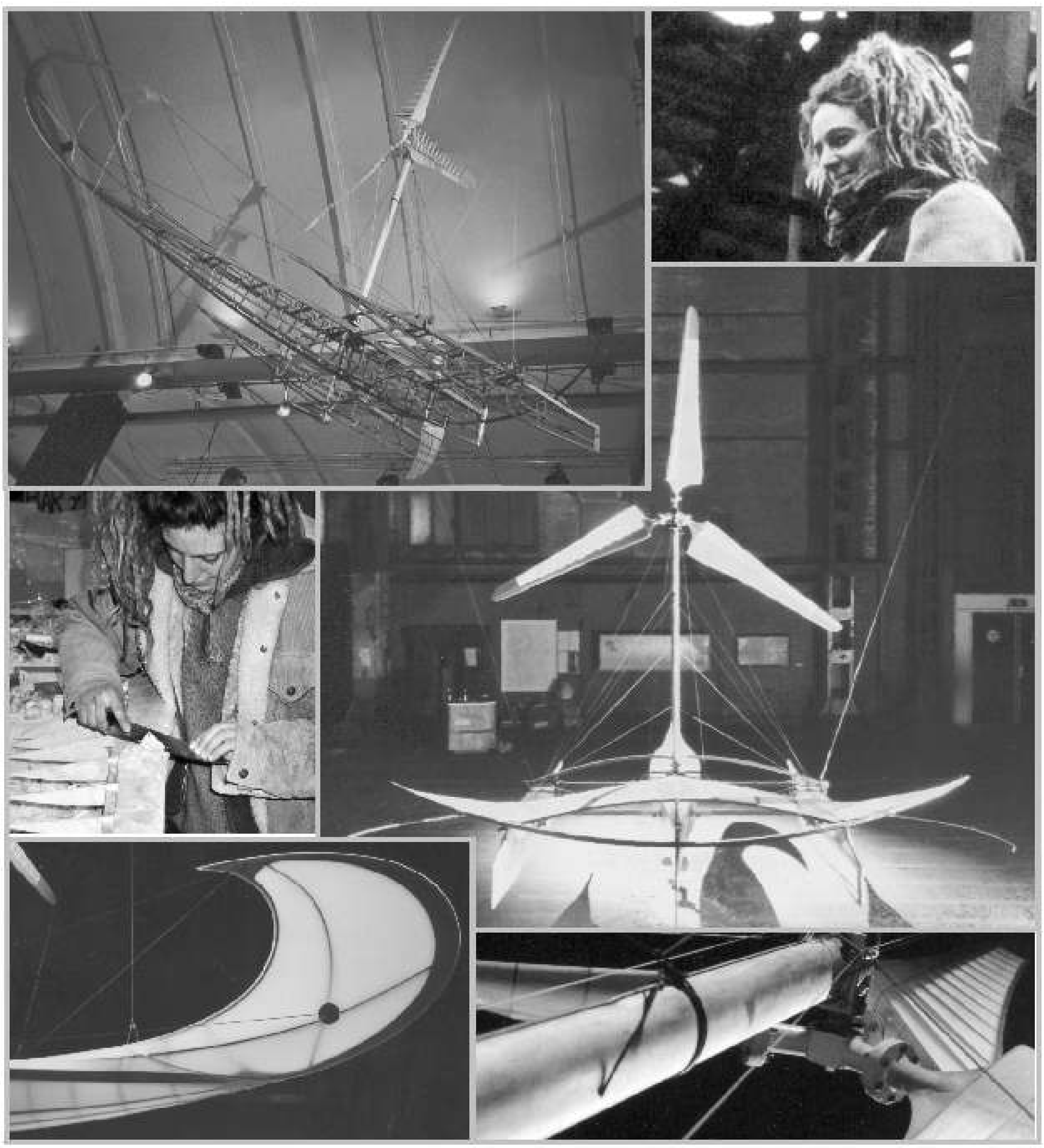
Catalyst

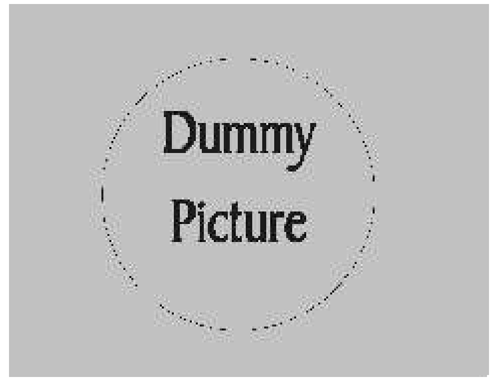
Journal of the Amateur Yacht Research Society

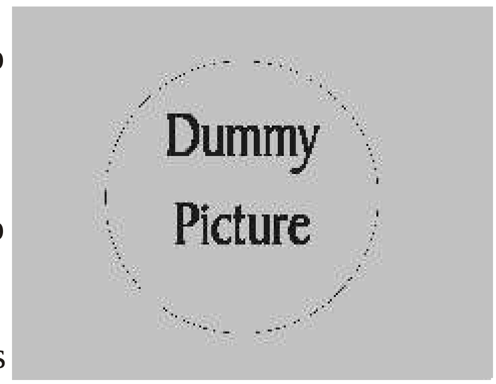
Number 25 July 2006

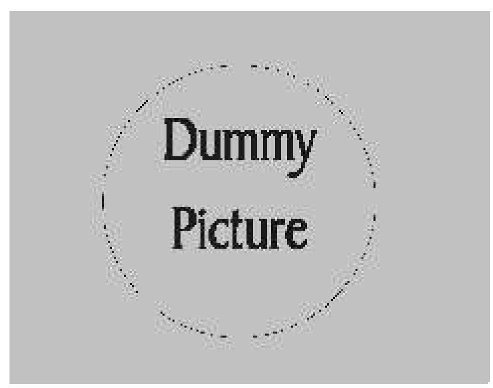


Features

Regulars

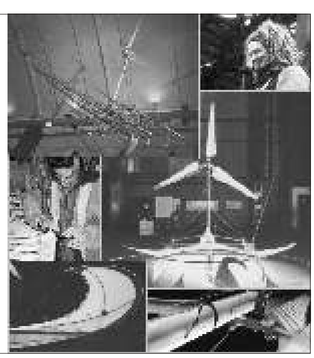


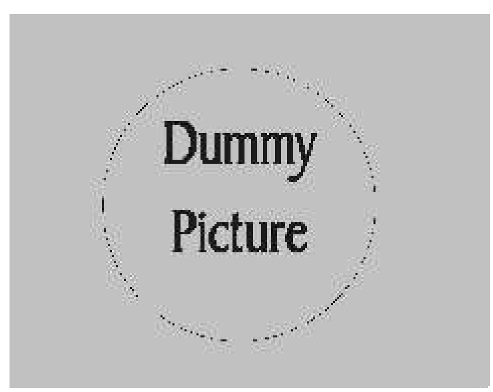




Cover shows Windwinder montage:

Wipke Iwerson and details of the Windwinder, including carving the blades of the 4 metre diameter NACA section 4412, three-bladed windmill. The purpose of Windwinder is to go to windward continuously , unmanned.





Catalyst

Journal of the
Amateur Yacht Research Society

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

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

AYRS subscribers receive both *Catalyst* and the booklets. Subscription is UK£20 or US$30 per annum for a 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 (0) 1727 862 268 or email: office@ayrs.org

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

Website: http://www.ayrs.org

ISSN 1469-6754

Catalyst

It is appropriate that I apologise for this issue of *Catalyst* being late. I had underestimated how long it would take me to replicate the existing format. I am trying to avoid the 'new broom' problem of sweeping out all the good stuff, so 'no change' is the mantra, and I hope you continue to provide material for the magazine.

You will find the majority of this issue is dealing with dead-downwind-faster-than-the-wind, but that reflects the material we have received.

Please use Catalyst. It exists for you and as a means for you to spread ideas amongst other like-minded individuals. Some projects may work best when an innovative thinker with few manual skills combines with an innovative skilled fabricator. Use this, your, journal to connect one with another. We can run a 'help wanted' column! If you have information to offer, don't worry about presentation. However you write:— in words or pictures or graphs or photographs, send it in and we'll work on it. Graphs and illustrations are easy for me, so a rough sketch or written table is all I need—so long as I can understand it, then I can produce an illustration for reproduction in *Catalyst*. You guys are the people doing the thinking and building, so please let us in on your work.

As for me, I am a graduate broad-based engineer on the Isle of Wight, presently running a small design and print business, living with my wife and a cat, playing in a jazz band and a skiffle group, and have interests in square rig, commercial sail and beach-launched offshore amphibious vehicles. I have earnt my bruises in small-boat seamanship in several dinghies and catamarans.

Percy Westwood, Newbie Catalyst Editor

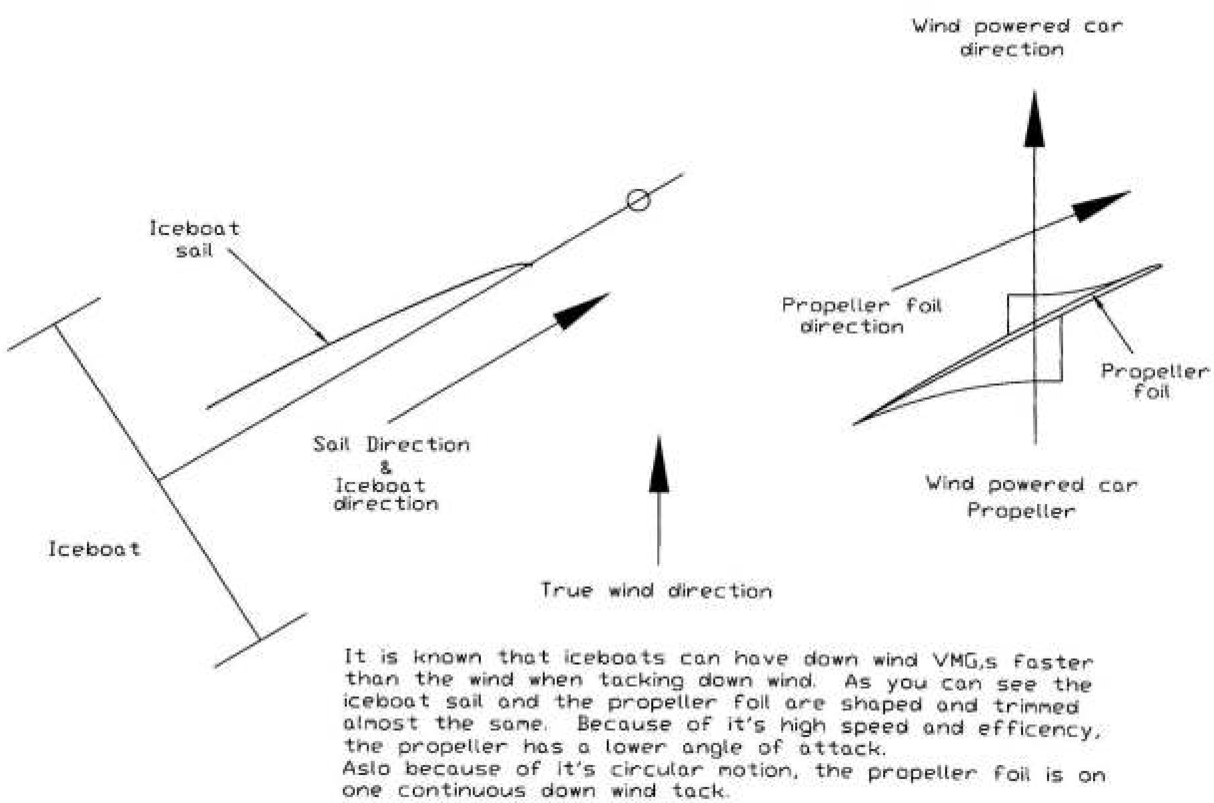
DWFTTW — Jack Goodman's Movie — commentary

I hope AYRS appreciates the risk to life and limb I took for them. To get this movie, I strapped the camera and the remote control unit to my wife's bicycle, and went out on the public roads to literally chase the wind. The car needs about 6 mph of wind to get to wind speed, and about 7 or 8 mph of wind to exceed WS. The gearing/propeller pitch is set to about 1.4 times windspeed and requires 9 or 10 mph of wind to achieve this speed. When the car gets close to 1.4 times windspeed, it takes off like a shot, and I cannot steer and keep up with it on the bicycle. After several near disasters, the included movie was shot. The wind was light and variable, never going over 9 mph on this run. The start was bad since I had forgotten to release the brake. Then the wind died to about 4 or 5 mph and the car just idled along. After a minute the wind picked up, and except for a few short lulls, the flag flies aft for the rest of the run. Note that the flag flies forwards at the beginning and the end when the car is stationary.

A comparison between the iceboat and the DWFTTW car is shown below

Jack Goodman imaginationltd@aol.com

The movie is at the AYRS website: www.ayrs.org, MOV05703.mpg



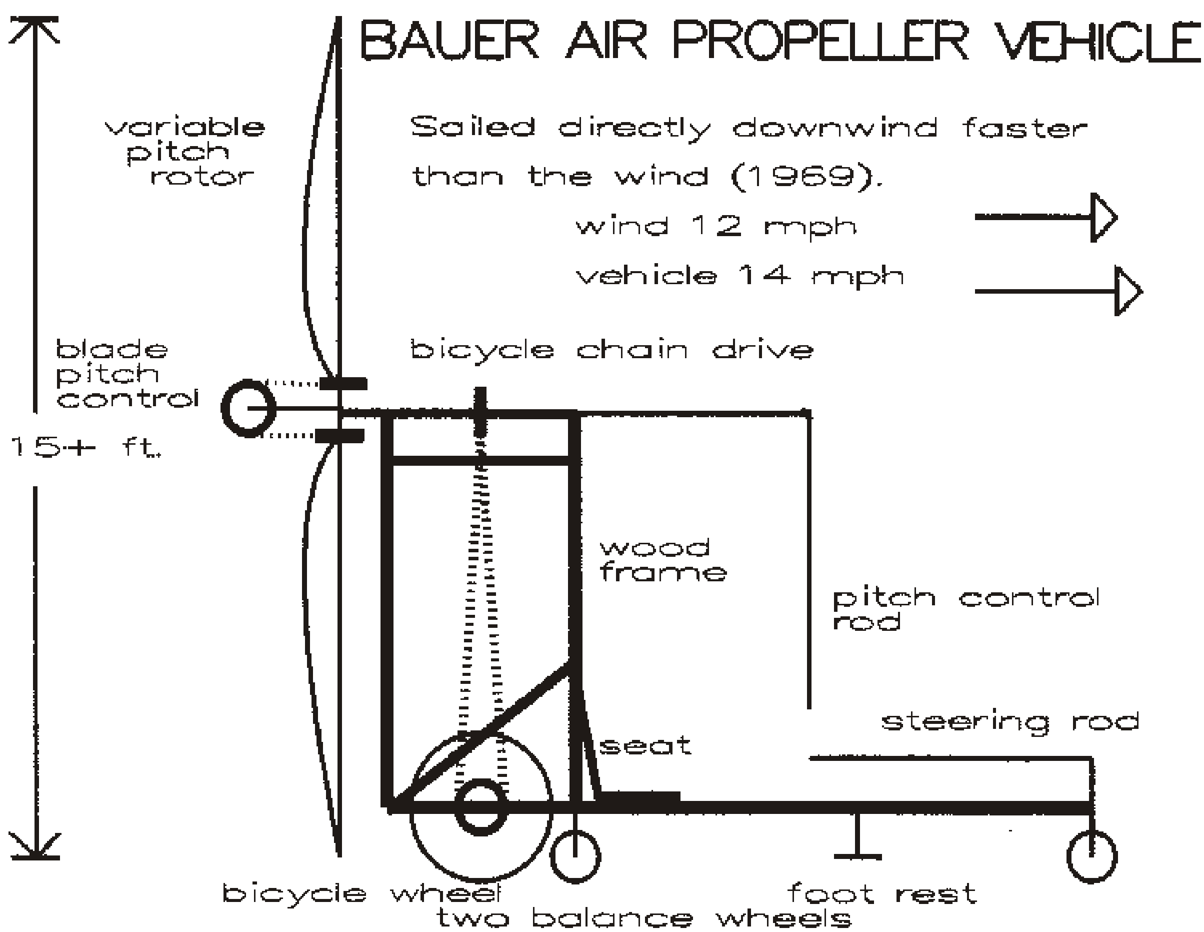
09/05/05 [DDWFTTW] To the Editor of Catalyst;

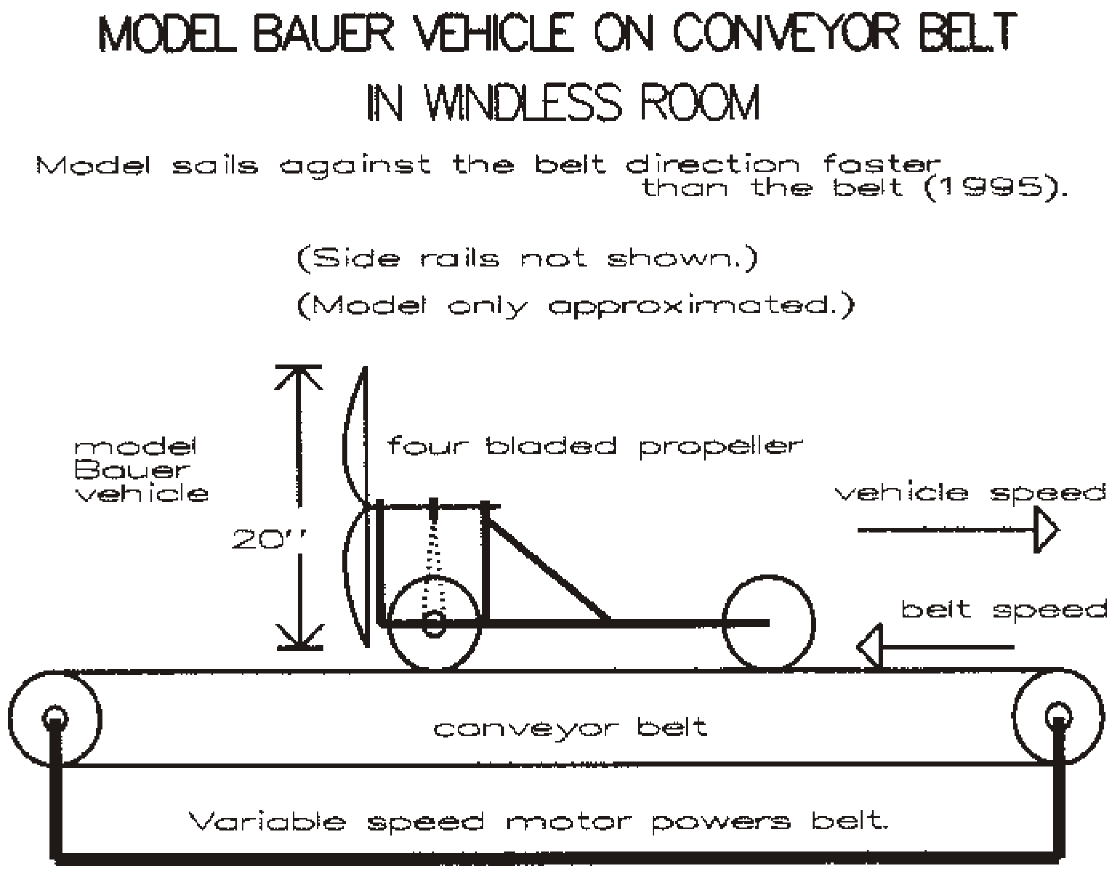
Sir,

In Catalyst 21, July 2005, John C. Wilson quotes me in his letter dated 14 June, 2005. That quote is from my personal e-mail to Mr Wilson which he quoted without my permission in order to imply an obscure criticism that he considers to be self evident. It is not self evident because my statement is accurate. He quotes my comment to the effect that if a researcher duplicated the Bauer model on the conveyor belt, and if the model failed to perform as expected, that failure would be regarded [by the scientific community] as due to a flaw in that model. Mr Wilson failed to put my quote into context. That context is the very considerable experimental and mathematical evidence that the theory is sound. No one has demonstrated a flaw in either the experiments or the mathematical calculations. Vague doubts are not science.

Mr Wilson then attempts to present an argument for scepticism. He quotes me again, without attributing the quote to any person or publication, as saying that the Bauer vehicle went directly downwind at 14 mph in a 12 mph wind. He takes issue with that statement by arguing that no wind is steady. If Mr Wilson wishes to express scientific scepticism about an experiment, then he should first read the original article and direct his comments at the procedures used in the original experiment, not at my summary description of it. My summary includes additional information which Mr Wilson ignored. Mr Bauer's career was as an aerospace engineer. We may reasonably assume that he was aware that wind is not perfectly steady. Bauer indicated that the wind indicator used on his outdoor vehicle showed a relative wind from ahead during the course of a 40 second run. Etc.

I wish to point out that Mr Bauer, himself, replicated his experiment in such a way as to precisely control the wind speed. He used a model on a conveyor bell in a windless room at AeroVironment in Los Angeles in 1995. One of the witnesses was the founder, Dr. Paul B. MacCready, a world class





aerodynamicist and inventor. He understands Bauer vehicles quite well and would have spotted any flaws in the demonstration. It is important to note that that demonstration controlled the independent variable of wind speed—since there was a zero wind speed. And the speed of the motorized belt could be easily observed and controlled. So Mr Wilson's concern about the inconstancy of the wind speed was resolved 10 years ago by Mr Bauer himself.

More recently (June, 2001, approximately). Bauer had his demonstration videotaped by Professor Frederick G. Allen of UCLA. Also, we now know that an outdoor experiment similar to Bauer's was conducted more than 20 years ago, independently, in Kazakhstan by Victor Korepanov of (Catalyst 18, Oct. 2004). So there are four demonstrations of sailing DDWFTTW on record. There may be close to a dozen articles explaining the mathematics of sailing DDWFTTW. The inventor and engineer, Jon Howes, presented an elegantly succinct mathematical explanation in Catalyst 12, April 2003. So as far as I can tell, Mr Wilson's continued skepticism seems to be based on ignoring the evidence. Even so it is a good idea, whenever possible, to replicate a controversial experiment until all of the skeptics are satisfied. In the previous issue of Catalyst I explained how to do that using a Bauer string yacht.

Mr Wilson states that his article on the subject of sailing DDWFTTW was intended to show that there is no theoretical limit on how fast one might go downwind in a wind powered vehicle. That is an important point; and I believe that it is valid. However, Mr Wilson neglects to say what kind of wind powered vehicle he has in mind. There are many candidates that I have explained. His recommendation to use a powered treadmill to test them is puzzling because a treadmill is not applicable to most of them.

Peter A. Sharp, Oakland, California;
e-mail: sharpencil@sbcglobal.net

01/01/06 [DDWFTTW] To the Editor of Catalyst;

Dear Mr. Fishwick,

In Catalyst 22, Oct. 2005, at the end of Peter Jefferson's correspondence (pg. 31), I read your statement: "Editor's Note: Insofar as Catalyst is concerned, this correspondence is closed until some one has some practical results to report". Given your previous commitment to publishing new ideas (catalysts), I'm confused. Why the seeming reversal of policy? At the top of page 10 you confirm that "reactions to the contributions of others are appreciated", but then at the bottom of page 31 you say the opposite.

I have no idea what you intend to prohibit as part of "this correspondence" since it has included all of sailing. For example, can we discuss PAS craft sailing across the wind as long as we don't mention that some could sail directly downwind faster than the wind (DDWFTTW)?

Nor do I know what you mean by "practical results" since many have been reported already — such as the Mill-Prop craft of Bauer, Korepanov, Schmidt, and Ansar, and the PAS Accumulator boats by HaveBlue that crossed the Atlantic. And how about the various reports on windmill boats too since I've shown that they work on the same principle as Bauer vehicles, the Mill-Prop principle, and can also outrun the moving medium that propels them by placing them on a conveyor belt in a windless room? How are all these not reports of practical results? There are many people who might take exception to your discounting their practical results.

Frankly, it strikes me as counter productive to use censorship to encourage practical results. If we can't openly plan DDWFTTW competitions, won't that discourage practical results? Records and awards seem to be the best incentives. But if you agree, then I don't understand why you didn't publish the prize rules for sailing DDWFTTW when I requested, in print, that you do so. How could that not discourage the practical results I was trying to encourage?

Please consider that prohibiting the correction of Jefferson's assertions gave them your official stamp of approval. That embarrassing for us all. For example, he defined "true wind" incorrectly and it can't get more amateurish than that. His comments also make my Metatheory seem like arbitrary nonsense, but I don't mind as long as I am allowed to defend it. However, you are now prohibiting me from doing so.

On page 2 you state, "Opinions expressed are the author's, and not those of the AYRS." (Of course, I know that's not exactly true since you exchanged your opinions for mine when you edited some of my articles, and also you validate articles simply by choosing to publish them, as opposed to those you don't but those are not my points.) You negated your disavowal (quoted above) when you prohibited rebuttals. That officially sanctioned Jefferson's remarks, and made Jefferson's words into your words. That negation is not even conditional upon the production of practical results (as you stated) since, as editor, only you can decide if something is a "practical result" (an ambiguous term that, if not clearly defined, can exclude anything).

I have worked extremely hard to be accurate and innovative, and to encourage participation to be a catalyst within Catalyst. For example, as Jefferson mentioned, I encouraged comments like his. I did so in order that they could be used as teaching tools. We can learn a lot from mistakes. I thought you supported that process. Otherwise, I see no justification for you to have published his remarks because they make no sense.

Jefferson's remarks illustrate the need for a better understanding of sailing metatheory before trying to produce further practical results in these new areas of research if only to be able to recognize a "practical result" when we see one. For example, if Jefferson had built and successfully demonstrated his proposed DWFTTW vehicle, would that be a satisfactory "practical result" as far as you are concerned? If you are unsure about your answer, then that illustrates my point. My guess is that not many members of the AYRS know enough sailing metatheory yet to correctly answer that question. Without an adequate knowledge of my Metatheory of Sailing, it could be a difficult question to answer.

Please also consider that if Catalyst is a scientific journal, then I have already given you many practical results in the form of successful experiments conducted right in the pages of Catalyst. I have stated very clear hypotheses about sailing DDWFTTW (and other directions) in the form of drawings and explanations of new types of sailing craft. Each of them has been put to the test of scientific scrutiny by all AYRS members, including professional engineers. Each hypothesis can be easily disproved if anyone can find a single instance where its design or function is inconsistent with the laws of physics. Yet no one (except me) has found a single flaw. So if you mean to imply that those experiments are not practical results, then what criteria are you using?

Maybe you believe that the time has come for nuts and bolts demonstrations that I should either put up or shut up. But nuts and bolts demonstrations of new sailing principles can only test the engineering quality of a craft, not the validity of its underlying physical principles. After all, it might “work”, but for the wrong reason, as illustrated by Jefferson’s proposed DWFTTW vehicle that is not even a sailing craft. Or, if it failed to work, the reason could be due to nothing more than excessive friction in a bearing, thus disproving nothing. Demonstrations can be impressive, and they can add confidence in an underlying principle, but they are not definitive scientific tests or experiments. They reassure only those who already understand and accept the underlying principle as valid. For those who don’t understand the principle, a demonstration doesn’t prove anything. For example, look at how many people still don’t believe that Bauer vehicles have sailed DDWFTTW. That’s because it violates their “common sense”. Maybe we should have a discussion in Catalyst about the differences between scientific criteria and engineering criteria. They overlap but are not the same.

I haven’t even finished explaining all the new ways to sail (such as PAS Lift Resailing). Yet you seem to expect me to start building boats already. Why? I have been working toward building a model boat (a Tazmaran) by further developing my vertical axis wind turbine (VAWT) to power it. But the research takes an enormous amount of time. For example, I have had to analyze three engineering theses (2 PhD. and one MSc) and explain why they misunderstood the underlying new principle, and why that substantially lowered the measured efficiency of each of their full scale VAWT.

Please consider that it took thousands of people across thousands of years to cumulatively invent our current sailing craft, even though those craft almost all work basically the same way (Direct Sailing). Yet you seem to be expecting me to single-handedly demonstrate a dozen radically new types of sailing craft, each based on an entirely new sailing principle (my various PAS techniques and my new Mill-Prop designs), within a span of about 6 years, and to do it in my spare time while earning a living. How likely is that? A respected engineer told me that one of my articles, alone, was equal to a life’s work. I think that’s an exaggeration, but I am being enormously productive. Yet you are demanding still more. Why the impatience? How many years did it take between the original conception by Hagedoorn (1975) of an ultimate sailing craft until Howes’ practical result with a model monofoil? 30?

Obviously, I can’t discern what you want or why. So, since the primary subject of Jefferson’s correspondence was sailing without a true wind, I will assume that my experimental demonstration (which I sent to you) of a crude model of a double land yacht that sails without a true wind (or air, or fluids) satisfies your requirement for a practical result (a nuts and bolts physical demonstration). If it doesn’t, please explain, or I will be thoroughly discouraged.

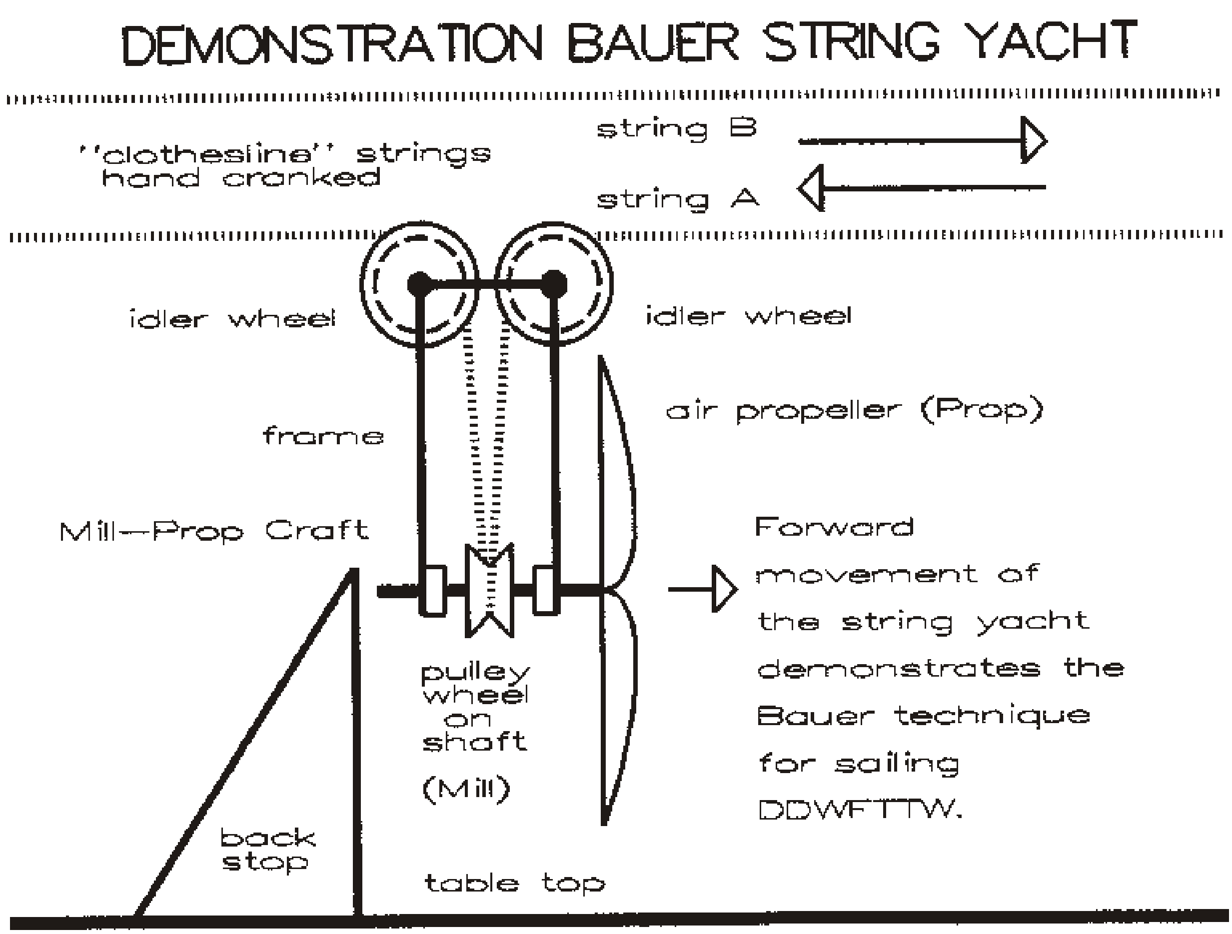
I believe my following critique *[Page ?, Ed]* contributes substantially to our fundamental understanding of sailing, and I hope you will agree.

Peter A. Sharp, Oakland, California; e-mail: sharpencil@sbcglobal.net

[DDWFTTW] A Bauer String Yacht Demonstration

Peter A Sharp

I gather from reading Catalyst that there are AYRS members who still insist that it is not possible to sail directly downwind faster than the wind (DDWFTTW) even though Andrew B. Bauer did so 30 years ago using a land yacht equipped with a very large propeller spun by connecting it to one of the wheels via a bicycle chain. Those members perhaps need to see a demonstration with their own eyes in order to believe it. So I wish to propose a simplified demonstration model of a Bauer air propeller vehicle that should be relatively easy to construct. (Perfecting any invention is usually quite time consuming, which is why I have not already built it.) However, to believe the demonstration, observers will need to understand it, and that could be a problem because most people are not yet familiar with the underlying symmetry and invariance of sailing. So I will mention some of the key concepts.



A prize

There is, I believe, a standing award of 500 pounds for the first person to make such a demonstration. Perhaps our Editor would be so kind as to publish the details of that prize along with this article. I exempt myself from the prize so that I can comment on it impartially.

The demonstration model, or a duplicate, could reside with the Editor of Catalyst so that any member could have access to it by appointment. That should put an end to further scepticism. And one of our members might wish to make a video of the demonstration and place it on the Internet, and / or demonstrate the model at boat shows as has been suggested.

String yacht

My proposed demonstration is a simplified version of Mr. Bauer's more recent, 1995 demonstration wherein he used a model on a conveyor belt, indoors, in a windless room *[See Page ??, Ed]*. The model advanced directly against the belt faster than the belt. That is physically equivalent to sailing DDWFTTW. It is merely a context reversal. From the frame of reference of the vehicle, the relative motions are the same. My demonstration is meant to be more portable, safer, and less expensive to reproduce than his — once the exact parts and dimensions have been worked out.

Instead of using a conveyor belt with the model riding on top of the belt, as Mr. Bauer did, I propose the use of a "clothesline" consisting of string circulating around two pulley wheels, with the model suspended from the bottom string. One of the pulley wheels would be hand cranked for precise control.

The string yacht is, basically, just an upside down variation of Bauer's model. However, the special advantage of its design is that, since the string is flexible, it can serve to rotate the propeller shaft's pulley wheel directly. That could achieve a higher drive train efficiency.

It will be most important to use an efficient propeller. Rubber band airplane propellers might be adequate, but they might not be large enough. Larger propellers can be more efficient than smaller propellers. Bauer used a propeller with a 20 inch diameter for his model. (I have not seen the model, so I am guessing that it was constructed like the full scale original.)

My tinkering indicates that unwaxed dental floss (or tape) coated with V-belt dressing provides good traction, is exceptionally flexible, and is surprisingly strong. So it might be used as the "clothesline". The "clothesline" pulley wheels could be mounted on separate stands clamped to a table top. The stands need be only about 2 to 4 feet apart, and the bottom string needs only to be high enough to insure that the propeller safely clears the table top.

The reason for the back stop is to hold the string yacht in place until the propeller is spinning fast enough to drive the string yacht forward (to the right in the drawing). That is equivalent to Bauer holding his model in place until its propeller was up to speed. The back stop should be located at the mid point of the string so as to avoid any assist from gravity due to sag in the string.

The parts of the whole setup should fit in a small box so as to make it easily portable. The builder could profit from selling duplicate models to science museums, and to universities for use in physics and engineering classes.

Variations

If the final model turns out to be too heavy and causes too much string sag, then a monorail beam could be run alongside the lower string. A support wheel fixed to the string yacht frame could then ride on the monorail.

Or, the string yacht could roll along a table top. Merely invert the string yacht top to bottom and then add free-turning support wheels. The "clothesline" pulley wheels could lie flat on the supporting surface. The string could also be used to guide the model. This arrangement would also enable the model to roll along a smooth floor instead of a table top, so the string loop could be as long as needed (unlimited extension).

This is a versatile option because, if the string were allowed to accelerate the string yacht backwards, the relative wind thus created would cause the rotor to function as a windmill, and the string yacht would be able to outrun the string. It could demonstrate how a windmill string yacht can sail directly down string faster than the string (DDSFTTS) that is propelling it.

Mill-Prop craft

The string yacht is a Mill-Prop craft. It works on the Mill-Prop Principle: A Mill (gas-mill, liquid-mill, or solid-mill) in one sailing medium powers a Prop (gas-prop, liquid-prop, or solid-prop) in the other sailing medium. Solid-mills and solid-props include devices such as wheels, pulley wheels, and oscillating

THE 9 MILL-PROP COMBINATIONS

mill = power producing device

prop = thrust producing device

solid = solid-surface

	gas—mill	liquid—mill	solid—mill
gas—prop	g—m g—p	l—m g—p	s—m g—p
liquid—prop	g—m l—p	l—m l—p	s—m l—p
solid—prop	g—m s—p	l—m s—p	s—m s—p

Mills and props rotate, circulate, or oscillate.

Solid—mills and solid—props are usually wheels or equivalent devices, such as pulley wheels or laterally oscillating ice skates.

Usually, the gas is air and the liquid is water.

skates, that interact with solid-surfaces. A string or cable can function as the equivalent of a solid-surface.

Mill-Prop craft have a range of operation in which the Mill can produce enough power to overcome its own drag, plus overcome the craft's additional internal and external sources of drag. That range is determined by 1) the type and efficiency of the Mill and the Prop, 2) the mechanical advantage ("gear ratio") of the Mill to the Prop, 3) the efficiency of the drive train, 4) the amount of propulsive and/or retarding drag created by the means used to support the craft against gravity, and 5) the parasitic drag of the craft.

Physical equivalence

All efficient Mill-Prop craft can sail directly down prop-medium faster than a moving prop-medium. And all efficient Mill-Prop craft can sail directly against a moving mill-medium. From the frame of reference of the craft, the craft can sail directly against its mill-medium regardless of which medium is seen as moving from the frame of reference of the stationary ground.

It is critically important to realize that a Bauer string yacht sailing against the string faster than the string is physically equivalent to a Bauer land yacht sailing DDWFTTW. That could be demonstrated experimentally indoors, although it should not be necessary to do so.

To do so, simply form a wind tunnel tube using clear, flexible sheets of plastic, and enclose the string yacht and its string. Keep the string stationary, and use a long string. Use a fan to suck air through the tube. Pull the string yacht to get it moving at roughly 0.6 times the speed of the wind. It would then accelerate and outrun the wind if, as in the drawing, it has the ability to advance against the moving string. The two contexts are physically equivalent. From the frame of

THE 18 MATERIAL MEDIA CONTEXTS OF SAILING

gas> gas	liquid> gas	solid> gas	gas gas>	liquid gas>	solid gas>
gas> liquid	liquid> liquid	solid> liquid	gas liquid>	liquid liquid>	solid liquid>
gas> solid	liquid> solid	solid> solid	gas solid>	liquid solid>	solid solid>

KEY: "top" medium / "bottom" medium

> = moving

solid = solid—surface or the equivalent

Alternatively, media may be side by side, etc.

reference of the string yacht, the relative motions of the mill-medium and the prop medium remain the same in both contexts. So the string yacht should function equally well in either case.

A string yacht in a wind tunnel could also function as a windmill string yacht heading directly up wind.

Wind not necessary

If the prize were to require the use of a true wind, that would be arbitrary and unnecessary. It would be based on false assumptions about the physics of sailing. So the string yacht should not be required to conform to that misconception. To require the string yacht to outrun a true wind would be to perpetuate the 6,000 year old myth that sailing requires wind.

Sailing craft do not require a true wind in order to sail. For the 5 (of the 9) Mill-Prop combinations that interact with a gas (air), the gas could be stationary (no wind). The craft would function normally. An example is a windmill boat (gas-mill / liquid-prop) sailing directly down river faster than the river under windless conditions by using only its relative wind. Another example is a Bauer vehicle on a conveyor belt, in a windless room, advancing directly against the belt faster than the belt.

The 4 other Mill-Prop combinations do not interact with a gas (air) at all. For example, the first solid-mill / solid-prop craft was Theo Schmidt's model vehicle sandwiched between two parallel planes. It sailed directly down plane about 4 times as fast as the moving plane (AYRS 100).

Although wind sailing is by far the most common form of sailing, it is certainly possible to sail without wind or even air. That is because sailing is craft propulsion using energy derived from the relative motion between two material media (or two different parts of one material medium), external to the craft, by interacting with both media (or both parts) simultaneously (not sequentially). Both material media must have unlimited extension, at least potentially, and the media motion must be essentially continuous rather than essentially oscillatory.

Attempts to define sailing that are based on the premise that wind or air is necessary will result in contradictions. I invite anyone who doubts that to present his reasoning for our consideration.

Windmill string yacht

In the string yacht drawing, the air propeller, as seen from the rear, rotates clockwise when the craft is operating as a Bauer vehicle moving to the right. However, as mentioned above, the string yacht could function as a windmill vehicle.

One option would be to remove the back stop and let the string yacht be carried along by string A (moving to the left in the drawing). That would cause the rotor to function as a crude windmill. It would turn the pulley wheel on the propeller shaft counter clockwise. That, in turn, would cause the string yacht to sail down string faster than the string. So the string yacht is either a Bauer vehicle (solid-mill / gas-prop) or a windmill vehicle (gas-mill / solid-prop) depending on whether its rotor is functioning as an air propeller or as a windmill, respectively.

If appropriately designed, all 9 basic Mill-Prop combinations could 1) sail directly against a moving medium, or 2) outrun a moving medium, or 3) both. The original Bauer vehicle did both. The string yacht's rotor blades could be shaped to do both. In cross section they would be symmetrical and would have small radius leading and trailing edges.

The conventional distinction between windmill craft and Bauer air propeller craft is merely an historical artifact due to incomplete knowledge. The distinction is not consistent because both a windmill and an air propeller may be combined into the same Mill-Prop craft such that the windmill powers the air propeller, as in the case of a windmill / Bauer blimp (gas-mill / gas-prop). (See Catalyst 20, April 2005.) A consistent, scientific classification must be based upon the 9 basic Mill-Prop combinations.

Note that from the frame of reference of the sailing craft, there are 9 basic sailing media combinations. However, an independent observer would see 18 media combinations (2 x 9) because he would treat each of the 9 combinations as if one of the media were stationary and the other were moving, or vice versa.

When the stationary medium becomes the moving medium, and vice versa, that is a context reversal. Context reversals look quite different to an independent observer. But from the frame of reference of the sailing craft, a context reversal looks the same as before, as long as the relative motions are still in the correct direction for normal operation. That is why it does not matter whether the string yacht advances against the string or outruns a wind. From the frame of reference of the string yacht, the two contexts are physically equivalent. It sails the same in either case. Sailing is based on symmetry and invariance.

A Double Land Yacht reveals Direct Sailing to be a Cam Action

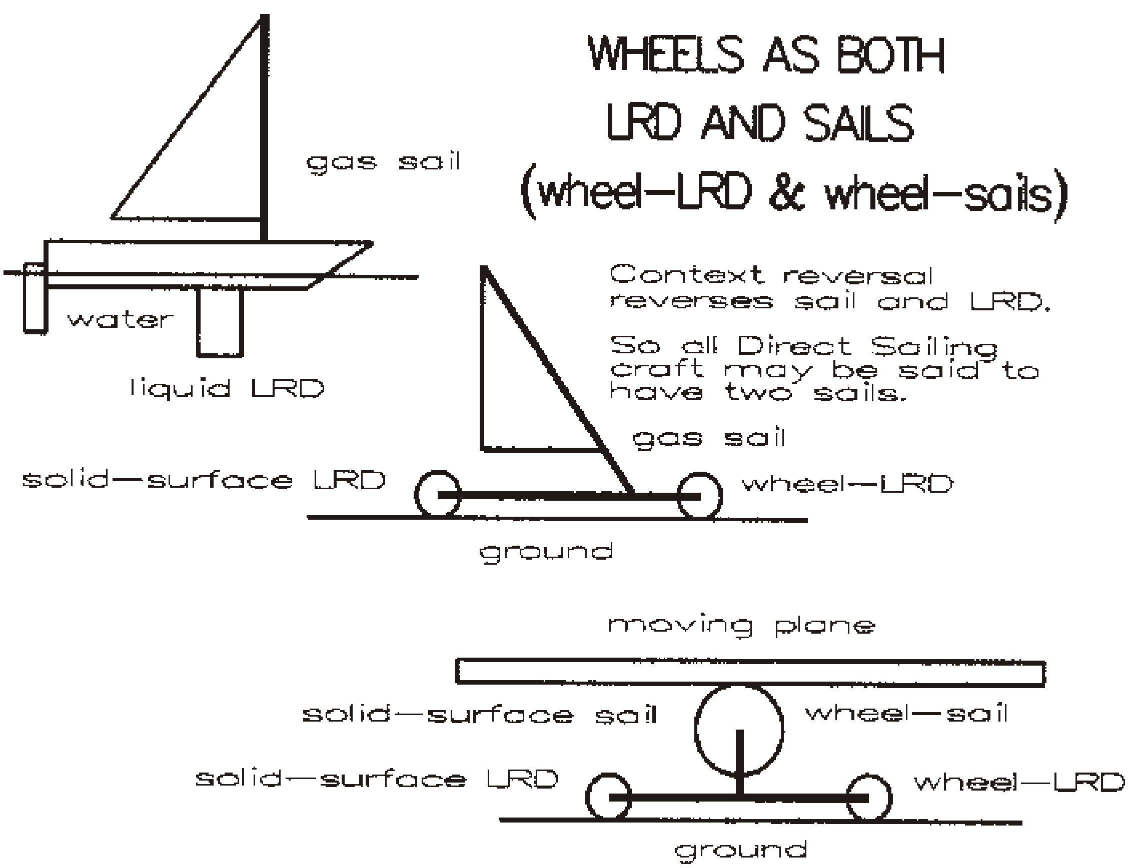
Peter A Sharp

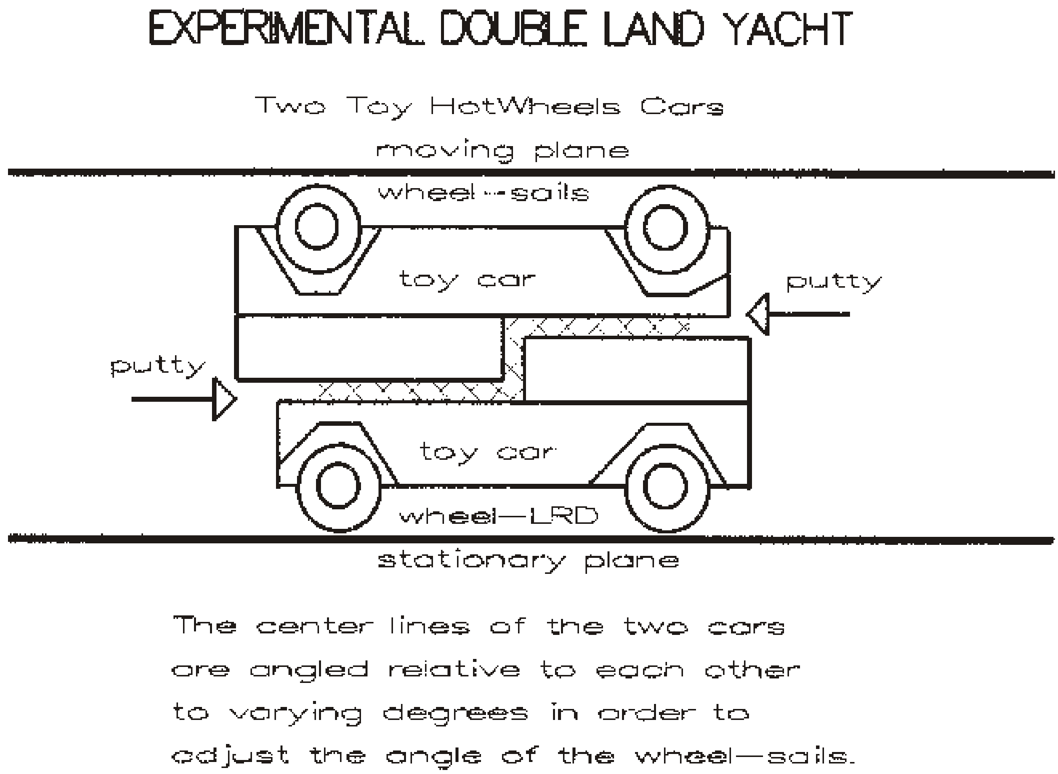
Most people do not realize the extent to which sailing is based on symmetry. We usually assume that a sailboat uses a sail and a Lateral Resistance Device (LRD) such as a keel, centerboard, etc. and that they serve different functions. We assume that the sail produces thrust and that the LRD prevents the craft from being blown to leeward. But the distinction between them is arbitrary. An LRD can function as the sail, and a sail can function as the LRD. What? How can that be?

Simple. If the sailboat is on, say, a rapidly flowing river during windless conditions, the sailboat can still sail normally in terms of the way it functions. The river carries the sailboat along and so the sailboat experiences a relative wind due to its own movement through the still air. The sailboat uses that relative wind to sail normally relative to the water – the river. So the sailboat will be able to sail back and forth across the river while moving downstream with the river.

Not only that. The sailboat could tack back and forth “upwind” against its relative wind while heading downriver. By doing so, it could actually outrun the river. (This capability is important to understand if one wishes to understand, by analogy, a Bauer air propeller land yacht that can outrun the wind directly down wind.)

Furthermore, if the sailboat were especially fast and exceptionally efficient, it could, at least in principle, broad reach using its relative wind fast





enough to be able to sail directly across the river between two fixed points on the opposite shores. From the frame of reference of the sailboat, it is merely broad reaching down “wind" at a high speed so as to achieve a Vmg equal to the speed of the “wind” (the relative wind). There are a few extremely fast boats that can exceed a Vmg of 1 under the right circumstance.

And if the conditions and the sailboat were just right, the sailboat could actually jibe back and forth across the river while making headway up river against the flow of the river. From the frame of reference of the water (or the craft), the craft would be sailing normally.

In these circumstances, the LRD functions as a sail, and the sail functions as an LRD. So when we make a distinction between a sail and an LRD, we are actually making an arbitrary distinction. That is because both devices can perform both functions without any material changes to either of them. Consequently, we may legitimately say that conventional sailboats have two sails, one in the air and one in the water. Many sailors and engineers are aware of that perspective.

Now let us consider land yachts. For a conventional land yacht, the wheels function as the LRD. However, if we put a land yacht on the deck of an aircraft carrier traveling at a moderate speed under windless conditions, the land yacht could sail using the relative wind. It could sail around on the carrier’s deck in all the same directions as it normally would if it were sailing in a true wind while on land. The land yacht, like all sailing craft, simply does not “care” or even “know” which of its two sailing media is actually moving and which is stationary. Sailing craft respond only to the relative motion between their two sailing media.

Using the same argument as for the sailboat above, we can conclude that a land yacht has two sails its sail and its wheels. Yes, that’s right; wheels can function as sails, as the aircraft carrier example demonstrates. That is because the energy to propel the land yacht comes from the aircraft carrier, not from the still air, so the wheels must be functioning as sails. It is the wheels that are producing the thrust, and the sail is functioning as an LRD.

Now things get really interesting. If wheels are sails, then there should be such a thing as a double land yacht that would have wheels on the bottom and also wheels on the top. Well, that is at least what my Metatheory of Sailing predicted. I had never heard of such a craft, so I was skeptical. I thought that maybe this is where my Metatheory reaches a dead end and has to be abandoned. There was a way to find out. I could build one to see what happens. According to my Metatheory of Sailing, it should sail approximately like a conventional sailboat or land yacht.

Fortunately, I had the ingenious work of Theo Schmidt to use as a guideline. Theo wrote a short article in AYRS 100 (“Down Wind Faster Than The Wind”, Dec. 1984) in which he described two models. One of them was a wheeled vehicle sandwiched between two planes that were parallel to each other. The model sailed directly down plane faster than the moving plane. Although Theo did not realize it at the time, his model was the first Mill-Prop craft of its kind. So Theo’s example gave me the idea to sandwich my double land yacht between two planes that were parallel to each other, and to then move the top plane as if it were the wind.

I decided to make the double land yacht that would be as simple as possible. I happened to have on hand some tiny toy cars made by HotWheels. I found two of them that fit together reasonably well and stuck them to each other, top to top, using the sort of nondrying putty used in offices for sticking things up on the wall. The bottom car was right side up, and the top car was upside down. Then I twisted the cars, relative to each other, around a vertical axis so that they were aligned roughly 30 degrees to each other.

I taped a piece of paper to the top of a wooden table to create a reasonably smooth surface with a bit of roughness to provide some traction. I put the model vehicle on the paper. Next I needed some sort of flat surface to move across the top of the vehicle to see what happens. Fortunately, I had a clear plastic book stand made for holding cooking books in the kitchen. It would permit me to look through the plastic to see what happens.

Well, to my surprise and delight, it worked! Although, I did have to be very careful to hold the plastic parallel to the table. It was quite difficult to adjust everything correctly in order to make the vehicle close reach. That is the disadvantage of a very crude experimental model.

I drew a guideline on the paper and moved the top plane (the clear plastic) back and forth along that line (away from myself and toward myself). I held the top plane in both hands and slid the sides of both hands along the surface of the table so as to keep the top plane level while it moved across the top wheels of the vehicle. That caused the vehicle to move back and forth. The reason I moved the top plane back and forth was to insure that I was not propelling the vehicle due to tipping the top plane, or due to gravity. I made sure that for each trial the vehicle moved back

THE 6 DIRECT SAILING DEVICE COMBINATIONS

gas—sail gas—sail	liquid—sail liquid—sail	solid—sail solid—sail
gas—sail liquid—sail	liquid—sail solid—sail	gas—sail solid—sail

Key:

gas—sail = sail, kite—sail, kite, etc.

solid—sail = wheel, pulley wheel, ice skate, etc.

liquid—sail = keel, hull, water—kite, etc.

Examples:

gas—sail/liquid—sail = sailboat

gas—sail/solid—sail = land yacht

solid—sail/solid—sail = double land yacht and forth many times over the same distance – at least one car length in each direction – and without changing its direction. That procedure insured that the vehicle was propelled only by the top plane's movement parallel to the bottom plane.

I angled the top wheels roughly 30 degrees relative to the top wheels around a vertical axis. I call that the "pitch angle" of the top wheels. The typical pitch angle was around 30 degrees, but 1 tried various angles. I used a protractor to measure the angles after drawing them. I used a straight edge ruler aligned parallel the center line of the bottom car and the top car in order to draw the angles on the paper below the vehicle.

Results; "Downwind": The vehicle easily moved "downwind" at the same speed of the top plane. Broad Reaching: The vehicle easily moved much faster than the speed of the top plane. Square Reaching: The vehicle moved at roughly the speed of the top plane. Close Reaching: This was difficult to achieve due to poor traction and slippery surfaces, but I was able to make two good runs and measure the angles. The vehicle moved more slowly than the top plane.

Run #1: The vehicle moved "upwind" at an angle of 15 degrees from a "cross wind" line (a line drawn perpendicular to the direction of the top plane). That is the same as an angle of 75 degrees of the "wind". The pitch angle of the top wheels relative to the bottom wheels was 35 degrees. The angle of incidence of the top wheels to the "wind" was 40 degrees meaning the angle between the direction of the "wind" and a line parallel with the top wheels (the direction in which they were aimed).

Run #2; the vehicle moved "upwind" at an angle of 28 degrees from a "cross wind" line. That is the same as an angle of 62 degrees off the "wind". The pitch angle of the top wheels relative to the bottom wheels was 24 degrees. The angle of incidence of the top wheels to the "wind" was 38 degrees.

Clearly, for higher speed ratios, the planes should have smooth surfaces and the wheels should have good traction. The experiment used smooth surfaces,

THE 12 MATERIAL MEDIA CONTEXTS OF SAILING

gas A > gas B	gas A gas B >
liquid A > liquid B	liquid A liquid B >
solid A > solid B	solid A solid B >
gas > liquid	gas liquid >
gas > solid	gas solid >
liquid > solid	liquid solid >

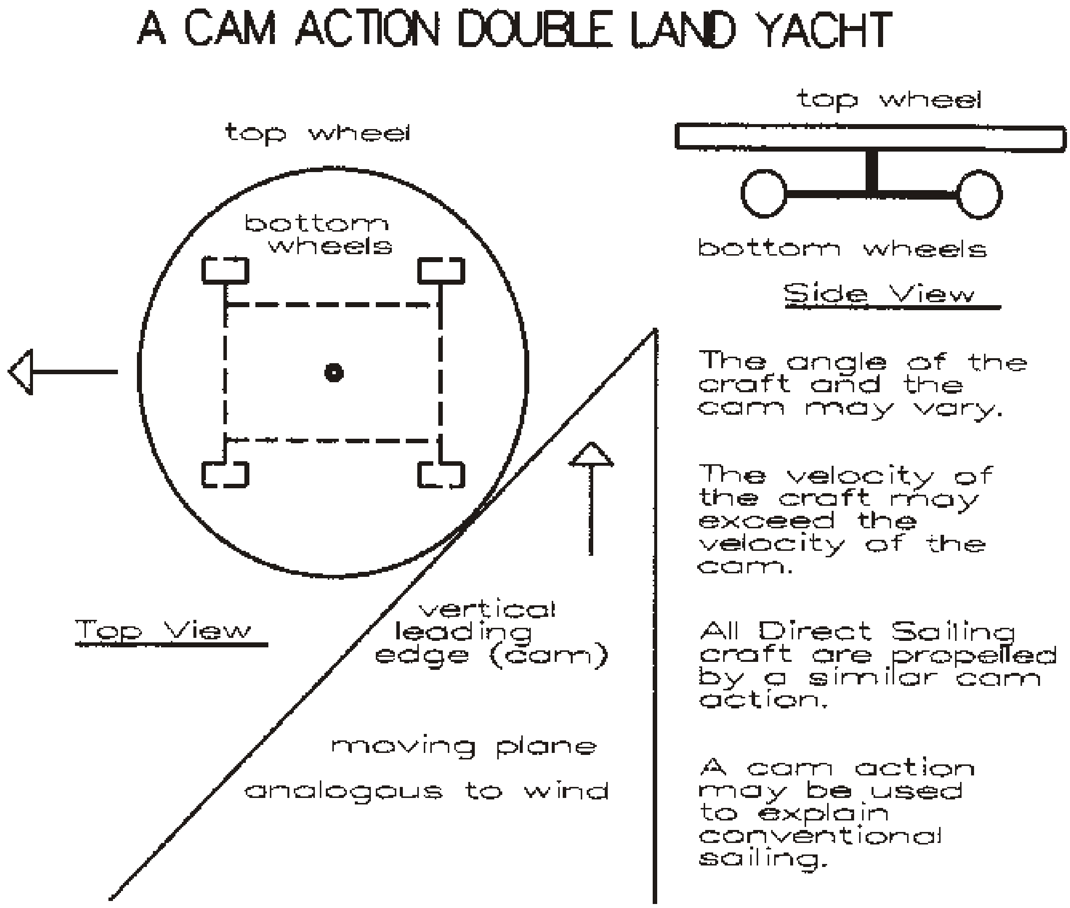
> = moving medium

Each sailing context consists of two media.

Other media may be present.

One medium, or one part of the same medium, is assumed to be stationary while the other is assumed to be moving.

Context reversals are shown side by side.



but the wheels had very poor traction. That is because the wheels of the toy cars are made of hard plastic to minimize rolling friction.

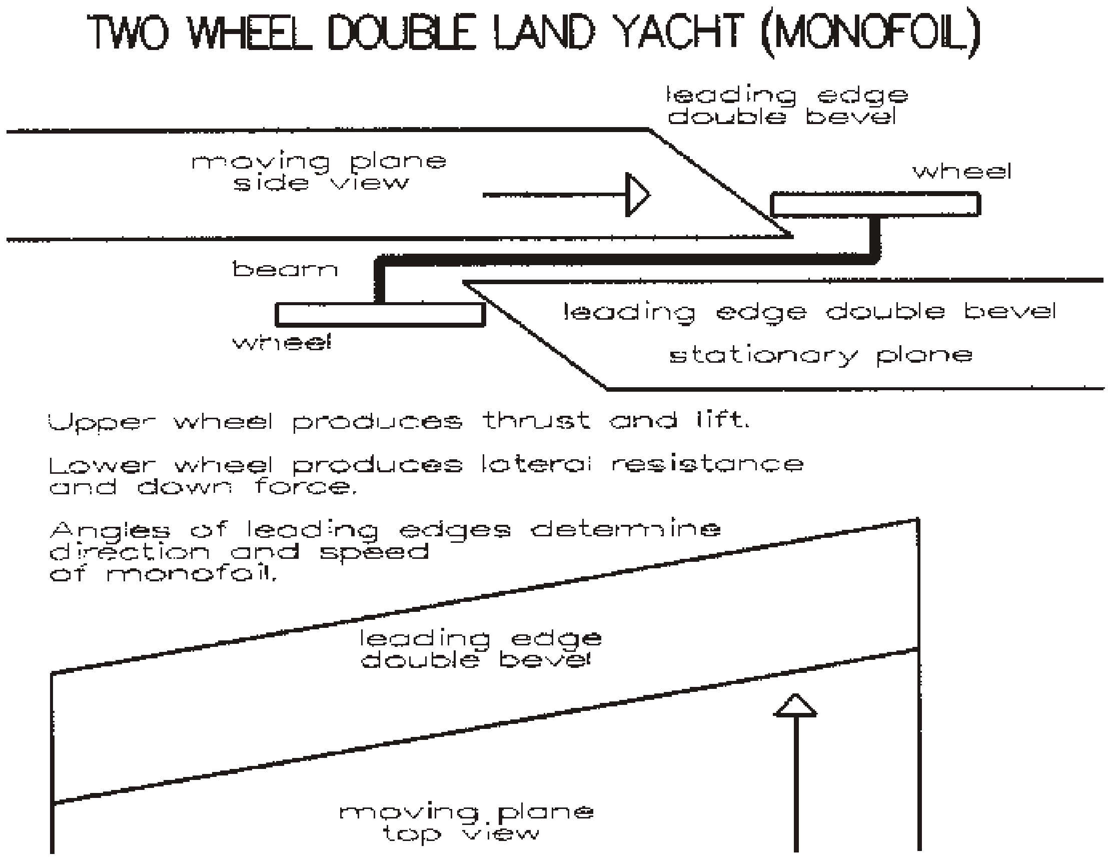
However, I was able to demonstrate that a double land yacht was indeed possible, and that wheels could function as sails, just as my Metatheory of Sailing predicted.

If well-built and properly adjusted, I expect that a double land yacht model should be able to broad reach at 4 or 5 times the speed of the moving plane.

To improve the experiment, the moving plane should he supported on four wheels to guarantee that it stays parallel to the supporting surface. The supporting surface should be leveled. And obviously, a model double land yacht could be based on a more sophisticated design than two toy cars stuck together with putty.

A good vehicle design would use three wheels on the bottom and probably only one wheel on the top. The wheels should have good traction. And the top wheel should pivot around a vertical axis in order to vary the pitch angle of the top wheel relative to the bottom wheels. The top wheel's "mast" should have a locking tiller with calibrated angle markings to indicate the pitch angle. And finally, the top wheel should he mounted in an inverted fork with a compression spring used to press the top wheel upward against the moving plane so as to insure good traction—since it is a friction-drive sail. Other researchers may wish to determine the maximum speed ratio that such a vehicle can achieve on various points of sailing, and how close to the "wind" it can sail.

But why in my title above do I mention "Direct Sailing"? I do so because there are four fundamental principles of sailing, and Direct Sailing is one of them. Direct Sailing includes conventional sailboats, kite-sail boat, kite boats, land yachts, ice yachts, and now double land yachts and even double ice yachts, plus various combinations of these. "Direct Sailing" indicates that the sail produces thrust directly without using the wind to rotate, oscillate, or circulate some device. However, Direct Sailing does not include the other 3 fundamental principles of sailing Mill-Sail Sailing (such as Flettner rotor ships, where a mill of some kind is used to rotate, circulate, or oscillate a device that creates thrust like a sail), Mill-Prop Sailing (such as windmill boats, where a mill of some kind is used to rotate, circulate, or oscillate a prop of some



kind), and Power Alternating Sailing (such as two windmills alternately oscillating fore and aft, with one always stationary, and producing power, while the other is moving ahead of the boat, with its blades feathered and with the stationary windmill spinning a water propeller on the boat).

So now we can see that there are 6 Direct Sailing device combinations, as shown in the accompanying table. These 6 combinations may be used to sail in all of the 12 material media contexts of sailing, as shown in the accompanying table. (The original publication of this table contained a typographical error.) A double land yacht combines a solid-sail with a solid-sail. In this case, the solid-sails are wheels. They could be pulley wheels, ice skates, snow treads, etc. We could easily construct a double ice yacht with skates on both the top and the bottom. Or we could construct an ice yacht with a wheel-sail on top. These are all variations within the category of solid-sail/solid-sail Direct Sailing craft.

But what is the physical nature of Direct Sailing if it includes wheels and skates as sails? Clearly, it is not just the interaction of a fluid with a sail. Nor does Direct Sailing require that the moving medium be deflected to propel the craft, as does happen to the wind acting on a conventional sail. A moving plane can impart energy to a double land yacht without the moving plane slowing or being deflected itself even though there is a momentum exchange from the moving plane to the craft.

Perhaps there is a general or inclusive term to describe the physical interaction of Direct Sailing. Until somebody can come up with a better one, I propose to call it a “cam action”. It works like a cam and cam follower. All Direct Sailing works like a cam action. And that includes Direct Sailing that involves fluids. Conventional sails may be said to function like fluid cams.

In order for me to demonstrate the close similarity of a solid cam action to a fluid sail—in order to show that conventional sailing nay be described as a cam action—let us consider a different kind of double land yacht and a different kind of moving plane.

In this new example, a large, horizontal top wheel spins around a vertical axis. See the drawing. The moving plane in this case has a vertical leading edge that contacts the wheel sail. The vertical leading edge is at an angle to its own direction of travel. This angle could be made. larger or smaller to best match the desired velocity (speed and direction) of the vehicle.

The purpose of the top wheel is to minimize friction to convert sliding friction into rolling friction. But this double land yacht would still function if the horizontal wheel were locked in place so that it became a fixed disc. In that case, its circumference would need to be as smooth as possible to minimize friction. The interaction between the top wheel (wheel-sail) and the leading edge of this moving plane (the "wind") is clearly a cam action.

This type of vehicle could be further developed toward a pure cam action. Instead of the bottom wheels doing double duty here – as they also do on a conventional land yacht – the two functions of lateral resistance and support against gravity could be divided between separate sets of wheels in order to further reduce friction – friction in the form of wheel scrub and side slip. The wheels of land yachts slide leeward a bit and that dissipates energy in the form of friction and heat. Wheel scrub could be eliminated, for example, by using horizontal wheels to resist side forces, and by using conventional vertical wheels to support the vehicle against gravity. The vehicle would be almost sandwiched between two vertical surfaces that pass each other, one just above the other. The simplest way to achieve this arrangement is to let the vehicle run along inside of a channel with a flat bottom and vertical sides. Horizontal wheels would be used to contact each side of the channel in order to provide high leverage to resist the side forces. The direction of the channel relative to the "wind" would be variable. And the angle of the vertical leading edge of the moving plane would also be variable.

Double land yachts demonstrate the prototypical interaction to describe Direct Sailing. Conventional interactions between wind and sail may be regarded as variations of this more general, cam action model. The moving medium is able to deflect the craft in a sideways direction like a cam deflecting a cam follower. At the most abstract level, double land yachts reveal Direct Sailing to be a cam action.

Perhaps the most sophisticated double land yacht would have only two wheels with a beam connecting their axles. It would function in a manner analogous to the ingenious monofoil craft invented and developed by Jon Howes. His monofoil craft uses a slanted kite sail to provide both thrust and lift, plus a slanted water foil to provide both lateral resistance and down force. Only the slanted foil touches the water.

In my simplified, side view drawing of a two wheel double land yacht (monofoil), it is the bevels of the leading edges of the two planes that provide thrust and lift (the top plane) and lateral resistance and down force (the bottom plane). There are other ways to construct both this craft and the leading edges of the planes. This and similar Direct Sailing double land yachts should be capable of especially high speed ratios when broad reaching because they would make use of a fixed lateral resistance surface. They would not experience heeling, side slip, or wheel scrub. The top wheel-sail could handle very high side forces applied by the moving plane. The exchange of momentum between the moving plane and the vehicle would be especially efficient. I expect that models of double land yachts will eventually be used in classrooms to explain conventional sailing.

Windwinder

Dear People of the ARYS,

I would like to become a member of your club. I built a boat for an unmanned expedition: *The Voyage to the Origin of the Wind*. This windmill-driven trimaran is unsteerable and constructed to sail only one course: directly into the wind. The boat itself is just finished, as well as a first version of the wind turbine. I'm busy with experiments for a better (safer) drive. Nobody will be on board, so the windturbine itself will have to be intelligent enough to react on a storm. Or very light winds. Could you bring me in contact with AYRS members who work with windturbines? It would be great to exchange ideas.

Wipke Iwerson

Windwinder

Out of Nothingness

It all started because the paper had got wet. "Impossible to read" said the adults. I hadn't learnt to read yet then, but I didn't agree with them at all. I had found a message in a bottle, a real message in a bottle! And they thought it wasn't interesting, just because there was not a single word to be seen on that wet mouldy paper. But I knew that this was the greatest discovery of my life.

Of course, you can't read a message from the other side of the world just like that! Not the way you learn at school. But I hadn't started school yet—and I found lots of things to read on this paper: green and grey smudges, brown scratches, black dots, gease spots, rust and mould, underneath a cracked layer of salt and sand, which told me of the long journey the massage had made before it was eventually fished out of the sea by me.

The journey itself—and only the journey—had drawn this message: its own chart. My chart. Throughout my whole childhood this piece of paper where there was not a word to be seen provided me with the most fantastic adventures.

The 'chart' changed constantly. I discovered that the scratches on the paper could also be read as a drawing of an airship. This was after I had finally realised what the mysterious bits of string attached to the bottle were: it had originally been hanging underneath a balloon! It must have crashed a long time ago. There was still a little bit of fabric attached to one of the strings.

I used these materials in one of the airships which I immediately started to build. None of these strange constructions flew for very long. But in the water, they worked very well! So I switched to building boats. However — they all went the wrong way! I made more boats. Explorers.

The grown-ups were completely baffled. But for me the challenge was clear. I wanted—I needed—to get in touch with this world on the other side of the horizon. This so-called unreachable world, the world that had sent me a balloon which had found me even though it had lost itself on the way. The message had arrived—with the wind that had filled it and kept it sailing. An invitaion to boundless worlds.

The grownups thought that one day I would be old enough to forget that dream: but no. Now I'm big enough to fulfill it!

Project: Get in touch with the source of inspiration.

Plan: Send back message in bottle.

Boat to the Origin of the Wind

I made a start: the boat which goes to where the wind comes from, with the wind as its only helmsman and headwinds as its driving force.

Probably the windturbine is not quite perfect yet or the construction is not sturdy enough; but that doesn't matter—it will just get as far as it gets.

Sooner or later my boat will arrive at some other coast or collide with another ship; then people will find it and will read a message on every part of it saying: “If you find me, send me off again. I’m on my way to the source: Where the wind comes from.”

Everyoneis invited to improve the construction, to add something, or to think up a completely different way to help the boat to continue its voyage to the source of the wind.

I ask everyone who joins in to send me a confirmation message with the geographical location and a few sketches of what they have changed, so that I stay informed of every step of the evolution.

I have no control over how people change the boat, just as I have no control over the course of the voyage.

And that is how it should be: It’s the voyage itself that I want to set in motion, a voyage of discovery that goes further than anything I could possibly imagine beforehand, and further than one single boat could go in its lifetime, however sturdily it was built.

My boat is mercurial, transitory, it cannot be held and it cannot be steered. This is its strength. It cannot be grasped by any force that wants to stop it. Instead it uses that force to get further. It lives on headwinds.

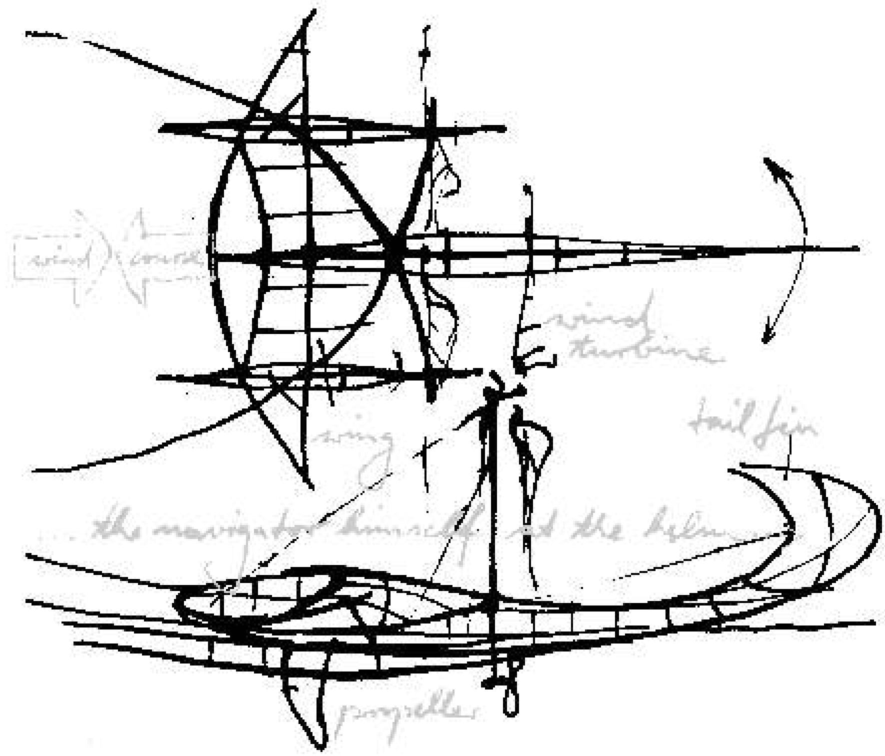
Each wreckage means development and reproduction, a new attept, a different perspective. This is the lifejourney of a species, not of an individual. A persistent dream, a floating challenge to everything that has always remained the same: this little vessel lives on the mere fact that as all the clever people say that this is impossible. For this has never been possible before. If thsi was possible, then why aren’t we doing it? Yes why arn’t we doing it?

On every island there is sure to be someone who cannot resist the challenge of having a go—even if its in secret.

The collective imagination of finders of bottled messages on all the shores of the world will make this species grow.

A whole flock of back-to-front messages in bottles will sail across the oceans after the first boat has long ceased to exist: home-made models, manned expedition-ships, winged fishing boats. On to the next wreckage, on their voyage of discovery towards what drives them.

In case the first boat—my boat—ends up in a gale an dsinks in the middle of the ocean before anyone finds it, in its hold there is an empty message bottle which will automatically start to come back as soon as



the hull breaks. The bottle is protected by leather and paraffin against collisions wwith coral reefs and ships. If that message reaches me, I will know it is my turn again: to build a new boat. (to be honest —I have already started.) Wipke, 2004

[From the captions on the photos on the cover: —*‘First version of the windmill with fixed blades. A new windmill is under construction which should be able to react to very light winds as well as in a storm, since the boat will spend the rest of its life alone on the ocean’. ‘Windwinder was exhibited at SAIL2005 at Amsterdam, and at the ART ROTTERDAM, March 2005’. ‘The skeleton is covered with nylon’. ‘The boat carries a message under the skin with instructions to finders to repair the boat and send it on its way again: to where the wind comes from’. ‘Windwinder length 8m, width 5.5m, windmill 4m diameter’.*]

How Wings and Sails Work

Peter A Sharp

Sails need not be curved in order to work as sails. Flat surfaces can function as sails. The reason that sails and airplane wings are curved is not to create lift *per se*. Paper airplanes work just fine with flat wings. The reason that sails and wings are curved is to delay stall so that they can function at a higher angle of attack and therefore produce much more lift.

The curve of the wing surfaces is not what creates lift. It is the angle of attack of the wing that creates lift. The purpose of the curve of the upper surface is to keep the passing air attached to the surface of the sail or ming so that the sail or wing does not stall and lose lift. It is the angle of attack that accelerates the air over the top of the wing by creating a low pressure behind the leading edge.

That accelerated air moves much faster than the air under the wing. The air going over the top of the wing reaches the trailing edge of the wing much sooner than the air that passes below the wing. They do not recombine at the trailing edge as shown in most textbooks.

NASA has a Web site to explain these relationships using animation. Just search for “how wings work NASA”. Another excellent site is that of John S. Denker. His book, See How It Flies is available free on-line. See especially Chapters 3 and 18. Most other discussions of how sails and wings work are only partially correct. The math is correct. The two basic explanations (so far)—the explanation of lift due to the Bernoulli principle (faster air causes a lower pressure), or due to deflecting the air downward (momentum exchange)—are both correct. But the understanding of the physical processes is often wrong.

I may have a third way to explain wings and sails that is equivalent to the other two, or, it may be only a better way to understand the momentum exchange explanation. But I do not have the engineering skills to analyze it. The explanation is in terms of centrifugal force. The lower pressure on the upper surface of the wing might be explained as due to the centrifugal force of the large mass of air both near and far above the wing curving over the wing, and thereby creating considerable centrifugal force acting to lower the pressure of the air on the top of the wing. We could say, in layman’s terms, that the air above the wing is pulled downwards by that centrifugal force, and the airplane is pulled upwards in equal and opposite reaction.

Like aerodynamic lift, centrifugal force is proportional to the square of the speed – in this case, the average angular velocity (and the average distance from the wing) of the mass of air that is curving up over the wing and then downward. As in the other two cases, the air must remain attached to the wing.

In layman’s terms, centrifugal force may be thought of as stretching the curving air above the wing, like a spring in tension, so as to “pull” upward on the wing as long as the air stays attached to the wing. Actually, it is just a relative pressure difference created by centrifugal force, and it is the relatively higher pressure beneath the wing that actually lifts the airplane.

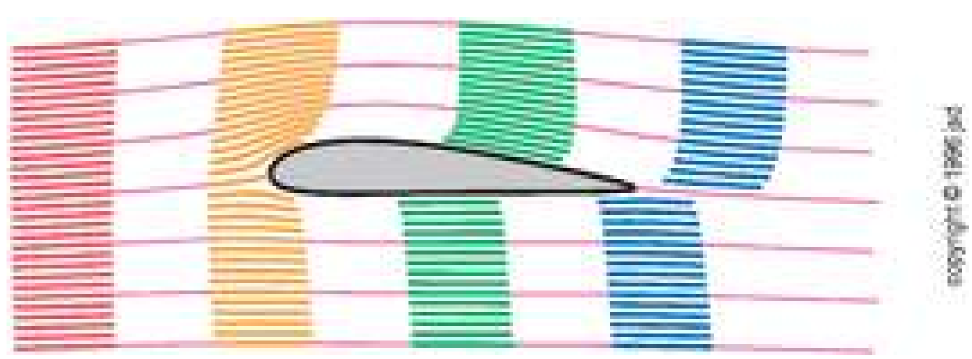


Illustration from John S Denker’s on-line book “See How it Flies”, noting top stream and bottom stream do not recombine.

[DDWFTTW] Response to Peter Jefferson, & Bernard Slotboom

Peter A Sharp

By analogy, conventional sailboats are actually "double sailboats". From the frame of reference of the craft, conventional sailboats have both an apparent wind and an "apparent moving water", and they use both an air sail and a water sail. Similarly, land yachts have an "apparent moving ground", and their wheels function as "solid-surface sails". A double land yacht merely uses two solid-surface sails (two wheel-sails), one on top and the other on the bottom.

Even from the frame of reference of the Earth, it is possible for wheels to function as sails. For example, imagine a conventional land yacht sailing around the deck of an aircraft carrier on a windless day by using the relative wind created by the forward motion of the aircraft carrier. The air is still, but the deck (the solid-surface) is moving. So the deck must be the source of energy for sailing. The wheels must be functioning as a sail. And the sail must be functioning as a lateral resistance device. Note how changing the frame of reference changes the way we may describe sailing.

In Catalyst 22, Oct. 2005, Peter Jefferson and Bernard Slotboom contributed their separate comments under the general headings of "DWFTTW". I wish to respond to them both. Sailing without a true wind was the main subject of Jefferson's correspondence. Although I am pleased to see Jefferson challenging parts of my Metatheory of Sailing, his comments (pp. 29-31) are based on fundamental misunderstandings that need to be corrected. Unfortunately though, our editor closed the correspondence until someone has some practical results to report. By coincidence, I had just submitted practical results, thus satisfying his requirement. I described a demonstration of a crude model of a "double land yacht" (a Direct Sailing craft) that sails between two parallel planes – without a true wind (or air, or even fluids)—in all of the same directions as conventional sailing craft.

As Jefferson mentioned, I encouraged responses such as his by asserting that sailing does not require a true wind (or air, or even fluids). I further asserted that claims that sailing requires a true wind will result in contradictions. So I will use his comments to illustrate my point and to further clarify my Metatheory of Sailing—which includes the 12 material media contexts of sailing, the 4 basic ways to produce sailing propulsion, and the differences between sailing craft and other wind powered craft. I have numbered my comments under the headings Jefferson used.

"Wilson's Spool of Thread":

(1) Jefferson is concerned about to how to devise rules to measure the speed of sailing craft with parts that oscillate fore and aft or change their position. That will not prove to be a problem if we require all craft and competitors to conform to the spirit of the competition, not just to the rules. We need speed trials for craft heading directly upwind and directly downwind so as to encourage research directed at overcoming those weak spots of conventional sailing. I would be glad to suggest rules to govern such competitions.

(2) Jefferson asserts, "On a wind-powered vehicle, the source of wind-power (i.e. the sail) cannot move DWFTTW." That is incorrect. As I have explained previously, drag type sails could be used to sail directly downwind faster than the wind (DDWFTTW) by employing the PAS technique of Drag Resailing. Two or more sails would open and close while alternately oscillating fore and aft relative to their craft, while moving with their craft. Only during the time period when a drag sail is actively producing propulsive power (or thrust), must it move slower than the speed of the wind. Its average speed may be higher than the speed of the wind. Jefferson's term "wind-powered" is ambiguous because it has multiple meanings (see below).

“Sharp’s Bauer String Yacht”, and “Definition of Terms”:

(3) Jefferson notes that the “Principle of Relativity”, from the Special Theory of Relativity (STR), has applications to sailing. That is true because the STR asserts that there is no fixed frame of reference, that all motion is relative motion, and that the same laws of physics apply in all frames of reference. However, Jefferson then needlessly interjects that it does not apply when approaching the speed of light. That is incorrect. Einstein devised the STR specifically to deal with speeds approaching the speed of light. The STR asserts that the speed of light remains constant in all frames of reference, strange as that may seem.

(4) Jefferson asserts that a craft’s performance in the middle of the ocean is not affected by the movement of the water. That is incorrect. Ocean currents must be considered when calculating speed and direction.

(5) Even though Jefferson acknowledges that it is not permissible to confuse one frame of reference with another, he does so. The term “true wind” has a specific meaning found in sailing dictionaries. It applies only to the wind relative to the surface of the Earth — and relative to the water only if the water is stationary relative to the surface of the Earth. He applies the term to other frames of reference. That is incorrect.

(6) Jefferson states, “I cannot accept Sharp’s assertion that ‘Sailing craft do not require true wind’”. He then attempts to prove that sailing craft require a true wind by defining the “true wind” incorrectly, while claiming that his incorrect definition is generally accepted. It is not.

Jefferson incorrectly defines the “true wind” as the wind relative to the surface that supports the craft — regardless of whether or not the surface (such as a river) is moving relative to the surface of the Earth. He then calls such a surface, moving or not, a “fixed” surface for the purpose of analyzing sailing. That is not the standard definition of “true wind” found in sailing dictionaries. It is not how sailing is analyzed because it leads to situations where there are different “true wind” speeds at the same location, which is contradictory. He cannot use a contradictory definition of “true wind” to prove that sailing requires a true wind.

Essentially, the true wind (without including the details, such as altitude, turbulence, etc.) is the average velocity (speed and direction) of the air relative to the stationary surface of the Earth during a given period of time (seconds, minutes, hours, days, etc.). The apparent wind is the resultant found by adding the vectors of the true wind and the relative wind (the wind created by the craft’s own motion). The apparent wind is also what the sails and the crew feel. The concept of the apparent wind involves a shift of the frame of reference to the craft itself. That can lead to new insights (see below).

(7) Consider this thought experiment that reveals how Jefferson’s definition of the “true wind” leads to contradictions: Assume a windless day, with a calm sea, in the middle of the ocean. A very large cruise ship is slowly motoring along. On the top deck is a very large swimming pool exposed to the wind. At a party for VIPs, to entertain his guests, the ship’s captain climbs into a pram and sails around the swimming pool by using the relative wind (measured as 10 knots) created by the forward motion of the cruise ship. Everyone has a good laugh at the absurd size contrast between the two vessels, both captained simultaneously by the same person.

What is the true wind speed? According to Jefferson, it is the speed of the wind relative to the surface supporting the sailing craft. In this case, that is the surface of the swimming pool. So, according to Jefferson, the “true wind” speed is 10 knots, even though it is a windless day. That is a contradiction. If Jefferson were to insist that the proper surface to use is the surface of the sea, then he would have to admit that it is possible to sail without a true wind since the pram is sailing around the swimming pool on a windless day.

Here is a key concept: Although conventional sailboats do not require a true wind to sail, they always require an apparent wind. However, the apparent wind may be derived entirely from the relative wind. As in the example above, there can be an apparent wind even when the true wind speed is zero. In that case, the apparent wind is the same as the relative wind. To sail, there must be a relative motion between the two sailing media, but either medium may be the moving medium. That is why it is possible to sail on a windless day, with no true wind.

In the case of a sailboat on a river on a windless day, the boat’s relative wind is determined by the movement of the river relative to the land, plus, the movement of the boat relative to the river. So in that case, the relative wind has two components to be combined by vector addition. But the boat and the crew would merely experience a single apparent wind as usual.

Sailing without a true wind was probably first done millennia ago using conventional sailboats on rivers, although the sailors may not have noticed because they would have felt an apparent wind as usual. At least in theory, an exceptionally fast sailboat could jibe upriver faster than the river on a windless day. A blimp with a water sail might also be able to do it. Furthermore, it is possible to sail without even air or fluids. Theo Schmidt was the first to do it using a model Mill-Prop craft — sandwiched between two parallel planes — to sail directly down medium four times as fast as the moving medium (see AYRS 100).

The model double land yacht I demonstrated (a Direct Sailing craft) uses one or more wheels on top instead of a sail, plus wheels on the bottom as is usual for a land yacht. It is sandwiched between, and is propelled by, two parallel planes moving relative to each other (like Schmidt's model). It can sail in all of the same basic directions as a conventional land yacht. Both its "wheel-sail" and its normal wheels function as rolling cams. By analogy, a conventional sail and a keel (lateral resistance device) function as "fluid cams". This is a new way to understand and demonstrate Direct Sailing (the larger class that includes conventional sailboats). It was predicted by my theory. Double ice yachts are also possible.

"A Mill-Prop Craft":

Jefferson proposes what he believes to be a new type of land yacht that uses a horizontal axis rotor disc. While the vehicle is stationary, the rotor disc functions as a windmill/flywheel to spin itself in order to store energy. Then it changes pitch and functions as a flywheel/air-propeller to propel the vehicle directly downwind. (This technique is inefficient.) Jefferson assumes the speed of his vehicle is equal to its top speed. (He ignores the time required to store the energy.) He declares that he is completely confident that his vehicle would go DDWFTTW. (I am not.) He classifies his vehicle as a "Mill / Prop" vehicle. (It is not). He asserts that it is not "wind powered while sailing faster than the wind" (It is entirely wind powered, but it is not a sailing craft.) He asserts that "all mill-prop type craft have the same limitation". (They do not.) So he seems to be trying to prove that Mill-Prop craft — such as a Bauer air propeller land yacht — are not wind powered when they sail DDWFTTW. (Actually, sailing DDWFTTW, or the physical equivalent, has been done at least 4 times by Bauer vehicles, and their performance has been validated by many mathematical and logical explanations.) Jefferson's argument fails completely, but his errors reveal what may be common misunderstandings.

(8) Any vehicle heading DDWFTTW is partially wind powered due to the reduction of aerodynamic drag provided by the tailwind, even though the apparent wind is from ahead. Cyclists are familiar with that effect. A tailwind enables them to ride faster even though they still feel an apparent wind from ahead. Pedal powered speed trial boats that use very large air propellers get a considerable boost from any tailwind while the propeller is spinning, even though they are moving much faster than the tailwind. So we already know that Jefferson's analysis is flawed because we know that his vehicle is at least partially wind powered when moving DDWFTTW (if it could). If a craft were entirely propelled by a tailwind, it would be a pure sailing craft. Jefferson's vehicle functions as a hybrid vehicle.

(9) Now we need to ask if Jefferson's vehicle is wind powered when it is moving DDWFTTW (if it could). Jefferson says it is not. But it is. All of the stored energy came ultimately from the wind, and all of the energy from the tailwind came from the wind, so his vehicle would be completely wind powered when moving downwind. But "wind powered" and "sailing" are not necessarily the same thing. Sailing craft are only one sub group of the larger category of wind powered craft.

(10) His vehicle is not a true (pure) sailing craft. So what is it? It is merely a flywheel car running on stored wind energy (and a hybrid due to the tailwind). It merely drives downwind—just as the world's automobiles on city streets, using their stored energy, drive DDWFTTW more than a hundred million times each day.

It is a flywheel car because it stores its wind energy before the designated trip, race, or speed trial. In contrast, a true (pure) sailing craft may only accumulate wind energy that is available during (not before) the trip, race, or speed trial; it does not start with any more stored propulsive energy than when it finishes. If it does, it is a hybrid. That distinction is clear and strict.

(11) Here is something surprising. We could turn Jefferson's vehicle into a pure sailing craft without changing any of its parts, and without even changing the way the parts work. All we need to do is change the situation slightly.

The key is to not store any wind energy ahead of time so as to insure that the vehicle functions as a pure sailing craft. To do that, we only need to change the way we measure the speed of the vehicle so as to include the time during which energy is being "accumulated". By "accumulate" (as opposed to "store"), I mean wind energy that is preserved, using onboard devices, during (not before) the time period of a specified trip, race, or speed trial. An accumulator functions like a mechanical capacitor. We then calculate the vehicle's speed as its average speed over the designated distance by including all of the time used to accumulate energy plus the time spent moving over the designated distance.

Note carefully that this vehicle now has access to no more wind energy than would be available to a conventional sailing craft that is actively sailing during the same period of time. The vehicle merely uses the same available wind energy differently. So it functions as a pure sailing craft. (For DDWFTTW speed trials, there are various legitimate ways to measure the craft's speed.)

(12) So now could it sail DDWFTTW? In principle, yes, but in practice, no. Jefferson's design is so inefficient that it would be unlikely to do so. Here are some factors that limit its inefficiency: Windmills cannot store energy efficiently as compared to advanced flywheels running in a vacuum. They suffer from high aerodynamic drag at high rpm since aerodynamic drag is proportional to the square of the speed. As flywheels, they have a low energy density. Adding more weight to the blades would mean the additional weight would have to be accelerated along with the vehicle. The centrifugal force on the blades would become extreme because it is proportional to the square of the angular velocity. Unloaded windmills tend to explode. Horizontal axis windmills and propellers have opposite blade twist, so one will be much less efficient than the other. Blades with no twist are less efficient. And, for propulsion, even large propellers are less efficient than powered wheels.

(13) The sailing craft I described above that uses accumulated energy is just one of many possible Power Alternating Sailing (PAS) craft using the technique of "short-term-energy-storage". It could also be called a PAS "Regenerative/Pregenerative" craft, or a PAS "Accumulator" craft. Such craft would typically proceed in cycles of accumulating and expending energy during the course of a trip or race.

An example of a reasonably efficient PAS Accumulator craft for setting sailing records DDWFTTW would be a highly streamlined land yacht with a wingsail. It would broad reach to accumulate energy by using one of its leeward wheels to power an air compressor. The air tank and compressor would be thermally insulated. Then the vehicle would turn directly downwind and cross the starting line (for measuring the distance traveled, but not the time elapsed). It would use its compressed air to travel at a high speed, and then drop a distance marker before it slowed to the speed of the wind. The elapsed time period would begin when the vehicle first began to broad reach, and end when it dropped its distance marker. Even so, its average speed directly downwind could be well in excess of the speed of the wind. The wingsail, wheel, and compressor would function together as a linear windmill when accumulating energy.

In the future, most sailboats will function as PAS Accumulator craft in order to increase their average speed, smooth out sailing, and supply onboard power. I previously reported on two such boats, built and tested by HaveBlue, that crossed the Atlantic. They used sails for propulsion and used the water propeller as a water turbine/generator to accumulate wind energy when sailing at higher speeds.

(14) Jefferson calls his vehicle a "Mill / Prop" craft. It is not. Mill-Prop craft, such as windmill boats and Bauer air propeller vehicles, do not store or accumulate energy (except incidentally; as does any moving mass). They use a mill to power a prop directly, and they are able to sail directly against their mill-medium. That is not the way Jefferson's vehicle functions.

(15) Jefferson mistakenly focused on his vehicle's parts when trying to classify it. Here is the key to classifying sailing craft: One must first ask how the craft functions in the specific situation under consideration. The parts of the craft are not a reliable guide as to how the craft functions. That is because the same parts can function differently in a different situation (as is the case for Jefferson's vehicle), and also, very different sorts of parts can be made to serve the same function in the same situation. Once a craft is classified according to the way it functions in its specific situation, only then can it be further classified according to its energy conversion parts. And lastly, it is further classified according to how it is supported against gravity (water displacement, air displacement, hydrofoils, etc.).

(16) But what about all of those numerical comparisons on p. 31 in "Peter Jefferson's table of the relative merits of DWFTTW craft"? Unfortunately, what his table actually presents are a few ambiguous comparisons between a conventional sailboat and a flywheel-motor boat, neither of which is relevant to sailing DWFTTW. The table is meaningless.

In summary: Because Jefferson's entire analysis is based on fundamental misconceptions, he proves nothing at all about 1) sailing without a true wind, 2) his proposed vehicle, 3) Mill-Prop craft, or 4) sailing DDWFTTW. However, my guess is that his (self identified) “purist” beliefs are still common among sailors. So clearly, to insure theoretical and experimental progress, we need to continue to have free, open, and informed debate – the first rule of research.

Slotboom’s Comments

On pg. 10, Slotboom presents an excellent explanation of sailing DDWFTTW. He imagines a tube of water with a very fast sailboat spiraling down the tube faster than the wind blowing parallel to the tube. The boat’s sail is analogous to a propeller blade of a Bauer air propeller boat, and its anti leeway device (lateral resistance device) is analogous to one of the water turbine blades of a Bauer boat. Serendipitously, Slotboom’s purely imaginary explanation can now be embodied in an actual physical demonstration of his concept.

The key is to use a model of the Direct Sailing double land yacht I described above, plus two, large, concentric, clear plastic tubes, with the model between them and in firm contact with them both. The inner tube, representing the ground, would be held rigid. The outer tube, representing the wind, would be moved longitudinally. External linear bearings (small wheels) would keep the outer tube concentric with the inner tube. The double land yacht would spiral down the space between the tubes faster than the outer tube was moving, thus demonstrating Slotboom’s tube concept. The double land yacht would need to be very light, and spring loaded, so that gravity would not inhibit its operation while spiraling.

Although this physical analogy would explain how a Bauer vehicle works, the spiraling model (a Direct Sailing craft) would not be, itself, a demonstration of sailing directly down medium faster than the moving medium. That is because spiraling is only a three dimensional variation of jibing in two dimensions. However, sailing directly down medium faster than the moving medium (DDMFTTMM) could be achieved if two such double land yachts were connected and operated on opposite sides of the inner tube so as to cause their combined center of mass to move directly down tube. The new model would be a Mill-Prop craft.

An interesting observation is that, in some instances, two Direct Sailing craft can be combined to create a Mill-Prop craft (such as this example), and two Mill-Prop craft can be combined to create a PAS craft (such as twin windmill boats alternately powering each other — a type of PAS Rewindmilling craft). This observation reveals the way these three fundamental ways of sailing are related in terms of their increasing functional complexity.

While the tube models, above, would be analogous to wind sailing, they would also be, themselves, true model sailing craft, not just analogies. A solid-surface / solid-surface sailing context, such as between the two concentric tubes, is one of the 12 material media contexts of sailing.

It should be noted that there are currently four basic ways to sail DDWFTTW, and Slotboom’s analogy addresses only one of them: a Bauer craft (a Mill-Prop craft). The other three ways (not yet demonstrated) are a PAS Accumulator craft (above), a PAS Drag Resailing craft (above), and a PAS Rewindmilling craft (above).

Another example of a PAS Rewindmilling craft (this one is called a Tazmaran) would be a catamaran with two vertical axis windmills (VAW) mounted at the ends of a very long arm (like a kayak paddle pivoted at its midpoint) that oscillated fore and aft 90 degrees as the catamaran moved forward. The aft moving VAW would be “on” and held approximately stationary to the water by a temporary sea anchor (a sideways daggerboard). The windmills would connect to the catamaran’s propeller via a drive belt. The VAW swinging forward faster than the catamaran would be “off” and feathered to minimize its aerodynamic drag. Its temporary sea anchor would be retracted. The cycles would repeat continuously. A Tazmaran is the only type of sailing craft that has the potential to sustain steady speeds in excess of the wind speed while on any direct heading.

Finally, consider that a Tazmaran (a PAS craft) would function only as a windmill boat (a Mill-Prop craft) if both sea anchors were raised, and if a VAW were turned “on”. And then, it would function only as a conventional sailboat (a Direct Sailing craft) if the vertical windmill blades were used only as wingsails. So a Tazmaran nicely illustrates why a sailing craft must be classified primarily according to the way it functions (produces propulsion) in a specific situation, rather than according to its parts. It also illustrates how these three fundamental ways to produce sailing propulsion are related in terms of their increasing functional complexity.

Pocock's 'The Aeropleustic Art'

Yachtsman appraises 1827 British Kite Classic

Roger Glencross

Jane Austen and the Bronte sisters are back in vogue and the Amateur Yacht Research Society enters into the spirit of the 19th century by this appreciation of a book published in 1827, The Aeropleustic Art, by a Bristol schoolmaster who built, patented and drove a kite buggy at 20 miles per hour almost two centuries ago.

The volume is virtually unobtainable, as is a second edition published in 1851 retitled A Treatise of the Aeropleustic Art or Navigation in the Air by the Use of Kites or Buoyant Sails, With a Description of the Char-volant or Kite Carriage.

A facsimile edition of the first edition was published in 1969 in a print run of only 95 copies, by Edward L. Sterne of San Francisco, who cannot now be traced.

One of George Pocock's purposes in publishing his work was to convince doubters that kite traction really worked. Even people who observed the kite buggy in action were not always convinced. A lady explaining the mechanism to her neighbors who were also watching, said:

"I'll tell you all about it. They have got a man up there behind the kite, and he is pulling them along." A scientist proved that it was impossible for Pocock's wheels of only two-feet six-inches diameter to revolve fast enough to achieve the speed that was claimed. Pocock stated that "publication is a duty which the author owes to his friends, ladies as well as gentlemen, for their protection against future insult."

Three Pocock char-volents pulled by kites travelling in various directions, eg tacking with the wind

How Pocock would have loved the Amateur Yacht Research Society, and joined it like a shot! He states in his first book that "the most extensive sphere of action for experiment presents itself on the unencumbered surface of the majestic ocean. There, how frequently, when laying to, or at anchor, or when under sail, or at any other season, when hands might be spared, what endless trials and improvements might be made by the application of the aeropleustic discovery. The first trial of his new kite control system was on a lake, where he kite-towed the earl of Suffolk's pleasure boat. Pocock envisioned that kites could "serve as ancillary sails to the navy, merchantmen, trading vessels, etc. After spreading all the canvas possible in the usual way, very considerable power may be added by the application of these buoyant sails as ancillaries, and this power may be so attached, as to counteract the injurious pressure which a crowd of canvas is known to occasion and which not infrequently causes too great a dip of the vessel on its lee; for let it be recollected, that the draught power of these sails, while aiding progress, is also exerted in buoying up the vessel."

He foresaw kiteboats when he said: “One thing is evident, namely, that from use of this novel principle will arise an entirely new branch in the art of sailing.” He hypothesizes many ideas for employing kites at sea, including a six-man amphibious kite buggy. He readily admits that many improvements could be made to kites and suggests kite buggy races to achieve this, “to compete with each other’s equipage in running with and against the wind, and in all the various angles of traverse.”

George Pocock is an example of an ideal inventor, supplying figures for every aspect of kite buggying, from VMG (velocity made good) to true windspeed versus force on the kiteline for various areas of the kite. He explains the all-important kite and buggy controls and his journeys were “timed by chronometer in hand.” He states what he has not tried and he went to the trouble of patenting his innovations in Britain and France, ensuring that design drawings are extant. He states what he believes to be the basic principles of kite buggying, so that when he gets it wrong we know how much he knew. Above all, he makes a clear distinction between the experiments which he carried out himself, and ideas which he hopes his successors will attempt.

The work is only 51 pages long and if one excludes the 30 songs, poems and quotations from famous poets, it is considerably shorter. Included in these poems are several self-written (self-inflicted?) stanzas designed to accompany long kite buggy journeys. Several are in Latin, one in Greek, mercifully in translation. In preparing this appreciation of the first edition of Pocock’s book, I have omitted to include an appreciation of his poetical works!

Pocock’s Inventions

Like most great innovators, Pocock pioneered not one but several inventions. These included the folding kite, kite trains used as traction, four lines for kite control in traction, and a purpose-built kite buggy. He eschews paper kites for linen ones for greater durability. While he may not have been the first to try all these, he was apparently the first to write it up in detail, and to me that is an equally great achievement.

The invention of the folding kite may not seem very exciting, but in fact it was what made all the other inventions practicable. “The whole scheme was abandoned for a considerable time, owing to the very great inconvenience of carrying and bringing back the kites, the length and breadth of which made them so unportable, so liable to be broken. They occupied much room also when laid by. ”When Pocock made joints in the wings and standard (i.e. the king-post), “they are now as portable and as easily stowed away as a large umbrella. ”This, and the replacement of paper with linen, “gave quite a new zest to the undertaking; and I felt renewed in hope again. The kites could now be taken in the car with little or no inconvenience.”

According to David Pelham’s Penguin Book of Kites, the first recorded account of a train of kites being used was by Alexander Wilson at Camlachie in Scotland in 1749. Wilson used them to raise thermometers to measure the temperature at various heights. Pocock tied several kites together, but always with the purpose of exceeding the height of his rival schoolfriends. As a result there was always the maximum possible gap between each kite. But he also noticed that the power of their draught increased to almost any extent and this is what made him interested in kite traction. He was able to pull a sledge very fast, and also pull his one-horse carriage with a full party, even on turf. He had proved that there was sufficient pulling power, even in a modest wind, provided that a train of kites was employed.

Kite control was now found to be the stumbling block. “It was not known how to control or direct that power whilst aloft in the air. It was easy enough to raise kites, but it was excessively laborious to stand against them, or to take them down again; especially when traveling, it became necessary, in order to prevent the entanglement of the strings in lofty trees, to detach the kites from the car; this required great bodily strength, and occasionally much more than was present; and so sickening was the toil, that the idea of succeeding so as to make the system either useful or pleasurable was again relinquished."

After many experiments, methods were discovered for the complete management of the kites-for reducing their power and for steering their course. This was achieved with four lines. A line goes to the top of the kite and is fixed and not controlled. A second, longer line goes to the bottom of the kite and is drawn in to increase the angle of attack and let out to reduce power. This also controls height. Two further lines are attached at the sides, for steering. "These act upon the kite much the same as reins do upon a gig horse. By this movement the traverse is performed; trees and other obstacles avoided, and many advantages obtained." He explains the chief advantage: "Where there is space for traverse, as on plains or downs, it Is possible to beat up against the wind."

George Pocock's fourth invention was the purpose-built kite buggy, or as rendered in French char-volant. "This vehicle, constructed expressly to be drawn by kites, has the following peculiarities: Firstly, before the charioteer, is an upright spindle, with a T handle at the top; the lower end of this spindle, which runs through the bed of the car, is square, fitting into a socket of a small horizontal wheel; round which, a strap passing leads round another horizontal wheel fastened to the pivot of the front axletree: by this apparatus, termed the guide, the chariot is directed with the nicest precision. Secondly, there is a regulator or drag, suspended by a spring, beneath the hinder part of the car; the shoe of this drag is pressed by a lever power on the ground, by which too great a velocity is prevented, or the vehicle suddenly stopped; this is effected without alighting."

He keeps a reel and chronometer on board. Pocock departs from the traditional coach building practice by having a greater length between the front and hinder circles. "The reason for the unusual length of the char-volant are, that it is far less liable to be upset, in turning, backing, or traveling swiftly."

Only a single sentence covers Pocock's claim to have achieved manlifting. "It was now proved that by these kites might be raised in the air to a vast height, and shall not a father's pride shield the vanity of family associations, when he observed that his daughter, who earnestly claimed from him the daring honour, was the first aeropleust! "Pelham says that she was lifted 300 feet into the air seated in an armchair suspended from the kite line. Amateur Yacht Research Society members still carry on the tradition of testing particularly dodgy experiments on their children first!

Results in Figures

Pocock's earliest carriage traveled at 20 miles per hour for a mile and this amazing speed encouraged him to persevere in spite of all difficulties. He managed 15 mph for several miles "when the wind was not furious, neither were the kites sufficiently powerful, for the bad state of the roads. This speed was also effected with the wheels not exceeding 30 inches in diameter."

He wanted to be able to predict how much kite area would be required for all conditions, "The power of a kite 12 feet high, with the wind blowing at the rate of 20 miles in an hour, is as much as a man of moderate strength can stand against. With a rather boisterous wind, such a kite has been known to break a line capable of suspending 200 pounds. This kite spreads a surface of 49 square feet. It should be particularly noticed, that these may serve as standing ratios, from which, by the rule of proportion, the power of larger kites can be calculated." He knew that kite power was proportional to kite area, not kite length, as some believed. "Two kites, one 15 feet in length and the other 12, have sufficient power to draw a carriage with four or five persons, when the wind is brisk." Pocock summarizes these results "selected from different authors and generally confirmed by experience" as follows:

Pace		Draught Power
A gentle breeze	3 to 5 mph	3.25 cwt
An active breeze	7 to 12 mph	5.25 cwt
Pleasant gale	14 to 18 mph	7.50 cwt
Brisk gale	20 to 26 mph	9.25 cwt
Strong gale	30 to 100 mph	

No experiments at hurricane speed have been made.

The draught power is calculated from experiments made with a four-wheeled car, weighing 2 cwt and drawn by two kites; spreading a surface of 100square feet.

The best velocity made good achieved was 115 degrees from downwind, with the kite reaching a maximum of 45 degrees from downwind.

Suggested Uses of Kites

For shipwreck rescues, Pocock urges that a collapsible kite be stowed in readiness on board, rather than the work of manufacturing the kite be started once the ship has run aground. He describes how mariners can be lifted to the clifftop by kites, but does not claim ever to have tried it. Pelham claims that Pocock lofted his son from a beach to the top of a 200 foot cliff and down again. Pocock hoped that the system would be so perfected that even female passengers and children might be rescued in a hammock or cot swung securely from the kite. He suggests kite bum-skiing, lofting a man from a ship for better observation, and for signaling at great distances by day or night. He suggests a miltary use: “They will serve for observatories, scalade [as in escalade, or scaling cliffs, Ed], for passing over and alighting on the opposite side of rivers, for telegraphic information and for signals.” He describes the techniques for crossing rivers in winds of various directions without claiming to have achieved it. “The day may not be far distant, when this system, having been proved perfectly safe and very delightful, ladies themselves shall be seen making their transit of our rivers.”

Pocock sees the ultimate kite buggy as a six-man amphibious vehicle designed to cross the Sahara desert. It needs a crew of three, with the other three resting, so it need never stop. It would have a boat-shaped body to aid lake crossings and it would have wheels and sledge runners as appropriate to the ground. It would cross 2,500 miles of desert in 10 days and 10 hours, at a cost of 80 pounds sterling. Any offers?

In another context, the author admits to the possibility of the kite buggy becoming becalmed. His proposed solution: “A method has been contrived for the accommodation of a pony, or pair. This accommodation consists of a low platform with two wheels, attached to the char-volant. The cattle are perfectly fresh to perform their duty and to return the favor of giving back-carriage to their winged associates, or of helping them forward, should the wind fail. Thus the equipage is rendered complete.”

Winds

The inventor knew of the fickleness of the wind and sought various means of overcoming it. These included auxiliary horse power, as just stated, and concentrating on the sea where tacking was a more practical proposition than on tree-lined roads. But his chief aid was the wind velocity gradient with which he was well acquainted. He urges study of “the higher regions of the atmosphere, where, when the winds sleep below, there are powerful and steady currents of air rapidly floating.”They are especially noticed at sea and had never yet been used, hence his use of trains of kites. It was important to get the kites up before the wind died at ground level, then the high-up wind kept the kites going even when it was dead calm at ground level. The unreliability of the wind in Britain means that kites buggies would be used for amusement only, unless auxiliary power is available. But not so in foreign parts. Pocock believed that kite buggies would really come into their own in those countries with predictable winds. He describes them as constant winds (e.g. The trade winds), periodical winds (e.g. the monsoons) and alternating winds (e.g. the sea and land breezes near coasts).

Blind Spots

If only George Pocock had met his contemporary Sir George Cayley, the great aeronautical engineer! Cayley could have put him right on a number of things. Pocock writes; “The primary power by which a kite is projected upward into the air will be found in the mechanical principle of the wedge, the wind acting as such on the inclined plane of the kite’s surface.” He did not question what prevented the kite from veering more than 45 degrees left or right of downwind: “By means of sidelines, an obliquity may be given to the kite’s surface, right or left; and thus the angle of incidence is formed on which the wind acting produces a traverse. By this method, therefore, the power is placed to draw an an angle, favorable to the desired course.” Pocock seems happy with a kite angle of attack also of 45 degrees and did not attempt to improve on it. “By the action of the wind on the before mentioned obliquity, which with a perpendicular, forms an angle of about 45 degrees, a power is produced which draws forward, and lifts upward in nearly an equal proportion.”

With Pocock’s less than perfect grasp of fundamentals, it is not surprising that he did not attempt new kite shapes. His sole comment on kite shape is; “The shape may vary, but for what is termed the pilot, or uppermost kite, the common circular-headed shape is certainly best.”Since Cayley also used this English arch top kite no doubt he was right for his times. Pocock always put the maximum gap in his kite train (of two kites usually) that the upper kite could carry in length of line. It did not seem to occur to him to use a dozen kites close together as per Jacob’s Ladder, but he only wanted to use the wind velocity gradient. He suggested races "to determine exactly how far to the right or left of the wind's course the kites might be veered with a given length of cordage and bearing different weights."

Pocock realized the keel-like resistance of the kite buggy wheels but considered that the buggy always traveled in the direction that the wheels are rolling, thereby showing that he had no concept of tire slip angle. He humbly admits that he is a landlubber unacquainted with practical navigation. He failed to repeat Benjamin Franklin's electricity experiment; "When raining, and when the pilot kite has been enveloped in a black electric cloud, and the cordage has been so fastened below as to afford the fairest opportunity for the discovery (of the electric fluid), no effect whatever resulted."(Don't try this at home, folks!)

Together with most of his contemporaries, Pocock had no doubt that breathing would be impossible when traveling at speed. When he found that his 20 mph journeys did not harm respiration, he had a ready answer; "That the swiftness of movement would almost prevent breathing is certain if going against the wind: but when traveling at such a rate, it is with the wind – and thus a perfect calm is enjoyed."

Pocock envisioned kites providing traction during a boat race.

Further Advantages of Kites

Pocock especially enjoyed passing tollgates without paying the dues, since the regulations omitted to list a rate for kitecraft. The unlimited power of a large kite train could exceed three pair of horses and since only the Monarch was allowed to exceed that number, kite riders traveled like kings. The cost in hay for the horses saved eight pounds sterling a ton and they could race 60 miles without a rest or a drink. Try that on your favorite nag!

No 19th century work would be complete without a claim to the moral high ground. Thus Pocock on kite buggying: "Wherever it might be introduced and practiced, manliness would succeed to effeminancy; sloth be banished by activity; and health, strength and courage, triumph over sickliness and fear." (Sorry, girls.)

Volume Being Reissued

As part of its mandate to increase and diffuse knowledge about kites worldwide, the Drachen Foundation supplied the Amateur Yacht Research Society, based in England, with a copy of George Pocock's famous book The Aeropleustic Art. Fittingly, the society – which gathers and disseminates research on sailcraft – now plans to reproduce the volume and make it available globally.

Dave Culp of the San Francisco area, a member of the society's governing board and keen yachtsman, with a particular interest in kite-powered boats, has taken on the project. The Drachen Foundation is helping by scanning into digital form, with high resolution, the book plates. Culp can be contacted via e-mail at dave@dcss.org. He also maintains a web site at http://www.dcss.org/speeds.

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

October

2nd - 8th Weymouth Speedweek
Portland Sailing Academy, Portland Harbour, Dorset UK
Note – change of date!

4th AYRS Weymouth meeting
Speedsailing.
1930 for 2000 hrs at the Royal Dorset Yacht Club, 11 Custom House Quay, Weymouth. Location Map: www.rdyc.freeuk.com. Contact: AYRS Secretary, BCM AYRS, London WC1N 3XX; email: office@ayrs.org. Note – change of date!

November

1st AYRS London Meeting *Subject to be confirmed.*
1930 for 2000 hrs at the London Corinthian Sailing Club, Upper Mall, London W6 9TA. Location Map: www.linden-house.org Contact: AYRS Secretary, BCM AYRS, London WC1N 3XX email: office@ayrs.org.

December

6th AYRS London Meeting *Subject to be confirmed.*
1930 for 2000 hrs at the London Corinthian Sailing Club, Upper Mall, London W6 9TA. Location Map: www.linden-house.org Contact: AYRS Secretary, BCM AYRS, London WC1N 3XX email: office@ayrs.org

January 2007

5th - 14th London International Boat Show
EXCEL Exhibition Centre, London Docklands

21st All-Day AYRS Meeting (Date to be confirmed)
0930 -1600 hrs, Thorpe Village Hall, Coldharbourlane, Thorpe, Surrey (off A320 between Staines and Chertsey – follow signs to Thorpe Park, then to the village). Details from Fred Ball, tel: +44 (0) 1344 843690; email frederick.ball@tesco.net

21st AYRS Annual General Meeting (Date to be confirmed)
1600 hrs, Thorpe Village Hall (see above). Details from the AYRS Hon Secretary tel: +44 (0) 1727 862 268; email: secretary@ayrs.org

February

7th AYRS London Meeting. *Subject to be confirmed.*
1930 for 2000 hrs at the London Corinthian Sailing Club, Upper Mall, London W6 9TA. Location Map: www.linden-house.org Contact: AYRS Secretary, BCM AYRS, London WC1N 3XX email: office@ayrs.org.

March

7th AYRS London Meeting. *Subject to be confirmed.*
1930 for 2000 hrs at the London Corinthian Sailing Club, Upper Mall, London W6 9TA. Location Map: www.linden-house.org Contact: AYRS Secretary, BCM AYRS, London WC1N 3XX email: office@ayrs.org.