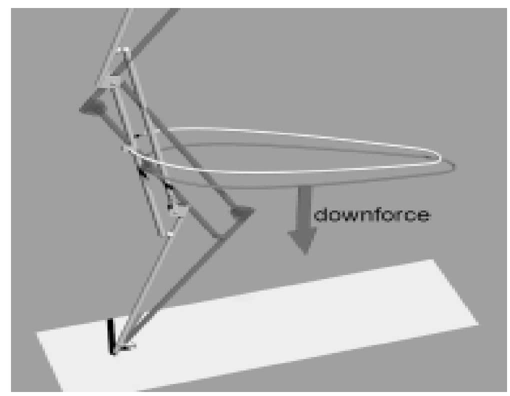
Catalyst

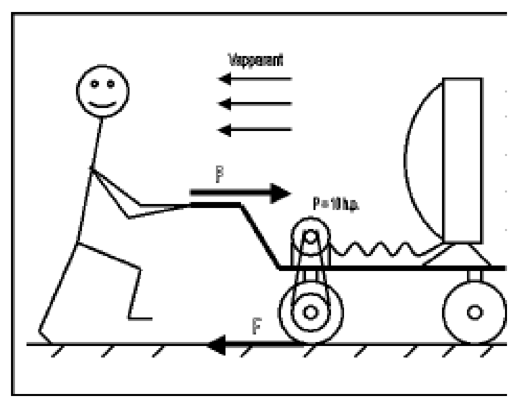
Journal of the Amateur Yacht Research Society

Number 18 October 2004

Features



Regulars



Richard Dryden's foldable "Transition Rig"

Catalyst

Journal of the
Amateur Yacht Research Society

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

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

AYRS subscribers receive both *Catalyst* and the booklets. Subscription is UK£20 or US$30 per annum for a Full Member, £10 or $15 for students and retired members. Subscription requests and all other queries to be sent to the AYRS Office, BCM AYRS, London WC1N 3XX UK, phone/fax +44 (1727) 862 268 or email: **ayrs@fishwick.demon.co.uk**

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

Website: http://www.ayrs.org

ISSN 1469-6754

Rogue Weather

As I write this, Hurricane Ivan is working its way through the United States, having left a trail of destruction through the Caribbean. This year too has apparently seen the first recorded hurricane in the South Atlantic. It would seem that the weather is getting worse.

Coincidentally though, there has been a fair amount of evidence publicly presented recently that suggests that we may not know about the weather at sea as we might. Various reports have highlighted so-called "rogue waves" with the suggestion that these events, which fall outside the predictions of established wave theories, are not merely statistical aberrations, but more commonplace.

Of course for most of us, the incidence of 30m waves in the Antarctic Ocean is of academic concern. However, the recording of sudden waves more than 2½ times the average height off the European and American seaboards is more worrying.

Clearly to produce seaworthy yachts, we must have an idea of what the sea can do. To date, an empirical understanding has been good enough; but given this new evidence, can we really say that is still true? Does anyone out there know? If so, could they please advise us?

Simon Fishwick

Subscriptions

Just a reminder that 2003-4 subscriptions run out with this issue. Thank you to those who have already renewed; we look forward to hearing from you others. You may find issuing a bank order is more convenient. Details (including the all-important refence number) from the AYRS office (contact details at left).

Centenary Cup and Unrestricted 20ft at Worthing

Rob Garka & Roland Lewis finishing first to win the AYRS Trophy

Sailing in Worthing first took place 100 years ago, in 1904. In honour of the occasion Worthing Yacht Club held an open race for the Alderman E T Cooksey "Century of Sailing in Worthing" Cup. This race was also the first for the Amateur Yacht Research Society Unrestricted 20ft Trophy - awarded to the fastest boat around the course of 20ft LOA or under, regardless of handicap.

The absence of wind early in the morning led to the postponement of the start, but by 12.15 an onshore breeze had set in and the fleet were sent off on a diamond course from close to the clubhouse. As might be expected, the fleet was dominated by catamarans, with only a handful of monohulls (a 505 and two Blazes) racing for the handicap prize. No fast skiffs turned up, although with the wind light they could have given the catamarans a good race.

From the start, the Tornado of Rob Garcka and Roland Lewis led, making good use of the windshifts over the 40-minute first lap to gain a lead of nearly half a leg over the Tiger of Hutchcroft & Garcka and Nacra of Winrow and Winrow. At the end of the second lap Garcka/Lewis still led, but a battle was developing for the following places between Chadder & Chadder in their Tiger, Winrow/Winrow, Hutchcroft/Garcka, and the Tiger of Farrow and Heasman. The procession continued for another lap as the wind increased to 7 knots and backed south-easterly; but with the Mayor of Worthing waiting to present the prizes, Race Officer Mike Hattemore called a halt at 2.45pm.

First across the line, and winners of the AYRS Trophy were Garcka and Lewis, but the Centenary Cup went on handicap to the Tiger of Martin and Sam Chadder. Prizes were also awarded to the first Junior Helm (Robbie Garcka) and the first Female Helm (Jill Andrews).

The AYRS Trophy race will be run again next year, and it is hoped that it will provide a regular event where any kind of boat - monohull, multihull, hydrofoil, etc - can race on level terms.

Century Cup (Handicap): *1st Chadder/Chadder (Tiger 1551), 2nd Winrow/Winrow (Nacra-18 34), 3rd Stevens/Stevens (Dart-16 1902), 4th Poole/Lloyd (5o5 8511), 5th Goodwin/Neale (Dart-18 5466).*

The Case for a New Mug

I have had a look at the article in the latest AYRS Journal 17 and have no comments on the draft rules for possible boats. I do however have a few concerns on the paragraphs related to race management. I have long learned that criticism and/or comment on race instructions is never well received - race officers are terribly possessive about their documents. So if I offend I apologise - just a little. My only concern is that the Club organizing the racing should get the documentation right.

Page 10 under **Rules.**There is no such thing as the IY and RR forming the IYRR. The International Sailing Federation (ISAF) replaced the International Yacht Racing Union (IYRU) many moons back. All references should be to the Racing Rules of Sailing (RRS) currently 2001 -2004. Note that changes will be introduced after the Olympics in August and will come into effect on, probably April 1, 2005, although earlier usage, if the revised RRS are published, maybe allowed.I am not happy with the phrase "equivalent rules in later editions." Could I suggest "as amended by ISAF."

Page 11 under **General.** Para 1. First sentence: Generally the RRS cannot be *modified.*See Rule 86 for guidance. They can be *changed* - (I know it is nit picking but the language is important) - although *amended* is commonly used. You actually do not have to state that the RRS are amended by Class Rules and the Sailing Instructions because, by definition, all documents are part of the Rules - see definitions on page 153 of the RRS - YR1/01. But if you do have major amendments to the RRS (see for example *proas,* it may pay to highlight the fact that thereare amendments to the RRS). Second sentence: This is redundant - see Rule 42.1 which is more comprehensive that the draft sentence.

Para 2. First Sentence: Under Rule 76.1 the Race Committee (RC) has the right to reject or cancel, not ban, any entry. Second Sentence: the Race Committee (better kept singular for consistency) may abandon or postpone a race (but not *cancel*). Normally a RC will abandon before the start for high winds, postpone before the start for a number of reasons or abandon after the start. See Rule 32.

Para 3. First Sentence: Currently the accepted figure is £**2**,000,000. The RYA has not, as far as I know, committed to that figure but uses it illustratively. I would suggest you use the £**2**,000,000.I know that there are problems with overseas entries where insurances are different but I would advise that you stick to £**2**,000,000 if racing is in the UK. Second Sentence: The Race Committee should accept a signature on the Entry Form that the relevant insurance cover is held. There is the risk, albeit small, that there is a "transfer of responsibility" to the Race Committee if it inspects insurance policies - and misses a point.

Para 4. Second Sentence: I do not see the relevance of Rule 16.1. Third Sentence: There are two penalty turns - 360º for hitting a mark (Rule 31.2) and 720º for a RRS infringement (Rule 44.2). The difference needs to be spelled out in the Notice of Race as you have only covered the 720º situation. I think further thought maybe needed in defining a penalty turn for a proa which has to "shunt."

Page 12. Second paragraph. Second Sentence: The host club does not decide the course - that is the responsibility of the Race Committee appointed by the host club, the organizing authority (see Appendix J of the RRS). Third Sentence: If you genuinely want a windward leg and the wind shifts so that you no longer have a windward leg you can (i) abandon that race and re-start it or, (ii) change the course during the race (Rule 33)

I would be happy to review any documentation - please remember that the advertisement and Notice of Race (NoR)are *invitations* and ought to contain all the information need for a competitor to decide whether or not to race. Current thinking is that the NoR should be loaded with as much information as possible and that the Sailing Instructions should be reduced to the minimum to allow a competitor to sail the race.

Regards, John Evans

jpevan1@eurobell.co.uk

[All of John's points have been taken onboard in the latest revision. However, while insurance for dayboats is normal in UK, we hear it is almost impossible in other parts, e.g. USA. £1M was set as the recommended *level because that was all Worthing required. - Editor]*

I strongly support in principle the proposed Unrestricted 20 Foot Class not least because I am trying to develop a fast tilt-wing hydrofoil proa. However, these craft are both light & spidery. I would prefer a greater LOA, suggest 6.5 metres (come on Worthing, go modern)!

I favour no restrictions on spars, sails or other wind-powered devices e.g. autogyro rotors or Flettner rotors, except that impractical wings should be banned. Kites on long lines are totally unseamanlike for racing.

Boats capable of high speeds (30-40 kts) and high acceleration should perhaps have a deployable water brake for safety reasons.

Insurance is another matter. Does anybody insure experimental craft? I propose to experiment on a deserted lake, strapped in & with a safety helmet!

Michael Collis
Sharnbrook , UK
Michael@thecollises.go-plus.net

The aim of Charles Magnan's proposed Unrestricted 20 Foot class is to see some interesting development at a budget rather less than that for a C class campaign, and rather more relevant to average sailors. I suggest that a length limit is a fundamental mistake.

Length limits always lead to boats that are high powered for their size, which usually results in a highly stressed structure, leading to high cost. For example, the Open 650 class that competes in the Mini Transat was intended to make single handed offshore racing more affordable, but now they are cheap only in comparison to similarly high-powered but larger boats. Even adding a sail area limit will not help. The Formula 40 had a limit of 90 sqm, but that only meant that the boats ended up with very high aspect ratio rigs, which again needed very high sheet loads to control twist and added a lot of compression loads to the structure. A length limit will also restrict competitive designs to catamarans and trimarans, possibly with hydrofoils. A proa always needs more length than a cat or tri with the same sail area, and triscaphs are even more firmly ruled out. For a perspective, in 1984 a triscaph called Amaran was exhibited at a Dutch boat show. The sail area, weight, payload, materials and cost were similar to those of beach cats such as the Hobie 16 or Dart 18, but the length was 12 m and the beam was 10 m. Scaling that design down to 6 m, such a triscaph could possibly carry a single 8 year old. If we want to encourage designs more varied than cats and tris, possibly with foils, the length limit must go.

An unlimited sail area again favours boats that are high powered for their size, and I would expect to see the development of a multihulled or foiled equivalent of the 18 foot skiff, though the restriction to a single rig would keep costs down a bit and encourage reefable rigs.

To keep costs down, something still needs to be limited. I suggest limiting sail area and sail height over the water (span for kites, though here the limit may be more generous), and leave everything else open. The limited power available will discourage very large and heavy boats, which people could not pull up the beach, but would offer freedom to explore less orthodox designs.

Robert Biegler, Trondheim
Robert.Biegler@svt.ntnu.no

Whilst I applaud Charles Magnan's ideas for a class with minimum restrictions I think that Sail Area would be a better one.

Looking at sailing at its most fundamental level it is described by the classical thermodynamic model of Source - Machine-Sink. The wind is the source of energy. This goes to the machine, and because the latter is less than 100% efficient the unused energy is dumped in the sink. The latter being the sea. Just as the wind is the source of the energy the sail area of the boat determines how much we can catch. This makes it a more fundamental determinant of the boats performance than does its length.

There are also established sail area divisions, i.e. 10 square metre, and classes A,B,C and D. Charles's comments about them are about right, so what I would suggest is that the Society supports one, or perhaps two of these, and establishes a competition to be sailed at a variety of members clubs over the season. This would provide valuable data about the performance of a wide range of configurations in a wide range of windspeeds and locations.

I would be interested to know what members think.

Graeme Vanner
graemevanner@aol.com

[Do we have here a request for another class - perhaps a B-Class without the size limits? AYRS by the way is, or was, the Secretariat for the 10 sqm Class - it's just that there are no boats!

What do other people think? This correspondence is still open! - Editor]

Romy Rig and Mast Bases

Having skimmed through the July issue received today, I find things I have for comment.

1. Romy rig – I hope the patent mentioned is not one that could inhibit development, and I have remembered (though unable to find a quote a Newsletter for the date) that Beynon-Tinker had the prototype of the "Tinker" inflatable at Ken May's party at Poole. This was rigged with a two-pole and crossbeam mast that plugged into the rowlock fittings of the dinghy and supported a lateen-yard and loose-footed sail. This sailed well – including nicely to windward - & the wide spaced base and forward slant of the "masts" and their connecting beam meant that the sail was not foul of the spar on the lee side.

The two ideas differ in detail but not in principle. B-T deserves some recognition – pre-1980 I think.

2. I am much bothered by Fig 5-52 of the *Atlantis* on p34. It seems the stub-mast is supported by a "pyramid" of rigging based on the twin hulls. This would attempt to provide torsional stiffness to the rectangle of two hulls and cross-beams by the rig to the mast.

I saw what happened to a new Wharram cat that some amateur had rigged with modern dinghy wire and rigging screws as a pyramid. They were brought back off the shingle into Yarmouth IoW by the lifeboat with the ex-mast a bit shorter in the middle and not much use for its prime function!

Helpful suggestion therefore – mast supported by three stays only – 2 to the hulls and 3rd pivoted to the centre of a cross beam acting as a whiffle-tree between the hulls. Difficult to overload.

3. (P16) The rotary parallel motion illustrated is fine, but the mechanism I had at Fred's party in 2003 in incomplete model form lacks a means of cyclic pitch modification to allow it to start from rest.

The Voight-Schneider version feathers to blades lying in the cylinder of their rotation – though it could provide a large cross-section as small depth for efficient canal-boat drive, and perhaps help the jet efficiency of human efforts. Has anybody got a method of cyclic pitch to go round as Fig (c) and feather as Fig (d)?

Enough to let off my immediate steam

O T (Sue) Lewis
Upavon, Wilts, UK.

ROCAT Update

You have expressed interest in the ROCAT rowing catamaran ... sorry it has taken so long, but here is a brief status report and a pointer to some further information.

The ROCAT is alive and well but, unfortunately, running a bit behind schedule. This is partly due to problems with the first hull moulds (which I had to reject on quality grounds and have remade by someone else), but it is also due to the number of innovations in the boat and the fact that it really is pushing advanced composites technology. It's immensely satisfying when something, that was recently no more than a figment of my imagination, is finally made to work ... but the slow progress can be very frustrating.

Things are moving much faster now that ROCAT Ltd has doubled its workforce ... Anthony Fryett (an extremely capable Plymouth University Marine Sports Technology graduate) joined the company in April and has been helping develop the ROCAT's novel production processes.

We now anticipate getting the first pre-production prototype on the water by the end of August then, after some intensive testing, we will build the first pukka boat for demonstration purposes and further sea trials. The journey has been a long one, but it looks as if the end is in sight.

Incidentally, the original prototype (which was at the London Boat Show), is the 2004 'Feature Boat' at the new National Maritime Museum in Falmouth.

Meanwhile, we have replaced the old (difficult to update Flash) ROCAT website with a basic 'development' site which will have regular reports on progress ... do visit and, if you can spare the time, drop us a line.

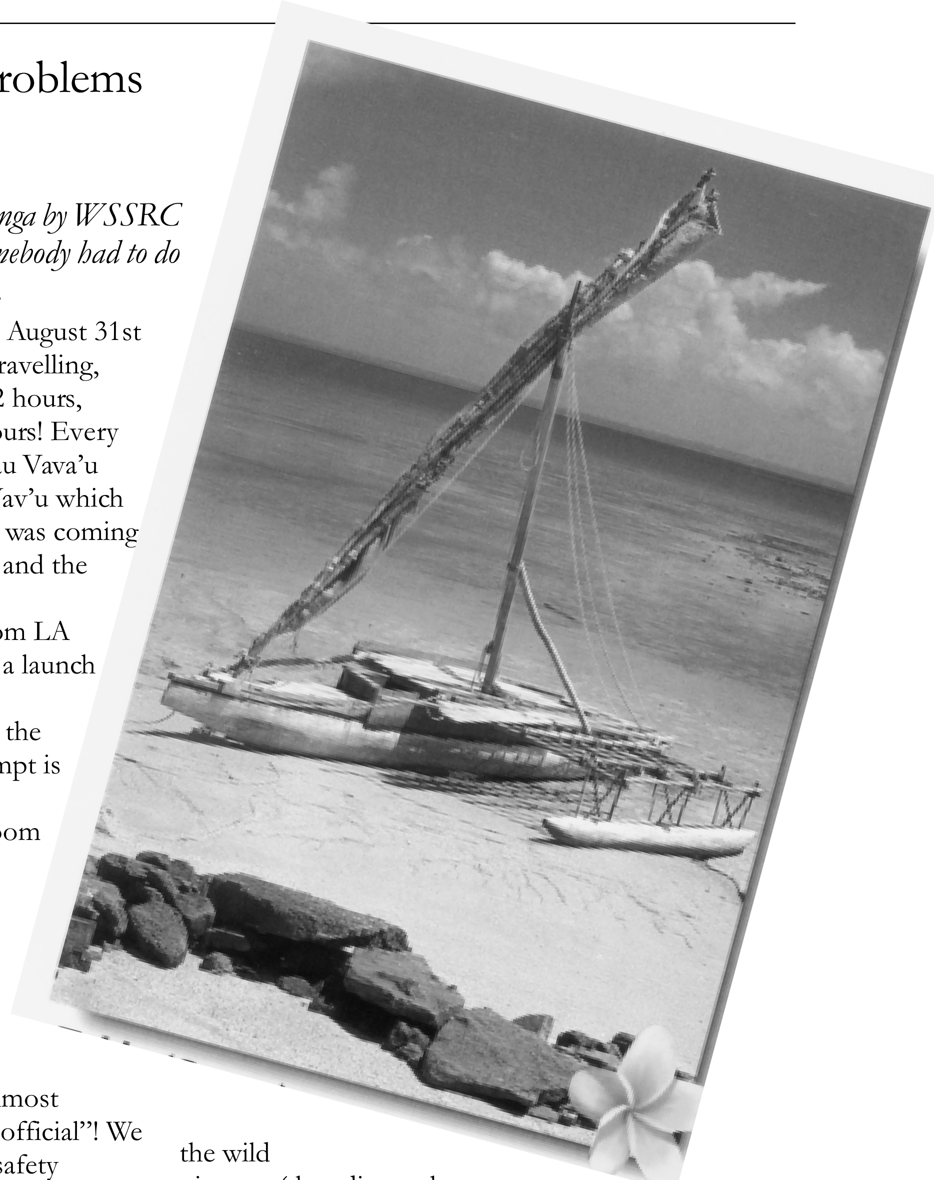
With our best wishes
Christopher Laughton & co
ROCAT Ltd
www.rocat.co.uk

Dear AYRS,
Here's the re-use whale, nearly finished to educate and show children ecoreefs through the holes in the bottom. It's a kite and electric outboard motor sailer.

All the best
Ken Upton
ecofrogtec@terra.es

TRIP TO TONGA (or Problems in Paradise?)

Michael Ellison has just been sent to Tonga by WSSRC to witness a speed record attempt (well, somebody had to do it!). This is part of his report to AYRS.



Departed Plymouth by coach 0730 on August 31st and returned on 8th at 1900 – 78 hours travelling, eight hours coach, flying 46 hours, boat 2 hours, airport waiting for baggage reclaim 23 hours! Every flight was on time or early except the Peau Vava'u airline flight from Tonga to Ha'apai via Vav'u which was late because the radio said an official was coming from London to observe a sailing record and the pilot is interested in sailing.

A couple from U.S.A. also flew out from LA and we were met at Ha'apai and taken to a launch with a forward cabin and a Yamaha 40hp outboard which was waiting to take us to the island where the base for the record attempt is established in a village. We landed on the beach and carried our bags ashore. My room was a hut made of concrete blocks, a corrugated iron roof and small veranda. The ceiling is covered with tapa cloth, above which live a family of pigeons. Luckily, they sleep at night. There is a comfortable bed, mosquito net, table and nails to hang clothes. It has a door but I never closed it, as stealing is almost unknown, especially from an "important official"! We had arrived in a land with no health and safety official, no mobile 'phones, no warning notices. If you want to sit under a coconut palm you can – safety is your own responsibility.

There are almost no doctors or dentists because there is little demand; no running water, and as this island is only 7 meters high the bicycles only have one gear, no brakes or lights or bells. There are two cars plus an ATV brought for the event team. Electricity runs from 0600 to 1400 and 1800 to 0200 but not on Sunday which is a day reserved for church and singing. The boat takes the children to school and brings them back; there are no lifejackets and the only lifebuoy I saw has a tree branch growing through the middle. No one can recall any child being drowned. Domestic water is collected from the roof of each building and stored in large covered tanks. Strangers drink bottled water from Australia. The village is surrounded by a stockade with sliding gates to keep the wild pigs out (they dig up the vegetable plots). There are lots of dogs to chase the pigs should they break in; they also bark at strangers but not at visitors living in the village. A different dog slept on my doormat every night. There are domestic pigs owned by villagers, I saw horses and a cow, chickens everywhere, many with chicks, but no cats or goats. There are no poisonous spiders or insects, and the sharks do not eat people who go to church nor the visitors to the island.

The islands are volcanic rock protected by coral growth. Waves break off the coral, which grinds down to form sand. 25 miles to the east are the high islands of Kao (1046m) and Tofua, which is active. It is thought that due to movement of the earth's plate in the area, the islands are rising but not as fast as the increasing water level.

In front of "my" hut on the beach was an outrigger built entirely of traditional material for comparison with the new proa of modern lightweight material for the record attempt, also for a film of the whole project. The idea is that the craft having a better sail area to weight ratio than a sailboard should be faster and so a copy has been built with a lifting rudder at each end, carbon wishboom inclined rig supported by bipod mast and semi-circle track. There is a lifting rudder each end in European style, and the two beams to the outrigger swing to bring crew weight "aft" and are joined by a net (canvas or fairing could not change shape). During my visit some runs were made to test the timing in force 3 to 4 breeze but no serious attempt could be made. In my opinion the shape necessary for a bow is quite wrong for record speed when it becomes the stern, and only the addition of foils can make this a serious contender. It is then not a modernised island craft.

A close look at the traditional proa gave me a real shock — the rudders do not work as on European craft by deflecting the water, they are fixed fore and aft on the lee side and steer by fore or aft movement of the blade altering the centre of lateral resistance and thus the direction of travel. There is no drag penalty of pulling a blade at an angle to the water flow. Why was this not made clear in papers I read at school? No mention in AYRS rudder design book...

The purpose of my expensive 25,000 mile journey was to help the islanders. Publicity would bring tourists who bring money. The islanders of all people should know from history — Captain Cook brought disease which decimated the population, and modern tourists will do the same. People used only to cities will have to be protected: they need medical facilities, water, electricity, tele-phones and some form of sewage treatment to limit pollution. Already Europeans are moving onto one of the islands and this is having a dramatic effect on the price of waterfront building plots. In Devon, probably all over England, we are building on waterside plots, which is great for developers and those who can afford to live there, but ordinary citizens are excluded from land where they have by tradition walked and freely kept boats. This is no benefit to local people here or in Tonga. I regret my contribution, which was not an obvious part of record speed under sail.

R Michael Ellison

Weymouth Speedweek ...

... will take place at the Weymouth and Portland Sailing Academy, Portland Dorset UK, from

Saturday 2nd October to Friday 8th October 2004.

The course is a measured 500 metres located in the middle of Portland Harbour. Dependent on wind and water, an inshore course may be set. These provide a challenge for the speedsailor to pit his wits against the elements and maybe even raise the world speed record from its current value of 46.52 knots..

The event is open to all kinds of sailing craft - boats, 'boards, kites, etc. There are NO rules deterimining seaworthiness, controllability or practicality, but it is suggested that anyone bringing a craft that is unable to sail back up the course as well as down it, should bring their own towboat as the rescue craft may not be available to help them.

Entry fees: Boats: £140 (for the week); boards: £90 (week) or £30 (per day) (NB Entry for boards may now be closed)

Details from www.speedsailing.com or Bob Downhill: tel +44 (1323) 644 879.

Weymouth Speedweek is sponsored by AYRS

BMIF Concept Boat Competition 2005

Concept Boat is an annual competition, now in its fourth year, intended to encourage interest in the design of future boats and to show the global small craft industry how they believe boating should develop. The Competition covers the full range of recreational and commercial/working boats, and each year has a different theme.

The organisers of the Competition, the British Marine Federation, supported by the Royal Institution of Naval Architects, wish to encourage everyone to influence the future of design, development and production of boating.

New for Concept Boat 2005 is the introduction of three categories of entry:

- 'Pure Concept',
- 'Concept and Design' and
- Entries from UK schools.

Theme of Concept Boat 2005?

The 2005 competition is open for entries that are a new design of recreational or commercial craft of up to 24m length, that encourages group activity boating as a recreational activity to as broad a range of people as possible:

"Boating for All".

The Judges will be looking for designs that either:

- are of low or moderate budget
- are suitable for group activities
- develop a production kit for easy assembly
- encourage/appeal to youth participation
- are a new boat for sea cadets or similar
- are a new racing concept

Anyone can enter Concept Boat 2005!

Whether you are a boating enthusiast, private owner, a yacht club member, a boatbuilder, naval architect, design studio employee, student, boat operator, surveyor, journalist, engineer or apprentice in the marine industry this competition is for you.

Such a broad mix will of course throw up many differing skills, but it is not your ability to produce beautifully crafted drawings that the widely experienced panel of judges will be looking for. Instead, they want to see practicality of design and originality of thought in the creation of a safe, eminently usable vessel and, where appropriate, stylish boat for the future.

In the 'Concept and Design' category the judges will additionally be looking for an entry that has considered powering and performance, stability and construction of the boat: in essence a design that has moved beyond pure concept into a developed concept.

Entries can be from individuals or from groups and from any country: historically over 50% of entries are from outside the United Kingdom. The schools categories are restricted to entries from UK schools.

How To Enter

Each entry must be in English and preferably submitted electronically or as hard copy. (An electronic copy of the entry form can be found on the website).

Please read the Terms and Conditions of how your submission should be presented. Additional guidance is also available on the website in the form of Chairman's Notes.

Deadline for entries: 31st May 2005.
(30th April for the schools catagories)

All correspondence should be sent to Concept Boat 2005, British Marine Federation, Marine House, Thorpe Lea Road, Egham, TW2O 8BF Tel: +44 (1784) 223 613; fax: +44 (1784) 439 678; email: enquires@britishmarine.co.uk; website: www.conceptboat.com

[The website is being rebuilt as Catalyst *goes to press Ed.]*

The Prizes

In each category there will be two prizes and in addition there will be an overall winner of Concept Boat 2005 chosen from the winning entry of each of the four categories:

- 'Concept and Design': winning entry will receive £2500 and runner up £1000.
- 'Pure Concept': winning entry will receive £1000 and runner up £500.
- The winner of the overall Competition will receive an additional £2000.
- Commendations will be awarded at the discretion of the Judges.

MOTHS ON HYDROFOILS

George & Joddy Chapman

(Photo: Richard Langdon, Ocean Images)

We visited the International Moth Class's European and (UK) National Championship meeting in July 2004 held at the Weymouth Sailing Centre at Portland, mainly to see Moths flying on inverted T foils and to quiz the sailors.

Moths are 11 feet (3355mm) long with 8 sq.m. of sail - so much for metrication! Tiny boats by most peoples' standards, they weigh around 30 Kg, so they can readily be picked up. The crew's weight is over two-thirds of the all-up weight, so although they are very tender to sail, a nod of the head is a significant ballast shift.

Although the maximum beam is limited to 225cm (7ft4) most hulls are narrower than 60cm and can be only 30cm at the waterline. Superficially, modern Moths all look much the same, with wide racks for the crew to sit or stand on to balance the boat. Michael Kerslake, the IMCA(UK) Honorary Secretary and Treasurer, tells us that "under the water, the Hungry Tiger and Prowlers hulls [Australian] are almost identical in shape. The 'Mistress' design in the UK is also very similar. With the exception of a few designs most now are very similar with a rounded U section at the front changing into a flatter section from under the mast backwards ending in a pintail. Adam May used Fastacraft foils on a Mistress hull."

Five Moths used lifting foils and two opted not to use theirs; the rules require a boat to stick to the same configuration throughout the Championship. One Australian and one Singapore registered boat used foils made by John Ilett (www.fastacraft.com) in Western Australia. Of the UK foilers, Adam May and Simon Payne used Fastacraft foils and Graham Vials used home-made, very similar, foils. May and Vials sail from the W & P Sailing Academy so we hope to see them at Speed Week.

Graham Vial's Moth: homemade foils - note small end plates.(Photo: Chapman)

The foils are similar in principle to those on the US Rave, both the main foil at the bottom of the (dagger board) strut and the rudder foil having a rectangular plan form 800 x 120 mm with an aspect ratio of 6.66, and a full span flap 24.6% of the chord. The main foil section is NACA 63412, a cambered section. The rudder foil is not all that much smaller than the main foil, the rudder being carried about 40 cm aft of the transom on an extension, which, being part of the 'rudder arrangements', does not count as an extension to the 11 ft length! The main foil flap is controlled by a feeler hanging from the top of the stem, the rudder flap by a twist grip on the tiller. Some boats had a device at the top of the rudder pin to allow adjustment of the foil's angle of attack. Both main and rudder strut/foils were - to our initial surprise - inserted from 'below' with the boat on its side in thigh-deep water.

Some non-foiling Moths had small fixed horizontal foils at the bottom of their rudders, which slide up and down in a box that forms the stock; and presumably the dagger board is inserted from above when the boom is held clear.

Sailing a Moth is not for the unfit or weak-minded! Particularly with foils.

You get the boat into the water on a launching trolley, and then hand it out to deep enough water. The Portland slipway is ideal for this. You then roll the boat on its side and insert the rudder and main strut/foil. Walk on into deeper water, right the boat, and climb on over the stern. Not easy and even the experts have difficulty. Then - it sounds simple - sail away!

Moth sailors must develop a remarkable sense of balance to be able to keep the little craft trimmed and pitched as they want them, but they do, superbly. The foilers who, as far as we could see led for much of the race that we watched, were able to sail foil-borne at something close to twice wind speed (17-18 knots in 8 knots of wind) for legs approaching a mile long. The wind dropped towards the end of our time and continuous flight became difficult. Rohan Veal reports a top, GPS measured speed of 21.8 knots on his web site.

Rohan Veal installing his main foil (Photo: Chapman)

Foil rudders on non-foilers (Photo: Chapman)

To use the lifting foils partially to resist leeway, they sail heeled to windward, which gives a bit of lift from the sail to more than match the downward force developed by the inclined struts. Sailing off the wind the hulls are pitched level, but close-hauled and still flying they take on a bow-up attitude. This is to increase the angle of attack of the main foil, presumably to keep the flap at 'neutral' and preserve the optimum section shape. A small pitch angle can look deceptively large.

While there was a fair range of windspeed over the week, one may conclude that slightly stronger winds favouring the foilers prevailed. We are assured that it is not simply because the foilers try harder!

The current foil leader is Rohan Veal whose site www.rohanveal.com is informative. There is more about development at www.moth.asn.au/developmemt, and the UK Association is at www.int-moth.org.uk.

Of the 31 competitors, three were noted as Juniors, 15 as Masters, i.e over 35 years old, and of these one lady and two veterans.

Any flying (or non-flying) Moth who comes to Speed Week will be welcomed, and stands a good chance of winning one or more day's speed tankard. For racing, speed measurement per se is maybe irrelevant, but a bit of accuracy in knowing how fast one can sail is better than unsubstantiated guesswork!

George and Joddy Chapman
20 August 2004

Leading results for the week

1st Rohan Veal, AUS 9338, Foiler, - British and European Open Champion

2nd Simon Payne, GBR 4059, Foiler, - European, National and Masters Champion

3rd Adam May, GBR 4063, Foiler

4th Ian Forsdike, GBR 4050, Non-foiling foiler (choice)

5th Mark Robinson, SIN 9330, Foiler

A comparison of bottoms! (Photo: Chapman)

Transition sailing rig

Richard Dryden

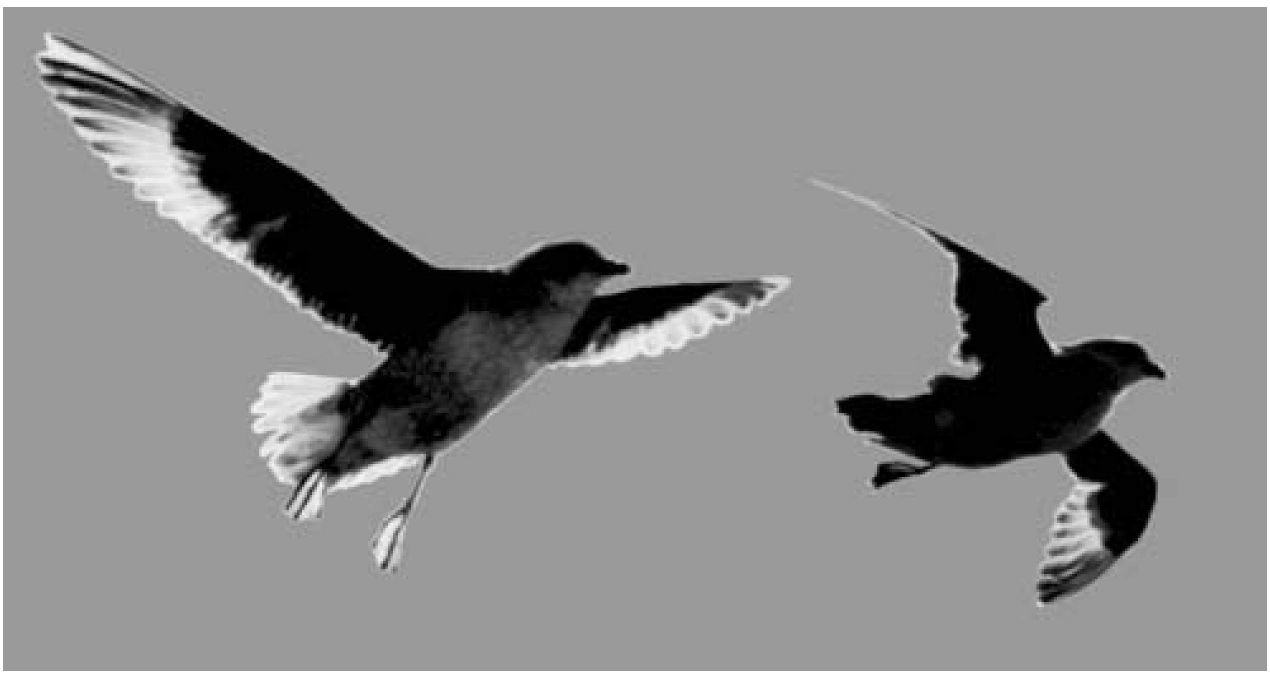


***Figure 1**: birds in flight, showing changes in wing geometry.*

Overview

The transition sailing rig takes its inspiration from the wings of bats and birds. It can change shape in use according to changes in wind strength, and can be folded into a convenient bundle when not in use. The idea arose in 1987, and I made a series of windsurfing prototypes in the years that followed. From mid-2000 I was funded for one year by NESTA (the National Endowment for Science, Technology and the Arts), and I now have working versions of the rig for canoes, kayaks, windsurfers, and dinghies.

The concept is protected by the following Patents: GB2225760 (variable geometry concept), GB2368829 (control systems for free-standing rigs), and Patent applied for GB2381515A (sail modules to provide wind assistance for larger vessels). There is an overview of the project on the website: www.transitionrig.com

The concept

I have always enjoyed watching birds such as gulls as they slope-soar along hillsides and cliff faces, fascinated by the way they can alter the geometry of their wings to cope with gusty conditions. In light airs, their wings are fully extended, while in gusts their wings are drawn in closer to their bodies and the outer segments of the wings become more sweptback.

In the 1980s I developed a passion for windsurfing in the warm conditions of Papua New Guinea. As a hobby I began to make specialised sails and boards for speed sailing. I soon discovered that each sail worked most effectively over a rather narrow range of wind speeds. At that time we did not appreciate the value of the additional roach and controlled twist in the upper part of the sail that now gives contemporary windsurfing sails a wider wind range. The combination of an unforgiving sail and unsteady wind greatly reduced the chances of sustaining a good speed over worthwhile distances. It was then that I began to wonder whether it would be possible to make a sailing rig that would be more adaptable to the changing conditions encountered on the water.

The idea of making a variable geometry rig came in 1987. Although the original inspiration came from the shape changes I had observed in birds' wings, I felt it would be more practical to follow the structural example of the bat's wing, where the flight surface is an elastic membrane rather than overlapping flight feathers. This approach would simplify construction and experimentation, and had the added benefit of making it easier to reverse the aerofoil when changing from tack to tack.

The jointed mast would have three segments: the lower one attaching to the sailboard would be a single strut, the middle segment would consist of two parallel struts, and the upper one would be a single strut. This mimics the arrangement of the skeleton in bats and birds, as well as in our own upper limbs. As a biologist, I quickly fell into the habit of naming the parts of the rig in the way that the biological equivalents are named. Thus, the lower segment became 'humerus', the middle struts became 'radius' and 'ulna', and the upper segment became the 'carpus'. (Carpus means wrist, so the use of the term here is not accurate - other bones such as the metacarpals and phalanges contribute to the skeleton of the tip segment of a bat's or bird's wing.)

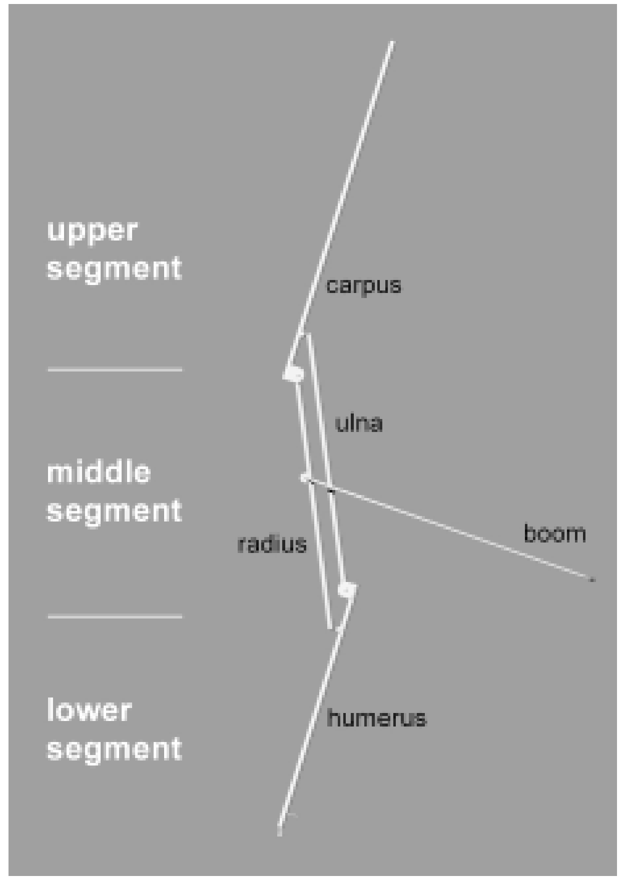


Figure 2: *mast arranged in three segments.*

The two middle struts (radius and ulna) co-ordinate the movement at the upper and lower sets of joints – as the 'elbow' flexes and extends, so must the 'wrist'.

The main aim of having a variable-geometry rig was to use it fully extended in lighter winds, and then flex the rig in stronger winds so that the centre of effort of the sail was brought lower and the upper segment of the mast made more sweptback. This I believed would make the rig more effective and more controllable over a wider wind-range than a conventional rig, adapting better to gusts and lulls. In the context of windsurfing, I envisaged that these adaptive changes would occur in response to changing loads placed on the boom by the sailor. In light winds, the sailor stands more upright on the board, putting very little downforce on the boom, while in strong winds, the sailor hangs most of their bodyweight from the boom to counterbalance the lift generated by the rig. Part of that increased load is experienced by the boom as a down force, and this could be used as a controlling force to bring about the shape-change.

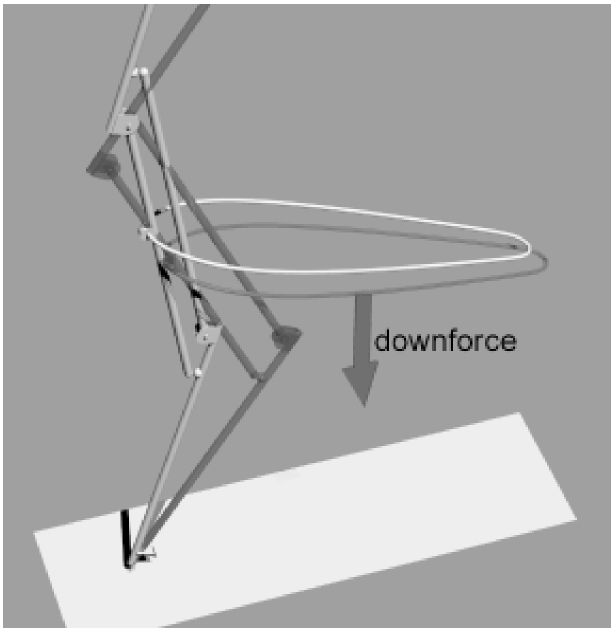


***Figure 3**: increased downforce on the boom flexes the rig.*

An additional advantage of a jointed rig is that it can fold into a compact bundle for transport and storage, without the need to dismantle any of the components. Thus, rigging and de-rigging can be achieved rapidly and conveniently.

The joints and tensioner

At first, my approach to joint-making was also influenced by biological structures. I made the hinge joints from glass- and carbon-reinforced epoxy resin, using large bearing surfaces with a saddle (concavo-convex) shape. These components were time-consuming to design and make, requiring the preparation of wooden blanks and the intermediate step of mould-making, but when completed had the advantage of being very resistant to the twisting forces they would experience in use without being unduly heavy. From start to finish, each generation of mast development would take about a year. (More recently, I have started to use much simpler metal joints which can be made and modified comparatively quickly, and this has speeded up the development process.)

The first prototype was crude and was never tried on the water, but it did enable some of the practical problems to be worked out. For example, for the mast to change shape in the required way, it has to be elastically tensioned so that it is fully extended when rigged with the sail, and then begins to flex when downforce is applied to the boom. I found a way to direct tensioning webbing around the front of the upper joints and around the back of the lower joints, making it adjustable at the foot of the mast. This made it possible to balance the various forces acting on the rig and also make allowances for sailors of different weights. Releasing the tensioner completely then allowed the rig to be fully folded.

Pronation/Supination

The basic geometry of the mast, the control of flexion and extension, and how to achieve folding were worked out through trial and error, but I found

***Figure 4**: above - saddle-shaped joint surface; below - joints between middle and upper segments – hinge joint on the left and universal joint on the right.*

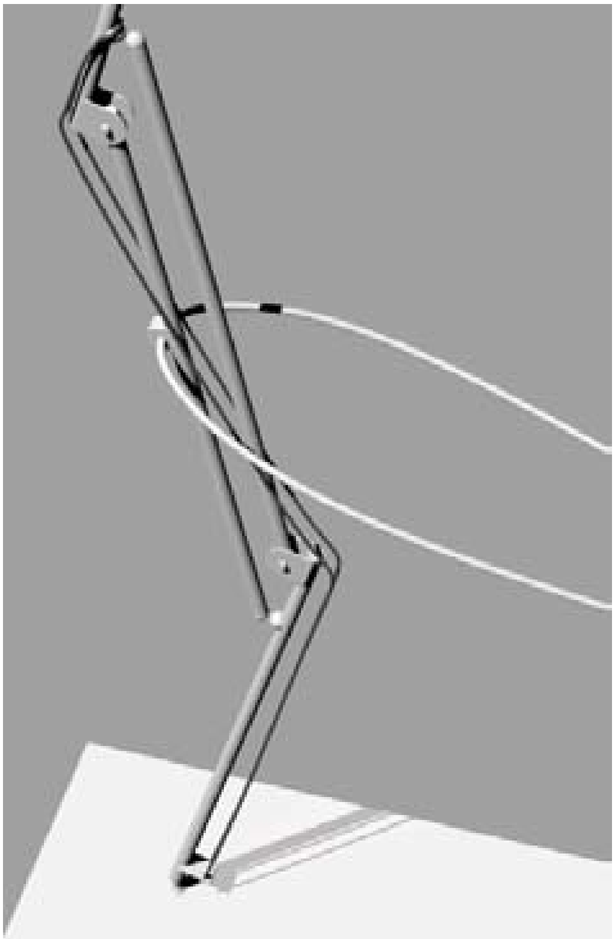


Figure 5: *arrangement of tensioner.*

that many design problems still remained. For example, the lower joints of the mast forming the elbow are set back from the leading edge of the lower part of the sail at about 1/3rd of the chord. This is a part of the sail that benefits from having a good aerofoil section to produce power lower down. To achieve a good section, the lower joints need to be displaced to leeward - away from the sailor - on each tack. If the mast can only flex and extend, this is not possible and the shape of the lower part of the sail is compromised.

It was not too difficult to achieve the necessary rotation - I followed the solution provided by the arrangement of our own forearm and the forearms of birds and bats. If, in addition to flexion and extension, the radius is able to rotate around its long axis at the lower end in relation to the humerus, and if the ulna is able to rotate its long axis at the upper end in relation to the tip segment (carpus), then the lower joints can swing from side to side in relation to the boom when tacking and gybing. The axis of rotation for this movement passes between the universal joint at the lower end of the radius and the universal joint at the upper end of the ulna. The interesting thing about this arrangement is that the boom, radius, and carpus work together as one unit, while the ulna and humerus work as another unit during these pronation/ supination movements. The rotation produces an interesting 'cupping' effect on the overall form of the rig, where the carpus leans slightly to windward in relation to the humerus. Before trying this system of joints in practice, my belief was that the correct rotation would occur automatically when the lower part of the sail 'powered up'. This turned out not to be the case.

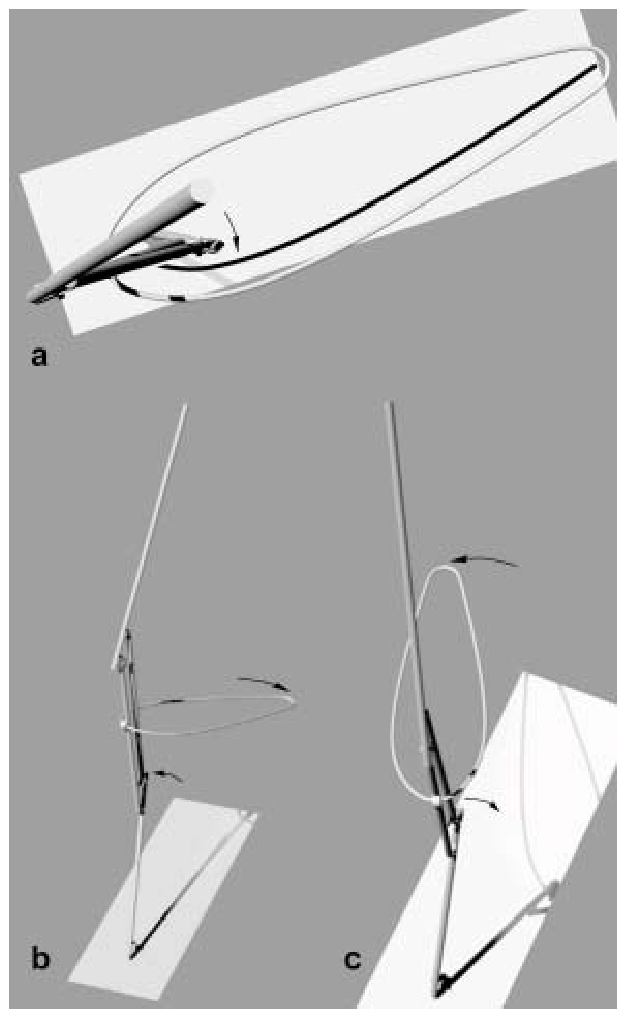


Figure 6: **a)** *view from above, showing the 'elbow' joint swung away from midline to conform with the camber of the sail;* **b) and c)** *oblique views showing the elbow joint swung from one side to the other.*

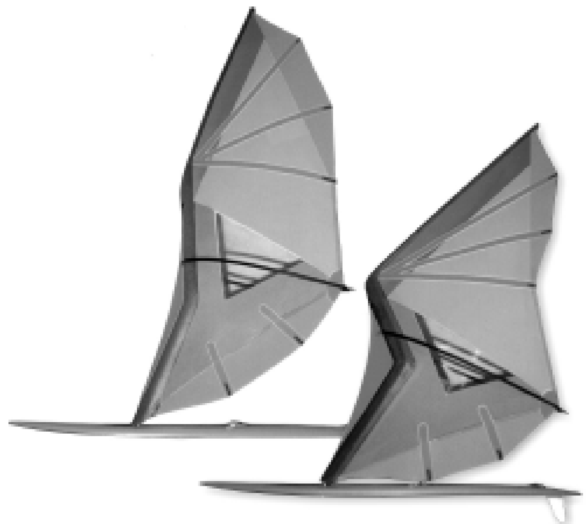


Figure 7: *on the left, the rig is fully extended as it might be in a light wind, and on the right it is more flexed in response to a stronger wind.*

The sail

The next challenge was to make a sail that could accommodate the shape-changes – flexion and extension, pronation and supination when going from tack to tack – and at the same time keep a good aerodynamic shape. Here I was faced by a dilemma: conventional reasoning and experience say that if you want a sail to remain stable, particularly in higher winds, you need to use a sail material with minimal 'give'. Indeed, one of the main thrusts in the development of contemporary sailcloth has been to reduce stretch under load.

As with many design problems, the trick is to find the correct balance between apparently opposing requirements, in this case shape change and aerodynamic stability. One of the main concerns with this type of rig is that as the mast flexes, the tension in the trailing edge of the sail (leech) becomes less. Within limits this is acceptable, since it allows the upper part of the sail to 'twist off' in stronger winds and reduce the power being produced. However, if the leech becomes too loose, the rig becomes difficult to control.

Early prototype sails made from stretch materials such as Lycra and Spandex worked reasonably well in the sense that they allowed shape-changes over a useful range while remaining reasonably taut, but they were unsuitable for a sailing application. The porous nature of the cloth allowed air to flow at least partially through the sail from the windward to the leeward side rather than flowing around it, greatly reducing its power, and if the cloth came into contact with water it became saturated, baggy and heavy.

The next step was to experiment with stretch fabrics coated on one side with a thin elastic film of polyurethane. These fabrics fulfilled many of the requirements that I had for an elastic sail cloth. They are lightweight, stretchable, tear-resistant, UV-resistant, available in a wide range of colours, and airproof. Their big disadvantage was that the fabric exposed on one side still absorbed appreciable quantities of water. However, the single-coated fabrics were good enough for the prototype sails to be tested on the water. In some sails, I laminated two layers of the single-coated cloth together so that the coated surfaces faced outwards, but this proved to be a time-consuming process and even then water was able to infiltrate between the laminations over time.

For several years I searched for a double-coated stretch fabric that would overcome the water logging problem. Technically, double-coated cloth is harder to manufacture than single-coated, and coating specialists were not prepared to experiment on my behalf without a substantial guaranteed order, which I was unable to provide. Eventually a double-coated material became available - it had been developed for use by the health service on operating tables and trolleys.

For windsurfing, it is helpful - and safer - to have a see-through sail so that you can see where you are going and avoid collisions. I had searched in vain from the beginning of the project for a transparent and stretchy material, and had to make do by inserting windows made of non-stretch clear plastic into the prototype sails. Then, by a stroke of good luck, an article about the transition rig was published in a science magazine and I received a useful tip from one of the readers - a clear elastic film had been developed for use in the female condom, and might have the required properties. Of course, for sails a much thicker gauge of film is required, and fortunately this was also available. The material has proved to be very useful, fulfilling most of the criteria for a clear, stretchy sailcloth. It does however have two disadvantages - it is very difficult and frustrating to sew because it clings tenaciously to the sewing machine's flat surfaces, impeding its passage through the machine, and it is also quite vulnerable to puncturing. In time I hope to replace sewing with heat welding, and it may be possible to incorporate a puncture-resistant mesh in the film, but for now the film provides a step towards finding the 'ideal' material.

The testing

By now I was regularly testing the prototype windsurfing rigs on the water, and repeatedly being reminded of the gulf between theory and practice. One by one my assumptions and pet ideas were being severely challenged. The pronation/supination movement gave the biggest headache. As soon as the sail powered up, the lower joints would flip across, but always in the wrong direction. Instead of moving away from the sailor on each tack, they would do the opposite, moving forcibly towards the sailor and giving the rig a very un-aerodynamic shape. I tried many different systems to produce the correct movement and lock the rig in the required shape, and although some worked reasonably well, none of them gave a simple automatic rotation when changing tack. I had hoped all along that from the sailor's point of view the transition rig would be used just like a conventional rig, with all its variable-geometry features looking after themselves automatically, and yet now I was having to fit additional controls. A compromise solution did eventually present itself, and now ensures that the correct rotation occurs without the need for levers and locks.

Figure 8: *a windsurfing rig using significant areas of transparent stretchy film.*

Free-standing version

Up until 1999, my attention was focused on developing a variable geometry windsurfing rig. However, my involvement as a volunteer on a nearby project to build an ocean-going catamaran caused me to think about how the transition rig idea might be adapted for use as a free-standing rig and applied to other types of craft. With the help of friend and colleague Alex McCall, a Mirror dinghy was modified to accept a cable-operated folding mast and sail. The most complex engineering occurs in the region of the mast foot, which has to be strong enough to support the unstayed rig, be free to rotate, and also allow the passage of multiple control cables close to the axis of rotation. The rig incorporates all the movements described above and has an additional control to allow tuning of leech (trailing edge) tension when the rig takes on different shapes. The steel cables for raising, lowering, and rotation are attached to horizontal levers beneath a false floor in the dinghy and operated by blocks and tackle. This version of the rig has come the closest yet to fulfilling the different aspects of the original concept.

Simplified versions of the free-standing rig have also been developed for smaller craft such as canoes and kayaks. These offer umbrella-like convenience in that they can be raised quickly when required, and folded away into a small bag when not required and stored out of the way. However, these smaller rigs do not have the capacity to change shape according to conditions - they are either fully extended or folded.

Having worked out the arrangement of a free-standing version of the transition rig and the control systems required, it then became possible to propose folding rig modules for larger ships. Tankers and some bulk carriers have significant areas of relatively free deck space, and it may be possible to provide sails as a way of reducing the amount of fuel they use. Even a 15% reduction would be worthwhile, given that oil is a finite, diminishing resource and that the burning of oil has a harmful effect on the environment. Folding, removable sail modules bring several advantages over fixed masts and rigging, and one of my ambitions now is to generate enough interest in the concept to be able to build a working prototype for testing.

In conclusion

The transition rig changes shape as it adapts to different conditions, being fully extended in light conditions and more flexed and streamlined in heavy conditions. Added to this is the convenience and safety of a rig that can be folded away when not required. These advantages come at a price – the rig is more complex and will require good design and materials if it is to match the strength and durability of conventional rigs without a significant weight penalty. And with complexity comes the potential for increased cost, at least in the early stages of development.

The variable geometry approach to sailing rigs offers an alternative pathway for development compared with more traditional rig designs. The name 'transition' was chosen for this concept because it implies both the evolutionary transition and the shape changes in use.

Richard Dryden
Newton Abbot, UK
rdryden@eclipse.co.uk
September 2004

Figure 9: *composite picture of the dinghy version showing folding of the rig.*

Four Times Faster Than The Wind

Victor Korepanov

Part 1: A stupid idea that helped to make a discovery.

More than 20 years ago, being yang guys, my friend and I decided to build a helicopter. Of course we did not have enough money and possibilities. All that we could build was a 7 meter air rotor with fixed pitch and a three wheel cart. Also we found a used 7.5 kW power station (an internal combustion engine combined with an electrical generator) and an electrical motor combined with a reducing gearbox. But all these things were rather heavy, and we understood that our helicopter will not fly with no way. But we did not want to lose our efforts.

We live in flat semi desert with hundreds of kilometers of empty territories around and we decided to build an air prop driven cart with the prop pushing from behind. Our 7 meter prop could provide a very big static thrust of about 120kg and we hoped to get very powerful and fast craft - this is why we left the prop as big as it was. And really, staying on brakes, with full throttle the thrust was so big that our mast began to bend and was ready to break and our cart slipped along the road with stopped wheels. After releasing the brakes our cart got a big acceleration, but in a few seconds its thrust sharply dropped to 15-20 kg and we could reach 30 km/hour only. Even boys on their bicycles could easily catch the cart. That was OK!

We liked riding anyway, but we forgot about the wind that can suddenly appear and to drop very fast in our region. Once I was riding our cart at maximum speed 30km/h as usual, but suddenly the apparent wind blowing in my face disappeared, the mast began to bend ahead and it was ready to break. I felt a big acceleration and in a few seconds the speed of the cart became about 50km/h. I understood that I had been caught by wind from behind. In 5 minutes I turned the cart back against the wind and I was surprised how slow my cart was! Everything was the same – the same apparent wind, the same sound of motor and the prop, but the speed was only 5 km/h. I thought that it will take me at least one hour to return back, but soon the wind had dropped as quickly as appeared and again I get a very big acceleration and reached 30km/h relative to land. I understood one very important and simple thing: for a motor with a prop it does not matter how fast the craft is moving relative the land – 30km/h, 50km/h or 5km/h. All its power is spent for going relative to air, i.e. for going against apparent wind ($V_{apparent}$).

As I said, we liked riding anyway, but gasoline was very expensive for us. One day a “genius idea” came to the head of my friend. He said:”We have an electrical motor and generator, what for we need the engine and to spend gasoline? We can rotate the generator directly from wheels and get electricity for electrical motor with the prop exactly the same way as we get electricity for bicycle head light from dynamo attached to the wheel. I knew physics and said that it is a stupid idea: to rotate the generator it is needed to create a force on the wheel that will pull the whole cart back. Of course the generator will be sending electricity to the electrical motor with propeller and the prop will create a thrust, but the thrust will always be less than the force on the bottom of wheel (drag force) that pulls the cart back. The cart will never get acceleration and it will stop soon. My friend said that our air prop is very big and it creates very big thrust – if the cart would be pushed till high speed it will move further itself. I knew that it was wrong, but we did too much together and there was not much to re-do, and I agreed just for his sake. We removed the engine and connected the generator to the wheel by chain and began our experiments.

First we connected the generator to a big electrical resistor and wattmeter to see if we have enough power. The generator created a very strong back force and it was very hard to push the cart by hand. The wattmeter showed good power, but when we stopped pushing the cart stopped very fast, in just 1 meter as if it had fixed brakes. Then we connected the generator to electrical motor with the prop. This time it was much easer to push the cart, because the propeller helped us, and after stopping pushing it moved itself pretty far, but always stopped. We made many attempts, but it did not go more than 15 meters by itself.

I said to him: ”Now you see it will never go by itself, because the power that the cart is getting through the drag force on the rear wheel is:

$P_{in}=F_{drag}\ V_{cart}$

And the power that goes out through the propeller is:

$P_{out}= T_{thrust}\ V_{apparent}$

And in the ideal case Pin = Pout

i.e.$F_{drag}\ V_{cart} = T_{thrust}\ V_{apparant}$

But, $V_{cart} = V_{apparent}$, so we can cancel them.

Then $F_{drag} = T_{thrust}$

You see, even in ideal case when efficiencies of transmission and air prop are 100% the thrust is only equal to the drag force, not more, and the cart cannot get acceleration. But in real life P_{out} is always less than P_{in} because of losses

$P_{out}=P_{in}$ Efficiency

and efficiency coefficient is always less than 1, i.e. $E<1$

The same with the thrust $T = F\ E$

and even when $E=0.999$ then $T=0.999F$

Thrust is always less than the back force and the cart will always stop.”

He thought a little and than said “Let us do one last attempt”. It seemed to him that if the cart got a higher initial speed it would go by itself. I agreed for the last time. We attached the cart to a three-wheel motorcycle by a long rope and began towing, and reached 30km/h. Our generator created the same power (7.5 kW) as it was before with the use of the internal combustion engine;, apparent wind was the same (30km/h); our prop created the same thrust (about 20 kg); but this time there was a strong drag force of about 70kg on the rear wheel, the tow rope was very tight, and there was no hope it would move itself. We needed 50 kg more thrust. But suddenly, the apparent wind disappeared and still air was all around. The mast began to bend ahead and was ready to break under the thrust of more than 100kg. I felt good acceleration ahead, the rope dropped on the road, and soon we reached 45km/h without towing! A new apparent wind was blowing in my face. In a few minutes the cart lost its speed and stopped – the desert wind had disappeared as quickly as arose.

I was shocked. I was shocked not because the cart went by itself for several hundreds of meters (I instantly understood that the cart was caught by wind from behind), but because of the cart was moving 1.5 times faster than the wind going directly down wind!

Later I understood that phenomenon and described it and sent the application to State Committee to get a Patent. That description was pretty close to Andrew Bauer’s one – the same piece of airscrew moving along helical path relative to land, the same vectors, but less mathematics. In 1983 I thought that I was the first. Of course the State Committee guys refused me not because they had read Andrew Bauer’s work. They were just normal people and were sure that it was impossible. I went to Moscow to the State Committee. You can imagine what a stupid look I had in their eyes with my models 21 years ago.

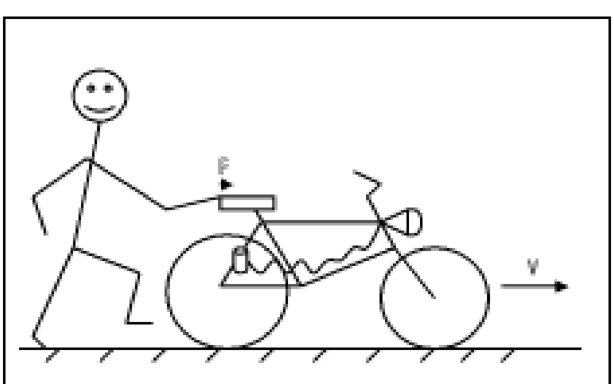


Fig 1

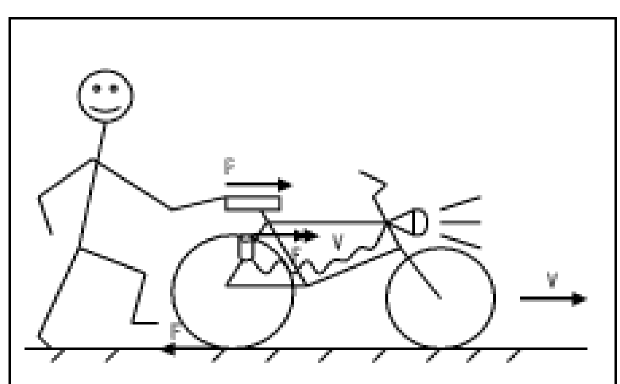


Fig 2

Part 2: How power can be taken from the road (or still water), and why we can get a static thrust of a prop as big as we want.

Much later I found more simple way of explanation of that phenomenon. I absolutely agree with Andrew Bauer, Theo Schmidt, Peter Sharp and other researchers that the energy for moving such craft is taken from the wind only. But the power (not energy) can be easily taken from unmoving land or still water.

To feel this let us look at the following example, say, you push a bicycle with hand along the road (Fig 1).

A very slight force F of your hand is needed to do this to overcome common friction. Then you turn on the dynamo on the rear wheel and you will need much bigger force F to push the bicycle with switched-on headlight (Fig 2). Everybody will remember that unpleasant increase of resistance:

Power that is sent to the headlight is P = F V, where F is the force on dynamo and V is the speed of rotation of dynamo. The same force F is pulling the bicycle back (positive drag force) and the same force F is acting on your hand. You have to provide the same power for pushing the bicycle, P = F V. The ***energy*** for moving whole system is coming from your hand, but the ***power*** for headlight is taken from land.

You can take a cart with bigger generator, say 10 horsepower and with very very big head light with the same power (Fig 3).

To provide this power you should run with the speed V=10m/s and overcome drag force F=75 kg; since P = F V, then P = 75x10 = 750 = 10h.p.

You will get a very powerful beam of light. This cart will keep moving while you provide a force of 75kg, when you take off your hands it will stop very fast. Do you feel it? It is a very hard job to push cart with the force of of 75kg (750N) and to run with V=10m/s (36 km/h). You provide the whole system with ***energy*** about 7500 Joules per second (10h.p.) and your generator is sending 7500 Watts of ***power*** to head light giving 75kg of drag force on the wheel.

Let us imagine now that you do this running down the wind with the same speed Vwind=10m/s (Fig 4).

You can take off your hands for a second, but the whole system will be alive by inertia: the same powerful beam of light, generator is still sending 7500 Watts of power, no air drag, the only drag is positive wheel drag F.

Can anything replace your hands to keep moving having 7500 Watts of power on generator and 75 kg of drag? Yes it can! Just throw away that useless head light and put electrical motor with air propeller (Fig 5)

Say, if you put 8 meter air prop you will easily get 130-150 kg of thrust consuming 7500 Watts of power. The cart will get a big acceleration and will go much faster than the wind.

Actually, to provide such thrust in still air much less power is needed. You can find a lot of information on the Web about Human Powered Helicopters, where American, Canadian and Japanese students got more than 100kg of thrust with less than 1hp (0.75kW) of power on the air prop more than 20 meters in diameter.

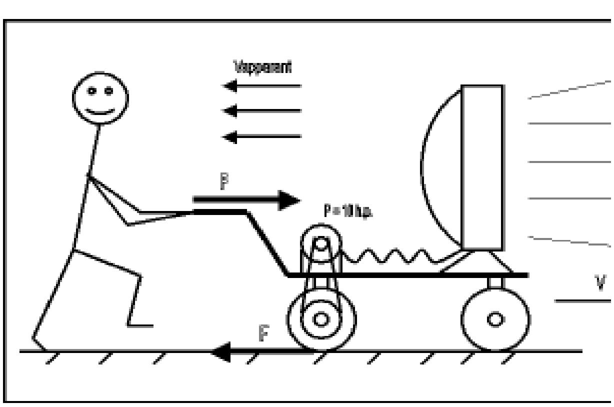


Fig 3

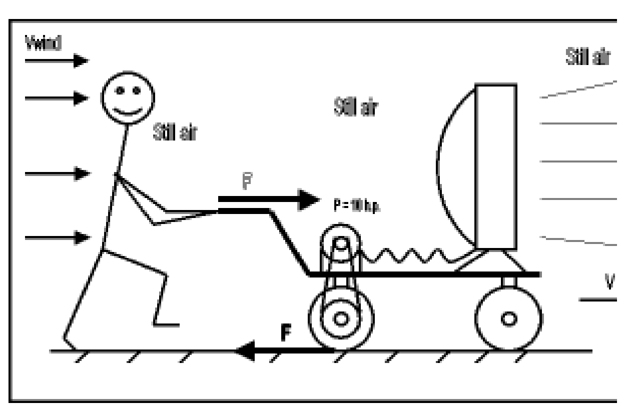


Fig 4

There is a formula for ideal air prop:

$P_{power} = T_{thrust} \times V_{apparent}$

then

$T = P/V$

but in still air $V_{appparent} = 0$

then$T = P/0$ - i.e. static thrust is endlessly big.

So, having any power, but a very very big slowly rotating air prop in still air, its thrust goes to infinity. We can get the thrust as big as we want even with a small source of power, and the craft will have to go ahead faster than the wind to give the air drag to equalize that extra propulsive force. The bigger is the power the bigger will be the speed, but in any case if the prop is big and perfect enough the craft will go faster than the wind.

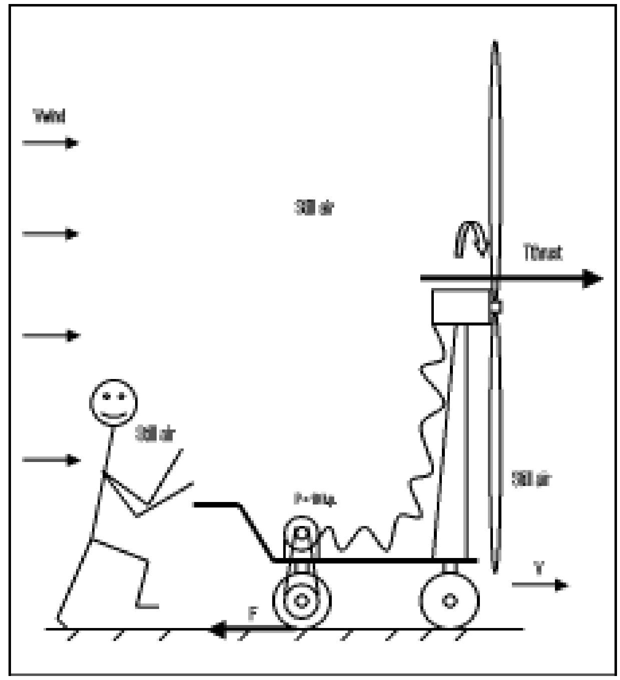


Fig 5

Part 3: Formula for the maximum speed of craft moving down the wind faster than the wind.

Let us determine the maximum speed of craft moving down the wind faster than the wind. So, on the yacht moving down wind along smooth road with good coefficient of friction are acting three main forces (Fig 6):

- T- the air prop thrust,
- D – the air drag,
- F – the positive drag force that rotates electrical generator.

Rolling friction is comparatively small and we ignore it for simplicity.

Let us imagine that the yacht has reached the speed a little bit bigger than the wind speed and slight apparent wind Vap is passing through the craft (Fig 7).

On the craft with its own weight about 150 kg are acting the positive drag force F which is approximately equal half of yacht weight (75kg) which makes generator to give 10hp while moving with Vy=10m/s, and also the small air drag D. An electrical motor fed with this power rotates a big propeller in almost still air and provides a big thrust T= 120-130kg that is close to the static thrust. At this moment the thrust T is much bigger than total resistance to movment:

$T >> D+F$

and it will continue accelerating.

Have reached the speed, say 1.5Vw, its thrust T will drop considerably and the air drag D will rise. The drag force F will stay the same because it depends on the weight and coefficient of friction only. But the thrust will be still bigger than resistance:

$T > D+F$

and the yacht will continue further acceleration.

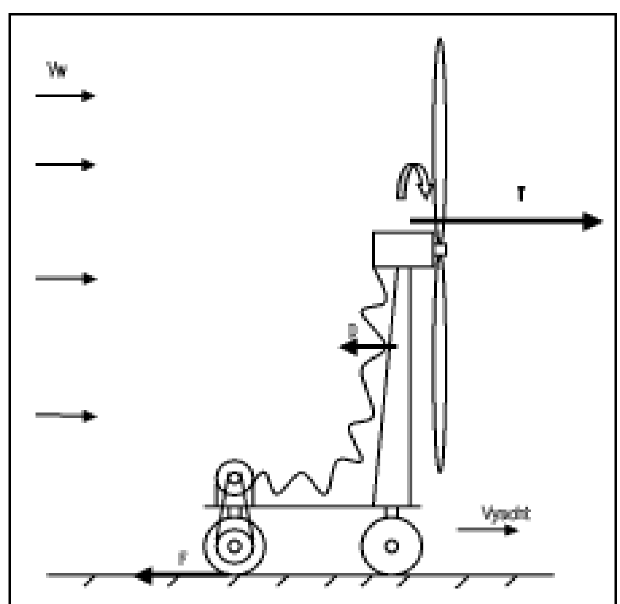


Fig 6

Then, at certain speed the yacht will stop accelerating (Fig 8).

At this point the yacht will have maximum speed Vmax and we get equation:

$$T=D+F$$

So, Vmax is hidden somewhere behind these letters.

Let us see, there is a formula from elementary physics for F:

$$F=m\,g\,k$$

where:

m- mass of yacht,
g- gravity acceleration,
k- coefficient of friction.

Then there is a formula from common aerodynamics for D:

$$D = \frac{C\,S\,\rho\,V_{ap}^2}{2}$$

where:

C- air drag coefficient,
S- yacht cross section,
p- air specific gravity,
V_{ap}- speed of apparent wind,

and $V_{ap}= V_{max} – V_w$

therefore $D = ½C\,S\,\rho\,(V_{max} – V_w)^2$

What about T? The thrust is created by motor with prop and the simplest formula is:

$$P_{mot}\,E_{pr} = T\,V_{ap};$$

or $$T = P_{mot}\,E_{pr} / V_{ap}$$

where:

P_{mot}- power of electrical motor,
E_{pr}- prop efficiency,
$V_{ap} = (V_{max} – V_w)$ - see above,

And also:

$$P_{mot} = P_{gen}\,E_{tr};$$

where:

P_{gen} = power of generator,
E_{tr} = transmission efficiency.

From Fig.8 we see;

$P_{gen} = F\,V_{max}$

where:

F = positive drag force
V_{max} = maximum speed of yacht

Therefore:

$$P_{mot} = F\,V_{max}\,E_{tr};$$

and then:

$T = F\,V_{max}\,E_{tr}\,E_{pr} / (Vmax – Vw)$

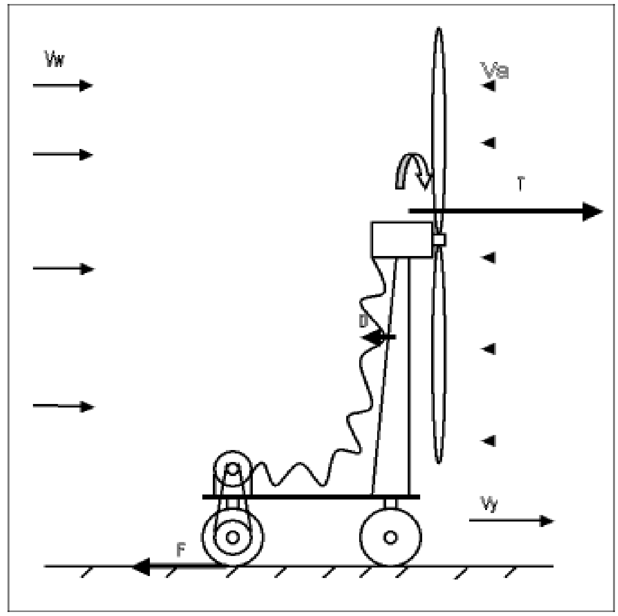


Fig 7

Let us put all these data into:

$$T = D + F$$

and we get:

$$(F\,E_{tr}\,E_{pr}\,V_{max})/(V_{max} – V_w) = ½C\,S\,\rho\,(V_{max} – Vw)^2 + F$$

So, we got a formula that can be used for determining maximum speed either for land or water yachts. Where F is a positive wheel drag in first case and F is a positive water turbine drag in the second case. (We can also add rolling friction or negative water drag to the right part of equation for precision, any time).

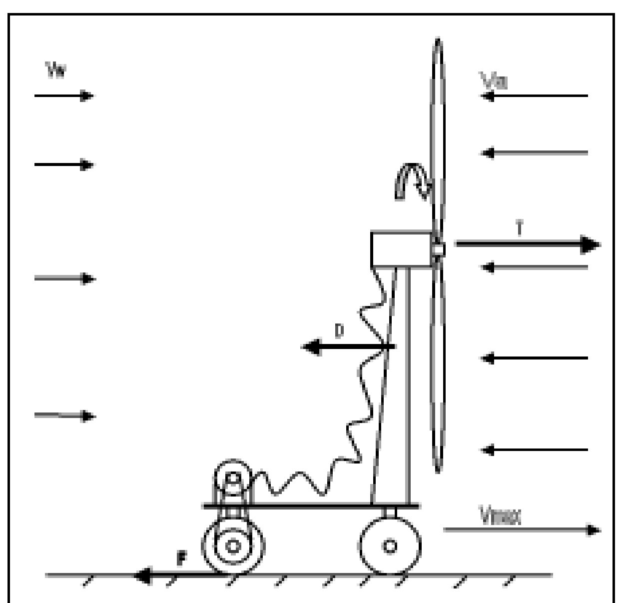


Fig 8

So, for land yacht:

$$F = m\,g\,k$$

then:

$$\frac{mgkE_{tr}E_{pr}V_{max}}{(V_{max}-V_w)} = \frac{CS\rho(V_{max}-V_w)^2}{2} + mgk$$

You can see that there is only one unknown item in this formula – V_{max}. That can be easily found for any yacht and certain conditions using mathematical methods for solving cubic equation.

I suggest not to develop this formula further so that everybody (including me) could determine maximum speed of any yacht in a few minutes using just a calculator and school mathematical knowledge. The simplest way of solving it is to use method of several approaches (iteration). Just remember that the left part of this equation is "thrust" and the right is total "resistance":

Thrust = Resistance

The acceleration of yacht will continue while the left part of equation is bigger than right one. When they are equal – it will reach the maximum speed.

Let us check this formula on Andrew Bauer's cart. We will see what is the maximum speed the cart could reach. So, Andrew Bauer's craft had approximately the following data:

m = 150kg (weight),
C = 0.8 (air drag coefficient),
Etr = 0.7 (efficiency of chain transmission),
Epr = 0.6 (air prop efficiency),
K = 0.5 (road friction coefficient),
S= 1.5m^2 (cross section of the cart),
Vw = 5.4m/s (wind speed)

As a first approach, let us presume it could reach 1.5V_W:

ThenVmax = 1.5 V_W; or V_{max} = 5.4x1.5 = 8.1 m/s and put that into the equation:

$$\frac{150\times9.81\times0.5\times0.7\times0.6\times8.1}{(8.1-5.4)} = \frac{0.8\times1.3\times1.5\times(8.1-5.4)^2}{2} + 150\times9.81\times0.5$$

or **309.015**x8.1 = **0.78**x(8.1 – 5.4)^2 + **735.75**
(8.1 – 5.4)

we get:

927.045N = 741.43N

We see that the thrust is still bigger than the drag, so the cart will continue acceleration. Let us presume it could reach 1.8 V_W:

so V_{max} = 1.8 V_W; or V_{max} = 9,72 m/s

Then

309.015x9.72 = **0.78**x(9.72 -5.4)^2+ **735.75;**
(9.72 -5.4)

we get:

695.28N = 750.3N

No, resistance is already bigger than thrust. Therefore the cart cannot reach 1.8V_W. Let us check a lesser value — 1.7V_W:

309.015x9.18 = **0.78**x(9.18 -5.4)^2+ **735.75;**
(9.18 -5.4)

750.4N = 746.9N

That's it! So, the maximum speed is about 1.71 V_W. Taking in account rolling friction it will be about 1.6V_W. It is very close to what Andrew Bauer really reached on his cart – 1.5V_W.

Let us check another craft – Mario Rosato's craft that he described in *Catalyst* #11, January 2003, page 36-38. This craft can also go along a normal road and has the following data:

m = 300kg (weight),
C = 0.35 (air drag coefficient),
S= 2m^2 (cross section of the cart),
Vw = 10m/s (wind speed)
Etr = 0.8 (efficiency of transmission),
Epr = 0.8 (air prop efficiency),
K = 0.5 (road friction coefficient),

$$\frac{300\times9.81\times0.5\times0.8\times0.8\times V_{max}}{(V_{max}-10)} = \frac{0.35\times1.3\times2\times(V_{max}-10)^2}{2} + 300\times9.81\times0.5$$

After several iterations I get V_{max} = 2.48V_W.

So, Mario's craft certainly can go faster than the wind and can reach 2.48V_W, and this is a normal craft!

What is the maximum speed that an ultra modern craft can reach? I made calculations for a perfect, but still real, craft:

m = 200kg C = 0.2
S= 1.5m^2 V_W = 10m/s
E_{tr} = 0.95 E_{pr} = 0.95
K = 0.5

So

$$\frac{200\times9.81\times0.5\times0.95\times0.8\times V_{max}}{(V_{max}-10)} = \frac{0.2\times1.3\times1.5\times(V_{max}-10)^2}{2} + 200\times9.81\times0.5$$

After several approaches I got **V_{max} = 4.2V_W**!!! Not bad for a land yacht is it? I think a water yacht can easily reach 2.5V_W going directly down wind.

Part 4: Windmill air prop.

Let us see what the airscrew in this craft is:

- By nature it is a windmill – it takes energy from wind, but it does not transfer it into torque or rotational moment;
- By appearance it is an autogiro rotor – it is rotating under the action of wind and creates propulsive force, but it cannot keep autorotation itself;
- By performance it is a pure air prop – it coverts torque into propulsive force, but this name does not look good – it does not reflect the nature of the screw. I would call it *Windmill air prop.*

There is a very amazing thing in doing calculations for this airscrew: we can use either windmill theory or air prop theory, but they both meet and give approximately the same result.

Say, we decided to make calculations for single seat land yacht that is able to travel with twice the wind speed in 10m/s wind. Using common knowledge in windmill theory we can roughly estimate the screw. It will be a 2-3 bladed airscrew with about 6-9 meters in diameter. Unfortunately windmill theory is not good for moving craft, especially for craft moving down wind. Much better results are given by air prop theory, which is widely and deeply researched during many tens of years and provides more than 90% of preciseness. From first glance, it is not difficult to predict dimensions of the screw given some experience in air prop making. The speed will be about 70km/h, shaft power about 20hp, it will be a single seat craft. OK, there are a lot of examples of such light craft around - it should be a 2-3 bladed airscrew of 1.2 - 1.5m in diameter. But this experience is good for nothing in our case – the cart will never go faster than the wind with such screw. Why? Using the formula I developed above we can see that the efficiency of air prop for this craft should be about 0.8. But 1.2-1.5m air screw for these conditions can only provide 0.5 -0.6.

If you want to keep to this diameter and reach the needed efficiency, you can try different variants of airscrew; you can try to change the number of blades, angle of attack, etc. But all empirical charts, diagrams and nomograms in any book in aerodynamics will show the efficiency not more than 0.6. If you decide to get 0.8 by any means you will see that the same charts, diagrams and nomograms will inevitably lead you to a big slow rotating air prop. You will get 2-3 bladed 7-8m air prop!

Amazing, isn't it? The air prop theory does not care about use of wind, but it gave us a windmill that is able to extract 7000-8000 Watt of needed power from the wind. It tells us that there is not any miracle and going down wind faster than the wind is not a result of a mysterious difference in the speeds of two medias – it is a result of use of wind energy. (Although most of earlier described mechanical models of our researchers are correct).

So, knowing that the airscrew is a pure air propeller, and knowing the efficiency of the prop for the speed you want to reach going down wind, you can calculate out all the parameters of your craft with 95% accuracy using well-known empirical and theoretical data for any part of the craft.

Any kind of transmission can be used (a mechanical one is lighter and simpler than electrical), but we should remember, that the shaft power in transmission is 2-3 times bigger than the power that is taken from the wind. The imperfection of transmission of 10-20% will lead to the waste of 30-60% of wind energy. The same with the air prop efficiency, and although these efficiencies can be quite usable for other kinds of craft, in our craft they will lead to loss of 100% of the wind energy inside the system leaving nothing for going ahead.

So, the air prop should be light with two, maximum three narrow blades. I am strongly against using six wide heavy blades in air prop that was mentioned in previous discussions.

I think now it is obvious that there is no "zero point" and there is no need to accumulate energy for passing wind speed, as it was presumed before – there is a strong propulsive force at this point.

I hope there are no secrets in this simple and tricky craft anymore. Why not for enthusiast, say for students of aerodynamic universities, to show the World that it is possible to go at least 3 times faster than the wind directly down wind, or to set some World Records?

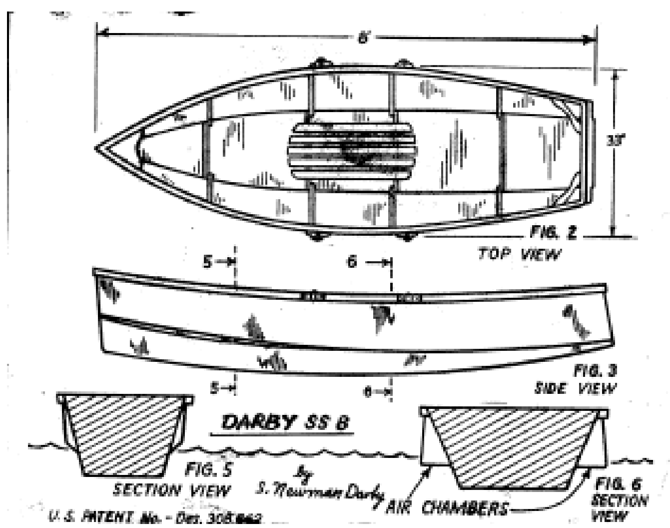
Victor Korepanov,
Piping/mechanical Designer,
KAZAKHSTAN, Central Asia.
E-mail: wind@mail.kz (home),
vigk@tengizchevroil.com (work)

Buoyant Keel Boats & Boards

Newman Darby

Newman Darby has been quietly building for some years boats and boards where the buoyancy function is separated from stability. He is not alone in this, as others, the best known probably being Phil Bolger, have been designing boats with the same essential idea. Here we present a couple of his designs.

Darby SS 8 Sailing Dinghy



Features

1. Shallow draft sailboat.
2. Can tack up wind with a draft of less than 5 inches (12cm).
3. Rudder is not below the bottom of the boat.
4. No centerboard or daggerboard is needed. The boat's hull is built to prevent slipping.
5. Small lakes will seem to have much more sailing area this way.
6. One can sail off a beach without a daggerboard problem.
7. Daggerboards cause drag and slow the boat down.
8. Daggerboard wells often leak or break and are in the way.
9. The oar locks are arranged so one can sit facing the stern or bow while rowing.
10. It only weighs 60 lbs so even a small person can carry it on their back.
11. It can tack up wind even better than many boats with daggerboards.
12. It has one seat and can carry a person weighing over 300 pounds. It tacks best with heavy people.
13. It is inexpensive and easy to build and takes no more time to build than a boat with daggerboards.
14. The Darby SS 8 has had many years of testing and proved to be very stable in strong winds.
15. Darby invented the windsurfing type sailboard and beach catamarans, but at first boat designers thought they would not work. Now millions sail these types of boats. The side step hulls do work and will also be commonplace in the future, but now they are new to people.

The Darby SS 8 was built of plywood, Fibreglass and epoxy. It is still in use.

Cindy Darby Tucker rowing the Darby SS 8. Note the kick up skeg which helps it go streight. This skeg is removable.

The lateral resistance designed into the hull allows this boat to tack up wind without a deep daggerboard or deep rudder. Because of its small size it can jib by swinging the boom over the bow like windsurfers do.

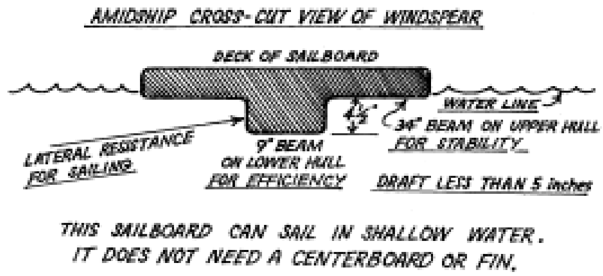
When sailing the Darby SS 8 it is easier to keep upright than wide dinghies with centerboards because the sailors can shift their weight on a narrow hull more quickly and there is not a centerboard well in the way in case of a strong wind shift.

Even though the Darby SS 8 is only 8 feet long (243cm) it easily keeps up with a 17 foot (518cm) canoe being paddled in a moderate wind and is much faster in strong wind.

In this picture the boat was delibertly filled with water to show how it keeps afloat. It is designed so all the water shown in the boat here can be spelled out in seconds in deep water and the sailor can roll back in easily without bailing.

The Darby SS 8 powered with a 1.5 H.P. gas motor. It also handles well with electric motors and can operate in less than 8 inches (20 cm) of water. It can operate in much shallower water than most PWC jet boats at slower safe speeds.

The *Windspear* Sailboard



The *Windspear* is an experimental sailboard designed to have improvements over the popular sailboards which are losing sales and discouraging beginners who soon quit sailing. It fills in the gap between the typical windsurfers and a self-reliant boat. It is a multi-purpose cruising sailboard with a unique hull design. It can be sailed in the hundreds of thousands of square miles of water where many people are reluctant to use the popular sailboards except to keep very close to where they launch.

The *Windspear* is extra wide for stability (about 34" wide), which would ordinarily be slow. For comparison most long boards average about 26" wide. To overcome this it has a long thin hull on the bottom shaped like a rowing shell, which carries much of the weight, yet moves through the water with little effort. This bottom hull is only 9" wide. The wake from this bottom hull then strikes the upper wide hull and stabilizes the sailboard. In high winds the center hull can lift like a water ski. The sides of this lower hull give the sailboard enough lateral resistance so it can tack upwind with out a daggerboard or deep fin. Because of this design this sailboard can sail and tack in exceptionally shallow water. This feature makes it easy to beach start and gives sailing a whole new freedom. The only fin it uses is shaped like a canoe paddle which can be snapped off in three seconds if needed for auxiliary power. This fin does not need to stick below the bottom of the sailboard.

The *Windspear* also works very well as a sit-upon kayak or a very seaworthy rowboat. With single or double blade paddle it handles much better than most long sailboards.

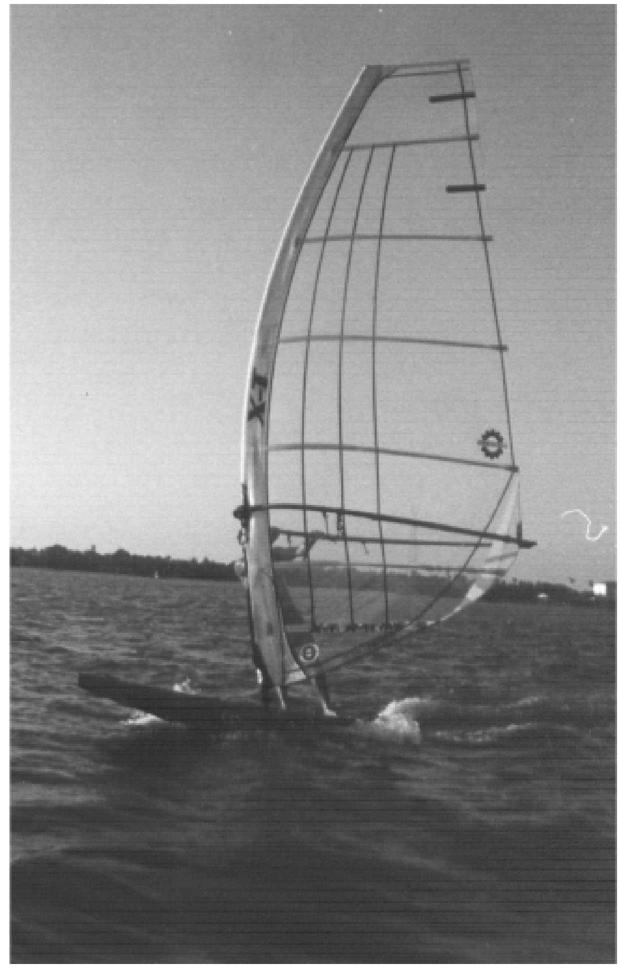
This combination of a fin and paddle can help in many conditions such as:

1. When the wind dies down and the current drifts the sailboard into rocks, shells, boats, docks, fisherman, etc.
2. The sudden still in the wind before a thunderstorm when you are trying to get back before lightening starts to strike.
3. When you are miles away from friends and suddenly are becalmed with sharks, alligators, watersnakes, angry fishermen, or etc..
4. The tide and wind start going the same direction.
5. Five miles from your launch site and your rig breaks so you cannot sail.
6. Tide drops and you must push over deep mud, quicksand, or sharp shell.
7. You are running late and must ask a stranger if you can leave your sailboard in his yard and run home, often for miles and over bridges with no walk ways.

All these things have happened to me in my 34 years of sailboarding and I am sure others could add different reasons for needing a paddle. The *Windspear* was designed to help sailboarders cope with many of these conditions so many people can feel safer sailing in different areas.

The *Windspear* was first designed to be a user-friendly windsurfer, but it also works well as a sit-upon kayak or seaworthy row boat. This stabler design may help bridge the gap with other boaters who are timid about sailing windsurfing style.

The *Windspear* is a real turn around in boat design. For hundreds of years boat designers have been using ballast keels to stabilizing their boats. Now the *Windspear* uses a buoyant keel that lifts up the hull to make a stabler craft. For example a forty pound sailboard designed this way can weigh minus twenty or even minus ninety pounds in the water compared to other sailboards in the water. The long thin hull on the bottom should be no more drag than a daggerboard and fin. Many will not understand this, but remember back when an airplane put pontoons where others had wheels and took the world's speed record. Many experts may consider this ridiculous or even impossible but I found after many years of experimenting that such hulls can be efficient and stable.



About Sept. 1990 my wife Naomi wrote and had published an article in the Boat Journal Magazine about a similar boat which I designed, patented, and built. I then got an order to design three kayaks for a Japanese kayak factory. Since then I see these types of kayak hulls in wide use. So we know this principle really works. I have since spent many hours sailing and testing the *Windspear* and at this early stage it is already my favorite sailboard and the design should get keep getting better in years to come. This prototype I am testing is made of wood and fiberglass and weighs 58lb, but because of its strong shape like a T-beam I believe it could be built much lighter using a foam core.

This sailboard is 12' long and I am planning on testing a 10' model.

The *Windspear* is not on the market. If anyone wants one contact me and I'll build one for you by hand on order.

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

October 2004

2nd BMMA meeting
Gosport. Contact:Mike Dunkley Tel: +44 (1252) 721439

2nd-8th Weymouth Speedweek
Portland Sailing Academy, Portland Harbour, Dorset UK. Contact: Bob Downhill; tel: +44 (1323) 644 879

6th AYRS Weymouth meeting
Speedsailing. 19.30 for 20.00hrs at the Royal Dorset Yacht Club, Upper Mall, Weymouth. Contact: AYRS Secretary, BCM AYRS, London WC1N 3XX; tel: +44 (1727) 862 268; email: ayrs@fishwick.demon.co.uk

November

3rd AYRS London meeting
Navigating inland waterways without an engine – Mike Bedwell. 19.30 for 20.00hrs at the London Corinthian Sailing Club, Upper Mall, London W6. Contact: AYRS Secretary, BCM AYRS, London WC1N 3XX, UK; tel: +44 (1727) 862 268; email: ayrs@fishwick.demon.co.uk

December

1st AYRS London meeting
Hydrofoil Sailing – James Grogono. 19.30 for 20.00hrs at the London Corinthian Sailing Club, Upper Mall, London W6. Contact: AYRS Secretary, BCM AYRS, London WC1N 3XX, UK; tel: +44 (1727) 862 268; email: ayrs@fishwick.demon.co.uk

January 2005

6th - 16th London International Boat Show
EXCEL Exhibition Centre, London Docklands. Those who can give a day or two, from 15th December onwards, to help build/staff the AYRS stand (reward - free entry!) should contact Sheila Fishwick tel: +44 (1727) 862 268; email: ayrs@fishwick.demon.co.uk

23rd All-Day AYRS Meeting
9.30am-4pm, Thorpe Village Hall, Coldharbour Lane, Thorpe, Surrey (off A320 between Staines and Chertsey – follow signs to Thorpe Park, then to the village). Details from Fred Ball, tel: +44 1344 843690; email fcb@globalnet.co.uk

23rd AYRS Annual General Meeting
4pm, Thorpe Village Hall, Coldharbour Lane, Thorpe, Surrey (as above). Details from the AYRS Secretary tel: +44 (1727) 862 268; email: ayrs@fishwick.demon.co.uk. Items for the Agenda should be notified before December 1st. The Agenda and Committee Report should be published with January's *Catalyst*.

February

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

March

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

April

6th AYRS London meeting
Subject to be confirmed. 19.30 for 20.00hrs at the London Corinthian Sailing Club, Upper Mall, London W6. Contact: AYRS Secretary, BCM AYRS, London WC1N 3XX; tel: +44 (1727) 862 268; email: ayrs@fishwick.demon.co.uk

May

2nd-6th AYRS sailing meeting
To be confirmed. Somewhere in UK. (Neap tide, going to Springs)

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

On the Horizon . . .

Mini Trimaran - Newman Darby
Flying Proa - Roberto Rampinelli
Walker Wingsail - James Wright
Unfinished Projects - Roger Strube
Sources and resources: reviews, publications and Internet sites

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

Printed by Hendi Systems Ltd, London N1 6DL.