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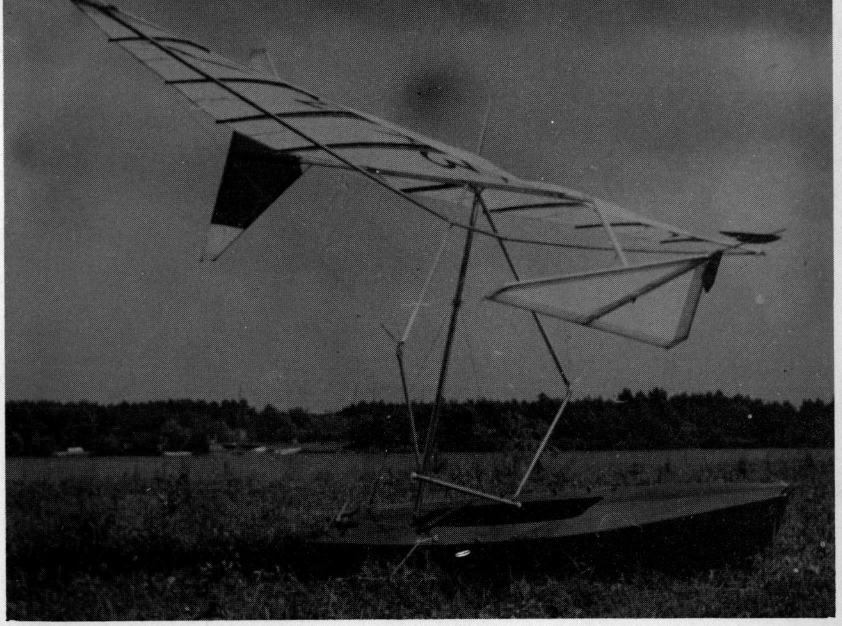
MARCH, 1976

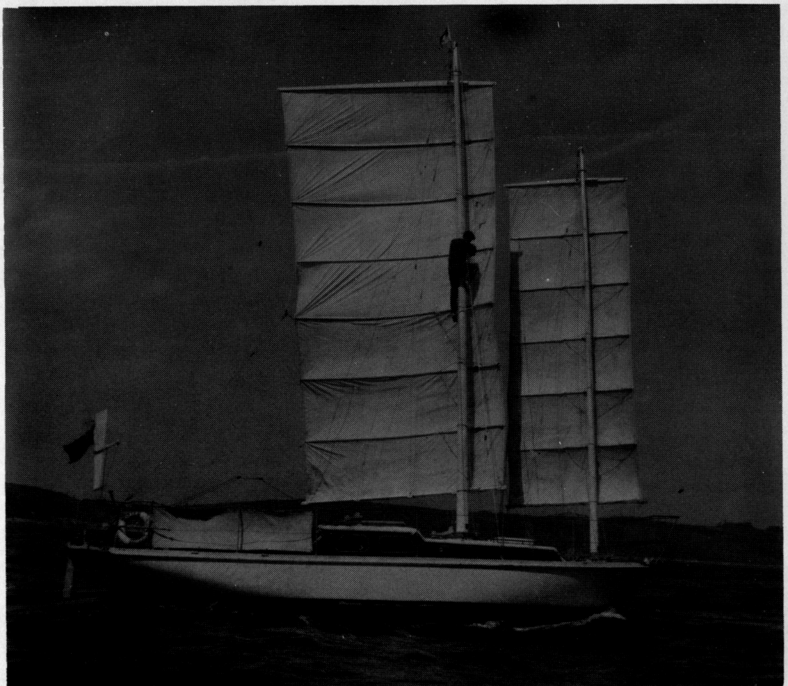
SAIL RIGS, 1976

AQUARIUS V, the United States Challenger for the "Little America's Cup." An International "C" Class Catamaran with Alex Kozloff, owner, on the wire and Robbie Harvey on the tiller.



WOLF AEROHYDROSAIL

Photo shows Dr. J. Wolf's stretched membrane sail wing built in Poland. It has handling problems! One feels it would be much better on a Catamaran platform. An earlier version is shown in AYRS Airs No. 2. The rig shown here is basically for a hang- glider.



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FOREWORD

This publication contains a selection of some of the recent thoughts and work of our members on the subject of sail rigs. Looking backwards, we all know that a huge variety of ideas have been dreamed up for harnessing the wind to drive a boat. Some of these have been quite impractical, others have possibilities and many, of course, are practical sailing systems.

Some ideas fail because they are "drawing board" systems in which perhaps no account is taken of rigging problems, the power of the wind, instability, the very existence of waves and so on. This is no place to cast aspersions or run the risk of libel, but most readers will surely be able to bring examples to mind !

Others fail because the inventor is too impressed by the beautiful performance of his models, does not appreciate the structural problems engineered by scaling up and finds that at full scale his pet is hopelessly heavy, structurally feeble, very slow or all three.

Apart from boats with recognizable sails, there are way-out schemes such as windmills or rotors, geared to a water screw; use of the rocking motion of the hull to provide propulsion effort and even kites to draw a boat along. The thought of the knitting which would ensue from kite-boats racing round a triangular course boggles the mind!

Everyone would like his sail rig to embody the extremes of the virtues of (a) lightness, (b) strength, (c) simplicity, (d) ease of handling, (e) durability, (f) driving efficiency. No one could reasonably expect to get all that and compromises are inevitable. If asked to give no more than two or three preferences, the ocean racing man would probably say (b) and (f), the pleasure cruising man (c), (d) and (e), the round-the-buoys racer (a), (d) and (f), (though his class rules usually make the decision for him), the round-the-world single hander (b), (d) and (e), the day-sailing potterer might plump for (c) and (d), while the speed record fanatic can do without all except (a) and (f). So everyone has a different list of priorities and on the above reckoning, (d) gets the most votes, four, from the six different classes of sailors.

Among the more successful rigs are, gaff rigs; spritsail rigs; various forms of squaresail; luggers, lateens; cutter, sloop and una-rigged bermudian craft; junk rigs; the pyramid rig; thick or thin wingsails with or without flap or camber control— all these can be made to sail well, all with their own virtues and snags. All have been the subject of serious consideration in previous AYRS. publications and a perusal of these is a recommended pastime.

Two things strike one, however. Firstly, nothing really new seems to have appeared in recent years, suggesting that every possibility has been explored; secondly, although each sail arrangement has its enthusiastic supporters, there is not one whit of hard evidence that any one of the popular systems is unequivocally superior in driving efficiency to the other. Only opinions and a few deductions involving many uncontrolled variables. We don't even know for certain that the famous "slot effect" from an overlapping jib is actually beneficial. This state of affairs certainly does us no credit.

The writer feels that systematic research into the relative efficiency of rigs is a task that the AYRS could undertake as has been suggested in the past quite frequently, to no effect. It may well be that there is little to choose in the way of efficiency between several types of rig, but a knowledge of which are the best and how they rank ought to be of prime interest and importance, even though an arrangement that suits a dinghy is unlikely if scaled up to suit a 50-ton cruiser! If we could show which rigs ranked highest in driving efficiency, effort could next be made to build into them the desirable qualities (a) to (f) listed above. (Hull research is quite another subject of course).

How could such an objective be achieved?

Four possible approaches are:—

(1) At full scale, one could have two identical hulls (dinghies or cats), fit them with the different rigs of some standard sail area and carry out boat vs boat tests. This would be expensive and time-consuming and it is difficult to imagine who could carry out such a huge task. It has been done to a very limited degree in a few one-design classes, as described in AYRS No. 33 page 50 for example.

(2) Use models in a wind tunnel. Again a large task involving many measurements with quite elaborate apparatus and where is the tunnel with qualified people to do all the work free? (Not a bad subject for a PhD. in aerodynamics though!). It is quite possible that such measurements have already been done with a range of many rigs. If so, we'd like to know. Wind tunnel sail work is referred to in e.g. AYRS Nos. 12, 26 and 40 highlighting the rather daunting complexities.

(3) Use two identical hulls (e.g. g.r.p. from the same mould), radio-controlled and carrying standard sail area rigs for boat v boat trials. This has been done to a limited extent by Col. Bowden and Clay Philbrick (this publication) used the method to test various rigs for his TEHINI catamaran. He found that his model results were valid at full scale. Essential for such work is suitable water readily to hand, a radio control enthusiast, a generous supply of well made model rigs of identical area (1 sq. metre?), a team of volunteers to make them, and plenty of good weather and patience. A large, complex task with plenty of difficulties but very interesting.

(4) What seems to be the simplest scheme is suggested in this publication by Joe Norwood. Basically in this, two rigs under comparison are mounted along a pivoted horizontal arm in the natural wind and their lift and drag components compared. The only measuring equipment needed is a ruler and if such a system can be set up somewhere and made to work properly, with plenty of test rigs to hand, it should be possible to rank them in order of efficiency on several headings in a very few days. The site would have to be remote from upwind buildings and trees to avoid unmanageable turbulence.

Comments, criticisms, suggestions, references to previous work on these lines and volunteers will all be very welcome!

Footnote: A few days after writing the comment above that 'nothing really new seems to have appeared in recent years,' BBC TV's Tomorrow's World (20/11/75) showed one Sgr. Corbellini's brainchild sailing in the Adriatic. From a distance, it appeared to be a conventional sloop with the sails permanently hauled in hard amidships, but it was spinning round and round continuously in tight circles! Close-ups showed that the sails were like a venetian blind with the slats vertical. The slats were of sailcloth apparently no more than 2 feet wide, fully battened, no overlap, and each on its own individually pivoted miniature boom attached to the main and jib 'booms.' The inventor apparently claims that his system puts to good use the normally "wasted" air on the weather side of the sail. Certainly its performance seemed to be good when sailing a steady course.

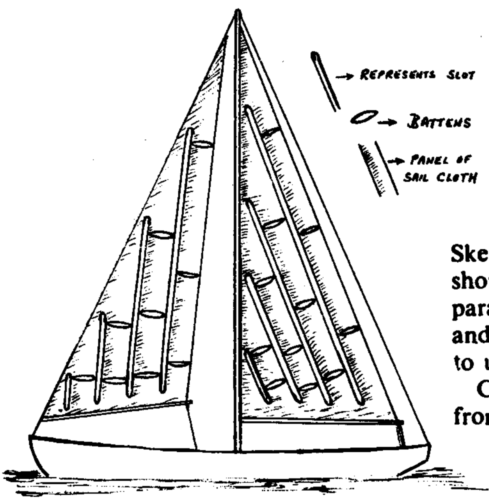
From: Ernest D. O'Mahony, Cambrae,
King Edward Road, Bray,
Co. Wicklow, Eire.

Dear Michael,

How about that crazy shredded sail? Did you see it? In the T.V. programme 'Tomorrow's World?' The brainchild of an Italian sailor. When I saw his small yacht pirouetting like a ballet dancer I thought it was trick photography. But no, it was actually happening. With sheets on mainsail and boomed jib only giving about 2 ft. of movement on either side of the centre line fore and aft the tiller could be put hard over and the boat simply sailed in circles.

Apparently his theory was that the driving force in the wind produced its maximum effort on the first foot or two of any sail and after this the energy was dissipated in a series of vortices. The result being that the driving force for a given sail area and gievn wind speed was being wasted. He reasoned that if the wind could be split before the vortices occurred, more energy would be spent in moving the yacht. After much experimentation he came up with the 'slotted sail' for want of a better phrase. Obviously, in the few minutes allotted to this item in the T. V. programme there was insufficient time to take in all the details but to the best of my recollection, it looked like the enclosed rough sketch. Could you look further into the 'ifs' and 'buts' of this idea and write to me on the subject. Perhaps the 'Tomorrow's World' team may be able to help.

sincerely, Ernest.



Sketch of slotted sail from Italy, shown on B.B.C. T.V. Slots run parallel to leech. Number, direction and position of battons is not known to us.

Claims more driving force and speed from sail area.

The "Little Americas" Cup, 1976

This will be held during February in Port Philip Bay, Melbourne.

Our front cover photograph shows the new challenger from the USA, AQUARIUS V. She won the selection Trials from no less than 7 C-Class yachts at Roton Point.

The field included advanced wing-sailers, PATIENT LADY II and III, COYOTE and the remarkable SPLICE. It is of great interest therefore that AQUARIUS V with her ultra-light-weight high aspect ratio, fully battened, soft boomless rig, should win and gives added interest to the result of her contest with the "solid" wing-sailed MISS NYLEX.

The **sail** of AQUARIUS V was made by Robert Harvey of Pacific Sailmakers. It was brand new just like the rest of the boat. It is made of 7¼ oz. "Texlon" "Dacron" cloth by Watts Sailcloth. Another Harvey brother is in the firm. He is Bruce Harvey, the world champion Tornado sailor of the Bruce Stewart / Bruce Harvey team. It will be hard to top them for high performance sailmaking credentials.

The **mast** is a 38 foot Sparcraft section 107 that has been chemically milled down to a weight of about 60 pounds.

The **rigging** wire is Kevlar, Dacron coated, made up by Yale Braided Products. Early problems with the terminations have been solved and the complete set of rigging wire is now only a few pounds.

The **hulls** are of the Riise design. Besides hull design, Norm Riise has worked up a complete computer program for all the characteristics of catamarans. These hulls are a refinement of the Taylor series of models designed for the U.S. Navy in the early 1900's. They are semi-circular on the bottom up to the water line (with all the weight on one hull). Instead of fibreglass, the hulls are made with "Kevlar" cloth epoxy and Styrofoam core making a sandwich construction. The decks are the same construction except the core is end grain balsa wood. The improvement in the stiffness of the hulls with the "Kevlar" cloth instead of glass is very noticeable.

Boards and rudders are foam core with wood and metal stringers and covered with fibreglass and epoxy.

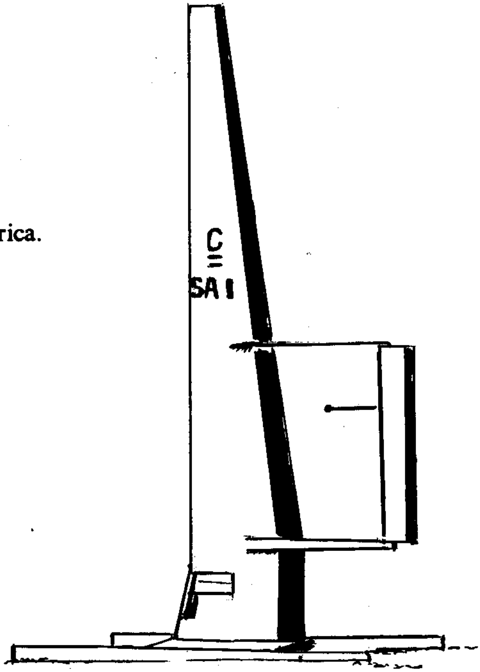
Cross tubes are 4" diameter tubes of 6063 T6 aluminium with a .072" wall.

There are internal sleeves at the high stress areas.

There is **no boom.** The typical circular track for the main sheet traveller is all that is used.

Altogether, it makes a 470 pound boat that dances lightly on one hull in anything but a drifter.

SPLICE C-Class from South Africa.



SPLICE (see drawing) in which the driver sits inside the vane-guided wingsail is clearly a developed version of Fin Utne's FLAUNDER, AYRS No. 14 page 7, which was designed in 1940, Russian ice yachtsmen have tried putting the helmsman inside wingsails apparently without too much success.

SPLICE was designed and built by Pat Beatty of P.O. Box 44. Bedfordview, 2008, South Africa. She is now owned by our member, Professor W. S. Bradfield in the USA Her sail can rotate through 360 degrees and the controlling tail vane is operated by hand in the cockpit. Foot pedals control the rudders. Another interesting feature is that the hulls have bulbous underwater bows in the manner of modern tankers, etc. There is a single connecting platform between the hulls so that the drag profile is remarkably clean. Presumably the dark trailing edges are flaps, but details are not yet to hand. In the Roton Point trials, she did not do too well, perhaps being untuned. At first she was top-heavy and the top section of the wing was removed. (What happens if she goes over!).

On PATIENT LADY III the fastest of the American wingsailers, the sail is in six sections, the wing, three flaps and two centre slats. The flaps and slats are pre-set in such a way that "gybing is as simple as in a Laser" according to the designer, Dave Hubbard.

THE SEMI-ELLIPTICAL SAIL
By John Morwood.

"How can I get extra power from all that wretched sail cloth up there?" is a question which every yachtsman must ask himself from time to time. The cruising man asks it in light winds and drifting conditions. The racing yachtsman has it perpetually in mind.

Patent offices the world over have applications each year for sail patents for new methods of setting canvas to the wind—or re-invented old methods. I confess to having taken one out myself before I started to study yachting seriously. I, like everyone else, wasted my money.

The answer to the above question is simple. The sail which will produce the maximum power per unit area, on all courses from the wind has the following attributes:—

1) The outline shape is a semi-ellipse of "Aspect ratio" yielded by the formula span /area = 3 or greater ($Span^2$= vertical height).

2) The canvas must be able to withstand some wind pressure near the luff without falling in. This can best be achieved by full length battens or yards.

3) The flow (Camber) of the sail should be about 1 in 8. (I am not sure of the precise figure, my researches show that the power is still increasing when the flow increases through 1 in 8.)

4) It is probable that the maximum flow of the sail should be about one third of the chord from the leading edge.

5) The sail should have no more than 2 or 3 degrees twist so that the angle of attack of the wind on the sail will be the same from the foot to the peak.

The Arguments for The Semi-Elliptical Sail:—

1) The coefficient of sail force of the sloop rig with genoa as in the 12 metre is 1.2 (Harry Morss). The coefficient of sail force of the single sail with either a "pocket luff" or streamlined rotating mast as are found with the Laser and Finn dinghies respectively is 1.5 (Edmond Bruce).

2) My own researches into dinghies' Portsmouth Yardstick numbers in relation to the square root of the L.W.L. and the Bruce Number (B.N. = square root of sail area divided by cube root of displacement) both show that the single sail dinghies gain about 5 Portsmouth Yardstick numbers over the sloop rigged dinghies.

These two pieces of evidence merely confirm each other and show clearly that the single sail is far more efficient that the sloop. Few people will be prepared to quarrel with the argument so far.

As regards the semi-elliptical shape, however, the evidence is 'softer' if I may use the word. It runs as follows:—

3) According to aerodynamic theory, the ideal wing shape for an aeroplane wing is a semi-ellipse. The spitfire aircraft of World War II was designed according to this principle.

4) Wind tunnel tests of sails show that the "wing tip eddy" comes off a point about three quarters way up the luff of a triangular sail. This means that the top 6% of sail is doing no work at all.

5) Wind tunnel tests of rectangular aerofoils show that the pressures at the wing tip angles fall off so that the lift forces along the wing assume an almost semi-elliptical wing shape.

I call this evidence "soft" because one assumes that a sail is analagous to the wing of a sub-sonic aeroplane and there is some evidence that aerodynamic effects alter appreciably in windspeeds of less than 14 miles per hour. However, the wings of Microfilm aircraft which fly at these low speeds still are found to be best when built to a semi-elliptical plan form. It is my guess that really low windspeed aerodynamics only alters in respect to the seating of the airflow on contact with the wing and the only difference between it and higher windspeed aerodynamics lies in the resultant increases of drag.

All in all, however, I estimate that the improvement to be expected from the semi-elliptical plan form is in the region of 10% to 15% and about 2 degrees closer sailing to the apparent wind. This is not as much as the improvement obtained from doing without the jib which is 25% but very valuable nevertheless.

The Arguments for Flow and absence of sail twist.

The information on the flow of a sail holds equally well for a triangular sail as for the semi-ellipse.

Rod MacAlpine-Downie once had a flow of 1 in 6 on the mainsail of a C Class catamaran which won its race but this was just before the C Class stopped using jibs altogether and started to use aerofoils sails. I have not seen such a large flow used on any boat since.

A kicking strap or boom vang increases sail force in quarterly winds by 25%.

Summary

I have given most of both the theoretical and practical arguments to prove that the semi-elliptical sail is the best way of setting canvas to the wind. Unfortunately, the windage of the hull and all the above-water parts of the boat have to be included in the resultant sail force and these also are a great source of inefficiency to windward, giving a loss of some 25% (Edmond Bruce) as far as one can gather from tests on an open dinghy. However, Bruce's tests used a dinghy with and without sail for his figures though hull windage must interact on the sail force, probably improving it.

Note to Inventors

If everyone who has that spark of inventive spirit which is inborn in so many people were to apply himself to the problem of setting a semi-elliptical sail to the wind, they would give a great service to sailors. The rest of this writing will be concerned with this problem.

The Squaresail

The first way in which to set a semi-elliptical sail is as a squaresail. Now, the Humber Keel is a squaresail barge which was alleged to look a whole point closer to the wind than the fore and aft rigged barges. Because her sail has most of the attributes of the semi-elliptical sail, one firstly feels that we are on the right lines in our quest. Unfortunately, the traditional Keel often made as much as three lengths of a sternboard on going about.

A member of the A.Y.R.S., George Dibb, once made a semi-elliptical squaresail which he put on a "Floiler" trimaran. Each yard of the sail was on a short sprit which allowed the sail to set outside the shrouds when close hauled. This allowed it to be braced around into a position similar to that of a normal mainsail. He and various A.Y.R.S. members who sailed the boat found the sail very powerful and close-winded. Putting about was the trouble. If exactly timed, the sail could be made to flip from tack to tack in the manner of a softish gybe but, if the timing was not right, the boat could go haring off on a sternboard at a considerable tare of knots to the consternation of the crew. Another fault was that the centre of effort of the sail was forward of the axis of rotation so that, if the sheets were let go, the sail came more fore and aft. This meant that in a puff, the boat could capsize. The sail was not "Fail-safe."

Many years ago, I made and sailed a similar sail of a rectangular shape on a canvas canoe. I only used one sprit at the bottom to get the sail outside the shrouds and ran the sail up lines at the edges. The sprit extended aft of the mast and was used, instead of a sheet, to set the sail to the wind. To luff, one pulled the sprit end aft, thus swinging the sail more athwartships. I found sailing the canoe interesting and different but not particularly difficult. I think that George Dibb's sail must have been similar. Perhaps the reason that neither George nor I persisted with our sails was that there is no clear incentive to go out sailing with some odd contraption which is hard to handle and with which one must be more alert than normal.

A "Fail-Safe" Squaresail

The first concept came from an old square-rigged sea captain who was a patient of mine. Being concerned with the fail safe problem, I asked him what happened when the braces of square yards were eased off. His answer was that the yards became more athwartships. That meant that they were fail safe, as opposed to a single square sail.

This immediately explained the use of the Spanker, or small fore and aft sail on the full rigged ship, a brig or brigantine. The concept appears to have been arrived at in Tudor times. The 16th Century Herring Busses had square rigs on up to three masts, while the men of war used one or two lateen sails as the after canvas.

The principle lies in the fact that the 'advance wind' of the fore and aft sail increase both the angle of attack of the wind on the aft part of the squaresail ahead of it and increases its speed and hence its force. It is this fact which makes the ship rig, the brig or the brigantine possible to handle.

My first 'invention' therefore was to think of using a simple mainsail aft of the semi-elliptical squaresail. An extension of this concept was to replace the jib of a sloop by a semi-elliptical sail which could either be set as a squaresail or by having wire spans across the yards, the sail could be pulled aft on each tack to set as a lugsail.

The second of the above ideas would be an improvement on the sloop. Everyone knows that the luffs of jibs should be as taut as possible. However, arguing from aerodynamic theory as given near the beginning of this article, it seems likely that the jib luff should actually be convex and stretch out forward of the forestay.

I have no doubt that both of the above ideas would work. However, it seems just a little foolish to prove that the semi-elliptical sail is the best and then set a fore and aft sail behind it to make it usable.

The Squaresail-Lugsail

Most of my thinking since devising the above rigs has been concerned with setting the squaresail with wire spans across the yards which are attached to the mast by some system which slides up and down as the sail is hoisted or lowered. Either, the wire spans can embrace the mast or run in sliders on it which, in turn, can slide up and down.

With all these systems, gybing has been made safe and easy, Putting about now becomes the manoeuvre of difficulty.

The simplest system is to use a streamlined rotating mast, stayed at the top. - The yards of the semi-elliptical sail have wire spans which embrace the mast. The sail is between the shrouds and the mast.

On each tack, the sail is pulled back by the sheet and becomes a lugsail. Gybing is simple enough but putting about needs the sail to be pulled forward out of the lee shroud, threaded inside the other shroud and pulled back onto the new lee side. With any great size of sail or in a fairly strong wind, I would think that it would be necessary to lower the whole sail to change tacks.

The Outside-the-Shrouds Sail

To avoid having to thread the sail inside the shrouds on changing tacks, I next started to devise ways of setting the sail outside the lee shroud. Naturally, I first thought of the way used by George Dibb and myself of short sprits sliding up the mast, three for a minimum, one for each yard as a maximum. The wire spans would be in eyes at the ends of the sprits to convert the thing into a lugsail.

Putting about with this would need a line from the boom or bottom yard, running forward. Pulling the sail forward immediately it lifted on putting about would slide it in the sprit and eyes; the sail would 'flop' onto the new tack and swivel the sprits over to the new lee side.

Another version of this is to have a crank in the mast at the bottom so that, while it still was stepped in the centreline of the boat, it actually rose outside the shrouds. The wire spans on the yards would run in sliders which could run up and down the mast. With this system, the vertical wire could of course, be replaced by a second mast, making an A-Frame. Staying with either of these two systems could be full and excellent.

People who have read my writings will several times have seen that I abhor poles on boats to which sail is not attached. This is because bare **round** poles produce relatively enormous drag in light winds. Fairly streamlined masts have very much less drag and even this becomes of less hinderance when it is on the weather side of the sail.

Two Easy Solutions

I came to my solution about the semi-elliptical sail about twenty years ago. At that time, most masts were made of wood and nearly all had stays. However, times and materials change and we now have thousands of small boats sailing with stay-less strong, light alloy masts. The most popular is the Laser dinghy.

Now, the forces produced by one of these semi-elliptical sail on the mast are far less than the forces produced by a normal triangular sail. The wire spans of our sail pull the mast in the direction of the sail force produced whereas a triangular sail pulls the mast aft, when close-hauled. If a stayless mast can work with a Bermudian sail, it will work far better with a semi-elliptical one. The only trouble might be that the mast socket will have to be a little further aft to get sail balance.

With a stayless mast, nearly all the troubles with the semi-elliptical square-sail-lugsail disappear. The sail with its yards can be put on the boat, the mast can be stepped inside the wire spans and the sail hoisted. The sail will immediately drift aft to become a lugsail. The bottom yard may then be pulled down by a line from the point where the wire span meets it and the sail will be almost twistless. The sail will be balanced so that the sheet force will be very small. No horse or sheeting to the boat may be needed. Gybing will be abolished.

Putting about will need a rope running forward. A sudden pull on this rope at the appropriate time will flick the sail onto the new tack. It would be wise to remember to release the boom downhaul first.

Owing to the lesser forces and strains of this rig, as compared with a single Bermudian sail on a stayless mast, it would doubtless be possible to use it on fairly large dinghies and catamarans. In my opinion, it is without question the most efficient and easiest way to set canvas on any small boat. A streamlined mast could be likely to improve efficiency still further but would not, in my opinion be vitally important.

In the larger sizes up to about 50 feet of boat, stays could be used. Two stays forward to the shoulders and two stays aft to the quarters would steady the masthead in a rolling sea and give it support. Running stays from the mast to the weather side of the boat, which could alternatively be on a track, would also increase mast support. These stays would have to be shifted to the weather side on each tack.

An A-Mast Rig

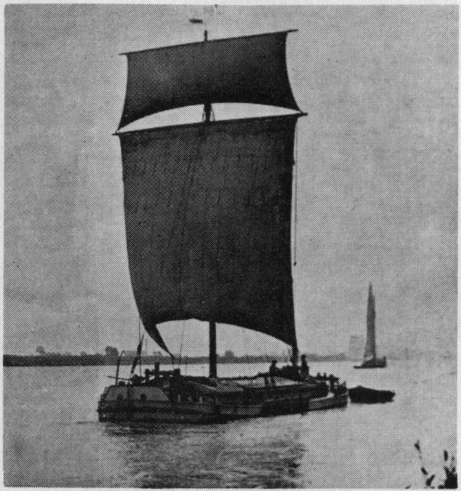
The second of my "two easy solutions" derives from the large Scottish fishing luggers. It must have been heavy work dipping the enormous lugsail of these boats in the strong winds of the North Sea because they often used two sails, one for each tack. On putting about, it was, apparently, easier to lower a sail completely and hoist another one for the other tack than to manoevre the large sail around the front of the mast.

My suggestion for the same idea is to have an A-frame mast composed of two streamlined extrusions meeting at the top and joined by struts for strength. The Ancient Egyptians used this system with success for a couple of thousand years so it should work. If the streamlined extrusions are aligned with the windflow, especially that on the windward side, there will not be the 'round pole drag' which offends me so much.

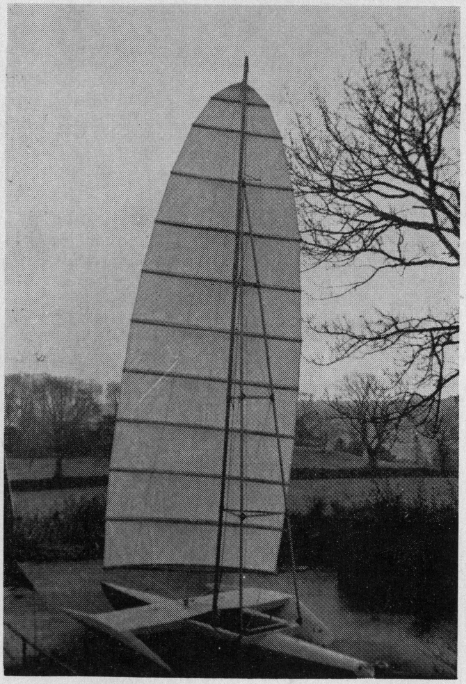
Two semi-elliptical lugsails are used, one for each tack. Each sail would be hoisted up its own limb of the A-frame. Being on the lee side and of optimum shape, it would be ideal to windward and reaching. The weather sail would lie along the weather gunwale. In quarterly winds and when running both sails would be hoisted.

This rig would suit a Thames Barge or a Norfolk Wherry. With large sails, such as these would need halliards the could be inter-comnected so that the weight of one falling would help to raise the other one.

One could imagine a 100 foot long steel Thames Barge yacht which was the headquarters of some club putting out of St. Catherines Dock in London and running wing and wing down the Thames. She might have to make a reach through the Downs from the North Foreland. Then perhaps, she might have to beat westwards inside the Goodwin Sands, dropping one of her sails for each tack but pointing up the windward better than any present Quarter Ton yacht and footing twice as fast. She would be a lovely sight.



THE HUMBER KEEL



The A.Y.R.S. Sail—George Dibb.

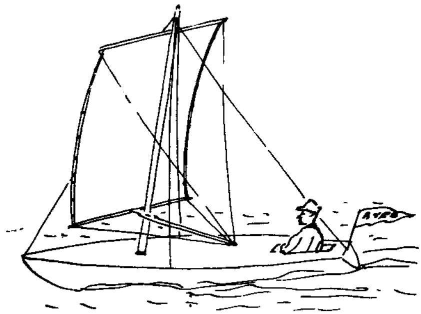


Fig. 3 Rectangular squaresail set outside shrouds. This sail was also set with the shrouds inside the triangles of the bottom T frame. The saile hoisted up the side lines.

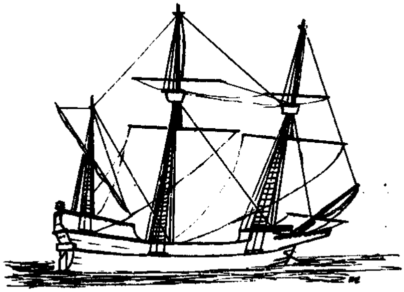


Fig. 6. Elizabethan Warship with Lateen Mizzen (often shown with 2 Lateen Rigged.

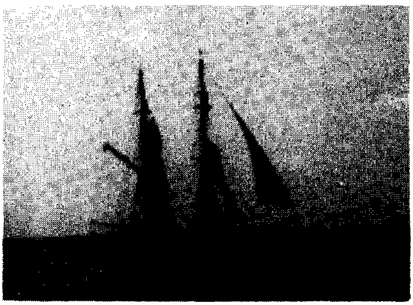


FIG. 4. BRIG ROYALIST.

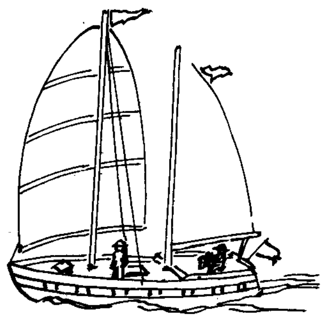


Fig. 7. A Brigantine Rig with a semi-Elliptical Foresail (To the 'expert' a Hermaphrodite Brig!)

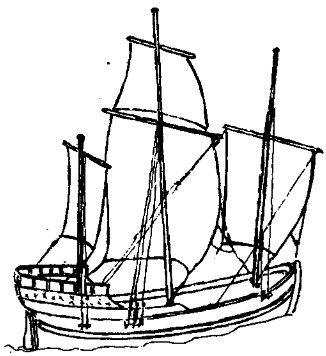


Fig. 5. 16th Century Herring - Buss (Science Museum Publication)

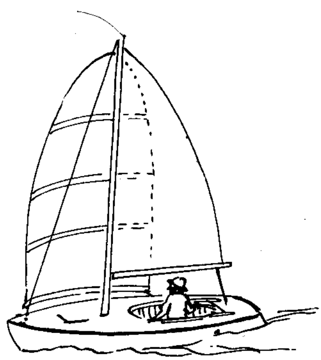


Fig. 8. Sloop with a Semi-Elliptical Foresail.

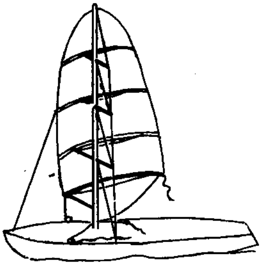


Fig. 9. Outside the shrouds square lugsail. Sprits slide in mast groove Port shrouds only shown.

Fig. 10. Crank Mast Rises outside the lee shroud. Staying is to the tip of the lower crosstree.

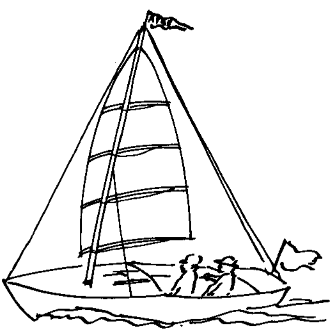


Fig. 11. Semi-Elliptical square-lug-sail with mast stayed to Windward by runners. It could be stayed to lee through Holes in the sail.

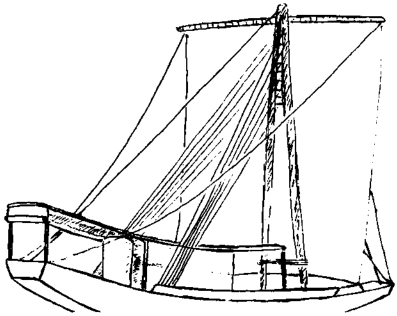


Fig. 12. Ancient Egyptian Ship IVth Dynasty, close hauled—note bow lines. She was of deep hard chine construction with flat floors and probably used leeboards.
after Bjorn Landstrom.

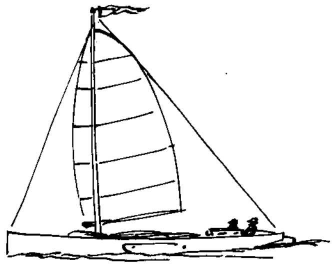


Fig. 13. Thames Barge Yacht with semi-elliptical sails on an 'A' frame mast. Weather sail lies along the gunwale.

Comments relevant to the foregoing article by Dick Andrews.

Box 35, North Waterford, Maine, 04267, U.S.A. July 28th, 1975

To tack the semi-elliptical square-sail:—The basic problem we face is that we are short-handed. A big crew such as the Arab dhows carry, or the Oceanic proas, etc. — and all sorts of clumsy rigs and hulls can be managed.

However, one can follow the practice of The Louisiana luggers. These craft were put from tack to tack in regular dipping lug style if convenient. But on short tacks the sail stayed on one side of the mast—the tack being hauled out to weather on a long horse. I would recommend this approach. A standing lug (on a boom?) for short tacking; a dipping (or swinging) lug on long boards.

In lighter winds it might be simple enough to swing the sail around. In more of a blow, control might be better if the sail were dropped before the shift. A jib would also help make the manoeuvre surer.

Camber ("Flow"):—The unique fact about ice sailing is simply that there is little resistance and **it does not increase with speed.**

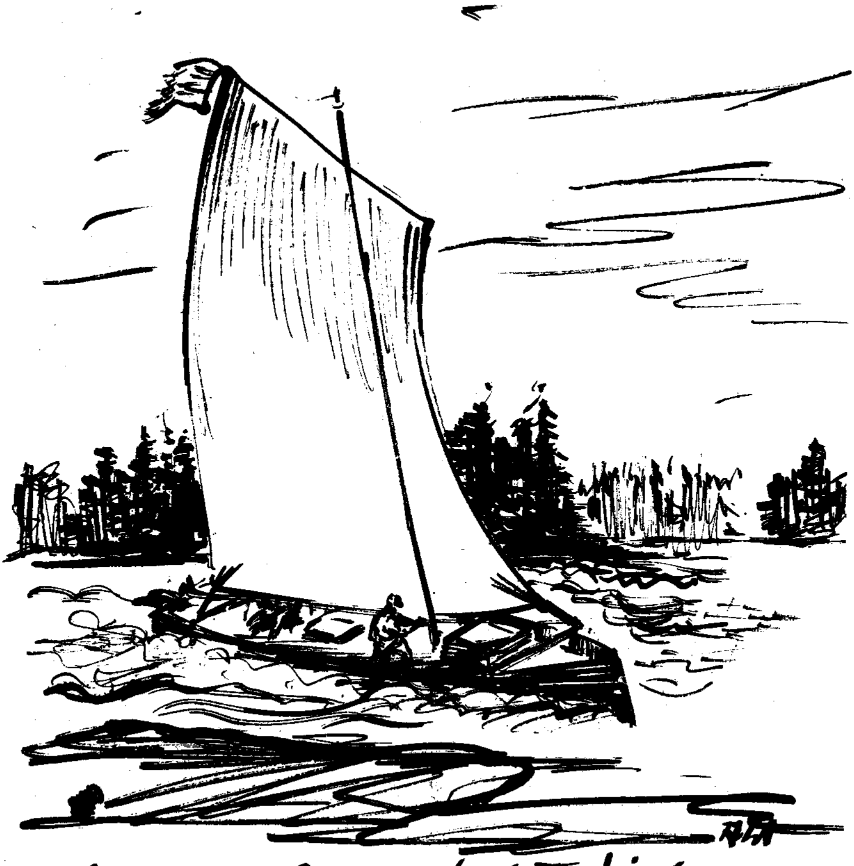
Therefore, the "stopper" is air drag. The less drag the faster you go.

The less parasitic drag, and the less induced drag, the more speed. A small amount of lift will do, if the ratio to drag is favourable.

A full sail, or over-rotated plank mast will simply limit speed due to the high drag.

On the water, "C" cats sail well to windward with quite flat rigs, but they cannot get down wind without quite full cambers. This is due to floating on water. Sliding on ice, one builds so much speed as one bears off onto a down wind tack that the air flow is still coming back almost right at you. So you still want a flat sail.

This moment incidentally, is one of the greatest thrills in sport, and there is nothing like it in water sailing. In fact, many ice sailors of top calibre have no interest in water sailing whatever, and spend the warm months in soaring, power flying, surfing, scuba diving, etc.



Louisiana Lugger short Tacking

Comments on John Morwoods article 'The Semi-Elliptical Sail'

By Jock Burrough.

John Morwood has for years had the brilliant original hunch that the SEMI-ELLIPTICAL sail would be most efficient, but like many researchers, he has been hoping that the theory and practice would catch up and prove him right. This has not yet happened.

I find his arguments hard to follow and some of the technical statements incorrect or unintelligible.

Under rating rules I believe the fore triangle is rated about 150% and the main only 100%. This is an argument for a single sail but together with arguments of Portsmouth Yardstick Bruce numbers and sail co-efficients are also used as arguments for the advancement of the semi-elliptical sail. John's theory of the inefficiency of the sagging headsail luff which is concave compared to a taught luff which is nearly straight and therefore the convex luff, as found on the semi-elliptical sail, would be more efficient is a possible theory, yet to be proven and not helped by the emotional reference to the Spitfire in World War Two.

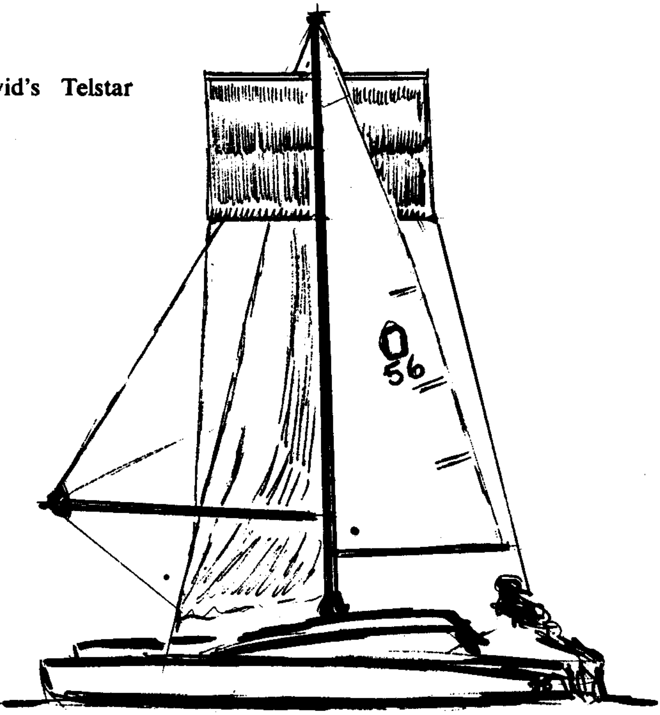
The brilliant record of the Spitfire might have been nothing to do with its semi-elliptical wing—neither the ME 109 nor the FW 180 had the semi-elliptical wing and the German fighters were considered in many respects to be the better flying machine by many including some Spitfire pilots but they did not have the eight guns of the Spitfire which could throw more than twice the weight of shell or bullet nor were they flown by young Britons desperately defending their own homes over their own homeland.

John says that the wing tip eddy comes off at a point about three quarters the way up the luff of a triangular sail and the top 6% of the sail area is doing no work at all. In a semi-elliptical sail, its semi-elliptical character is mostly in the top 25%, and this seems to be the useless area that John claims.

Again reverting to the single sail argument and the examples given in its favour, may be we are all the time referring to sails which are not suffering from mast interference, e.g. double-luffed on whippy unstayed masts, wing-masts, wing-sails and headsails, the fore triangle, etc.

I have a vague idea that this argument ends up with a chinese junk sail, fully battened by definition but with the leading edge, i.e. luff, convex if not straight. All we have to do now is to keep it up there. Perhaps the whole thing should be inflatable.

St. David's Telstar



SQUARESAIL ON A TELSTAR TRIMARAN

By the Viscount St. David's, 15 St. Mark's Crescent, Regents Park, London, NW1 July, 1974

Clarke in his book "Trimaran Development" suggested that a squaresail could work well on a Tri.

We had one made for our Telstar, TRIPLET with a 9 foot drop and the same width as the ship, 15ft. We have extra long booms so that the sail can do double duty as an awning for use in Adriatic ports in summer.

The sail is hauled up the forward side of the mast by a spinnaker halyard, leading the tail of the halyard down through a single block, lashed to the mid-point of the spar (one of our two spinnaker booms) and so down through another single block near the foot of the mast to one of our jib-sheet winches. If we wish to drop it in a hurry the helmsman needs only to let go the halyard and it steadies itself down to the deck. The sail does not need braces as it can be braced round well enough with its two sheets.

We can set it low down as a squaresail and if necessary, it can be braced sharp up, by shifting the lead-blocks down to leeward until the yard clears the shrouds. Its best use however, is as a topsail right up at the mast-head where it catches the most wind in light weather. Up there it does not blanket the jibs so much and is so high above the cross-trees that it can be braced round on to a reach.

Off the Dover Cliffs in light airs and setting mainsail, genoa on the forestay, working jib boomed out to weather and the square topsail fully aloft, we walked past a much larger keel boat with its spinnaker set.

I doubt if we could carry it high in reaching winds of more than force 3. I think it would need proper braces and in any case, might overpower the ship (it is 5/6 the mainsail area, a lot of canvas to set high) though we once carried it well up before the wind in Force 4 with only a genoa with it. My conclusions are:—

(1) That a full-scale square-sail with all the extra rigging it would need, would be a very good rig for an ocean cruising trimaran, but less useful for coastal work.

(2) That a sail like ours, which lacks the area of a full-size squaresail, is still good, either on its own as a course or set up high above a normal rig as a topsail and needs less rigging and is more versatile.

(3) That a squaresail of our type can only get away with having no braces if its head is very little wider than the ship and if it has a fairly shallow drop. This means that it can only be of useful area if set on a very wide hull such as a scow, cat or tri.

I would like to see one of deeper drop at the luff, but gored out amidships to the same drop as ours. This would catch more wind where not hindered by the main or the jibs but still allow passage for the forestay and shrouds.

Will anyone else try this out and say what they think?

THE 'JUNK' RIG

(see photograph inside front cover)

by Michael Ellison.

The Junk is a trading craft from China and adjacent waters and the word is used to describe a variety of craft generally of the hard chine, flat bottom type. The rig on these craft varies from area to area depending on their requirements for river sailing, offshore fishing or coasting.

In general, 'Junk Sail' is used to refer to a full battened sail having part of its area forward of the mast. The cloth or sail material (often old rice sacks or anything else available) is cut flat. The traditional sail is set on a mast with stays, for coastal sailing.

Col. H. G. Hasler has done a lot of development work on a rig which has become known as the 'Junk Rig.' There are a number of important alterations to the traditional rig and some problems remain to be solved.

On his own 'Folkboat' class yacht, "JESTER" the rig proved an outstanding success and this yacht has competed, almost unchanged, in all the Observer Single Handed Atlantic Races.

A Nicholson 36 class hull with a schooner version of Col. Hasler's rig completed the 1964 Single Handed race. On this yacht the foremast and foresail were the same size and area as the single mast on "JESTER." During the race the foremast broke due to rolling.

For the 1972 Single Handed Atlantic Race, Jock McLeod used an up dated version of the schooner rig on his 47 foot "RON GLAS" — he had a comfortable passage without problems.

Another famous yacht to use the Hasler version of the rig is "GALWAY BLAZER." She completed a single handed circumnavigation but was dismasted at least twice. (As she was rolled over by storm seas this may not be the fault of the rig!)

Apart from these 'long-distance' yachts, there are a number of small cruising craft fitted with the rig. A number of catamarans designed by James Wharram have tried the rig without much satisfaction.

The most satisfactory way to consider the rig seems to be to list the main advantages and problems with the rig. Anyone considering its use can then consider its merits for their particular purpose.

The Wharram Catamarans did not use an unstayed mast because there is no cabin to support the spar. The major advantage of the unstayed mast is that drive can be taken off the sail at any time even when running. Sail can be hoisted with wind against tide and there is no drive until the sheet is pulled in.

Advantages:

- Easy to Reef
- Inexpensive to buy.
- Expensive winches not needed.
- Full battened Sail.
- Gybe is no problem.
- Sail setting and reefing can be done from cockpit which may be enclosed.

Disadvantages:

- Takes a long time to 'fit up.'
- Great lengths of line to stow.
- Unstayed Mast.
- Battens are wrong stiffness.
- Chafe is a problem.
- Inferior to windward when sail is against the mast. (Luff forced to leeward, sail takes 'S' shape).

Explanation of above:

To reef all that is needed is to lower on the halyard, pull in on the downhauls and adjust the sheets. All these lines can lead to a convenient sheltered position, no need to go out on deck. Just as easy to hoist more sail as the wind moderates.

'To Fit Up' refers to the initial securing of the sail to the mast. Even a small sail can take two people an eight hour day to prepare. The sail has full length battens. Secured to each batten is a downhaul line—a line which passes round the mast and back to the batten and one end of a sheet. Each end must be secured with a bowline and each of these must be secured with a whipping to prevent it coming adrift. A piece of plastic hose or other material must be passed over each batten to prevent wear on the mast.

Inexpensive because the sail is cut flat and is a simple sewing job—no special shapes to cut.

Length of line—To reduce the compression load in the mast, it is necessary to use a purchase on the masthead on the main halyard (see sketch). If a four part tackle is used, there will be rope equal to four times the height of the mast to stow. The downhauls have to be slacked out as sail is hoisted so that some care is needed to keep the lines clear.

Winches are not needed because having part of the sail area ahead of the mast reduces the load on the sheet.

The unstayed mast seems to cause most trouble on larger yachts, say above 30 feet. if they have a quick jerky roll. Also they will not heel so easily and impose a greater load. It is possible to build a mast that is strong enough and correctly tapered but it has to be thick—causing windage —and it has to be supported at the keel and deck which uses cabin space and needs a very strong deck or cabin top adding extra weight and expense.* As part of the sail area is forward of the mast the position for the mast on this rig may be different from the design of a bermudian 'standard' mast for a production boat.

Full battens. These are an advantage on any sail, they are more efficient, the sail will last longer and is easy to control because it does not flog. It is easy to reef, roller reefing is quite possible if the pockets are fitted to roll down parallel with the boom. (Roller reefing is quite unnecessary with the junk rig.) With any full battened sail, it is necessary to have a small slot near the middle of the sail in order to inset new battens when the sail is set. Sitting on the end of the boom at sea trying to fit a 14 foot batten into a small pocket soon teaches the advantage of the slot. Full Battens are not fitted to the sails of racing yachts because they are heavily penalised. Many unkind members suggest that this is because there are a lot of sail makers on the rule making panels around the world. General cruising yachts do not adopt full battens because their owners assume that the racing fleet would use them if they offered any advantage.

Battens of the wrong stiffness—On a junk sail there is no tension in the sail to hold the batten in a curve, the curve is provided by the wind pressure. The thickness of the batten is chosen for an average wind strength. Below this chosen strength the battens will be too stiff—this is in a light wind when a curved sail is needed. In strong winds the battens will bend too much—this is when the sail needs to be kept flat for a good windward performance.

The Gybe—With no rigging for the boom and yard to catch, the sail will swing round freely and will only be restrained by the sheets. The area forward of the mast reduces the load.

Chafe—As the sail is not held tightly to the mast, it is free to swing fore and aft as the yacht pitches. As with all other rigs, it is worst in calm weather. The junk sail suffers most when pressed against the mast and chafe is probably less than on a bermudian mainsail when running with the sail clear ahead of the mast.

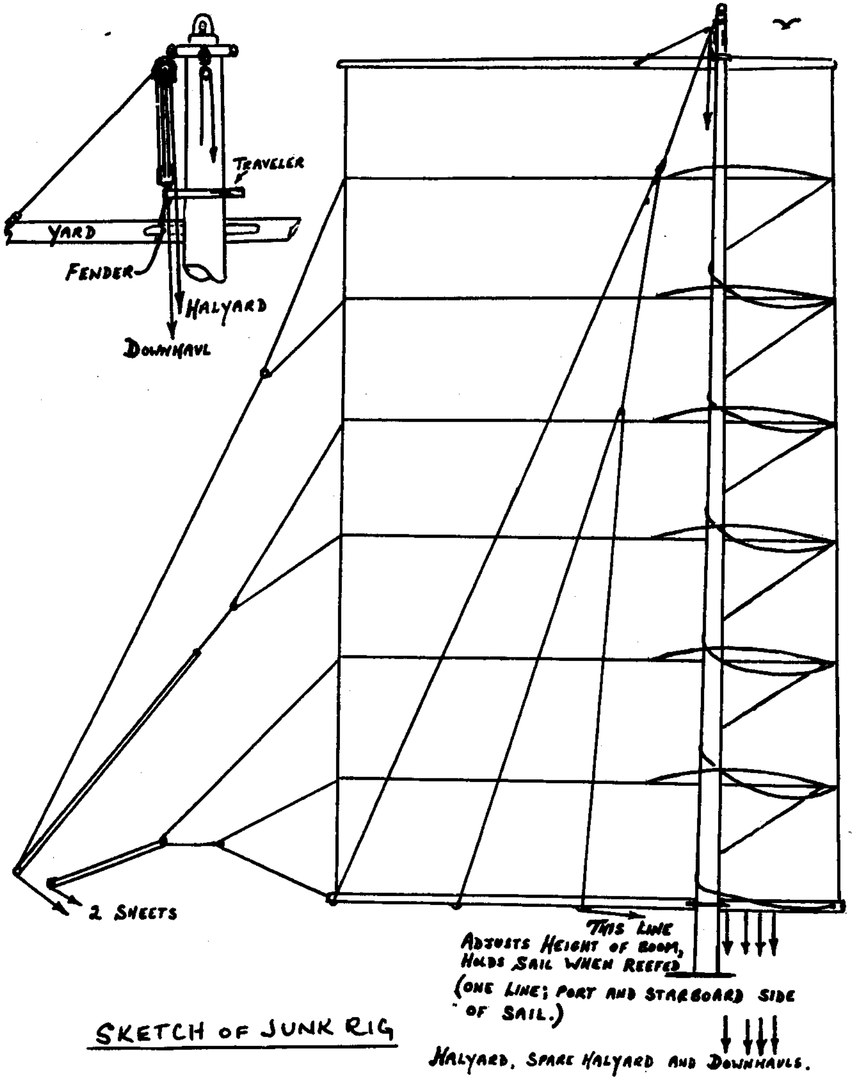
Summary:

The junk rig is easy to handle and is at its best on broad reaching or down wind courses. It is at its worst to windward, especially when the sail is against the mast and in light or strong winds. For long distance down wind cruising and for yachts with a reliable engine, it offers a number of advantages. The loss of performance is especially noticeable on light easily driven craft and it does not seem suitable for catamarans which rely on an outboard auxiliary as it may be impossible to beat off a lee shore under gale conditions. The loss of performance will be less noticeable with a heavy displacement single hull yacht.

* **(Editor's Note).** The unstayed pole mast is a cantilever, the deflection of which is proportional to Wl^3/d^4 where l is the height, d the diameter and W the load. W is itself proportional to the sail area, that is to l^2 so that in dimensional terms the deflection is proportional to $L^5/L^4=L$. Therefore, for example, doubling the dimensions of a mast doubles its flexing, at the same wind strength. To make a mast twice as long and as stiff as the original, it would have to be made 2.4 times as thick and would be 11.3 times as heavy! Unstayed masts must therefore be kept small and sail area increased by more masts not bigger sails. Masts should be evenly tapered, the masthead being no thicker than is necessary to support the blocks, etc. Similar considerations apply to wing masts if unstayed.

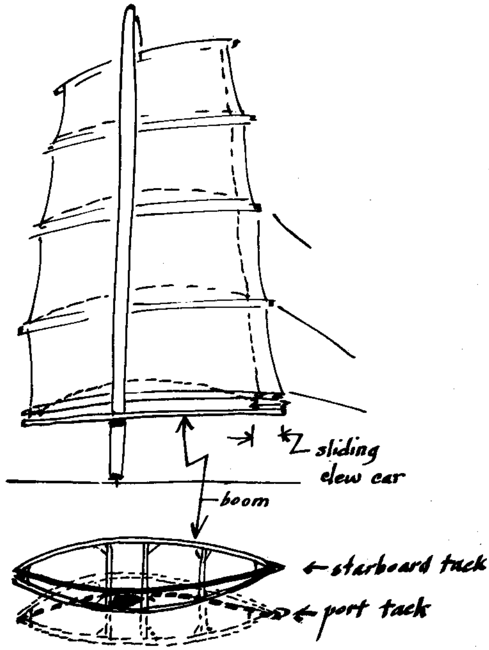
A note to the model maker:—if he is working at say 1/12th scale, his full-scale mast would have to be 22.4

times as thick and 6000 times heavier, if solid and of the same material.



SKETCH OF JUNK RIG

Dick Andrews' Chinese Lug with variable camber



CHINESE LUG WITH VARIABLE CAMBER

Letter from Dick Andrews, 25 Andulon Drive, Ossington, New York, June, 1975

Dear John,

I enclose a sketch of an idea for giving a Chinese lug some variable camber. I have never fooled with this rig, but would gather that a problem with it is fine control. Very simply, the notion is of a sort of hanging wishbone boom under the bottom batten, working otherwise like the device on similar full battened rigs where the bottom batten has a camber sprung into it, by a boom holding it at only the two points.

For this rig the boom would have to have a wishbone form simply because it is going to have to move laterally as the sail shifts shape.

As to the subject of camber generally— I always thought that bending air gives power but makes a lot of dirty air. I do know that you cannot really sail fast with a sail having a lot of camber in it. Not at all. Once you are going fast, you have to have a very flat sail so that you are "splitting the wind" in a nice, neat, narrow way—rather than causing a big splash.

The great problem in tuning an ice boat rig is to get enough variation in the package so that you can have the right camber for different speeds (or power requirements) and be able to shift cambers just by hauling on one string.

Ellis' variable camber ice boat boom is only useful in light air and for relatively slow speeds, where one also encounters high surface resistance

—all over or in spots. You have to handle two strings, which is only possible with rather light loads of air. But it is useful because—in that situation—you can quickly have a good camber—and then as quickly, get rid of it as you are going faster so that a fuller camber would hold you back.

The usual approach is to set up the geometry of stays, sheeting and masts of various properties, in relation to sail cut, so that you are getting a pocket when you want it, and getting the rig flat when you want that.

One way is to have a plank mast that rotates a good bit and makes a pocket with an otherwise quite flat sail—and then unrotate the stick and even have it bend to flatten. Others bend back the top of the stick, etc. The sheeting base is varied by sliding deck block attachments, to pull the mast back more or less rotated as the sheet is got in hard.

It is a basic element of high speed sailing that you must have a completely free sheet, free to run out of your hands, and also—you must get it in and out very fast BECAUSE YOUR RATE OF ENCOUNTER WITH WIND VARIABLES IS VERY FAST. (It is not true that high sailing speeds smooth out the flow).

The fast cat boys are finding flat rigs—solid foil—better to windward and also that the solid flat sail drives them around from tack to tack. But the best sail downwind remains the soft sail with full camber sprung in. Or in the "D" and other classes, free to use jibs, a genoa is good downwind, as of course they are sailing so very much slower relative to wind speed, than is an ice boat.

The statement has been made to me by a cat fancier, that it had been thought that the solid foil rig for a "C" cat with panels giving variable camber, would speed them up off the wind but might be slower upwind. But it has turned out, according to this source, that—quite to the contrary—the solid rig is faster upwind but not so fast off the wind as a canvas sail, full battened, with usual teardrop mast.

Reply by John Morwood

Dear Dick Andrews,

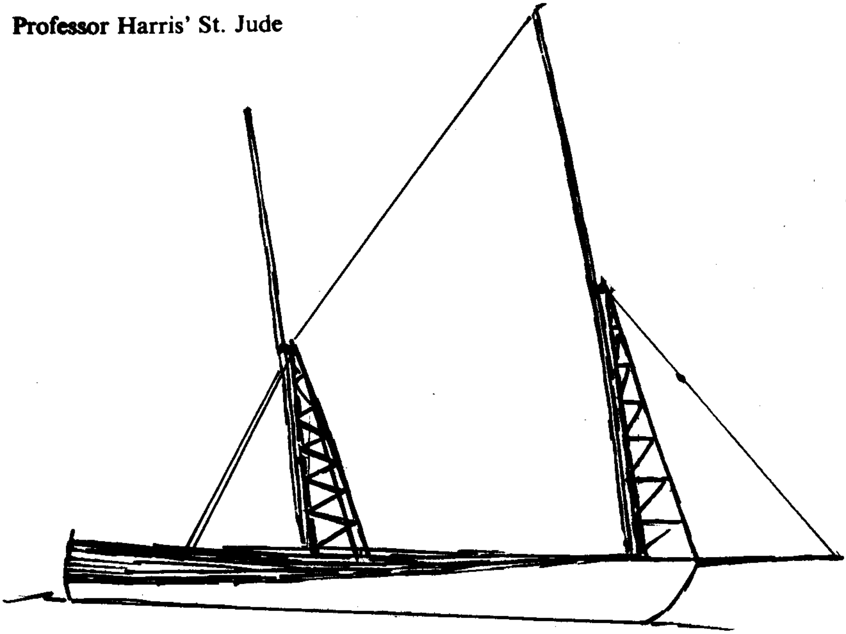
I think that the camber control of your Chinese sail would work, but it still leaves the mast to windward on one tack. I intend to think of my difficult-to-tack semi-elliptical sail.

Camber. For maximum thrust to side force ratio, there must be an optimum camber. Wind tunnel tests show it to be about 1 in & 7 (Eiffel) However, light wind aerodynamics may well be different and greater camber useful. I guess, however, that by a flat sail you mean less camber than 1 in 7 say, 1 in 12. However, when the great wind pressures get into the sail, one wonders if the sail gets fuller. Measurements would be useful.

In the matter of camber, my fixed flow sail will be useful. Owing to the yards, the flow will not increase in stronger winds. Racing with such sails should soon find the optimum flow for various wind strengths. However, it is not likely to be adopted for racing.

Wind Variables. Your statement that "It is not true that high sailing speeds smooth out the flow" intrigues me. Thinking of ice yachts, I have worked out the opposite. Most of the wind is due to the speed of the boat. Therefore, if the boat is constant in speed, wind variations should not have much effect. Do you think that the divergence is due to wind DIRECTION variation, as found by Fin Utne with his wingsail? Possibly, of course, my argument is simply wrong.

Professor Harris' St. Jude



ST. JUDE, A KETCH WITH MODERNISED LATEEN RIG

By Prof. A. J. Harris, 38/42 Whitfield Street, London, W1 October, 1975

Hull:
L.O.A. 42′
L.W.L. 38′ 6″
Beam 11′ 6″
Draft 6′ 6″
Displacement 8 Tons

Sail:
Main 390 sq. ft.
Mizzen 260 sq. ft.
Jib 150 sq. ft.
Mizzen staysl. 420 sq. ft

Spars:
Main yard 42′, 60 lbs. wt.
Main mast 18′, 70 lbs. wt.
Mizzen yard 33′, 40 lbs. wt.
Mizzen mast 15′, 50 lbs. wt.

The lateen rig has a reputation in folklore for being weatherly; it has always had three inherent defects.

(1) with a mast aft of the yard, the whole sail has to be taken forward of the mast when going about. The difficulties of doing this were such that tacking was often abandoned in favour of wearing ship.

(2) With a sail laced to the yard, itself seized to the mast at a particular point, it was not possible to slide the sail up and down the yard. Hence to lower the sail meant to lower the yard; to reef meant to lash the sail up to the yard.

(3) The yard itself was heavy and cumbersome; it was not easy to get a single spar of the needed length and the spar was often made of two or even three lengths fished together.

These defects are readily overcome in modern times by the following devices:

(a) The mast can be located perfectly easily **forward** of the yard; in St. Jude the mast is of tripod form and is thus of minimum weight and great strength and stiffness.

(b) A slide track or luff groove enable the sail to be lowered without lowering the yard and reefed with reefing points parallel to the foot.

(c) The use of light alloy extrusions enables the yard to be greatly lightened.

Once these defects have been overcome, the lateen rig is found to have the following virtues:

(d) The spars are in fact light and easily handled. Before designing St. Jude, I carried out some research and found that in the Mediterranean, a traditional lateen yard of 42′ 1 (that of St. Jude's main) would have a butt of 6″ diameter and a tip of 3″ diameter; the equivalent in light alloy is even lighter. It is classic that there are two solutions to any structural problem; one is strong and the other is whippy; the lateen is whippy. As a result of this light weight, it is easy to lower both spars and masts on deck singlehanded without extra tackle.

(e) The absence of stays permits spilling the wind when off the wind

(f) Gybing has no terrors.

(g) As with any loose-footed sail, the leach can be set up or slackened at will.

(h) With an aerofoil-section yard, it can be rotated so that its incidence relative to the line of the sail optimises lift.

(i) A mizzen and main lie "wing and wing" very readily.

And How Did it Work Out?

I fumbled a lot with the attachment of the yard to the mast and dropped the yard overboard several times before finding a satisfactory answer—I underestimated the downward force on the attachment. A variant of the ball and socket joint as used for trailers would probably be ideal. (I have a simple loop bolted to the yard lying over a pin on the mast.

At first, when on the wind, the main was sheeted with two separate sheets running to fairleads well aft; going about required an operation like tacking a big genoa. If one was quick, all was well; if not she tended to lie in irons. I now have a special sheet for close-handled work which runs back to a fair lead **amidships**; tacking thus needs no adjustment to the sheets.

I have also rigged a jib, sent up flying, which improves the balance and gets her going well on the new tack.

Down wind, it is in theory, possible to tilt the yard until the sail is nearly square rigged. I did not get the geometry quite right for this; a bigger rake would be needed to gain full advantage—as it is the foot droops on the deck. At first, I had extravagent ideas of swinging the yard around forward of the mast when off the wind; the complications were enormous and the advantages not very large. It cannot reasonably be done with a jib, anyhow.

It is not feasible to hoist a big spinnaker without losing the advantages of lightness and flexibility of spars, (Heaven be praised, say some), but I was able to stiffen up the mizzen with two running backstays to enable it to carry a large mizzen staysail as light weather sail though it has the disadvantage of filling on a rather narrow range of headings, like most mizzen staysails.

The secondary rigging is very light and simple. Apart from the running backstays on the mizzen, I have a light line running like a triatic stay from the peak of the main to the mizzen mast head; I have two foot ropes on the main yard and one on the mizzen. That's all. There is no standing rigging. I fixed brails but did not use them.

There are many more adjustments to be made with this simple rigging than with a classic Bermudan rig-rake of yards fore and aft; inclination transversely; bend and rotation of yards; tightness of leach and foot. It will take me a while before I have mastered them all and determined the best for a given heading and strength of wind.

All in all a very simple, subtle, easily handled rig and one which I believe to be efficient. In a boat rather over-endowed with novelties, this one, I regard as wholly successful.

FOLDING BIPOD LATEEN RIG

By Capt. W. A. Stewart, C.B.E., R.N. (Retired), Yew Tree Cottage, Old Buseldon, Hampshire Sept. 1975

I have for long thought about lateen rigs for both small and larger boats and have recently made a working sailing model of my ideas, in which the yard does not have to be dipped.

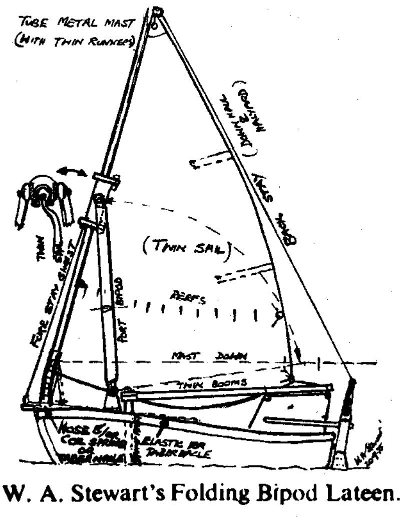
The basic idea was to eliminate rigging and to reduce to one single sail without Twist, requiring minimum effort to make sail from the mooring. It should be suitable for navigation in rivers or canals with many low bridges.

For years, I have battled with old fashioned gaff rigs such as Mersea Island Oyster Smacks, Falmouth Quay Punts and now I am 70, I find it not only impossible to hoist sail—with my gammy back—but I cannot haul in sheets especially large genoas and the like. Hence I have designed the folding Bipod Lateen. It is suitable for a complete range of craft from 10ft. dinghies to 70 ft. trimarans, schooner or ketch rigged perhaps for larger vessels.

The drawing depicts the best of models of many variants and I find the forestay hauling against the backstay locks the whole unit beautifully solid with a slight bend in the mast/yard.

The sail is actually a twin sail on split booms and loose footed so that by opening out the booms one has a goosewinged rig for down wind work. The rig can be lowered instantly for passing under the lowest of bridges and virtually springs up by itself controlled only by the backstay from the top of the lateen yard.

The model sails beautifully **no handed**! and goes about most professionally with a change of wind.



W. A. Stewart's Folding Bipod Lateen.

EXPERIENCE WITH THE PYRAMID RIG, 1975.

(See photograph inside back cover)

By Jack Manners-Spencer
Fryers, Norleywood, Nr. Lymington, Hampshire, U.K.

In AYRS publications, the first description of the Pyramid rig is given by H. M. Barkla in No. 17, page 34, 1958. J. Manners-Spencer gave a full description of his develop ment of this idea in AYRS Airs No. 8 1974. He has now fitted his latest version of the rig on his Prout Snowgoose catamaran, CHEFREN, Our back cover photograph shows this boat with the addition of a "ghoster" for light airs. He describes all this and his experiences with it as follows:

Rig Details. The rig was designed for setting two working sails of total area, 460 sq. ft.—equivalent on the conventional rig to No. 1 jib plus staysail plus mainsail. The sails are triangular, i.e. with no convex roach or battens with luff/foot ratio of 2.9 : 1. The heavy-weather sails, each of 90 sq. ft., are set on intermediate luffwires attached to the mast on tangs just below the three spreaders. The Rig is balanced so that 26% of sail area lies ahead of the mast. The mast rotates inside a bearing-tube fitted between bridge-deck and cabin roof,lined with tufnol rings at top and bottom. The heel of the mast is dished and sits on a stainless-steel plate. There are four external stays to steady the mast in a seaway and for setting auxiliary light-weather sails off the wind; these stays are connected to a separate headbox, which is separated from the main headbox by two s.s. plates to minimise friction. Mast length is 39 ft. above deck (44 ft. overall), diameter 7 in. 10 gauge with sheathing to 14 in. above gooseneck band of tubing $7\frac{1}{2}$ in. dia. / $\frac{1}{4}$ in. wall. The particular tubing used was dictated by what was available off the shelf within a short time (delay would have been 21 months otherwise)—and undoubtedly, the whole mast structure could have been made much lighter with adequate safety factor. Total mast weight is 250 lb. Cost off the shelf £200 (ex VAT), for tubing only.

Sailing Experience. The boat was collected in April from Canvey Island in the Thames Estuary and sailed around to Lymington (200 miles) in mainly light airs; the journey took $2\frac{1}{2}$ days, because of engine failure, calms and strong adverse tides, necessitating kedging for 6 hours on two occasions. There was no attempt to tune, and in spite of this the Rig pushed the boat along well in ghosting conditions and sailed within 45 degrees close-hauled in stronger winds as well.

Throughout the rest of the summer, local sailing was conducted in winds not stronger than Force 4, so it was not possible to experiment deliberately in severe conditions. However, on one occasion, the boat had to claw back against a Force 6 wind, a distance of 20 miles; with only the two heavy-weather sails set 180 sq. ft. total) a speed of 5 knots was maintained at 45 degrees to the wind and 100 degrees between tacks in a very lumpy and confused sea (wind-over-tide).

Later in the season, the boat was entered for two races. In the first one, the Crystal Trophy, a good start was made against the other four Snowgoose cats in the race—holding slightly ahead on a broad reach, in spite of setting 120 sq. ft. less sail area. On the second leg, we were close-hauled and began to fall behind slowly, where the other boats were able to make better use of their greater sail area. All the boats were slamming heavily into the short seas, and after 30 miles or so one of my aft poles broke in the middle under the strain of heavy jarring—thus causing me to retire. In retrospect, all my poles were too slender for this type of punishment, and I have increased diameter and gauge since then with no repeat of this trouble yet. The mast showed no sign of strain in these conditions.

In the second race (MOCRA Shambles race—180 miles) all the sailing was either close-hauled or dead-run. We set auxiliary sails on the external forestays in an attempt to minimise the disadvantage of lower area in the Pyramid, but these tended to disturb the airflow around one or other of the Pyramid sails; as a result, we rounded the first windward mark after 60 miles 2 hours after the other Snowgoose in the race. However, some of this was due to the reduced weight of the other boat (our Portsmouth number was 84 and his 79), and also the fact that my sails were very out of tune—having been recently converted to hanks from the Jibswitch system. We of course, missed the tide and the others made good use of their spinnakers (which I have not set as yet), and so we never caught up.

In August, we took the boat on a three week cruise to Brittany. Mainly the winds were light, but on two occasions we ran for about 70 miles or more in Force 7/8 winds. I set the full area, as the apparent wind was more like Force 5/6, and it was a great relief not to have to worry about accidental gybes—particularly as the steep seas caused a somewhat weaving course on occasions. Our passage time from Alderney to Lymington was 10 hours—an average of about 7 knots—the final part of which involved a close reach in Force 7 conditions. As we made the transition from dead run to reach, I was able to lower the leeward sail with ease and then proceed the rest of the way on one working sail only.

General Conclusions

(1) Sheet forces are higher than anticipated in stronger winds at the stage where one is just about to reduce area. In future Rig balance will be increased from 26% to 28% or more to alleviate this problem; alternatively, if limited reefing is applied to the two working sails the balance will automatically be increased with stronger winds. Care must be taken not to increase balance beyond about 30%, so as to ensure guaranteed weathercocking at all angles of attack.

(2) Once the light-weather area for windward sailing has been established, the. Pyramid Rig should be designed to accept this full area. Putting in the equivalent of mainsail plus No. 1 jib is not enough, except for motor-sailors. Use of a convex roach also minimises mast height and dimensions of rig base, for a given area of sail. The use of full-length battens should improve performance and minimise wear and tear and noise. Both of these will be tried out on my rig in the near future. The use of auxiliary sails, set on the forestays, is very inconvenient in light and variable winds—particularly because boat accelerations cause large changes in wind direction. However, a reacher was set across the stern of the boat, set on the windward backstay, with good effect on a broad reach in stronger and more constant winds.

(3) The proven superiority on reaching courses should make the Rig suitable for fast offshore passages. It is too early to draw quantitive conclusions on relative windward performance—this will have to await trials next year with the increased area and full-length battens—but it

seems likely that the slot effect for the sloop and cutter rigs will give them the edge for shorter races.

(4) On the handling side, the Rig has been a real pleasure to use on every occasion throughout the season —particularly as most of my sailing is effectively singlehanded, my wife having to attend to our young children. I would not hesitate to recommend it for the typical family cruiser.

TESTING A PYRAMID RIG FOR A PROA

By J. Norwood, Jr., PhD., 1021 Valencia Ave., Coral Gables, Flo. 33134, USA. May, 1975

As I said in my article in AYRS 9, I have been attracted to the Pyramid rig for use on my new proa, THUNDERBOLT. With regard to the rig's suitability for high speed, I refer the reader to Barkla's remarks on pp 34-35 of AYRS No. 17. A member in Tampa is building a large pyramid rigged catamaran and his scale model tests for pointing ability have been most encouraging.

I found in sailing George Chapman's TIGER with an ice-yacht uni-rig last year that the centre of effort cannot be got far enough forward to enable the angle of attack to be increased on the bow foil. Consequently, TIGER was speed limited by the pitching moment. The pyramid rig enables me to have sufficient sail area and to concentrate this in the fore-and-aft direction, such that the C.E. can be moved far enough. Lief Smitts KOTAHA suffered from this same balance problem I believe.

To test if the Pyramid rig with high aspect ratio, full battens, head foils and considerable roach is efficient, I decided to make model measurements before proceeding. I was in spired to devise such a test by Jack Shortall and John Morwood who have strong negative feelings concerning lift to drag ratio of even such a "clean" pyramid as I am using.

Since wind tunnel facilities are not available to me, I decided to use the wind that Nature provides and make measurements of the lift-to-drag ratios of rigs under comparison.

The apparatus shown schematically with this article represents my thoughts on how to proceed. My PhD. dissertation was in a similar type of measurement in electrodynamics, so I know that the method can be made accurate.

A six-foot rod is mounted horizontally so that it can rotate in the horizontal plane on good bearings. Two test rigs are carefully modelled with 2 sq. foot areas. The configuration for comparing drag is represented in the top part of the diagram. The rigs are fitted to rotatable mountings, R_1 and R_2 which can be positioned along the arm, aligned crosswind. The positions of R_1 and R_2 are adjusted until the moment (due to drag) are, as near as possible, equal. Microswitch contacts or light spring balances at the end of the arm could indicate when this point is reached.

Thus $D_1a = D_2b$ is obtained for each value of β from the stall point to say 30 degrees. Next, to compare the lifts, the rod is aligned along the wind with equal offsetting extensions at each end on which the rigs are equally mounted and the experiment repeated, moving the pivot point. The forward sail must not blanket the aft one and the sails should be swapped over so that the difference due to partial blanketing may be subtracted.

Then: $L_1c = L_2d$ for each β

So that $L_1/D_1 = L_2\,da/D_2\,cb$

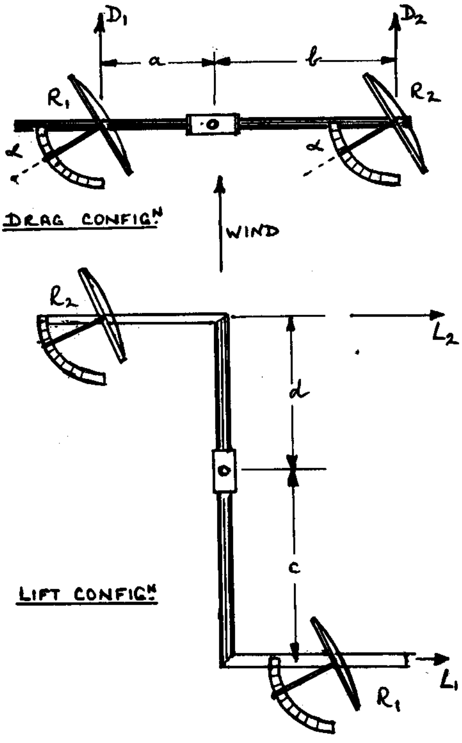
and $$\frac{(L_1/D_1)}{(L_2/D_2)} = \frac{ad}{bc}$$

An ice yacht rig will be used as the control standard for both my pyramid rig and the type of sail discussed by G. S. Taylor for his proa, BOTJE in AYRS No. 47, page 56.

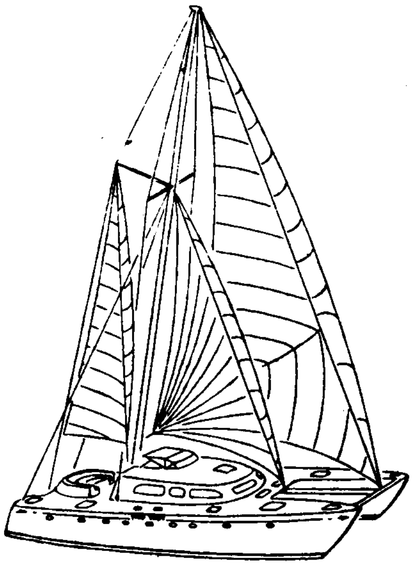
There may of course be a much better way to do this, but in any event it would seem that the development of such an experiment where model rigs can be tested against others having known characteristics would be of great interest to the members.

Ed. Joe Norwood unfortunately has been unable so far to conduct his proposed experiment due to pressure of work. However he hopes to bring THUNDERBOLT to the 1976 John Player Speed Trials at Portland, which we would greatly welcome.

The "Lift Configuration" as proposed by Norwood still embodies large drag couples from each rig, interfering with the lift component. It would probably be necessary to mount the rigs as before on the main arm but with one above and one below it to minimise blanketing and they would need to be swapped over for a repeat test to compensate for the wind velocity gradient near the ground.



J. Norwood's Sail-Rig Comparison proposal



B. Eiland's Mast-aft rig on a 55 foot Cruising Catamaran

A NEW MAST-AFT DESIGN FOR A CRUISING CATAMARAN.

By Brian Eiland, 605 Poinsettia Drive, Orange City, Fla, USA, 32763.

This rig was developed for use on several new cruising catamarans of my design. The pictured plan is still conceptual inasmuch as the staying arrangement may be altered in the final version. However the sail plan will be as shown in the drawing, with no conventional mainsail aft of the mast and so no boom or traveller.

...The mast is stepped in the cockpit and is canted forward with the masthead slightly forward of amidships. The mast is stayed in much the usual manner except that the fixed backstay from the masthead posses over a spreader. The two backstays at the stern are actually single continuous stays. This allows both sides to carry the load at all times as the lee side remains taut. The spreaders athwartships can be wide as the headsails do not overlap them. This permits greater shroud angles and smaller compression loads on the mast.

The harmonious effect which the two headsails have upon one another is noted by the lifting, pulling draft areas in the sails on a close beating situation. The smooth leading edges offered by rod furling gear, combined with the ability to sheet the headsails in very close without dangerously narrow spreaders, results in a superior pointing rig. Furl the genoa totally or partially and your balance centre moves aft to correct for lee or weather helm.

Now a little history. I am very interested in the potentials possessed by catamarans as ideal cruising sailboats. These boats require a superior pointing rig as a result of their speed bringing the apparent wind forward in all but a running situation.

Conventional mainsails are not good pointing rigs. Additionally the rectangular area of the mainsail one foot deep behind the mast and all way up the mast is wasted sail area because of mast induced turbulance. To this add the engineering complications and in-use problems of bendy mast and booms for shaping mainsails and their worth becomes truly questionably. Look at the recent increase in the use of loose footed mains. That's one small step towards my design.

So I chose a double headsail rig with the mast raked forward. In commenting on my design in the February Issue of RUDDER, the singlehanded trans-atlantic sailor, Jerry Cartwright, noted that he has personally found headsails easier to manage at sea than the mainsail.

Now to deal with the most noted

question about my rig; what about the backstay tensions and compression loads to the mast. Actually, the rig is not a significant departure technically wise, if you consider the number of older boats with their mast raked aft (some even to a greater extent than mine is raked forward). However, I do have some newer ideas for limiting mast loading.

First, we must limit the amount of pre-tension that is required in the stays and shrouds. This pre-tension is required because of the standing rigging materials and hull deflections under load. Note that the mast is stepped directly onto one of the main tubular space frames of the boat. The shrouds are also tied directly to this frame forming a complete truss structure. This combined with the fact that the spreaders can be very wide, results in a rig requiring virtually no pre-tensions in the shrouds.

The forestays present somewhat of a different problem due to their requirement of high tension to maintain an efficiently shaped headsail luff. To reduce these high tensions and point loads, multiple staying is definitely the answer (this also reduces the size of the fittings required).

The main problem up until present is that multiple staying was accomplished with a number of fixed length stays such that very often several of these stays were not working for you half the time (i.e., the lee backstay was slack). Why have a piece of rigging not doing a full time job, and having to double the strength of the one that was loaded. The concept of the continuous stay allows the backstay in this case to follow the athwartship movements of the mast while retaining a load holding capability in both strands.

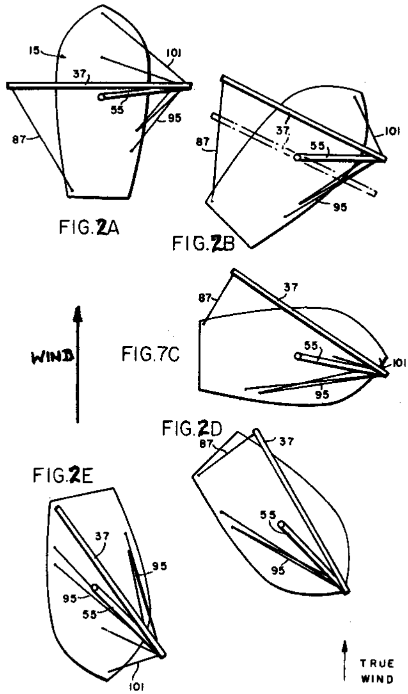
Properly stayed the mast in my design will most likely see less compression loading than the conventional straight standing mast. There are other rig designs which might accomplish many of the goals I set for mine, but mine has the additional good fortune as to not look too radical. In fact, I consider it quite pleasing to look at. I expect the rig to be balanced in heavy weather conditions under the conventional jib-mizzen configuration or under main-staysail alone.

Editor's Note—Mast-aft rigs have been described in AYRS publications, Nos. 9, 26, 27, 33 and 78. On page 118 of No. 78, a rig rather like Eiland's is shown in action.

A PATENTED MAST AFT RIG

By E. F. Hiscock (British Patent No. 1 347 447, 1974).

The drawings are taken from the patent specification and are largely self-explanatory. The mast (44) is an inverted Y but nothing is said as to how it is meant to be supported. The inventor points out that with the wind abeam the centre of effort does not shift out-board as with the bermudian rig so that weather helm does not develop. One imagines that any crew might have considerable problems in avoiding entanglement with the various spars and lines.



E. F. Hisock's rig: position of spars on various courses.

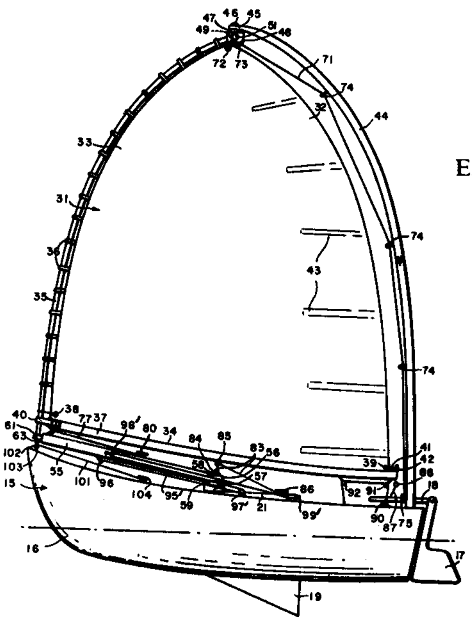


FIG. I

E. F. Hisock's Patented Rig

WISHBONE CRUISING RIG

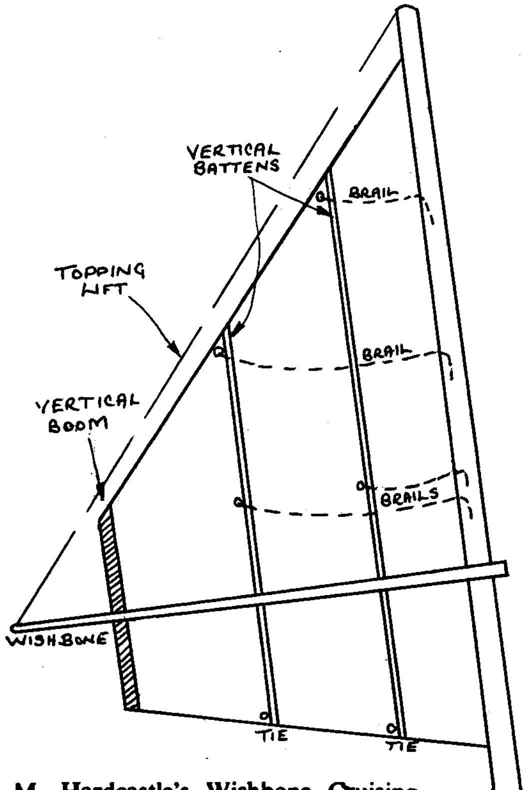
By Mike Hardcastle, 5 Oakwood Close, Grendon, Atherstone, Warks. CV9 2BU. Nov., 74

Thinking about cruising rigs, particularly the ratio efficiency/easy reefing, I came up with the idea illustrated in the enclosed drawing.

Brailing seemed to work very well on the shorthanded Thames Barges, but the spritail is not very efficient to windward. I have tried to combine the quick reefing of brailing with the efficiency of an ice yacht wishbone sail form.

Admittedly, the aerodynamic form would be somewhat spoiled when reefed but the compensations could be worthwhile. I have not tried this out, the sketch is as far as I had progressed, but I will perhaps make a model sometime.

Ed:—This rig is very similar in plan to R. R. A. Bratt's successful quadrilateral sail described in AYRS No. 76 Page 68 and used in establishing the official world's 10 sq. m. speed record of 15.0 knots at Portland, 1974. Both resemble that referred to by H. M. Barka in AYRS No. 17 page 35, a rig dating to 1949. Another very similar profile is Don Robertson's Bipod Lateen in AYRS No. 26 page 10.



M. Hardcastle's Wishbone Cruising Rig.

MODEL TESTS ON TEHINI VARIATIONS

By Clay Philbrick, PO. Box 83, Vashon, Washington USA, 98070.

Clay Philbrick has conducted a large number of tests on scale models at 1 inch = 1 foot of the 52 foot LOA. Wharram "Tehini" Catamaran, carrying various rigs. The drawing we reproduce shows the general configuration. All the final rigs were cutters and Philbrick describes the most successful as follows:

Model 3B. Foresail, Staysail and main; 195, 205, 400 sq. ft. respectively. 50 ft. mast. Was 1-2% faster but not closer winded than TEHINI with 820 sq. ft. cutter rig.

Had 7 sq. ft. skeg aft and spade rudder which gave sluggish directional control and failed to come about under radio control. 17ft. Centreline beam.

Model 9C. 54 ft. mast without spreaders, 17 ft. Centreline beam.

Model 9D. 50 ft. mast with spreaders, 17 ft. centreline beam; fore, stay and mainsls, 240, 240, 520 sq. ft., 7½ sq. ft. spade skeg, 12 to 14% faster than 820 sq. ft. TEHINI, pointing 3 degrees higher.

Model 9F. 61 ft. mast, fore, stay and main, 290, 290, 630 sq. ft. as in the drawing. Small midships fin and aft spade rudder. Only marginally closer winded than 9D and 1-2% faster. Control (by radio) superb. 19½ ft. Centreline beam.

Each description represents a solution for a particular size of sailplan.

For example, a 9C rig on 16 ft. beam boat with smaller spades, produces lee bow burying, lower speeds, weather helm buildup, lack of directional control in strong winds and tacking difficulties, to a noticeable degree. All three combinations have good sailing abilities including the ability to sail by sail balance alone while beating. The 9C rig (9D) combination also balances off the wind in moderate wind and sea.

Absolute performance figures are hard for me to obtain but running two or three models simultaneously, gives good relative performance and behaviour comparisons. The course, 1 mile long across a channel in Puget Sound—hence real life conditions are met. Good or bad model behaviour is a value judgement and not a numerical value. My requirements for sailing ability tend to be demanding, as I readily compare model behaviour with our C-Class cat.

In the search for a good rig for "Tehini," over the past 2½ years, I've tested briefly the ketch, schooner, Junk, Una and Junk ketch, and mast-aft rigs. All suffered from poor performance and windward ability, particularly when reefed. To get a model to go to windward in over 30 mph. wind wasn't possible until the 3B cutter rig finally did it under stysl. and main, self-steering by sail balance, beating very well to windward in force 8 conditions.

With the cutter rig it took many tries (20 rigs or so) to achieve a general configuration that balanced well in all wind speeds, had a flat performance curve from 3 to 40 mph. wind, and damped out pitching. The size, shape, placement and overlap of sails was found to be important. The next 10 cutter rigs were an attempt to get the maximum boat speed while retaining the other virtues of 3B. I consider the optimum combination for larger polycats to be the 9D combination with its very good speed and excellent behaviour. The 9F rig was beyond the capability of these hulls—a study of hulls, daggers and greater beam is now the order of business. The search for speed under sail, while retaining good cruising qualities is a challenge.

To date I haven't seen scale speeds over 18 knots for a cutter rigged boat —4 kn. for two masted rigs, and una Junk rig. The big cutters hold about 45 degrees off the wind when beating their best. I'm sheeting to wide travelers for stysl. and main for a vang effect and the jib is led about 13 degrees off c.l. boat and Genoas up to 18 degrees off. This produces good smoke flow and good boat performance.

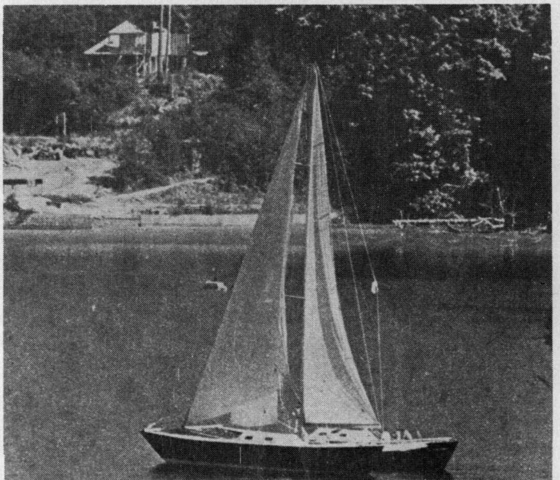
A hull that has least running resistance when upright in moderate sea states may not have least resistance under real world sailing conditions.

Since completing this description of his model work in 1972, Mr. Philbrick has completed the full scale vessel exactly to the configuration as to rig and underwater form as the optimum rig shown in the drawing. The splendid CHIPAQUIMA is shown under sail in the photograph, also on the cover of AYRS 11. The main, stay and fore-sails are 635, 300, 300 or 1100 sq. ft. respectively.

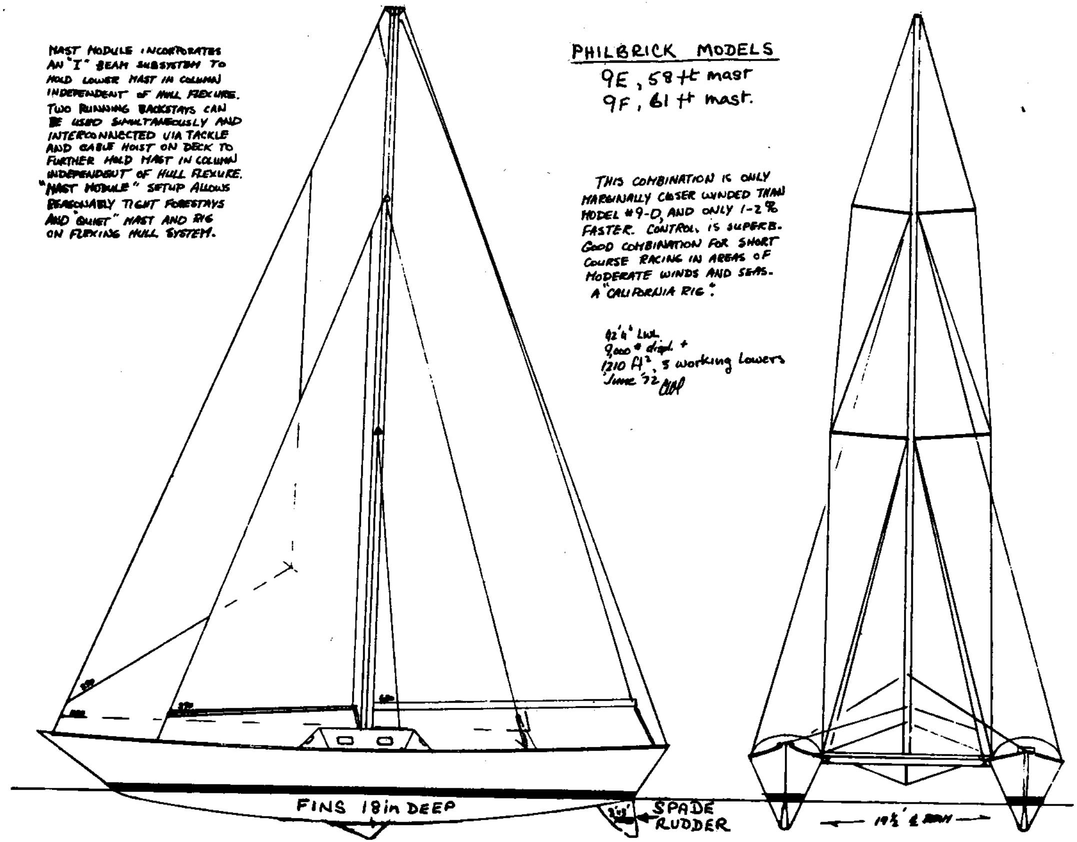
The designer is delighted with the performance which, he claims fully vindicates his careful preliminary small scale experiments. He reports that the boat flies to weather in strong winds, with the bows rising under stays'l and main only (the full rig depresses the lee bow). He claims 14½ knots at 50 degrees off the true wind and 23 knots reaching in about 20 knots of wind. She comes about fast.

A unique and very interesting feature is that the four main beams and the mast support module are **lashed** to the hulls. Spread over a large area lashings are light, strong, cheap and are easily observed for replacements.

Clay Philbrick



Clay Philbrick's modified Wharram Catamaran, "Chipaquima," 51 ft. LOA. with 60 ft. mast.


MAST MODULE INCORPORATES AN "I" BEAM SUBSYSTEM TO HOLD LOWER MAST IN COLUMN INDEPENDENT OF HULL FLEXURE. TWO RUNNING BACKSTAYS CAN BE USED SIMULTANEOUSLY AND INTERCONNECTED VIA TACKLE AND CABLE HOIST ON DECK TO FURTHER HOLD MAST IN COLUMN INDEPENDENT OF HULL FLEXURE. "MAST MODULE" SETUP ALLOWS REASONABLY TIGHT FORESTAYS AND "QUIET" MAST AND RIG ON FLEXING HULL SYSTEM.
PHILBRICK MODELS
9E, 58 ft mast
9F, 61 ft mast.
THIS COMBINATION IS ONLY MARGINALLY CLOSER WINDED THAN MODEL #9-D, AND ONLY 1-2% FASTER. CONTROL IS SUPERB. GOOD COMBINATION FOR SHORT COURSE RACING IN AREAS OF MODERATE WINDS AND SEAS. A "CALIFORNIA RIG".
42'4" LWL
9,000 # displ. +
1210 ft², 5 working lowers
June '72
FINS 18in DEEP
SPADE RUDDER
19½' ℄ BEAM

THE INCLINED SAIL

By Harry B. Stover, Rt. 2, Box 434A, Lancaster, Va. 22503 U.S.A.

There is nothing new about the idea of using an inclined sail to overcome heeling moment. However, there is a body of opinion which feels that this is not a fruitful path to follow. For example. Edmond Bruce stated that the efficiency falls off as the square of the cosine of the heel angle.* Although I agree with this, I think the idea of the inclined sail should be considered at least one more time before abandonment.

In the 1940's, I made a model similar to Fig 1. The model was light weight, planked balsa, barge shaped, but capable of planing. The sail was large, about square, and built-up, model airplane style. The idea was, of course, that the wind force, being perpendicular to the inclined sail, would not heel the boat.

Although I have seen reports in AYRS that others had a certain amount of success with similar rigs, I have to report complete failure. The slightest puff of wind would heel the boat until the sail, which was hollow and buoyant, hit the water. So why do I say this idea should be re-examined, if my model failed?

An unexpected event occurred durings test which I believe offers a chance at a solution. I had given up trying to sail the model to windward or with wind abeam and decided to see what would happen down wind. Even in this condition the wind forced the sail down until it was in the water as in Fig. 2. I was trying the model in the reflection pool in Washington and, after release, I had to wait until it drifted to one bank or the other before recovery.

* This means that a sail inclined at 45 degrees will lose half its drive—Ed.

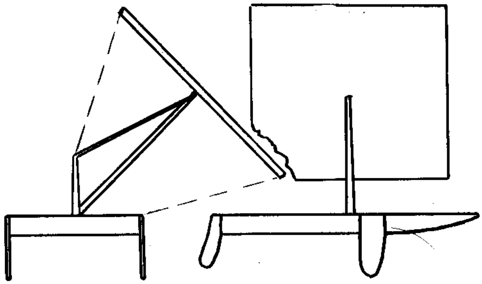


Fig. 1
GENERAL ARRANGEMENT

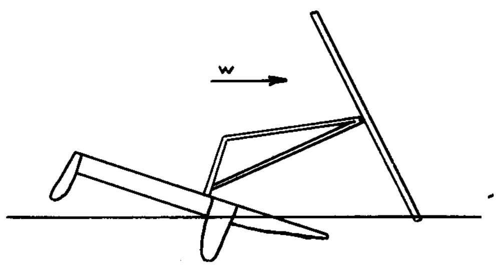


Fig. 2
DOWN WIND

It was drifting around in the Fig. 2 condition with a lot of people making various comments until it got turned around. The wind hit it aback and the model took off and planed across the pool backwards as in Fig 3. I took it home and turned the sail over and rigged it to sail in all conditions with the sail on the windward side. From then on I had to ballast the lee side and the model would heel to windward.

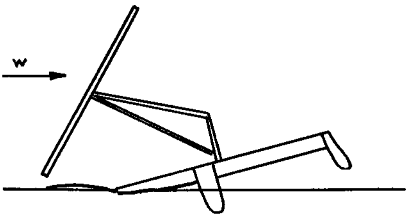


Fig. 3
PLANING - WIND ABACK

So what I am saying? I am saying that there is a difference in a leaning sail depending upon whether it is leaning toward or away from the wind. I have never been able satisfactorily to explain why this should be, but I have a sort of partial explanation.

My first inkling of what might be going on came from Terence Surman's explanation as to BOTJE's "Aerodynamic Ballast" in AYRS No. 58. Mr Surman bases his explanation on a stalled airfoil effect.

Another aspect is that, to the extent that the wind is blowing sideways over the sail as shown by Fig. 4., there is a centre of pressure shift which seems to favour the slanted sail which is set out to windward. Still another aspect is that if the boat does heel, the sail in the leeward position becomes more nearly vertical while the sail in the windward position becomes more nearly horizontal, thus spilling its wind. This can also be seen from Fig. 4.

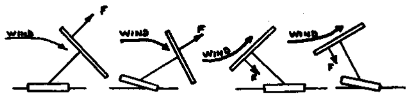


Fig 4
CENTER OF PRESSURE SHIFTS

It is my present opinion, which should be checked by more testing, that an inclined sail in the lifting leeward position must be much nearer the horizontal than indicated by normal balancing out diagrams. I also think that an inclined sail in the depressing windward position can be much nearer the vertical than indicated by normal balancing out diagrams. See Fig. 5.

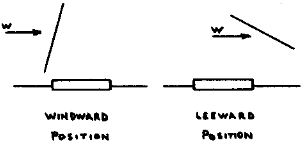


Fig. 5
EQUAL HEELING EFFECTS

Ever since my backward sailing model shot across the reflection pool, I have been convinced that herein lies a possible answer to the problem of handling really large sail areas but it was not until I saw the article on BOTJE 111, in AYRS No. 47, that a possible practical solution occurred to me. The boat would be similar to BOTJE 111 but the mast would be stepped nearer the main hull and would lean toward the outrigger which is always carried to windward. The sail would be sheeted tack and clew, bow and stern of the outrigger.

See Fig. 6. The boat would always sail with the outrigger to windward as discussed in the BOTJE article (AYRS No. 47). The BOTJE outrigger was inclined and high sided to serve as an airfoil. I believe it would be better to use a more normal outrigger float to reduce the windage. If necessary to incline the sail still more, outriggers could be added to the outrigger float as in Fig. 7.

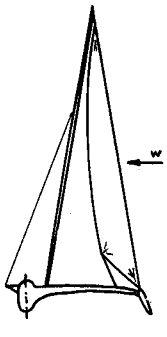


Fig. 6
Modified Botje III

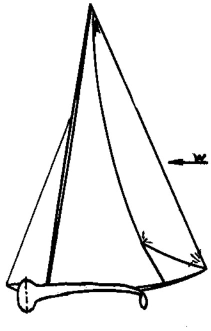


Fig. 7
Extra Outriggers

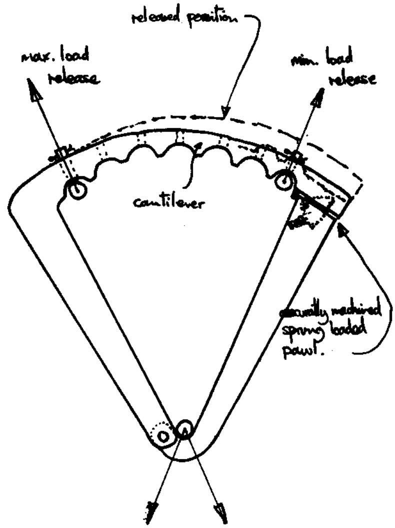
WEAK LINKS FOR CAPSIZE PREVENTION

By R. L. Cundall, c/o Folly Inn, Whippingham, Isle of Wight. July 1975

I am most interested in the article in Airs No. 9 by F. Taylor, concerning a weak link system for multihull capsize prevention.

Once a multihull has been designed and proved to be a seaworthy craft in most conditions (provided evasive action is taken during extreme wave conditions) then any capsizing movement must be directly related to sail loads and hence sheet loads. The concept of a weak link or trip mechanism where major overloads could be exprienced is a very sound and well proven idea. Electrical fuses are an example.

May I suggest, therefore, a reusable, variable strength "weak link clip," which could be put at mast head or anywhere as the safety of the yacht requires, but certainly between mainsheet block and traveller as suggested, provided the fall of the sheet is made on to the block.



R. L. Cundall's Weak Link System.

I can envisage one of the simplest mechanical systems to be based on the "Senhouse Slip" for quick release, actuated by a notched cantilever to give variable load release. Depending on the point of sailing, tension of sheets, state of sea, etc., then the correct notch could be selected to give main sheet release with excessive wind gust overload. A retaining strap, between boom and mainsheet horse, after release would retain enough wind in the sail to be able to manouver and facilitate easy recovery of the mainsheet.

By taking various main sheet load measurements (load and strain measurements is my job!) at near capsize state and relating this to cantilever design, it would be reasonably easy to construct the "weak link" to be a reliable and standard part of multihull equipment.

I am sure there must be other applications for a link of this kind, where instant release is required when a shock load is experienced. Jib release could, of course, have the link in series with sheet from clew to winch so as to dissolve any winch release problems.

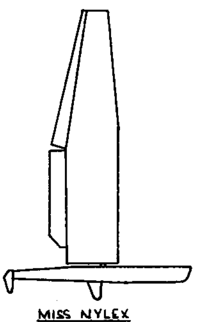
Unfortunately, I do not, and have not sailed a large multihull, so I am not fully aware of the problems involved, but I hope my suggestions are relevant to the subject of multihull safety.

If there is any interest in this "weak-link" clip then I would be delighted to take part in practical experiments to evaluate the feasibility of the system.

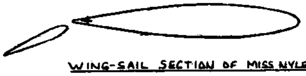
WINGSAIL DEVELOPMENTS

By Commander G. C. Chapman, RN.
The Rock, St. Brent, S. Devon, U.K.
October, 1975

In earlier articles I have described the development of a type of wingsail suitable for dinghy-size boats, and discussed the possible benefits of wing-section sails over ordinary soft sails (References 1—3). Since I made the Mk. 1 and 2 wingsails, the latter shown on the front cover of AYRS No. 76, there have been various steps forward.



MISS NYLEX



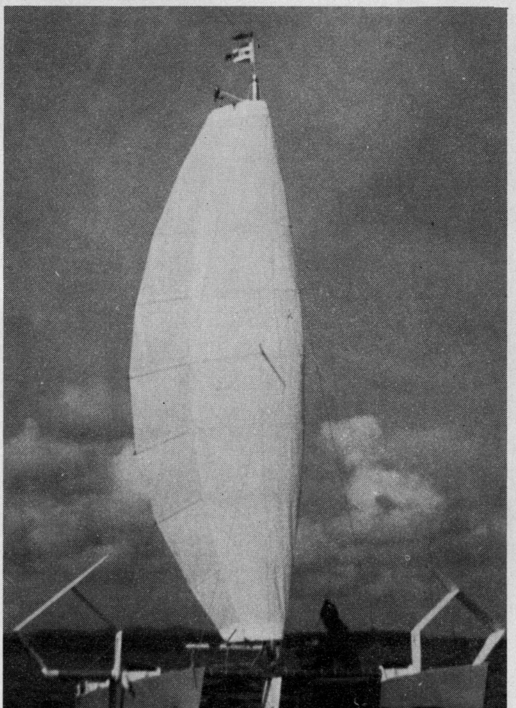
WING-SAIL SECTION OF MISS NYLEX

In Australia, MISS NYLEX has been built and sailed to retain the "Little Americas' Cup" for C-class Catamarans. She has a rigid wingsail with a movable flap (see sketch). The flap is some 25% of the total chord, and is set a short distance clear of the trailing edge of the wing: its angle relative to the wing can be controlled. The effect is that the helmsman has available a fully variable section, from symmetrical (with the flap in line with the wing) to a full deflection of perhaps 45 degrees. This latter condition enhances the lift coefficient to a claimed maximum of 2.5 compared to around 1.6 for most other wingsail sections—for use on broad reaches and down wind. (Reference 4) Close hauled and in a stronger wind sufficient lift can be developed with a small deflection of the flap, and with less drag—much less drag than for a comparable Bermudian rig. It is also noteworthy that the foot of the wingsail comes close to the trampoline, effectively increasing the aspect ratio.

Back in UK, Reg Bratt's SHOOTING STAR and BOREAS have used his own design of wing-mast and sail to good effect. (Reference 5). This design has four features; a wing-section mast to reduce drag: the leech-batten and wishbone, to reduce the effect of twist: the 'cut-away foot' to reduce the vortex at the foot of a sail, normally caused by a long foot and boom: and a raising of the sail's area into the stronger wind which prevails as one ascends. This design has proved its efficiency in that at 10 sq. metres (107.4 sq. ft.) it has driven BOREAS (a slightly modified UNICORN)at 15 knots compared with 16.2 knots on a standard UNICORN with its 150 sq. ft. battened una-rig sail, both at Portland Speed Trials, 1974 (ED. This gives BOREAS a

7% better "Bruce Number" than the UNICORN).

My own BLUEY, a 16ft. by 10ft. catamaran, in 1974 set the Mk 3 wingsail. This was a logical development from the Mk. 2, embodying as improvements (a) a curved leading edge, with more of the 'solid' wing ahead of the mast, to stiffen the wing in its fore-and-aft plane and (b) a greater proportion of the chord as wing. However the foot remained much as before with a conventional boom, and a gap below it—for the helmsman to crawl through when tacking. Being mounted on a catamaran, the mast has to be stayed, instead of being stepped IN the boat: and to simplify manufacture, I used 3 in. by 16 swg aluminium tube for the mast. Two main modifications were made during 1974: the luff had several inches cut off to enable the wingsail to conform to the IYRU measurement rules, and bring it within 10 sq. metres: and a pair of spreaders had to be fitted to the wing-batten half-way up the mast, with jumper stays, to stiffen the mast wing combination in the athwartships plane. Without the jumper stays, and with some rather alarming bending of the mast and momentary slackening of the rigging, BLUEY did 12.2 knots at Portland in October, 1974.



G. C. Chapman's Mk. 4, 10 sq. Metre Wingsail and foils. Raised by rotation about axis of forward cross-beam.

The Mk. 3 wingsail perpetuated the arrangement of flap battens used in the Mk. 1 and 2; namely the continuation of the battens, in elasticated pockets, into the trailing edge of the wing. The term 'flap' applies to the single thickness part of the wingsail, abaft the 'solid' part, referred to as the 'wing'! This has the result of restraining the deflection of the flap relative to the wing, particularly when the wind blows on the 'wrong' or 'leeward' side of the wingsail

The headboard, projecting aft from the 'headbox,' is sheeted by sheets led up from below: and the normal clew and boom-end are sheeted in normal fashion to a sliding block on the after cross-beam. The leech-line is of 1.5 mm. wire. Thus when closehauled, with the sheet well pulled down, the flap is held taut and to windward, relative to the wing, so that any tendency for the flap to twist, is reduced. However, slight crinkling or creasing occures where the flap battens enter the wing.

The Mk. 4 wingsail adopts Reg Bratt's proven advantages, while retaining the ability to lower the wingsail easily which MISS NYLEX does not have. The main features are:—

(a) Wing section is 57% of chord: flap is 43%.

(b) Wingsail is symmetrical about the horizontal axis at half height.

(c) Mast is just over one-third of way aft in wing: so cloth acts as a jumper stay forward and aft of mast.

(d) Mast is just less than 25% of total chord from luff, so that CE is just abaft mast, to reduce sheeting force yet retain feathering capability.

(e) Flap battens butt against aft-ends of wing battens (or formers)—to help support flap against leech-line.

(f) Wire leech-line is tensioned by a winch on boom.

(g) Head-board sheets are "driven" by footboard.

(h) Restraining sheets are fitted at half-height.

(i) Jumper-struts and stays from Mk. 3 are retained.

(j) Weight of whole rig is 57 lb. (0.53 lb./sq. ft.).

(k) Only a 'mini-boom' is required.

The photo shows most of these features. One view of the design rationale is that the wingsail can be considered as **two** Mk. 3's fixed boom-to-boom, with the sheeting force for each matching the other and cancelling it. There is thus (in theory) no need for any downward pull to be exerted on the clew, from the hull. In practice, the flap is rather like part of an umbrella with the wind underneath it—it wants to turn inside out. This inversion is prevented, when under way, by applying tension to the leech line—compressing the flap battens against the aft ends of the wing-battens. The half-height sheet also assists. But to tack, one does have to turn the flap 'inside-out'—so the leech line must be capable of release, and of course there must in practice, be some stretching of cloth both in the flap and in the wing. The winch and half-height sheet work well, and the wingsail when set and drawing is virtually twistless, and holds its camber. Its construction occupied about 130 man-hours.

Two areas in particular have needed reinforcement as a result of breakages experieced in increasing winds. Despite the near-balance, the foot-box and the key along the mast, take the whole torque exerted through the sheet, boom, mast and wingsail: and for tacking, the second wing-batten up is used by the crew to push the wing one way while pulling the flap the other. So footbox, key, and wing-batten are having to be strengthened. I expect that when this is completed the wingsail will withstand use in any wind whose associated sea the hull can withstand—true winds up to 25 knots and apparent winds a knot or two more.

Because the flap-battens no longer reach inside the wing, a wind on the 'lee' side will cause the flap to hang rather sadly at right angles to the wing, a situation reached by failing to put the flap about when tacking. Though the wing-sail will still drive the boat like this. I believe I have now evolved satisfactory drills for tacking and gybing—the 'detail' is too long-winded to give here: suffice to say that in light and moderate winds there is no difficulty. The basic sailing of the boat with this wingsail is a joy, and heaving to and sailing away again are simple.

As yet, I can give no figures to indicate how much better this wingsail is than the Mk. 3 or any other. At Portland this year (1975) with the Mk. 4 wingsail but up on hydrofoils, BLUEY did 12.4 knots. However, whereas to do 12.2 knots as a displacement boat, the Mk 3 wingsail had to be sheeted hard down and nearly close hauled, with the Mk. 4 wingsail and foils the sheet was well out and for a lot of the time the wing sail was operating with a very low angle-of-attack. So low that I am seriously investigating the possibility of using a full-wing-section, symmetrical, flap-less wingsail—but only, please note, for the high speed runs when a high lift coefficient is less importan. that a high lift/drag ratio. But for all-round use the Mk. 4 sail is certainly good, and I suspect that with tuning and improvements to the foil system—particularly for pitch stability—it will be possible to make even better use of it, at high speeds.

References:

1. Disa's Wingsail, AYRS No. 58, page 53 and page 64, Oct., 1966.
2. Wingsails for Plain Boats, AYRS No. 76 page 53, July, 1971.
3. Choice of Foil Sections for Yachts, AIRS No. 7 page 41, Nov., 1973.
4. Catamaran Sailing to Win: by Chris Wilson and Max Press, published Kaye and Ward (UK 1973) or A. S. Barnes and Co. Inc., Cranbury, N.J., 1973.
5. Shooting Star, AYRS No. 76, pages 68 - 71, July, 1971.

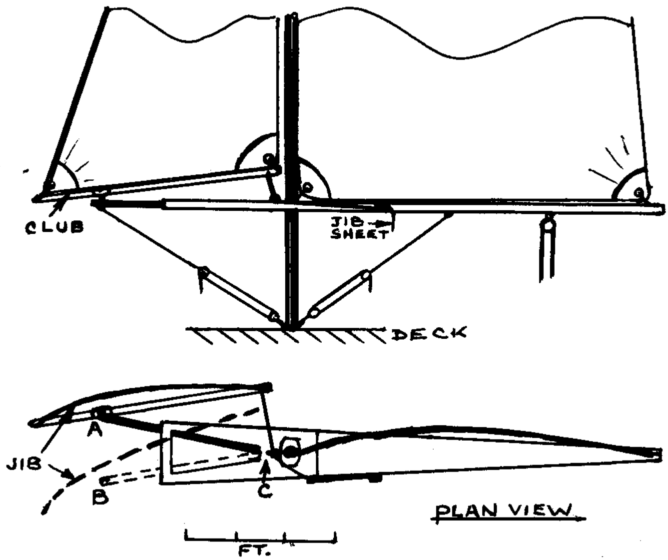
Editor's Note: The wingsail with flap as used for Miss Nylex is exactly as suggested by P. V. MacKinnon in AYRS No. 14, page 7, 1957. The same idea had also been used by P. S. Germaine in 1944 as shown in AYRS No. 26 page 36, 1959.

THE BOOMSPRIT RIG

By K. R. May, Brook House, Middle Street, Salisbury, U.K. Sept., 1975

This rig was fitted to my proa-tri, KEEEK for the 1975 John Player Sailing Speed Record event at Portland in the 10 square metre class. It evolved partly to utilise the mainsail I already had and partly to provide an easily managed rig for the harassed proa pilot who can spare only one hand for the tiller and one for the mainsheet, both in constant play during a speed run. Feet are fully occupied to stop one falling off and to adjust ones position on the crossbeam, so there is nothing to spare for jib adjustment.

As it happened, I chose to sail as a tri with no anxiety about capsize, therefore less demands on the helmsman, but the simplicity of handling the rig was still a great asset.



"BOOMSPRIT" RIG

Looking at the plan view in the diagram the 'wooden boom' is made up to the long narrow V shape with the rotating mast passing through a hole in the boom and connected to it by a gooseneck. Forward of the mast the boom forms a yoke containing the boomsprit AC. This is pivoted at C and controlled by cords (not shown) so that it can be set anywhere between AC and BC. At A is a universal pivot connected to the jib club. On the club the pivot can be slid back and forth to find the best position for the set of the jib so that it has a very taut luff and a taut leech to minimise twist and sag. The jib is also fully battened. Because the jib is semi-balanced only a single light line is needed for the jib sheet. Adjusting the boomsprit between A and B gives the range of position for the jib indicated in the plan view. I fitted this pivoting boom sprit idea because I had no means of telling which would be the best position for the jib, all looked equally good on a model. In the event it seemed that a position as good as any was with the boomsprit central. (This will enable the rig to be much simplified and stronger because the pivoting complication can be done away with and the main boom made from two aluminium tubes bent into a wishbone shape enclosing the mast).

Once the jib sheet has been set to give the best airflow behind the mainsail, there is no further occasion to touch it whatever the course and the jib is self tacking. The only exception is on a dead run when it is best to have the jib sheet hard in with the boom athwartships. Other advantages are that the jib is never blanketed on any course and the pressure on the boom sprit takes some of the load off the main sheet. A larger jib in relation to the main might be better still in this respect (present ratio 1 to 2½).

Disadvantages are that the rig is slightly heavier than the normal sloop rigs and takes a little longer to hoist because the two 3-part-boom downhauls have to balance each other and at the same time, give maximum tension to the luffs. It is not possible to have an overlapping jib unless the unacceptable complication of a folding or telescoping club is used. These are described in AYRS No. 26 pages 22, 23. However we do not actually know if a jib overlap is an advantage or not.

In use the rig showed a few points of inadequate strength in strong winds but these are easily rectified. Once hoisted, it was certainly easy for the singlehander to control and drove the boat to a very close second place in the speed trials. Whether or not it actually has good driving efficiency compared with advanced rigs, I have no means of knowing. It was certainly far from being close-winded, but this may largely be due to the big windage of the hulls on which it was mounted.

Other examples of foresails on main-boom extensions are in AYRS No. 33 pages 18 and 32 and AIRS No. 1 page 43.

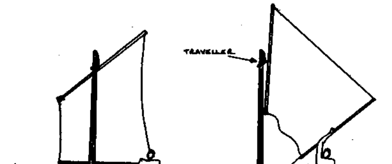
THE DIPPING LUGSAIL

By Roger Mulholland, 20 St. Leonard's Road, Exter. Nov., 1975

Having had the privilege of sailing the Exeter Maritime Museum's "Clovelly Picarooner,' I share Dr. Morwood's enthusiasm for the Dipping Lug Sail (page 11 of AIRS 10), but I would like to make a couple of points.

Firstly, "carrying the foot of the sail around the lee gunwale," this works giving a slight but noticeable increase in speed if the clew is brought down to gunwale level (on the picarooner the Tack of Foresail is already at gunwale level being attached to an Iron Hook in the bows). But one then needs a look-out perched in the bows or must continually lift up the foot of the sail and peer under to make sure one is not about to run into something. In practice, I prefer to sacrifice Theoretical Efficiency and hoist the yard a little higher up the mast which brings the foot of the sail up to allow me to see where I'm going (Alternatively, and at greater expense, one could have windows in the foot of the sail).

Secondly, I prefer to have a boom with the sail loose-footed to keep a curved foot. The reason for this is that the further off the wind one comes, the more the foot of a boomless sail "bags" unless one pushes the clew out with an oar which is a nuisance. Also by taking a rope from the forward end of the boom, back behind the mast instead of attaching the tack to a fixed hook, it is possible to come about by pulling the boom back behind the mast and letting it swing forward again on the now lee side of the mast.



In the sailing position, the weight of yard, sail and boom aft of the Traveller is greater than that in front, so in trying to swing the yard more nearly horizontal, the weight keeps both Luff and tack rope in tension. The traditional method of tacking, the dipping lug involves unhooking the tack from the bows, unhitching the halyard from the weather gunwale, bringing the whole sail and yard round the back of the mast and finally re-attaching the halyard to the new weather gunwale and the tack to the hook in the bows. Not so easy if you're single handed! The traditional luggers also have a standing lug mizzen. This is not efficient if considered purely as a driving sail, but for manoeuvring and as an auxilliary rudder, it is invaluable. From my admittedly limited experience, it would appear that a Lug rigged boat without mizzen is more difficult to tack than one with.

Has anybody tried a dipping lug on a Bembridge Redwing? and if so, how did it compare with the conventional Bermudan sloop rig ?

TAKE A FEATHER —

Some Thoughts by Michael Ellison.

Take a wing tip feather from a seagull—this has evolved over a long period to give lift in one direction—upwards—at minimum drag.

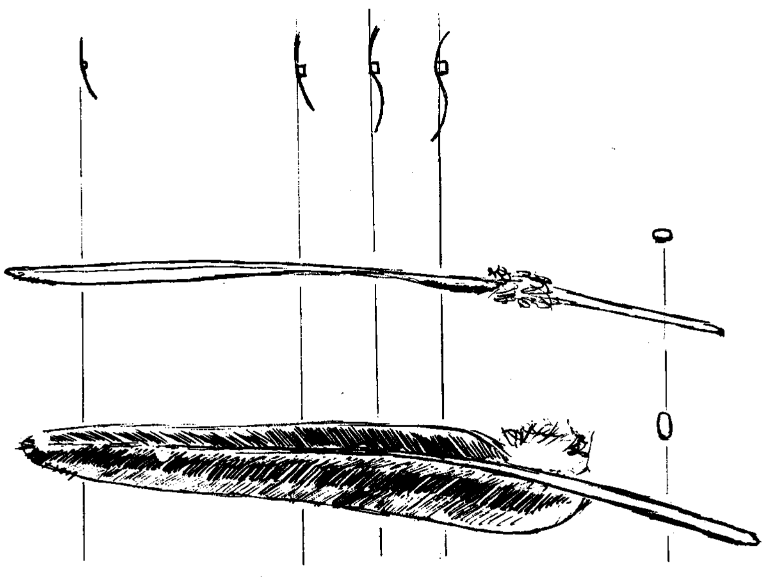
Sit the feather upright as required on a sailing craft and notice the position of the "mast." A further look at the root of the "mast" of the feather shows that it is nearly circular in section and therefore it must be at the centre of 'lift' or 'effort' because otherwise the 'mast' would twist or revolve in its holder. (It's hard to prevent a smooth circular section from revolving—to do this an oval shape would have developed).

Taking a number of wingtip feathers it seems that birds developed for fast flight have less 'sail area' forward of the 'mast' than those intended for lower windspeeds.

These observations fit in quite well with the shape of modern wing sails and the proportions are similar to those of the Morwood semi-eliptical square sail and Col. Hasler's version of the junk rig.

Editor's Note.

but the root is oval in section! Cut it with a razor, where the feathers are, the mast is rectangular.



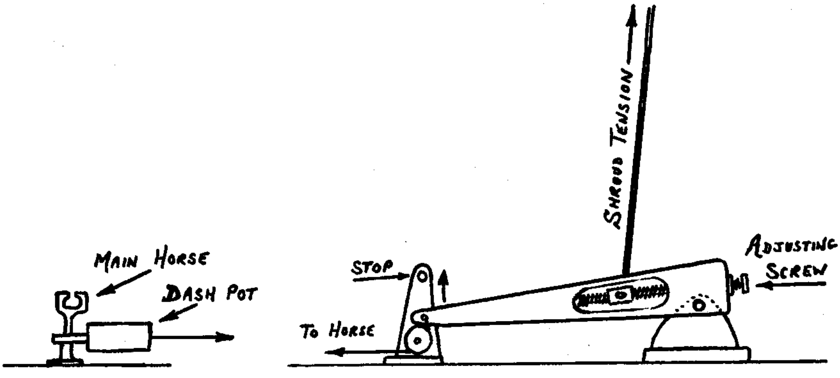
Wing Tip Feather from Seagull.

ANTI-CAPSIZE SHEET RELEASE

From Lord Strathcona, 89 Barkston Gardens, London S.W.5. Oct. 1975

Reading about the problem of preventing the multi-hull capsize set me thinking that the capsizing force is transmitted from he sails to the hull by he rigging. I therefore devised a system of sensing the shroud tension so that it could release the main sheet.

Dimensions would depend upon the forces involved and the whole thing would need to be carefully engineered to avoid jamming or frustration by friction if inadequately lubricated. There is of course, considerable choice of layouts. The principle seems sound yet I've not yet seen it suggested.



Anti - Capsize Sheet Release

By Lord Strathcona.

NAVIGATION BY COMPUTER

In the second part of this article, the author solves the problem of establishing a D.R. position after a period of tacking, using the Hewlett Packard 45 pocket calculator.

by E. N. Trounson

Vector calculations

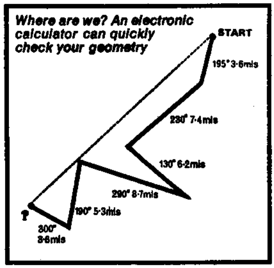
The ability to perform the operations described last month does not exhaust the possibilities of this remarkable machine. The facility is provided of operating in rectangular coordinates and interchanging these with the resultant vector which in a nautical context is the course steered and distance run. Also different vectors including negative values may be added to display course and distance made good.

Position after tacking

Establishing a good D.R. position after a period of tacking is perhaps the most vexatious problem facing the navigator. A solution can be found by plotting on the chart (assuming the watchkeepers have kept a note of the course sailed) but the work is tedious especially in heavy weather and when a tidal set has to be allowed for.

Suppose the yacht makes alternations of course as shown in the accompanying diagram. The lengths of the various legs are conceived in miles as read from the ship's log but could equally be times elapsed at constant speed.

There is no need to do any drawing! Simply enter successive courses and distances together and press keys R Σ+. The equivalent horizontal and vertical distances are accumulated automatically in X and Y stores whence the resulting angle and distance can be extracted by keying for polar coordinates.



Where are we? An electronic calculator can quickly check your geometry

Begin each entry with the course.

195 Enter 3.6 R Σ+
230 Enter 7.4 R Σ+
130 Enter 6.2 R Σ+
290 Enter 8.7 R Σ+
190 Enter 5.3 R Σ+
300 Enter 3.6 R Σ+
RCL Σ+ →P
(displays distance) (18.93)
X ⇄ Y
(displays bearing (−132)
360 + (228)

Course made good 228° 18.93 miles.

Suppose an average tide of 115° 1½ knots over 6 hours.

360 −
115 Enter 9.0 R Σ+
RCL Σ+ →P (17.49)
X ⇄ Y (−160.26)
360 + (199.74)

Corrected course made good 200° 17.49 miles.

Course and Distance to a given destination

This problem is traditionally solved by means of Traverse Tables which are not very easy to use and apt to baffle the occasional navigator.

The calculation is complicated by the fact that while a minute of latitude always represents a nautical mile (neglecting the slight eccentricity of the earth) minutes of longitude are miles at the equator but zero at the poles.

Before they can be used as a measure of distance in an E-W direction they must first be converted into a quantity called *departure* by multiplying by a factor which is the cosine of the mean latitude for the passage in question. Minutes of departure can then be treated as miles.

The principle is to find first the difference of latitude of the two points expressed in minutes, i.e. the 'vertical' mileage, then the departure in minutes which is the 'horizontal' distance. The calculator reckons journeys S or W as negative in accordance with the usual convention of rectangular coordinates. Finally convert to polar coordinates, i.e. course and distance to run.

For example take a passage from Eddystone Light (50°11'N, 4°16'W) to Isle Vierge (48°38'N, 4°34'W).

Begin with latitudes. Key **destination first.**

48.38 DMS→ STO 1
50.11 DMS→ STO 2
+ 2 ÷ STO 3 (49.41)

Mean latitude is 49.41°

RCL 1 RCL 2 − 60 X STO 4 (−93)

d lat is −93 i.e. 93'S.

Now longitudes, destination first and *West is negative* so use change sign key.

4.34 CHS DMS→
4.16 CHS DMS→ − 60 X (−18)

d long is −18 (i.e. Westerly)

RCL 3 COS X (−11.71)

departure is −11.71

RCL 4 TO POL (93.7)

Distance is 93.7 mls.

X ⇄ Y (−173)

Displays course −173°

360 + (187)

Course is 187° true.

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