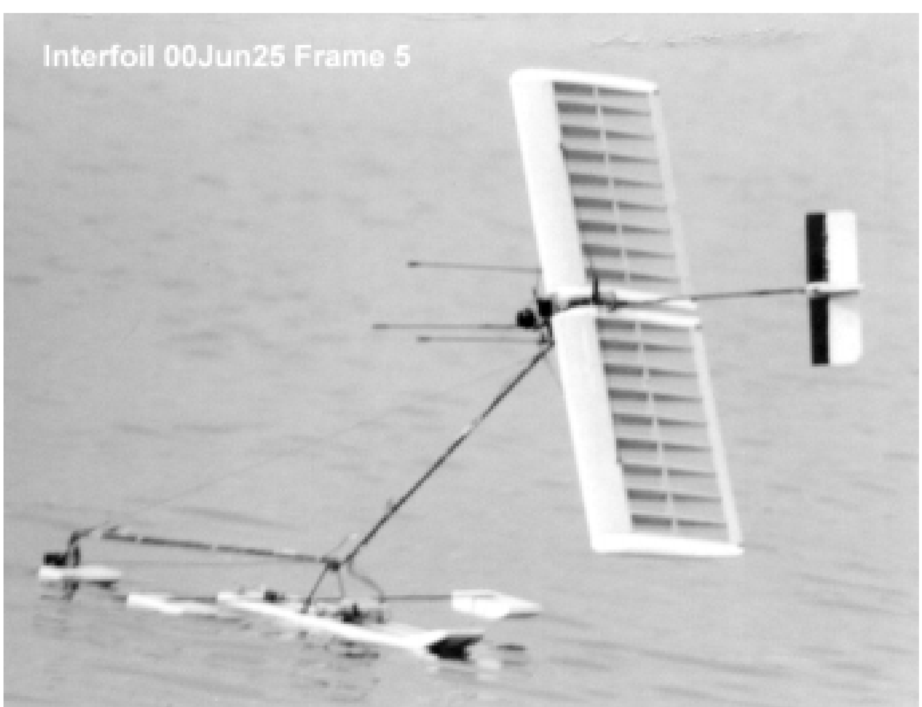
Transport.

Although the Twin-Surfer is larger than a standard wind-surfer it is still light enough and small enough to be carried on a car roof.

A Fundamental Theory of Sailing and its application to the design of a Hydrofoil Sail Craft

Stephen Bourn
October 2001

This is a (very) condensed version of Stephen Bourn's full paper, which presents a general comprehensive but succinct theoretical framework for analysing the forces acting on a sail craft and the resultant sail craft performance. An innovative type of hydrofoil sail craft, whose design was guided by the theory, is described. This type of craft should have superior performance to all existing types of high performance sail craft on all courses in most conditions. The theoretical analysis shows that the system of forces acting on any sail craft at equilibrium can be reduced to an equivalent system of three forces acting in a vertical plane. The resultant forces represent the net aero, hydro and gravitational forces. The geometrical relationships between these forces and the air/water/craft velocity triangle in the horizontal plane leads to a fundamental equation governing the limits of sail craft performance. Consideration is given to the implications of the theory regarding the necessary attributes of high performance sail craft in general. The particular type of hydrofoil sail craft described in the paper would be almost fully airborne when in use. A single inclined aerofoil and a single submerged inclinable hydrofoil would generate the main aerodynamic and hydro forces that would support and propel the craft.



Stephen Bourn

Introduction

The full paper analyses the problem of the fundamental limitations on ultimate sail craft performance. The general attributes required for high performance sail craft become apparent from the analysis. Guided by the analysis a novel hydrofoil sail craft has been designed, and is described.

A few well-understood basic principles are applied to the problem. The primary principles come from simple Euclidean geometry and statics, that branch of engineering mechanics that deals with rigid bodies at equilibrium under a system of forces. Results from aerofoil theory, which is equally applicable to foils operating submerged in water, are also used. Basic results from the hydrodynamic and hydrostatic theory applicable to the motion of a hull on the water surface are also needed. The principal initially used from aerofoil theory is the simple fact that lift, a force component perpendicular to the direction of flow, can be generated.

An innovative approach is taken to the analysis of the complete system of forces acting on a sail craft. The system of forces acting on a sail craft at equilibrium is reduced to an equivalent system of three resultant forces with concurrent lines of action lying in a vertical plane. The resultant forces represent the net aero, hydro and gravitational forces. The geometrical relationships between these forces and the air/water/craft velocity triangle in the horizontal plane leads to a fundamental equation governing the limits of sail craft performance. The equation relates the apparent wind angle to basic parameters associated with the net aero and hydro forces.

The approach taken in reducing the system of forces obviates the need to give independent consideration to heeling, pitching and righting moments.

The theory is applicable to all sail craft. This includes displacement yachts, dinghies, multihulls, sailboards and kite powered craft. The theory can be applied to ice and land yachts, with appropriate substitutions for references to water. While the theory may apply to all sail craft, the emphasis is on high performance, meaning high speed relative to the true wind speed, and high absolute speed.

The hydrofoil sail craft described in the paper would be almost fully airborne when in use. A single inclined aerofoil and a single submerged inclinable hydrofoil would generate the main aerodynamic and hydro forces that would support and propel the craft. The craft should have superior performance to all existing types of high performance sail craft on all courses in most conditions.

Section outline

The full paper is structured as follows. Section 2 introduces the velocity triangle and the arc of constant apparent wind angle. The dependence of various performance measures on apparent wind angle is presented. An expression is given for a velocity ratio that changes and must be accommodated as course changes.

In Section 3 the horizontal components of the net aerodynamic and hydrodynamic forces are examined and their geometric relationship to the velocity triangle.

In the next section the full three-dimensional system of forces is considered. These are reduced to three resultant forces, representing the net aero, hydro and gravitational forces. The aero and hydro force to weight ratios are expressed as functions of the force elevation angles. An equation relating the apparent wind angle to the drag angles and the force elevation angles is derived. This is the fundamental equation determining sail craft performance. The relatively low hull drag at low Froude number is discussed. The basic equations for fluid dynamic lift and drag are introduced and discussed in relation to the velocity ratio variation that accompanies changes in course. Finally in this section the relevant literature is reviewed.

In Section 5 the general principles are considered regarding the relative locations of the centre of gravity and the aerodynamic and hydro centres of pressure, and the elevation angles of the resultant force lines of action. The attributes required for high performance and for stable equilibrium are deduced. The design implications of aspect ratio and induced drag are discussed. Finally the designs of a variety of existing types of sail craft are reviewed.

Finally in Section 6 the novel hydrofoil sail craft design is presented. Cavitation is discussed. Alignment of the craft in response to the course, apparent wind and net forces is shown. The resultant forces and lines of action in the vertical plane are shown. The craft geometry is parameterised and an equation derived relating the resultant force elevation angles. Representative values are assumed for the craft geometry and drag angles, and a full analysis of relative craft performance is undertaken. Finally specific performance measures are derived for a particular example craft weight, aerofoil area and true wind.

[*Since the full paper is overlong for a Catalyst article (21 pages) , we print here just Section 6. AYRS hopes to print the full paper in a booklet in due course – Ed.*]

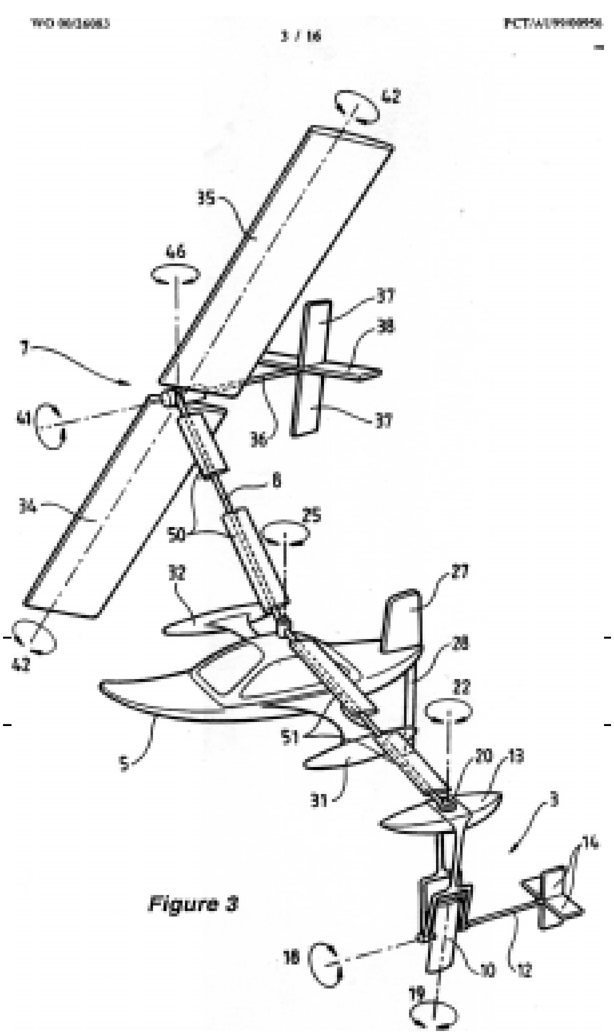


Figure 6 Perspective drawing of a hydrofoil sail craft [9].

A high-performance hydrofoil sail craft

The author has designed a novel type of hydrofoil sail craft, which should be capable of sailing at very high speeds and small apparent wind angles. It is fully described in the patent application [9]. A perspective drawing taken from that publication is reproduced at Figure 6. The numbered parts are described in [9].

The design goal was a craft of minimum necessary complexity that was capable of high performance over a wide range of true wind speed V_T and course angle γ. This capability was required on both tacks and in unsheltered waters.

All of the general principles for high performance and stability of equilibrium were considered and generally accommodated. The design choice process led to selection of the following general features. The locations for center of gravity CG, and centers of pressure CP_A and CP_H are fixed. In use a single aerofoil and a single submerged hydrofoil generate the main aerodynamic and hydro forces, respectively. Only the hydrofoil, together with its supporting struts and stabilisers, remains submerged, the rest of the craft being airborne. The main aerofoil and hydrofoil have fixed areas S_A and S_H.

The craft must be able to accommodate a range of projected drag angles ε_{IA} and ε_{IH}, and it must be capable of providing a range of force elevation angles ϕ_A and ϕ_H, and coefficients of lift C_{LA} and C_{LH}. This can be achieved as shown in Figure 6 by providing three degrees of freedom in the gimbal assemblies supporting the aerofoil and hydrofoil. Yaw rotation about the vertical axes maintains alignment with the air and water flow respectively, keeping the foil lateral axes transverse to the respective flows. Roll rotation about the horizontal axes controls the lift elevation angles ϕ_{LA} and ϕ_{LH}. Finally pitch rotation about the foil lateral axes changes the incidence angles α_A and α_H, thereby controlling the coefficients of lift C_{LA} and C_{LH}.

In addition the hull is free to rotate, about a vertical axis, with respect to the main beam connecting the aerofoil and hydrofoil assemblies. Yaw rotation combined with rolling ϕ_L through $\pi/2$, that is rolling the foil to be horizontal and then beyond on the other side, allows the craft to sail on either tack. Furthermore the foils can be thick and asymmetric. This is necessary to provide a wide range in the coefficient of lift while maintaining low drag.

Since the ratio of foil areas S_A to S_H is fixed, it is desirable that the force ratio F_A to F_H remains reasonably constant as the force magnitudes change. This is achieved if CG is close to midway laterally between CP_A and CP_H. Fortunately this is not inconsistent with other requirements.

Recall that each foil has three degrees of freedom associated with it. Yaw can be controlled automatically by provision of fins to maintain alignment with the fluid flow. The pilot must control roll and pitch. This could be achieved by provision of a joystick for each foil. Steering is achieved by generating

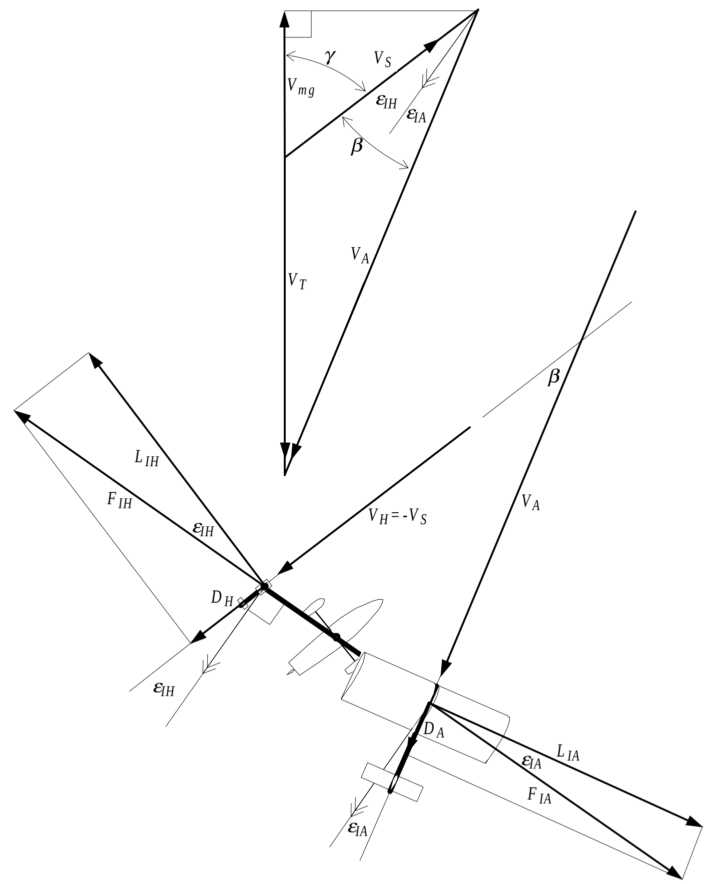


Figure 7 Plan view of craft with forces and velocities overlaid.

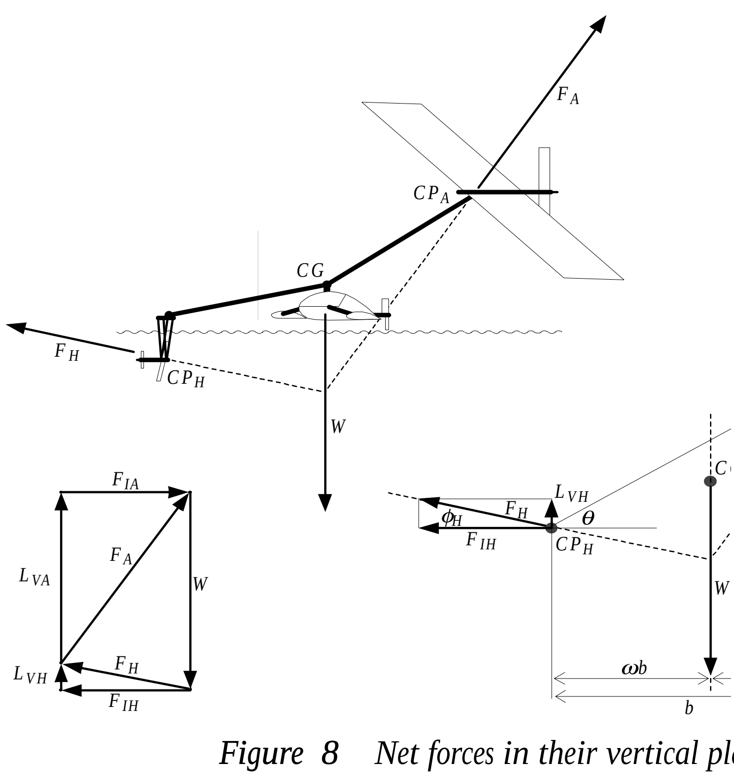


Figure 8 Net forces in their vertical plane.

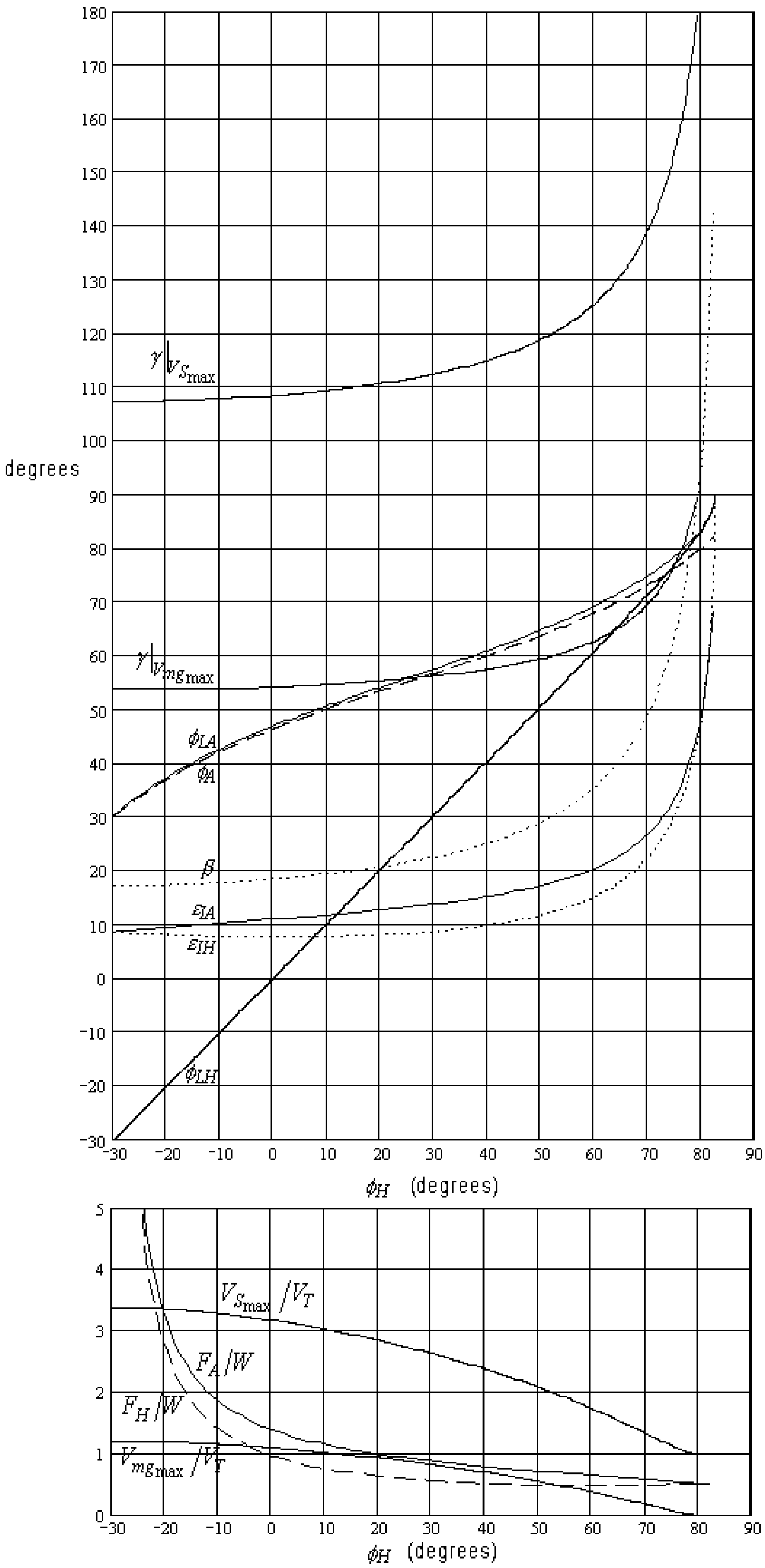


Figure 9 Angles, velocities, forces as functions of ϕ_H .

transient net lateral forces by coordinated adjustment of the aerofoil and hydrofoil. The foil assemblies should be reasonably well balanced about their axes, both with respect to fluid dynamic pressure and inertial mass. The wind velocity gradient must be accommodated to fully achieve balance.

Further discussion and detail regarding the design and variations may be found in the patent application. The topics discussed include control and operation of the craft, including take off from rest and changing tack, stability, the use of stabilisers and elevators, and choice of foil section shapes and properties.

Use of a single submerged hydrofoil is virtually mandated by the stated design goals and the principles governing high performance. There are additional benefits. Hydrofoils have superior lift to drag ratios compared with planing surfaces. A submerged hydrofoil avoids the problems associated with the rough state of the water surface. It also avoids ventilation that can affect surface piercing foils. A disadvantage is the drag associated with the supporting struts. Ventilation may further increase drag on the struts.

Cavitation

The pressure distribution over a foil may be expressed by $\frac{1}{2}\rho V^2 C_p$ where C_p is the coefficient of pressure and varies over the surface. The pressure distribution changes as the incidence angle α changes. When the magnitude of the pressure drop at some point on a hydrofoil surpasses the ambient fluid pressure, cavitation occurs, and performance is impaired. For example water at V_H=28 kn has dynamic pressure

$$\frac{1}{2}\rho_H V_H^{\,2} \approx 1\,\text{atm}\,.$$

Cavitation could be a performance limitation, and foil shape for high speed should be carefully selected to control C_{PH}. This requirement limits the foil thickness and reduces the maximum value and range of C_{LH}. Although control of C_{LH} is limited, equilibrium can still be achieved by adjusting C_{LA}, ϕ_{LA} and ϕ_{LH}. Ultimately further increases in speed will require the adoption of super-cavitating hydrofoils, but these have markedly inferior lift to drag ratios.

Force geometry

Figure 7 is a plan view of a hydrofoil sail craft. Superimposed on it are vectors representing the water flow and apparent wind. Also superimposed are the horizontal force components. For simplicity the forces are shown acting at the aerofoil and hydrofoil gimbal centres. This is equivalent to assuming negligible drag on the main connecting beam and hull. Finite drag would slightly offset the craft total aerodynamic centre of pressure. The inset diagram shows the velocity triangle. The velocities and forces shown in Figure 7 are identical to those in Figure 1 [*not shown here* - *Ed*]. Notice that the main connecting beam is aligned with the forces and lies in the resultant force plane, under the assumptions of negligible beam and hull drag. A bonus of this design layout is that the main structural component, the beam, tends to be in tension, rather than compression. This allows it to be a comparatively lighter structure, although there may be bending moments that it must withstand.

Figure 8 shows an offset frontal view of a hydrofoil sail craft. In fact it is a view normal to the resultant force plane. The waterline is represented in the figure, and all but the lower part of the hydrofoil assembly is airborne. The resultant forces and their lines of action are superimposed. The resultant forces and their lines of action are reproduced without the craft but with the force components shown, and the elevation angles ϕ_A and ϕ_H marked. To complete the force analysis the craft must be characterised by two further parameters. These are the elevation θ of the aerodynamic centre of pressure CP_A with respect to the hydrodynamic centre of pressure CP_H, and the lateral position of the centre of gravity CG expressed as a proportion ω of the lateral distance from CP_H to CP_A. These parameters are shown in the figure. Also shown in Figure 8 is a pictorial representation of the vector sums of the forces and their components.

The condition of concurrency of the force lines of action is equivalent to the algebraic constraint

$$(1-\omega)\tan\phi_A = \omega\tan\phi_H + \tan\theta \qquad (11)$$

This determines the relationship between the elevation angles ϕ_A and ϕ_H. The ranges of ϕ_A and ϕ_H are limited by

$$\theta \le \phi_A \le \frac{\pi}{2} - \varepsilon_A, \quad \text{and} \qquad (12)$$

$$-\theta \le \phi_H \le \frac{\pi}{2} - \varepsilon_H .$$

The elevations ϕ_A and ϕ_H are related by (11), and so the upper bounds are determined by whichever is the most restrictive of these two conditions. Recall from the previous section that high performance requires a craft to be relatively wide. For the hydrofoil craft described in this section that is equivalent to requiring small θ. This is confirmed by (12), which states that ϕ_A is bounded below by θ.

Performance analysis

A hypothetical example will now be given to predict the performance that could reasonably be expected in practice. Modest parameter values that should be achievable are assumed. Let θ=30°, ω=0.45 and $\varepsilon_A = \varepsilon_H$ = 7.5°. As shown in Figure 9, ϕ_A can be plotted as a function of ϕ_H, using equation (11) and the assumed values for θ and ω. Next the necessary corresponding force to weight ratios F_A/W and F_H/W can be plotted using (7) and (8). Also the resultant projected drag angles ε_{IA} and ε_{IH} and the required lift elevation angles ϕ_{LA} and ϕ_{LH} can be plotted using (3), (4), (5) and (6), and the assumed drag angles ε_A and ε_H. Following this, the apparent wind angle $\beta = \varepsilon_{IA} + \varepsilon_{IH}$ can be plotted. Finally the expressions dependent on b in Table 1 for relative speeds on various courses can be evaluated. In Figure 9 the relative speeds $V_{S_{\max}}/V_T$ and $V_{mg_{\max}}/V_T$, and their corresponding course angles, have been plotted.

Now suppose the example craft has a gross weight of 175 kg, so W=175 kgf, and is operating in true wind V_T=10 kn. If the craft could sail with apparent wind β=20° then from Figures 2 and 9 it can be seen that a maximum speed $V_{S_{\max}}$ ≈30 kn would be possible, and the best speed made good upwind would be $V_{mg_{\max}}$ ≈10 kn on course γ≈55°. The elevations ϕ_A≈50° and ϕ_H≈15° are required to achieve β=20°. From Figure 9 it can be seen that this would require F_A slightly greater than W=175 kgf. On course γ≈55°, with β=20°, the apparent wind would be V_A≈25 kn. Suppose the craft has an aerofoil area S_A=15 m^2. Assuming a coefficient of lift C_L=1.2 and applying (10) gives sufficient lift L_A ≈180 kgf.

In winds too light for the craft to become airborne, there are niches in which existing craft may have an advantage. For displacement mode sailing, longer craft have a Froude number advantage. Craft that can deploy massive light air rigs may be able to achieve a force to weight ratio advantage.

Conclusion

The full paper shows that the system of forces acting on any sail craft at equilibrium can be reduced to an equivalent system of three forces representing the net aerodynamic, hydro and gravitational forces. The resultant force lines of action lie in a vertical plane and are concurrent. These are sufficient conditions for equilibrium, it is not necessary to give separate consideration to heeling, pitching and righting moments. There is a direct geometrical relationship between the resultant forces and the velocity triangle. This relationship leads to the fundamental equation (9),

$$\beta = \arcsin\left(\frac{\sin\varepsilon_A}{\cos\phi_A}\right) + \arcsin\left(\frac{\sin\varepsilon_H}{\cos\phi_H}\right)$$

which seems to be new, relating the apparent wind angle β to the drag angles ε_A and ε_H and the force elevation angles ϕ_A and ϕ_H. This single equation encapsulates the factors controlling performance, namely the aerodynamic and hydro lift to drag and force to weight ratios. Note that equation (2) $\beta = \varepsilon_{IA} + \varepsilon_{IH}$ relates the apparent wind angle β to the projected drag angles, not the drag angles themselves.

Equation (1),

$$\left.\frac{{V_A}^2}{{V_S}^2}\right|_{V_{mg\max}} = \left.\frac{{V_S}^2}{{V_A}^2}\right|_{V_{mg\min}} = \frac{1+\sin\beta}{1-\sin\beta}$$

which also seems to be new, indicates the extremes to be encountered in the ${V_A}^2/{V_S}^2$ ratio as course γ changes. Sail craft must be able to accommodate these extremes. A benefit of decreasing apparent wind angle β is a corresponding reduction in the variation of this ratio.

The achievement of high performance and stable equilibrium imposes certain general design requirements on the relative locations of the centre of gravity *CG*, the aerodynamic centre of pressure CP_A and the hydro centre of pressure CP_H, and the elevations of the aerodynamic lift ϕ_{LA} and the hydro lift ϕ_{LH}.

A hydrofoil sail craft has been designed with minimal necessary complexity that generally accommodates all of the attributes required for high performance and stability of equilibrium. The craft is designed to operate on both tacks in unsheltered waters over a wide range of true wind speed V_T and course angle γ. The craft should have superior performance to all existing types of high performance sail craft on all courses in most conditions. The feasibility is demonstrated by example calculations showing exceptional performance.

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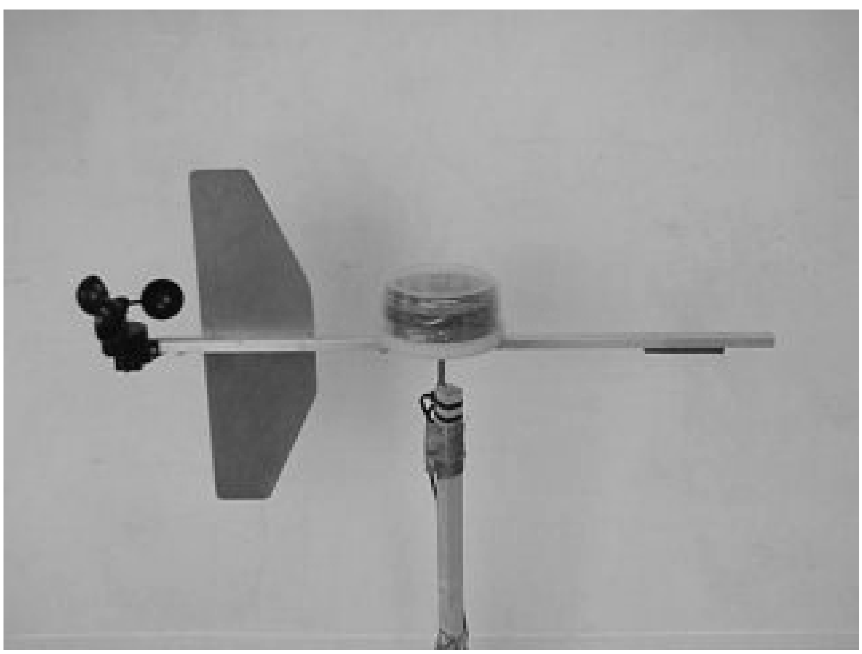
Description of Wind Logger

Bob Spagnoletti

Weymouth Speed Week is about having a good time; it is also about getting some performance data for the boats and boards to help with future developments. This project fits with the latter objective.

Project Objectives:

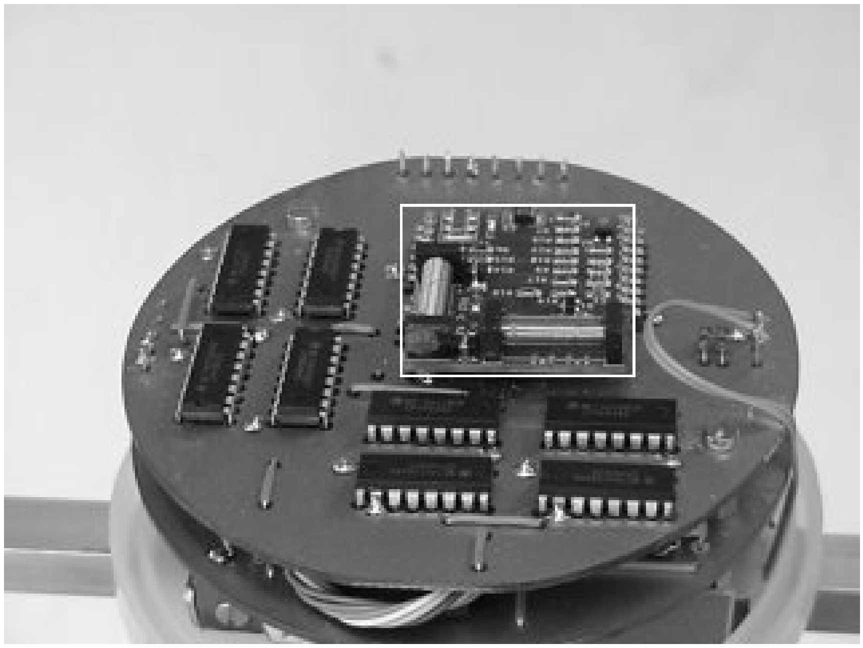
To record wind speed and direction throughout the day for later analysis in conjunction with the boat / board speeds. The Joddy timing system used at Weymouth Speed Week already provides spot windspeeds at the start and finishes of each run, however this is only averaged over a short period of time and does not give direction. Clearly we have to record the course direction to make best use of the data. Ideas for later developments came out of some very useful conversations with Peter Martin.



Hardware: The hardware consists of the sensors, cup anemometer and compass, and the data logger board. The compass and the windspeed counter are built on a separate printed circuit board, firstly to allow flexibility, and secondly to cram all the electronics and the battery into the waterproof case. The case its self is a 300ml food storage tub from Woolworths at £ 0-99.

The compass is a pre-assembled module from Precision Navigation http://www.precisionnav.com and is available in the UK through Willow Technologies. It gives the compass heading to around 2 degrees accuracy in ~ 200ms provided it is kept level. A version with a mechanical gimbals is also available but it is probably less robust and thus less suitable for my later developments.

Two 16 bit counters are also included, one for wind speed and a spare for later developments. The whole lot is interfaced to a Stamp 2 processor. The Stamp is also connected to a battery backed CMOS



The electronics with the lid removed (actually the bottom of the upside down food storage container is removed) The compass module's printed circuit board is outlined.

RAM (32k x 8), with a clock. The upshot of al this silicon wizardry is that the device can log 8 bit states of the two counters, the compass heading and the time (hh:mm:ss) 4000 times.

The Stamp 2 processor is manna from heaven to a cyber-challenged individual like myself. It is a simple processor with built in EPROM memory and an RS232 programming port that allows you to write PBASIC (a BASIC like language, ideal for manipulating bits and bytes) programs and run them as soon as the power is switched on. It is manufactured by Parallax Inc. www.parallax.com and available in the UK from Milford Instruments http://www.milinst.com

Mechanics: All the components, the anemometer, the data logger and the tail plane are mounted on an aluminium channel. This has a vertical bearing assembly in the middle so the whole assembly points into the wind.

I had intended to use an optical sensor on the cup anemometer but I did not complete it in time so I used a magnetic read switch device from Autonic. This had two problems in my application; firstly it is heavy and secondly it has a magnet in it so it must be kept away from the compass. These to problems meant that the overall device was bigger and heavier than I first envisaged. When mounted on top of a wooden pole (18 mm x 18 mm) in a strong wind it made the pole swing about violently!

Calibration: In order to calibrate the anemometer it is necessary to find a known steady wind speed. This is where the other counter is useful. I will fix the wind logger to a “bow sprit” on my bicycle and connect the spare channel to the front wheel sensor. On a windless day (or still frosty night) I can now calculate the speed with a fair degree of accuracy and check this against the anemometer. Until this is done I will rely on the manufacturer’s figure.

User Experience:

The device is straightforward to use: Simply switch it on and mount it on its pole. It will take reading every 10 second until it runs out of memory space. At the end of the day it is connected up to a PC by the RS232 port and switched on, it now offers the chance to download the results to the PC. When this has been done the memory is cleared, ready for the next set of results.

The RS232 port and on/off switch are visible on the bottom of the module, the battery is behind these.

The prototype was used for real for the first time at Weymouth Speed Week 2000. It performed reliably for the 7 days of competition. Excel let us down when it came to plotting out the results so we were not able to post wind speed results as quickly as we would have liked. The mechanical layout needs improving, it is currently too heavy and has too much inertia. These problems are being addressed.

The results show fairly dramatic changes of wind speed over a short period of time, this initially led me to think that the device was not working properly. Discussions with Joddy Chapman and a look at some data published else where suggested that this was expected. There is far more structure in the wind than I had ever expected! The changes in direction are probably exaggerated due to the mechanical problems mentioned earlier.

What is good? In a word, flexibility. The Stamp is easy to programme and the hardware will allow logging results at 0.25 sec to 5 minute time intervals. Power consumption is modest, a PP3 battery should do for 15 hours logging, it would be possible to programme it and the compass to go to sleep to save power and extend the recording time.

Dirty Linen

The Stamp software needs tidying up and additional features adding. Presently the compass takes a single reading every 10 seconds, in order to average out the swinging due to the mechanical deficiencies. It would definitely be better to take readings every 0.5 seconds or so and then average.

Further developments: During my early thinking on this project I had a number of discussions with Peter Martin, who suggested that it could also be used as a performance log for a dinghy or sailboard. Joddy Chapman has published a number of articles on this subject in AYRS *Catalyst* and elsewhere, but here was an opportunity to get some information about sailboard performance.

A basic sailing boat performance log has to record water speed, apparent wind angle and speed. My logger has a spare counter for water speed. By fixing the compass relative to the boat and using a wind vane with a magnet in it, I can measure apparent wind angle. With this data it is possible to get useful information about the craft. I have not yet resolved where to mount it on my sailboard but a bowsprit is my present favourite.

I will keep this up to date as and when I make progress.

Amended 14/02/01

AYRS John Hogg Memorial Prize – Revised Rules

The AYRS announces the second award of a Prize to be awarded in memory of John Hogg, the distinguished yachting researcher and amateur, who died on July 24th 2000.

The prize of £1000 has been donated by his family to commemorate John's life and work.

The aim of this international award is to encourage and recognise important amateur contributions to the understanding and development of sailing performance, safety and endurance. Preference will be given to current work where the prize money is likely to benefit further development. It is expected that an award will be made in a subsequent year.

Nominations, whether of oneself or another, should be submitted to The Secretary, Amateur Yacht Research Society, BCM AYRS, London WC1N 3XX, to arrive by 15th October 2002. Nominations may be made by or for anyone, whether or not a member of AYRS. Those nominating someone else must obtain the written agreement of the nominee before forwarding the entry.

Submissions must be made in English, preferably in hard copy sent by post, to arrive by the due date. It will be appreciated if submissions are made in triplicate since a copy is needed for each of the three judges. Since under some circumstances electronic transmission can lead to errors, poor reproduction and confusion, the format of all material sent by email or on disk must be agreed in advance with the AYRS Secretary.

'Amateur' in this context means work done as a pastime and largely self-funded. Details of any grants or other funding received should be given. Work carried out as part of normal employment is not eligible, but subsequent commercial exploitation of research need not debar work carried out originally as a pastime. Those with ongoing projects are as eligible to apply as those whose work is completed.

The submission should cover the following:–

• A summary, of not more than one page, identifying the nominee, and the work submitted, and including a short statement of its merits justifying its submission.

• A detailed description of the work itself, its novelty, its practicality, its degree of success to date, and (briefly) hopes for the future. The use of already published material, whether or not peer reviewed, is welcome. Diagrams, graphs and photographs may be used, and video material on VHS PAL system may be helpful. Reference to web sites in support of the nimination is not acceptable, however material from websites may be transcribed into the submission document.

• A brief biography of the the nominees should be included, and his/her amateur status and qualifications should be explained.

Nominees may care to say for what they will use the prize should they win.

AYRS will wish to publish brief summary accounts of winning entries, and also that of other entrants, and may also seek further articles from entrants about their work, using their submissions. Grant of permission to publish such articles is a condition of entry. However information received as part of a submission will be treated 'In Confidence' if so marked.

The winner and runners-up will be announced at the London Boat Show in January 2003. All short-listed entrants will receive one year's free membership of AYRS and a certificate.

The Judges, whose decision shall be final, will co-opt experts as required. Submission of an entry will be taken as signifying the entrant's acceptance of these rules.

Requests for copies of the definitive set of rules, and queries concerning possible entries may be made by phone or e-mail to the AYRS Honorary Secretary, Sheila Fishwick, on tel/fax +44 (1727) 862 268, e-mail: ayrs@fishwick.demon.co.uk.

Your Letters

Autism and Sailors

We all know the type of sailor I'm talking about, the words we normally use don't really describe him (it's almost always a him), we use the words “diffident”, “loner”, “solitary”. We even have single handed races especially for this type of sailor, although there are always a sprinkling of truly gregarious competitors in single handed races.

I'm talking about the kind of sailor who is only really happy when he is sailing. He is dependable, organised and logical. He is usually not too worried about the kind of boat that he is sailing; but, even when he is on a powerboat, you will often see a jury rig or steadying sail.

I know of what I speak, because I fit the parameters that I have just listed. It was first commented on by friends who said things like "I never saw you smile until we went sailing". I have spent a great deal of my life in around and on top of boats, especially sailboats. I have been lucky enough to have had the experience of a diverse number of boats, and there have always been rational reasons for the absolute satisfaction and enjoyment that I get from them. Whether it was that aggressive win by the thickness of the headstay fitting whilst team racing at college, or slowly drifting to within a few feet of a resting heron, or my first transatlantic landfall, or even sailing a hundred foot schooner rail-down in the Caribbean with pilot whales alongside. All of this is heady stuff, but always there seemed to be an indefinable extra to my enjoyment. The fact was that I liked any boat no matter what; and even if I thought rationally about all the reasons for my liking boats, there was always a synergistic effect.

Others seem to have the same affliction: captains of industry, who are delighted to be invited for a sail in a Bequia "two-bow" boat; Wall Street financiers, who spend their Winter weekends racing tiny, badly-designed, dinghies in freezing conditions. Maybe even you, the reader who spends a disproportionate part of your income on a sailboat. In fact the whole sailing game seems an irrational waste of money when looked at in a logical way.

Seven years ago my son, who was three at the time, was diagnosed with P.D.D. autism. After I had gotten over the shock and denial phase, I studied the problem in depth, and especially the hereditary issue. It all seemed remarkably familiar. When the occupational therapist came back from testing my son, and stated "Mr. Hughes, your son likes being in small spaces and also likes being rocked", light bulbs started to illuminate in my head. She did not seem to catch the implication of my reply, which was; "Isn't that strange, I've enjoyed living on sailboats for ten years".

Autism is described as a symptomatic disease; which is the medical profession's way of saying that they don't really know what causes it, but they can and do parcel the symptoms together. Some of the symptoms include;

An inability or unwillingness to communicate well.
Insistence on sameness, resisting change in routine
No real fear of danger
Little or no eye contact
Unresponsive to normal teaching methods
Sustained odd play
Preferring to be alone
Noticeable physical overactivity or underactivity
Tantrums
Inappropriate attachment to objects
Uneven gross and fine motor skills
Thinks in pictures
Learns by doing rather than watching

Now the preceding list pertains to almost every obsessive sailor that I know. Now, I am not making light of this situation – as the parent of a child with PDD Autism, I live the reality every day. Nor am I saying that every sailor fits somewhere on what doctors call the PDD Autism spectrum. I am, however, saying that probably I fit there, and probably so does my wife, and that Autism is an inherited condition. I know that sailing is being used as an educational tool more and more. My hope is that it can be recognised for its therapeutic value in the case of Autism.

For the time being, my son and I love to go sailing together. As a baby he would fall into a deep sleep almost as soon as we got on the boat. Now he sleeps maybe half the time. I distinctly remember the incremental improvement in his demeanor one day when we chartered a boat and sailed out to Damariscove Island in Maine. It had been a tense Summer with our business, and our son seemed to have no outlet for his frustrations, and was often close to uncontrollable. He had an after-lunch nap, and just stood in the companionway as we slowly sailed and drifted back to Christmas Cove. He was animated and interested, but totally self controlled – the perfect child – an unusual occurrence in those days.

I am now in the process of helping set up a charitable sailing school in Portland, Maine. You can find details on the Web at <http://friendsinternational.org/sailing.html>.

I spent some time this past Summer (2001), offering sailing to other Autistic children. By the very nature of this population, it is tough to measure success. The only measure that I have is that parents and caregivers were wildly enthusiastic; and that they saw their children reacting and participating in a positive manner, even though that might not be obvious to an observer who was not aware of their "normal" benchmark demeanour. I know of occupational therapy only as an observer. I know also that there is a field called recreational therapy. I feel that the foregoing fits under the aegis of recreational therapy, and that probably many members of AYRS have been self-administering recreational therapy for years.

I would urge readers to seek out autistic children and offer to take them sailing. Please listen to feedback from parents and caregivers. Let's hope that the new crewmember becomes a delighted and delightful addition, but most parents of these children would be happy with descriptions such as "a little more enthusiastic" or "more engaged than usual".

Please send your reactions to Catalyst or to

Gareth Hughes
triatic@yahoo.com

DIY Boatbuilding

Has anyone who has built DIY boats in the UK set up web pages about their projects?

I am planning a page of UK boat project web links and would love to know about any such links you may have please!

This is not a commercial venture - it's intended to be useful and fun for boat nuts in the UK.

Gavin Atkin
GAtkin@ubminternational.com

Meginhufers

A few years ago I read a long article that the Vikings got to the USA and went down the coast as far as Florida. I think the article was in TIME magazine.

The keel on my boat is similar to the meginhufers. I got the idea from old drawings. It is like a surf board on top of a rowing skiff, and on the very bottom, I have a long steel section to give lateral resistance and easy beaching. (This was a galvanised railway overhead power cable support.)

Also I put a hump in the bow part of the hull to give me lift.

My experience, after 18 years of using the boat, is:

1) At low speed there is no difference as compared to normal keel boats.I have experience on many types.

2) When you have enough wind the lateral resistance starts to increase and is very good .But this could be from my chine.

3)Once there is good wind, the hull surfs and is very stable on its course. I trim the sails and with a little bit of shock cord it keeps very steady.

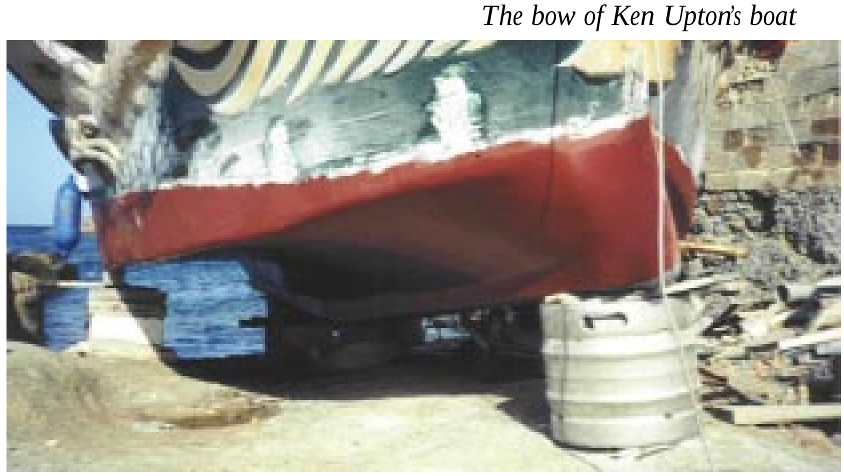
4) The added advantage is that in tidal waters it sits upright and draws very little water ....My boat weighs about 6 tons and draws 65 cms.

Having a double skin bow to make the lift off hump has other advantages, like when you drag anchor and go on the rocks.

I would recommend it to anybody thinking of building a fast boat, it's a very practical idea. But do not use a dagger board as I have in the bow. Move the rig aft and use lee boards.

all the best
Ken Upton
<cyberlifeboat@wanadoo.es>

The bow of Ken Upton's boat



Rob Fraser at speed

An Exposé of my Planing Foils

Ref: Kennebunk Weekend 1999

My hydrofoil having turned into a craft with four wave piercing planing foils; one at each corner; necessitated that I should speak about it. The planing foils have not been developed to any great degree as of yet but the fundamental fact of having a planing boat that does not smack the waves has been demonstrated. My thanks to Simon for his perspective on the planing foils relative to the base air-entrapment hulls. (I should have contributed to the wine)

Of some interest to people was the makeup of two of the planing surfaces which incoroporated the struts and lifting surface from one piece of 1/4" by 6" aluminum 4" long. The relative lengths of the sections and the angles used are arbitrary for now.

The majority of the 4' piece is first milled to a foil shape with a flat bottom. This can be accomplished by chamfering the top two corners with a carbide blade on a table saw set at about a 5 degree angle. These cut surfaces are then cleaned up and rounded using 36 grit paper on both a grinder and a belt sander. Files made for aluminum are good for a rest from the noise.

To be able to bend the aluminum where you want without it cracking and without bending equipment is worthy of note. What I do is reduce the thickness of the 1/4" thick aluminum where the bend is to be made. This can be started with a file but if a sharp notch is left the aluminum will crack when bent. I use the side corner of a belt sander to make a rounded depression. To make the bend secure the aluminum just below the depression and pull the other end by hand; with the depression on the inside of the bend. Once a 45 degree bend has been made the aluminum at the 45 degree bend can be further reduced in thickness by using the belt sander on the outside of the bend. The piece can then be further bent by hand to form an acute angle.

The bend one inch back from the end is made first by laying the 4' piece on a board sitting on a concrete floor with the one inch sticking out over the end; kneel on the aluminum and beat the end with a sledge hammer. This is after having notched the inside of the bend.

Happy planing,
Rob Fraser
rfraser@accesscable.net

Catalyst *owes Robert an apology over this letter. It was sent in 1999, but lost in the files, and has only now been found.*

Sails in no wind

Dear Editor,

(Enjoying Catalyst No. 5. Keep up the good work!) While researching something, I was browsing through some old A.Y.R.S. newsletters and ran across the 18 January 1986 issue which might be of interest to our members.

If anyone is familiar with whirligigs, they might have run across a whirligig which consists of four, say catboats, mounted on horizontal rods about one foot long with mainsheet arranged so that the boats rotate about a vertical central axis in a breeze. Other whirligigs are woodchopppers with bellcranks to chop wood, etc, farmer milking a cow, etc.

Anyway, in the newsletter one Giusseppe Gigliobianco, with a model, connected the rotating boats masts (I assume) to "small blades in the water" so that the model could sail directly into the wind. This is perfectly believable.

Here is the point of all of this: Consider doing away with the blades in the water and power the four rotating sails through the Voith-Schneider linkage system. Thus, with power, the boat could move without any breeze. If there is a breeze, then of course the sails could be oriented to power the boat a la wingsail.

I wonder how this arrangement would compare with a rotor ship which cannot move when there is no wind. I did no text research to see if this has been mentioned somewhere else in AYRS pubs. Here is another point. There is lots of neat information in the old AYRS newlstters. Don't discard them. Ideas beget ideas.

sincerely,
F. Bailey

Hydrofoil Control

During the speed week symposium, the subject of hydrofoils flying at the best depth below the water was dicussed. Apparently people have tried various mechanical linkages to sense the wave surface and have these alter the depth of the foils. However the delegate *[Emile Lautier]* felt they were not quick/ reliable enough, and their presence created extra drag. His prefered solution was to use a computer to control the depth via a servo within the vertical shaft.

This sparked off a debate about another method – drawing in air down the vertical shaft to induce cavitation above the winged surfaces. Theoretically, this would cause the hydrofoil to go lower in the water, until the vent hole in the vertical shaft submerged. However, according to Graham Ward, in practice it is not sensitive enough.

Rather than trying any of these methods, I have thought of another way. Whilst it is a mechanical approach, it would be contained within the vertical shaft and so cause no extra drag. It relies on the principle that water always finds its own level, and employs simple technology that has already been used with rudders to make them self-steer. Essentially, it is to have enclosed within the vertical shaft a free floating device to actuate a trim tab on the trailing edge of the hydrofoil. For this to work sea water must be permitted inside the vertical shaft. The way I imagine it working is:

- A wave crest passes the vertical shaft; free floating device rises which actuates the trim tab which inclines the foil: hydo-foil climbs towards the best height.
- A wave trough pases the vertical shaft; free floating device decends which actuates the trim tab which negatively inclines the foil: hydro-foil descends towards the best height.
- When the hydrofoil is at the best height, the free floating device keeps the trim tab in a neutral position.

I offer it as a suggestion for others to try. Maybe no one has thought of this yet? I would be grateful if you would pass it on.

Thanks,
Mark R. Tingley

Computer Rowing Model *(ref Catalyst No 2)*

I finally have my webpage up: <http://www.atkinsopht.com>

William C. (Bill) Atkinson
343 South Avenue, Weston, MA 02493-1948, USA
watkinson@compuserve.com

Another view comes from Leo Lazauskas at the University of Adelaide, who has investigated the effect of dynamic sinkage and trim on rowing shells and kayaks. There is a draft paper on the University site that might be of interest.

"*The effect of fore-aft asymmetry on the squat and resistance of kayaks*" is on the Web at <http://www.maths.adelaide.edu.au/Applied/llazausk/hydro/kayak/kaysquat1/kaysquat1.htm>

Although the (draft) paper deals with kayaks, there are similar trends for rowing shells. For rowing shells there is of course the added complication of the rower moving in the shell which can amplify the sinkage and trim at some stages of the rowing cycle; at others it can attenuate the dynamic movement.

Solar Boat Race, 2002

It is with regret that I am writing to notify you of the cancellation of the Solar & Advanced-Technology Boat Race for 2002. This great event has been one of the highlights of the Australian Science Festival for the last six years but sadly we have had to make the decision not to run this event in 2002, due to lack of adequate sponsorship for the event.

Unfortunately, the move of the Australian Science Festival and National Science Week to August has meant that the race cannot be run during the festival in 2002 as the weather in August is not suitable. We have explored many avenues for funding through government organisations and corporate sponsors over the last six months to run the race as a stand-alone event in April/May or as part of the Canberra Festival (which is held in March each year). Sadly, we have been unable to raise adequate sponsorship for the event.

We will certainly consider running the race again in 2003 if enough funding can be found. However, for 2002, we have no option but to cancel the event. The decision to notify race entrants and stakeholders of the 2002 race cancellation was made as soon as it was realised that sponsorship would not be forthcoming. We apologise for any inconvenience, but hope you understand that the cancellation has occurred due to events beyond our control.

Rob Simpson Project Manager
ASF Limited PO Box 193, Civic Square ACT 2608
Email: boatrace@sciencefestival.com.au
URL: www.sciencefestival.com.au

AYRS boat storage compound at Weymouth?

Many AYRS members like me are interested in making boats sail faster, and in UK we are now very fortunate to have two excellent annual events where speeds can be measured, Winds Of Change and Speed Week. However my enjoyment of these events is reduced by the way they show so brutally that windsurfers using standard sails and boards are much faster than any of our experimental boats.

This is not true at world record level, where as illustrated by Richard Boehmer's diagram on p24 of Catalyst No.6, craft like Yellow Pages and Longshot have achieved speeds in the 40-50 knot range which challenge the world's best sailboarders. But the 2001 Speed Week results summarised on p 4 of that issue confirm this complete domination of UK speed sailing by windsurfers, with numerous runs in the 30-35 knot range while no boat reached 20 knots.

Since Crossbow's retirement 20 years ago I think there has been literally only one timed boat run above 30 knots in UK, John Lindley's standard (American-built!) Hobie Trifoiler in 1998.

I feel a major reason for this sorry state of affairs is that the logistics of developing a fast sailing boat in UK are so difficult, and that a big factor here is our lack of a permanent site where experimental craft and their support boats can be kept safely ashore near a stretch of water suitable for fast sailing, and where AYRS members without boats can visit to help with testing.

I have discussed this problem with Bob Downhill, who thinks it could possibly be solved by arranging for AYRS to have a reserved compound on Phil and Sandra Gollops' Weymouth and Portland Sailing Academy site (WPSA), where the last two Speed Weeks have been held. This would offer permanent outdoor storage for experimental craft (rigged) and support boats, with launching into Portland Harbour from a nearby slipway.

Indoor storage for sails and gear could probably also be made available, and of course Weymouth and Portland are very well supplied with overnight accommodation which now includes the excellent Youth Hostel described by Mark Tingley on p 27 of Catalyst No.6.

Before discussing the details and financial arrangements of this proposal with the Gollops we need to know

(a) how many boat-owning AYRS members might be interested in keeping their craft at WPSA, and what charges they would consider reasonable,

(b) whether non-owners would be prepared to visit Weymouth to help with sailing trials, e.g. launching and recovery, providing and driving support boats, crewing, on the assumption that an efficient internet or telephone system is set up to announce activities at the site and match owners with helpers.

Please contact Bob Downhill (tel: 01323 644 879, email robert@speedweek.demon.co.uk), Slade Penoyre (tel: 01276 472 208, slade@penoyre.freeserve.co.uk) or Catalyst@fishwick.demon.co.uk with your views.

Slade Penoyre

New Wingsail

In September 2001 Dynawing launched a range of double surfaced, soft wing sails for the windsurf market. These sails are claimed to point higher, produce more power and produce less heeling than any other windsurf product on the market today.

The Dynawing product line-up starts with a 4.5m (48square foot) sail designed for the beginner board rider and used in windsurf schools to reduce the number of sails required per student. This sail is very easy to uphaul, planes early and sails directly into the wind [*it says here - Ed*].

The 6m, 7m and 8m wings are designed for the more advanced riders who can handle this size of rig. Recreational riders enjoy the Dynawings as they can ghost along on the plane long after the others have fallen off as the puffs die away. Dynawings are a great deal smoother to use than a traditional sail as the torquing force is greatly reduced. This same reduced heeling force generated by the wing when compared to a traditional sail, means it is not so tiring to rideall day long. Dynawings enable the board to point higher going upwind, so it is a lot easier to go where you want to go.

The 9m custom produced sail, is a big rig and designed for the strong, out-and-out performance enthusiast. Experienced riders love the Dynawing's increase in performance over traditional sails and the ability to use a smaller fin to greatly improves top end speed.

Contact: Peter Bell -
Dynawing, Inc. 4601 Langland Rd - Suite 106, Dallas, Texas 75244 USA.
Email:Peter.Bell@dynawing.com
http://www.dynawing.com

SWIFGIG

Roger Collins <bluejacket@cytanet.com.cy>

Long term offshore cruising imposes special requirements for yacht tenders. .

A yacht tender may have to become a lifeboat that can be sailed to a port of choice, and heave-to when the weather dictates. For instance, on entering Indonesian Waters, the BA Pilot tells you that ‘There are no rescue services in Indonesian Waters”. Going round in circles in a liferaft with no chance of rescue is not sensible.

If you want to avoid annual services, you need a hard tender that doubles as a lifeboat. Liferaft services do exist in Asia and Africa, but after seeing one liferaft canister open up full of Taiwanese telephone directories and no liferaft, and observed ‘experts’ mixing critical two part liferaft adhesives by guesswork, it seems smarter to eliminate liferaft service altogether.

These are some important yacht Tender imperatives:

· A sailing rig that can be rigged and un-rigged at sea inside four minutes.
· A fast boat that can be sailed with or without a cover erected.
· Able to heave to in bad conditions with sail and spars stowed.
· On capsize, not to remain inverted.
· Positive buoyancy, especially near the gunwales so when awash it floats upright.
· A fast balanced boat that can be motored, sailed, rowed or sculled.
· Lightweight hull weighing under 45kgs (99lbs) and strong.
· Stowage for water and food for 4 people for five days.
· Can be stowed in 2.3m (7’8”) on the mothership.
· Hull-form that can handle moderate waves.
· Enough space for a crewman to be able to stretch full length off watch.
· Dry enough to keep stores in perfect condition after shopping trips.
· Can be launched off the mothership inside 30 seconds.

To achieve these aims practical research with many trials has been undertaken. It was discovered that a small boat with adequate freeboard LOA of about 3.2m (10'3") could handle quite rough water and still remain near the target weight of 45 kg (99lbs).

A shorter boat did not handle conditions so well; a longer boat ran into weight and stowage problems.

Inflatable boats do not like sunlight and coral; it is difficult to get them to sail fast too. Against that, inflatable boats are cheaper to build.

Requirements pointed towards a hard dinghy in modern composites including waterproof resin and an aramid outer skin that will resist abrasion and penetration. This is a more expensive option, but the correct solution.

Polyurethane injection molding was considered, but rejected on the grounds of excessive weight and appearance.

A 3.2m joining boat was settled on, leading to many trials as to joining methods and materials.

Stainless Steel Joiners, even 5mm plate, bent. AB1 (Aluminium bronze) was strong enough, but was heavy, and became a damage nuisance to the mothership.

Acetyl joiners were settled on. Sheer tests on joining components averaged at 1768kgs before sheer on three test components. Acetyl is unaffected in water. Stainless Steel is unreliable immersed and when deprived of oxygen in conventional fixings can cause unexpected sheer. For example, the writer recently had six out of eight halyard winch studs sheer during a passage in heavy air in the Gulf of Aden.

Swifgig - The Boat

Length LOA 3.2m (10' 3"); waterline LWL 3m (9' 8"). Construction is honeycomb cored multiaxial e-glass, with an outer layer of aramid fibre for abrasion, and impact resistance. Vynelester resin is used exclusively. Design parameters were to be four times stronger than a 3mm-ply laminate. The hull shape will plane in the right conditions. Drag is only 5kg with two up under outboard at 4kts.

Flotation

There is 444kgs (980lbs) of positive flotation. It was found that four separate air chambers were effective and the lightest option. There is backup closed cell foam flotation in each chamber. There are four Holt waterproof hatches for stowage access. Swifgig floats the right way up if awash; and if not overloaded, will automatically empty out until you have enough freeboard to complete the job yourself. The self-bailer will get the last remnant of water out when you are off sailing again.

Joined Boat.

For those yachts that cannot take a full length Swifgig, the joining version stows in 2.3m (7'8") – less stowed length and weight than the best selling 3.1 inflatable RIB.

Dodger.

More than fifteen years in the tropics tells us that orange liferaft covers are counterproductive to the occupants. The sun heats up the interior space so much, thirst becomes a real issue, so fresh water consumption goes up. Swifgig's cover is white. Over the crown of the dodger is aluminium foil material that reflects heat, and cold. There may be some radar reflective element in this too. On the joins are large borders of Red reflective tape that can be seen at night from air or sea if light is applied. During the day, the large red squares can be seen from air and sea.

The result of this arrangement is a cooler working and resting environment.

The cover is held by boltropes in Aluminium tracks to keep as much water out of Swifgig as possible. There are heavy zipped escape hatches fore and aft.

In a recent Tasman rescue a (well-known make in service) Liferaft dodger was swept away by large waves. The occupants suffer massive heat loss – in one case a survivor spent six days in hospital suffering from hypothermia after just six hours exposure.

Swifgig's dodger is very low profile, mounted on unbreakable flexible polycarbonate battens to take wave action in heavy air. The dodger is depressed into the hull form and erected by lifting with fingertip pressure. There are no structural airbags that need to inflate in an emergency. There are two airbags on top of the dodger than can be inflated fully after launch. These provide further anti-capsize measures and provide further insulation and stiffness. The boat can heave-to with a small float at the masthead to assure self-righting.

The mast is small enough to stow inside the boat in one piece.

The boat can be sailed *with the dodger erected.* This is important for survival, exposure even after a few hours in an open boat can be extremely debilitating.

Sailing

The Rig

Imagine a squall coming with thirty knots in it, and you in a dinghy. It can be a frightening experience, especially being led by a 3-metre wall of spray. At sea, you need to able to get the sail off the boat and under the cover inside four minutes and a drogue out to hold the boat head or beam to wind.

Swifgig's Mast is short, unstayed, in one piece and less than 2m length. Construction from a matrix of carbon fibre and glass provides a very stiff spar. The Mast to deck joint is a double start thread and with three turns the mast is seated in a slot in the foredeck. The head of the mast is a machined Acetyl insert that takes a quick release hook to which the halyard block is attached. The halyard hoist starts round a Holt block/jammer at the foot of the mast just above the deckline. Extremely simple to rig and unrig at sea. The mast and sail can easily be taken off, or just the sail.

Swifgig sail spars are of varying widths in glass and run the full length of each luff edge of the sail. Many trials were necessary before the final arrangement was settled.

Each sail spar demounts into two sections. When the sail is taken down at sea, the spars are simply drawn apart; the sail folded lengthwise down the boat and stowed in the sail bag complete with spars, and stowed inside the dodger.

Swifsail.

The sail is completely different in the way it drives the boat. Sail shape is very specific, and the result of many trial sails and different rigs.

Reading the sail is hard at first because habit makes us treat the sail like a conventional foil. The intention is to form two strong vortex flows on the leeward edges of the sail. This is quite different from a normal airfoil effect. Swifsail acts like a Concorde wing. Very low heeling force is evident. Weather helm needs to be controlled, so you must be attentive not to impede flow by creating excess hull turbulence.

The sail is of varying aspect ratio. By easing halyard tension, the sail lower luff is gradually moved nearer to the surface of the water as you sail further off the wind and the heading angle increases. This is the fast way to sail the boat.

Swifgig daggerboard is a strong cored e-glass NACA foil with low wetted surface. It's fast and gives good lift.

The sail is de-powered by bringing the luffs toward each other, thus breaking down the vortex flows.

Steering

The boat is steered with an oar. This works well, and creates less drag than a rudder when you are sailing Swifgig correctly, so is faster. Australian and New Zealand surfboats use this method of steering, it is practical and the oar is easy to ship on reaching the beach.

Specifications:

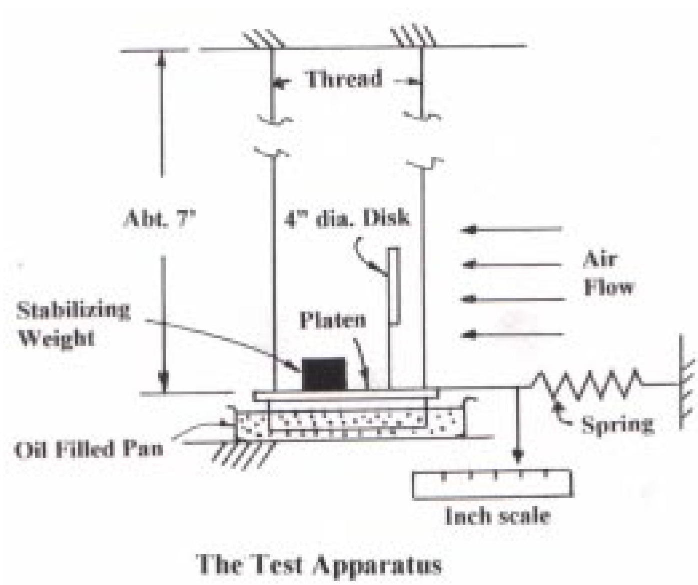
LOA	3.11m (10ft 2.5”)	Draft	8cm (3”)
BOA	1.25m (4ft 1.5”)	Draft (Centreboard down)	0.7m (2ft 3”)
LWL	3.05m (10ft 0”)	Hull weight	44kgs (97lbs)
		Sail Area	4.48m² (51ft²)

Precision of Results For A Small Wind Tunnel

And A Failed Downwind Experiment

Frank Bailey

In A.Y.R.S. Journal No. 125 was described a small wind tunnel with an exit opening of about one foot square. This article attempts to ascertain how any results one could obtain with this small size tunnel might be compared to those obtained by an establishment with a very large tunnel. Actually, this exercise was done in order to see if there is some unusual downwind sail configuration which might have a benefit over what is now normally used. Unfortunately, both results were disappointing but the thought processes may have some merit.



The Test Apparatus

The apparatus is shown in the sketch. The beauty of this arrangement is that there is no friction involved in taking any readings. A commercial hand held windspeed meter was used to measure airflow velocity. The critical item in the arrangement is the small spring. The spring constant, lbs. per inch of stretch, was arrived at using gram weights up to 15 grams and about 1.6" stretch. From the graph of extension versus grams you will see that it is not a linear arrangement but if you put some initial stretch in the spring, we are working in the linear area. The hanging platen has transverse and longitudinal fins on the bottom to act as dampers when they are immersed in a tray of oil. The whole apparatus, other than the windspeed meter cost practically nothing and was mostly assembled using masking tape and scrap material.

The well know drag formula for immersed bodies was used to calculate the coefficient of drag if you know the force on the body and of course the other constants and variables in the formula. I point out here the formula uses velocity squared over 2 so that we do not misunderstand that the 2 is in the drag coefficient somewhere.

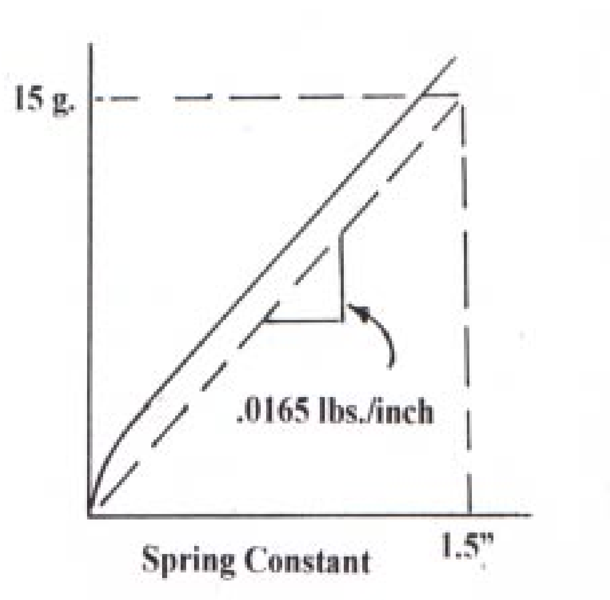
The results are shown in the table overleaf. The experiment was done for three windspeeds simply because my fan had three available speeds. As you can see, the experimental drag coefficients developed here are not in particularly good agreement with standard handbook values except perhaps in the case of the spheres. In general, they seem to be low. I don't think any of my readings could be off by more than 10% and maybe much less so there is something inherently unknown here. I speculate the problem might be with the surface roughnesses and the limited outlet area of the tunnel. However, it appears all the calculated coefficients are about the same order of magnitude which at least might tell you my arithmetic is correct (maybe) and the methodology is fairly sound.

Drag Coefficients	Air Speed Feet/sec. 4.55	10.12	12.30
Flat Plate 3.7"x 5.7"	.83	.50	.52
Book Value	?	?	?
Reynolds Number	N.A.	N.A.	N.A.
Flat Plate 5"x7"	.83	.54	.54
Book Value	?	?	?
Reynolds Number	N.A.	N.A.	N.A.
Ping Pong Ball 1.48" dia.	1.01	.31	.44
Book Value	.40	.40	.40
Reynolds Number	3530	7860	9630
Plastic Ball 2 ½" dia.	.64	.32	.32
Book Value	.40	.40	.40
Reynolds Number	5990	13310	16300
Long Cylinder ¾" dia.	1.14	.60	.63
Book Value per foot	.90	.90	.90
Reynolds Number	1800	4000	4890
Long Cylinder 1" dia.	1.04	.53	.54
Book Value per foot	.90	.90	.90
Reynolds Number	2390	5320	6520
Flat Disc 4" dia.	1.29	.68	.66
Book Value	1.00	1.00	1.00
Reynolds Number	9570	21280	26060

You might also conclude from these results that the wind tunnel could be used to find order of magnitude differences. A lot more tests could be run to pin down more unknowns but why bother.

Now for the failed experiment.

We are interested in two phenomena described in your standard hydraulics textbooks. I will describe each one. First, envision two older ladies in crinolines seated on a shaded porch in Charleston South Carolina in summer fanning themselves in the intense heat of that town. Their fan moves the air and their hand encounters a resistance. Or, the other way around, move the air against the fan, and the fan feels a force on it. Secondly, consider a turbine. Some fluid emerging from a jet of a certain area with a certain velocity impinges on a curved blade of another area that may also be moving away from the jet thus causing a force to push the blade. Now wouldn't it be advantageous in downwind sailing if the two forces noted here could be generated at the same time and could be additive? That is, could we figure out some sail arrangement that might cause these two forces to complement each other? It could be two spinnakers, one port and one starboard plus a couple of staysails. This is why the previous determinations of drag coefficients were attempted. (On the other hand, we could merely stay with the forces generated and dispense with most of the tedious calculations.) To test this hypothesis, an idealized sail rig was constructed on a 5" by 7" flat plate as shown in the sketch. It was constructed with a certain drag area, 5" x 7", on one side and on the other side with vanes added to approximate a jet on a vane arrangement. It was put in the tunnel air stream both forward and backward. To make a long story short, there was no appreciable difference in the drag force or the coefficient of drag either forward or backwards. This tells you that drag forces and changes of momentum forces do not add, which you might have guessed at the start considering relative speeds, etc. Basically, in downwind sailing, you should hang out all your sails that you can but of course we knew that already.



Spring Constant

Grams/pounds versus inch extension

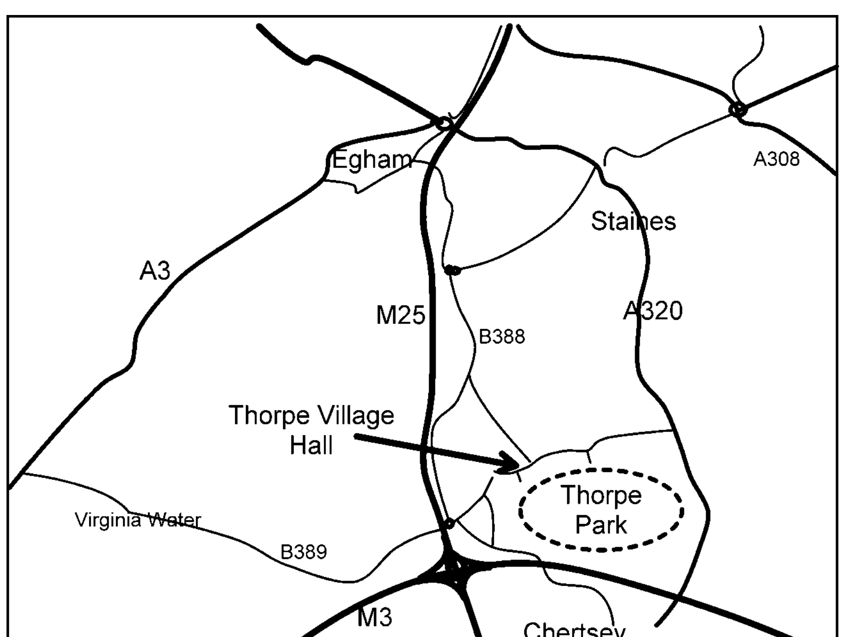
All is not lost however because please consider this. In the April 2001 issue of "Discover" magazine, page 21 and 22, there is an article describing a new book by David Anderson and Scott Eberhardt titled "Understanding Flight", McGraw-Hill, 2001. Mr. Tom Blevins also tipped me off to a condensed version of this book when he made available to me an article by these two individuals titled "A Physical Description of Flight". They have a new outlook on lift and drag. So why cannot we have a new outlook on downwind sailing? Is just plain drag the only answer? Of course there has been I suppose somewhere experiments on downwind sail shapes, Marchaj, etc. But have they been made in the light of the Anderson and Eberhardt material? Is this an area for fruitful further research or to add an apt phrase, is this just another straw in the wind?

A Boat Building Day

A day of discussion on boat-building theory and poractice will be held in the Thorpe Village Hall (between Staines and Chertsey, Surrey, UK) on Sunday 17th February 2002 from 9.30am to 5pm. (Follow the signs towards Thorpe Park then enter the village.)

Bring your project along, or if you cannot bring it, bring some pictures (OHP or 35mm slides for preference) and be prepared to talk about it!

Details from Fred Ball, tel: +44 1344 843690; email fcb@globalnet.co.uk



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@fishwick.demon.co.uk

January 2002

3rd - 13th London International Boat Show
Earls Court Exhibition Hall. Those who can give a day or two, from 16th December onwards, to help build/staff the AYRS stand (reward - free entry!) should contact Sheila Fishwick tel: +44 (1727) 862 268; email: ayrs@fishwick.demon.co.uk

12th AYRS Annual General Meeting
19.30 for 20.00hrs at the London Corinthian Sailing Club, Upper Mall, London W6. Contact: AYRS Secretary, BCM AYRS, London WC1N 3XX; tel: +44 (1727) 862 268; email: ayrs@fishwick.demon.co.uk

February

5th AYRS London meeting
Downwind faster than the wind. 19.30 for 20.00hrs at the London Corinthian Sailing Club, Upper Mall, London W6. Contact: AYRS Secretary, BCM AYRS, London WC1N 3XX, UK; tel: +44 (1727) 862 268; email: ayrs@fishwick.demon.co.uk

17th Boat Building Day
9.30am - 5pm, Thorpe Village Hall, Coldharbour Lane, Thorpe, Surrey (off A320 between Staines and Chertsey – follow signs to Thorpe Park, then to the village). Bring your project along, or if you cannot bring it, bring some pictures (OHP or 35mm slides) and be prepared to talk about it! Details from Fred Ball, tel: +44 1344 843690; email fcb@globalnet.co.uk

March

5th AYRS London meeting
Patents. 19.30 for 20.00hrs at the London Corinthian Sailing Club, Upper Mall, London W6. Contact: AYRS Secretary, BCM AYRS, London WC1N 3XX, UK; tel: +44 (1727) 862 268; email: ayrs@fishwick.demon.co.uk

April

2nd AYRS London meeting
Hydrofoils. 19.30 for 20.00hrs at the London Corinthian Sailing Club, Upper Mall, London W6. Contact: AYRS Secretary, BCM AYRS, London WC1N 3XX, UK; tel: +44 (1727) 862 268; email: ayrs@fishwick.demon.co.uk

28th Beaulieu Boat Jumble
National Motor Museum, Beaulieu Abbey, Hampshire, UK email: events@beaulieu.co.uk

September

28th (to 4th October)
Weymouth Speed Week
Portland Harbour, UK. For entry details etc contact: Nick Povey tel:+44 (1342) 825292; email: nick@speedsailing.com

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

On the Horizon . . .

Electric Propulsion Design — Theo Schmidt
Proa Foil Sections — Tom Speer
The Maximum Speed of Yachts — Bob Dill
Alerion Electric Auxiliary Conversion — Charles Houghton
KCat70 —a High Performance Motor Sailer — G Coombs
More *Sunshine* — Chris Evans
More sources and resources: reviews, publications and Internet sites

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