The International Hydrofoil Society (IHS) Hydrofoil Correspondance Archives

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Updated last August 20, 2006

Design of Foils: Foil-Struts-Controls-Performance

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"1","950336","2","Re; Re; **Revolutionizing a watersport**||950336","Good response, Tom. When you say " it's much better to specify the pressure distribution and then calculate the section shape that will produce it. Would you be suggesting to use Xfoil

to do the calculation?","2005-12-20","Ray Vellinga","nopswd","
","rvell@san.rr.com","949055"

"2","949055","2","Re; Re; Revolutionizing a watersport||949055","I don't think the radius+ogive middle is a very good way to go. That was the philosophy behind my Proa 1-series.

The sudden change in curvature at the junction between the ogive and radius caused a sharp pressure spike:

This, in turn, led to laminar separation, premature stall from the leading edge, and increased drag. Separation near the leading edge is especially bad for a hydrofoil, because it leads to ventilation and the sudden loss of three-quarers of the lift.

So, while ogive sections may be easy to construct, I'm not enamored with their hydrodynamics.

Today, it's much better to specify the pressure distribution and then calculate the section shape that will produce it. That way you can see what needs to be fixed in the hydrodynamics and go after it directly instead of shooting in the dark by modifying the geometry. ","2005-12-17","Tom Speer","nopswd"," "," ","946625"

"3","946625","2","Re; Re; Revolutionizing a watersport||946625","Tom Speer, any discussion of ogival hydrofoils sections is of interest to me. I have made and flown several such foils. They are easy to construct by welding a rolled piece of metal plate to a flat metal plate and then grinding to make the welds fair.

You have mentioned the idea of adding a radius to the leading edge of the ogival foil. This could be done by welding the forward edges of the top and bottom plates to a rounded section--a tube or a bar. Two questions: Do you have some guidelines on choosing a radius to the rounded leading edge? And, is the junction between the rounded edge and the top plate and the bottom plate a big problem? Would you think this to be a difficult transition?","2005-12-12","Ray Vellinga","nopswd","
","rvell@san.rr.com","945783"

"4","945783","2","Re; Revolutionizing a watersport||945783","Yes, it's possible to design fore-aft symmetric foils that will work equally well in both directions. You basically have two possible approaches: sharp-edged, and rounded edges.

Examples of the sharp-edged foils are the ogival that have been used by may hydrofoil designers. They have the advantage of being simple to construct and have low drag within their design range of angles of attack. The problem with sharp leading edges is they only have a small range of angles of attack at which the flow is attached. Outside that range, they experience leading edge separation. This can lead to sudden ventilation - a charactersitic that has bedeviled many craft that use these sections. You can find

section data for ogival sections published in the literature and in books like Hoern'er's "Fluid Dynamic Drag".

The round-edged approach promotes leading edge suction for low drag and does not necessarily suffer from leading edge stall. There will be a separated zone at the trailing edge which can cause some increased drag. Elliptical sections have been used for some stopped-rotor VTOL aircraft.

To the best of my knowledge, the only round-edged sections specifically designed for use as hydrofoils can be found at http://www.basiliscus.com/ProaSections/ProaIndex.html. XFOIL predicts the Proa-3 series sections have performance comparable to NACA 6-series sections.

","2005-12-10","Tom Speer","nopswd"," "," ","935018"

"5","942165","2","**Foil works in forward or reverse direction**||942165","You haven't said specifically which watersport you want to revolutionize, but I'm pretty sure I know. I won't say it outright here because you seem to be concerned with someone stealing your idea. I have had discussions with others wanting to do the same thing, and have evaluated some of the pitfalls. If you drop me a line at tothebin@adelphia.net, I'll send you my contact info and we can talk, I'm in Stuart Florida. I may not have the ultimate answer for you, but I think I can help.","2005-12-03","Scott Smith","nopswd"," ","boatswithwings@adelphia.net","941596"

"6","941596","2","Foil works in forward or reverse direction||941596","Nat,
I appreciate your response, but have no idea what you said. I'm not familiar with a "soft" foil. I have so many questions, I feel I'm just going to be more of a burden than anything on here. But again, I am willing to pay someone for their time. Also, maybe there is somewhere I can go for more info, I have tapped the internet for all its worth.

Thanks to all,
Derek","2005-12-02","Derek","nopswd"," ","Derekseaman@gmail.com","941408"

"7","941408","2","Foil works in forward or reverse direction||941408","I SUGGEST THAT YOU CONSIDER A SOFT FOIL OVER A RIGID SPAR FOR SAFETY. ALSO, IF PROPERLY DESIGNED IT COULD BE INHERENTLY STABLE. (THAT IS IT WOULD DEFORM TO REDUCE THE ANGLE OF ATTACK IF STALL APPROACHES.) NAT K","2005-12-02","NAT KOBITZ","nopswd"," ","kobitzn@ctc.com","940695"

"8","940695","2","Foil works in forward or reverse direction||940695","Thank you all for your help. Unfortunately, I am still unsure if the design I have in mind is possible. There are many variables that are not taken into consideration with hydrofoil boat designs that I have to think about. For example, instead of proplusion, this board will be towed, and the rider of the board will be able to manipulate the board in ways we

could not with a boat. If there is anyone that would be willing to give me a little more in depth advice, possibly over the phone, or in person (I live in Orlando), I would be more than willing to pay for your time. I need to first determine whether it would be physically possible to do what I want, and then if it is, I would have to explain some of the problems that might arise that are not addressed with any other hydrofoil. If all goes well, I would like to make a few prototypes, and start a company that would revolutionize the fastest growing watersport.

Thanks for everyone's time,
Derek Seaman
407-739-1827","2005-12-01","Derek","nopswd","
","derekseaman@gmail.com","938319"

"9","938319","2","Foil works in forward or reverse direction||938319","A complete copy of this 57 page report is in my hands. Today I offered it to Barney Black to be posted on the IHS site. If he accepts, you can download it from there soon.

I have used the Ogival sections with some success. They are useful because they can be built easily using sheet metal, a welder and a metal grinder.","2005-11-26","Ray Vellinga","nopswd"," "," ","935301"

"10","938089","2","Re; **Hydro foil designs**||938089","Go to a good technical library and take out a copy of "Theory of Wing Sections" by Ira Abbott and Von Doenhoff, by Dover Publications, Inc., NY c 1959.

All the airfoil sections described there will work as foils. The charts shown for lift and drag coefficients will be accurate for air or water. Just remember that water is 800 times more dense that air so the resulting speed, lift, drag, etc. will differ accordingly.
","2005-11-26","Ray Vellinga","nopswd"," "," ","935322"

"11","935334","2","Foil drag, size vs. angle of attack||935334","Ray, you seem to know what you are talking, about please look at my posting and see if you have any input.
Thanks
Dan Bush","2005-11-20","Dan Bush","nopswd","
","lostboys81@bellsouth.net","918835"

"12","935322","2","Hydro foil designs||935322","I have a 1973 Carri Craft Catarmaran. Full displacement hulls. Lenght 57", beam 12'.If I did the calculations correctly theoritcal hull speed is close to 20 knots. I am not willing to repower or pay the fuel penalty for this speed. I should mention I have lived on /traveled in this boat for three years and the following speeds and fuel economies are from more than 1000 hours of travel,deterimined by gps. While in drydock two years ago I added three fins/stabilizers on each hull, 8" wide and 8' long. This solved the problem of excessive roll at anchor or docked. When I added these fins I expected to lose a knot or more due

to extra drag. Much to my surprise and pleasure I actually picked up a knot in speed. Boat weighs approximately 38,000 lbs empty, has twin Isuzu 150 horse diesels, and the best speed I have gotten out of her to date has been a little over 12 knots at 2400 rpm slinging 20x20 four bladed nibrile props. I have solved an over heating problem and can now go to a continous 2700 rpm. Fuel effiency at 9 knots is(I am not a liar, normally I tell people three knots per gallon) 4 knots per gallon at approximately 50,000 lbs gross weight. Currently I am in dry dock and it occurred to me that by reshaping my stabilizers as hydro foils I could gain more speed. I need foil designs. It seems that the strenght of my stabilizers is sufficient to support the weight of the boat. Idiots ran STRAPS over the fins and lifted my boat with no damage.They moved it while I was not present from one place to another in the yard. The front fin is canted upwards three inches out of level which I suspect is the reason for my speed gain. I currently have helicopter foil designs which I may expand out to eight feet and install. It seems to me with the front fin pitched 3% higher then the middle and last foil like Burt Rutans designs the level of the boat should be limited by stalling of the front first. I am seriously contemplating adding trim control but before I do this I would like to add hydrofoils and play with it for six months.
I should add that I am a fully competent welder, actually "enjoy" fiberglass work, can wander around a machine shop and identify a tool or two. Feed back on hydro foil shapes would be greatly appreciated. This is not "pie-in the sky", I will be modifying my stabilizers in the next few weeks. Your help will be greatly appreciated and is worth a wild time out fishing, or traveling to some exoctic port to get into exoctic trouble.","2005-11-20","Dan Bush","nopswd"," ","lostboys81@bellsouth.net","2"

"13","935307","2","**Foil works in forward or reverse direction**||935307","I have a photocopy of a few pages of Report No. E-79-6 "WATER TUNNEL OBSERVATIONS ON THE FLOW PAST A PLANO-CONVEX HYDROFOIL", by R.B. Wade, February 1964, Division of Engineering and Applied Science, CALIFORNIA INSTITUTE OF TECHNOLOGY, Pasadena, California. On the cover page, it also says "Office of Naval Research Department of the Navy Contract Nonr-220(24)", and "D.J.Nigg" in handwriting. I forget where I got it, maybe from Donald Nigg himself. Is he still making foils?

Anyways, the paper gives lift & drag data for a foil with an "ogive" section. That means straight line on the bottom, circular arc on the top. The model used for testing is 0.19" thick, with a chord length of 2.77". At zero degrees angle of attack CL is 0.4 and CD is 0.013. This would be the same forward or reverse.

Maybe someone with access to the whole report could get it posted on the IHS website. As a last resort, I could scan what I have, but it's incomplete. Not sure about the copyright issues here.","2005-11-20","Mac Stevens","nopswd"," ","stevensm@earthlink.net","935018"

"14","935301","2","Foil works in forward or reverse direction||935301","I have a photocopy of a few pages of Report No. E-79-6 "WATER TUNNEL OBSERVATIONS ON THE FLOW PAST A PLANO-CONVEX HYDROFOIL", by

R.B. Wade, February 1964, Division of Engineering and Applied Science, CALIFORNIA INSTITUTE OF TECHNOLOGY, Pasadena, California. On the cover page, it also says "Office of Naval Research Department of the Navy Contract Nonr-220(24)", and "D.J.Nigg" in handwriting. I forget where I got it, maybe from Donald Nigg himself. Is he still making foils?

Anyways, the paper gives lift & drag data for a foil with an "ogive" section. That means straight line on the bottom, circular arc on the top. The model used for testing is 0.19" thick, with a chord length of 2.77". At zero degrees angle of attack CL is 0.4 and CD is 0.013. This would be the same forward or reverse.

Maybe someone with access to the whole report could get it posted on the IHS website. As a last resort, I could scan what I have, but it's incomplete. Not sure about the copyright issues here.","2005-11-20","Mac Stevens","nopswd","
","stevensm@earthlink.net","935018"

"15","935018","2","**Revolutionizing a watersport**||935018","I think the use of foils may change the watersport I love. Unfortunately, I cannot seem to find the information I need to make a basic hypothesis on the design. Every hydrofoil I have seen is based upon moving in one direction (boats don't reverse at high speeds). Is it possible to have a hydrofoil design that allows movement in opposite directions and will perform well either way? If you could imagine a symmetrical jet propelled boat, so that it could go backwards or forwards either way. Any help would be appreciated.","2005-11-19","Derek","nopswd"," ","derekseaman@gmail.com","2"

"16","931880","2","Re; **Assistance wanted - foil design**||931880","Dear Bob,

Please give me a call or send me your phone number and email contact.
You can call me on (203) 313 4061.

My company, Hydrofoil Assisted Water Craft HAWC Technologies was recently formed.

We work to help people like you, and believe we will have a solution for you. We need to assess your vessel's basic information first in order to do a speed prediction based upon the vessel's length, displacement weight and power amongst some other info.

Looking forward to talking with you.

BR
Gerhard ","2005-11-14","Gerhard Kutt","nopswd","
","caemarine@earthlink.net","926828"

"17","926832","2","Assistance wanted - Foil design||926832","We have a 24 meter commercial Catamaran with a cruising speed of approx. 25 knots with full load. We

plan to retrofit the vessel with "aasisting" foils.
We are looking for an hydrofoil expert that can assist in the design and technical specification of "assisting" foils that will be placed between the hulls of the Cat. The goal is to reach a cruising speed of approx 27-28 knots and with a lower the fuel consumption than today. (if possible)!

Best regards, Bob Email: swedbob@hotmail.com","2005-11-05","Bob","swedbob","
","swedbob@hotmail.com","2"

"18","926828","2","Assistance wanted - foil design||926828","We have a 24 meter commercial Catamaran with a cruising speed of approx. 25 knots with full load. We plan to retrofit the vessel with "aasisting" foils.
We are looking for an hydrofoil expert that can assist in the design and technical specification of "assisting" foils that will be placed between the hulls of the Cat. The goal is to be able to reach a cruising speed of approx 27-28 knots and lower the fuel consumption.

Best regards, Bob","2005-11-05","Bob","swedbob"," ","swedbob@hotmail.com","2"

"19","925912","2","Foil drag, size vs. angle of attack||925912","I appreciate the feedback, but it wasn't really what I was asking. I'm not trying to determine the optimum foil size or profile at this time. I am trying to find out at a fixed speed and weight, which has less drag, a larger foil at lower angle of attack, or a smaller foil at higher angle of attack. A perfectly trimmed hydrofoil boat (without active controls) will perform quite differently if the overall weight or weight distribution changes. I see three directions to attack this problem. One is to have foils sized and trimmed for optimum performance when the boat is lightest, then increase the angle of attack when the boat is heavy. The second is to size and trim the foils for the boat at its heaviest, then run the foils at a reduced angle of attack when the boat is lighter. The third is of course to size and trim the foils at a point halfway between the weights, and then re-trim accordingly as the weight changes. I'm trying to figure out which will have the least drag penalty when run at the most commonly used weight.","2005-11-04","Scott Smith","nopswd"," ","boatswithwings@adelphia.net","920315"

"20","920315","2","**Foil drag, size vs. angle of attack**||920315","Check your data. I believe it is in error.
NAT KOBITZ","2005-10-26","NAT KOBITZ","nopswd","
","kobitzn@ctc.com","918835"

"21","918835","2","Foil drag, size vs. angle of attack||918835","Scott Smith: Look on page 522 and 523 of "Theory of Wing Sections" By Abbot & Doenhoff for the best Lift over Drag ratio, L/D for the wing section NACA 63412. This section is in common use.
The best L/D is at about Coefficient of Lift = .4. This occures at -6 degrees Angle of Attack.
The Excel formula attached determines that the area should be 1.32 square feet.

If your cord were 4.75 inches, the span should be 40.1 inches. ","2005-10-24","Ray Vellinga","nopswd"," ","rvell7829@yahoo.com","917973"

"22","917973","2","Foil drag, size vs. angle of attack||917973","This is a rather simple question, and I hope there is a simple answer, but here goes: I am looking at the design of a foil wing that must support a fixed weight at a fixed speed, let's say 1000 pounds at 30 mph. Which has less drag, a larger foil at lower angle of attack, or a smaller foil at higher angle of attack? Other considerations such as stall angle are not important.","2005-10-22","Scott Smith","nopswd"," ","boatswithwings@adelphia.net","2"

"23","917248","2","Re; **Stevenson SportFoiler Published**||917248","This is indeed good news, as there have been many requests over the years for these plans. IHS should ask permission to reprint them in the next hydrofoil CD-ROM","2005-10-20","Barney C Black","poopdeck"," "," ","916786"

"24","916786","2","Stevenson SportFoiler Published||916786","Stevenson Projects produced a set of plans for the SportFoiler, a single person surface-piercing hydrofoil. Unfortunately, several years ago they abruptly discontinued the plans, although many of us have asked for them.

To my delight, Stevenson Products has published the plans (for free!!) online. The address is: http://www.stevproj.com/TheSportfoilPlans.pdf

I want to thank the people at Stevenson, as this project shows just how easy hydrofoils are to build. Don't dismiss these plans. ","2005-10-19","Barry Steele","nopswd"," "," ","2"

"25","908696","2","Re; **Req for Technical Paper**||908696","I don't have a copy of the paper; however you may be interested in the following excerpt from IHS archival correspondence taken from www.foils.org/students.htm, and you may want to try the email contact:

[18 Jan 01] We were sort of toying with the idea of using supercavitating foils. Do any of you know where I can get some good information on supercavitating foil sections, or the design of supercavitating hydrofoil vessels. I don't remember who asked, but I am pretty sure we are just doing our hull with FastShip and then doing analysis using NavCad. If you have a better suggestion (which can be handled at an undergraduate level) Id love to hear it as well. -- Earon S. Rein, MIDN USN (m015346@nadn.navy.mil)

Responses...

[18 Jan 01] Two suggested sources:

Altman, R., "The Design of Supercavitating Hydrofoil Wings," Technical Report 001-14, Hydronautics Inc., April 1968.
Martin, M., "The Stability Derivatives of A Hydrofoil Boat - Part II", Technical Report 001-10(II), Hydronautics Inc., January 1963.
[18 Jan 01] The best info I'm aware of on supcav foil sections is the Carderock work in the 1970s on the "TAP-2" series of base-vented supercavitating foils. The work may have been done by Young Shen but I'm not sure. -- Mark Bebar (bebar@foils.org)

","2005-10-06","Barney C Black","poopdeck"," "," ","904808"

"26","904808","2","Req for Technical Paper||904808","Where can I find this paper Altman, R., "The Design of Supercavitating Hydrofoil Wings," Technical Report 001-14, Hydronautics Inc., April 1968[. Can somebody email me the pdf version of this paper at the following mp_mathew@hotmail.com.","2005-10-01","M.P. Mathew","nopswd"," ","mp_mathew@hotmail.com","2"

"27","889045","2"," **Supercavitating Foils**||889045"," I have to design supercavitating hydrofoils for a hydrofoil vessel going upto a max speed of 70 knots. I was thinking of going for Tulin's sections. But I also know that the L/D charecteristics for this type of sections below 40 kts would be absymally poor. Am I correct? Can I use the public domain XFOIL(by Mark Drela) for getting the fully wetted Lift and Drag charecteristics for these sections for the non cavitating regime(upto 40 knots)or is XFOIL not suitable for sharp leading edge profiles.

My second question: Can I use base ventilated tulin section foils so that I can get supercavitating regime even at low speeds. How are supercavitating flows and base ventillated foils related. Can I use linearized Tulin's theory for base ventillated foils. Are base ventillated foils approaching sigma (cavitation no.) = 0 . How do i get the lift and drag coefficients for base vented foils otherwise. Any references will be highly appreciated. Thanx
","2005-09-06","MP Mathew","nopswd"," ","mpmathew73@yahoo.com","2"

"28","888679","2","Re; **Question on fully submerged foils**||888679","My Dynafoils use a fixed rear foil, fully submerged. The front foil is a simple mechanical system, fully submerged foil coupled to a surface follower. There are no other controls except steering and throttle. It can be a handfull to control at times, but only because it is short, with deep foils and lots of power. At moderate power levels and reasonbly calm seas it handles just fine, with no roll control aparatus or trimming of the foils needed. On smaller boats with less roll moment, steering works just fine to control roll issues.","2005-09-05","Scott Smith","nopswd","
","boatswithwings@adelphia.net","872569"

"29","888667","2","Re; **Cheap ready made hydrofoils?**||888667","I have copies of the old Popular Science articles on how to make wooden foils cheaply, with a tablesaw.

Would work very well for you. Drop me a line and I'll e-mail them to you, free.","2005-09-05","Scott Smith","nopswd"," ","boatswithwings@adelphia.net","2"

"30","884493","2","Re; **Idea; Use Air to Bank Turns**||884493","Grant,

Your proposal to use air feed to control the lift force on a hydrofoil is a sensible one. So sensible in fact, that it has been successfully implemented on both small and large hydrofoils!

The name most commonly applied to this method of hydrofoil stabilisation is "controlled ventilation". In this context, the term "ventilation" refers to air being drawn down to the foils. On the other hand "cavitation" refers to water changing state to 'steam' due to very low pressure as sometimes occurs on hydrofoils so isn't as accurate a description of what is happening.

My understanding is that this concept was first practically applied by the Swiss based company Supramar headed up by the hydrofoil pioneer Baron Hans von Schertel. Early experiments were carried out on a Supramar ST 3A fully submerged air-stabilised hydrofoil research craft. Later, various large passenger hydrofoils adopted the concept, in particular the Supramar PT 150 of which three were built. My understanding is that air stabilisation may have variously been used to assist with roll, pitch and heave stabilisation of hydrofoil.

Hans von Schertel wrote a number of technical papers on this concept at the time pointing out its advantages over conventional flapped hydrofoils. None the less, it never seems to have achieved widespread application. I don't know why.

You would be able to find out more details if you can gain access to early issues of Jane's Surface Skimmers or the journal "Hovering Craft and Hydrofoil" from the 60's.

In more recent years, there had been renewed interest in foil stabilisation using air feed. A research project in Australia had considered this approach for use in controlling lift on motion control foils (for catamarans and the like). In that case, the concept had been referred to as "lift dumping foils". I don't believe this progressed to any operational systems.

I was not aware of any Italian research / patents on this concept but would be interested to hear more about that.

Good luck with your own experimentation.

Martin","2005-08-28","Martin Grimm","nopswd","
","seaflite@alphalink.com.au","883043"

"31","883043","2","Re; Idea; Use Air to Bank Turns||883043","I believe this type of foil control is called artificial cavitation. I am not sure what or how much effect it has on foils at different speeds. It may not be enough effect to control the boat. The Italian patent was for large fast ferries carrying a couple of hundred passengers. I don't think it was ever used. I think that Boeing may have investigated this idea too. I believe they held a few patents for artificial cavitation in other forms as well. I was thinking it might have application in smaller recreational boats.

My first test will be to try to improve the turning ability of My Volga. A 90-meter turning radius is not exactly turning on a dime (with very little banking). My first trial will be to use some 1" rubber hose and a lot of duct tape. Two hoses (port and starboard) will run from the cockpit to the bow and down to the center two struts (of 4) on the front foil the hose will end right at the top of the foil. A valve at the cockpit controls the airflow. Massive amounts of duck tape should smooth out the bump the hose will make as it goes down the strut. The strut is not hollow; it is made of 1/4"" stainless steel. Any ideas?
","2005-08-25","Grant Calverley","nopswd","
","grant@sanjuantimberframes.com","882728"

"32","882728","2","Re; Idea; Use Air to Bank Turns||882728","Revision #1 of Idea
On rethinking it seems air passages on from the struts to the foils should not be crossed from port to starboard and visa versa. On a boat unevenly loaded or running parallel to waves it would not right its self. It could even get dangerous as the heavy side of the boat would lose lift and sink even lower. The lower it sinks the greater the lift on the opposite side. Opps bit of a problem. It would be easier to make a foil without the cross over air tube feature anyway.

Another benefit to not having it cross over is after an operator initiated banked turn is complete the boat would right itself automatically. The lower (deeper) side would have more lift than the upper side creating a righting effect. The operator initiated banked turn air system would need to override or supply more air than the altitude control air system. The two systems would be somewhat fighting each other.
","2005-08-24","Grant Calverley","nopswd","
","grant@sanjuantimberframes.com","882721"

"33","882721","2","Idea; Use Air to Bank Turns||882721","Hello,

I have been kicking around a simple idea for stabilizing fully submerged foils for a long time. I did a patent search a while back and found that an Italian had patented a very similar idea for fast hydrofoil ferries before I was born in 1963. It seems like a good Idea so I will attempt to describe it. Maybe some one else can use the idea and make it real. I am not an engineer but would be interested to have some feedback.

The system would have almost no moving parts. It would use hollow struts and foils. Air supplied to the tops of the foils to reduce lift would main mechanism for stability, banked turns and attitude control. Two separate sets of holes on the port and starboard

sides of the foils (like holes on a flute) would be across the top in the low-pressure area.

Banked Turns. When a banked turn to the right is desired an air is supplied to the right side of the foil decreasing its lift creating a banked turn. The mechanism could be as simple as a two tubes and valves (for port and starboard turns) near the steering wheel. Open the valve just before starting your turn. Electronically a turn signal lever like on a car would work well and is already instinctive to use. I have a Volga 70 and may try a duck tape and plastic hose version of this banked turn concept next year. (when I get it running)

Altitude Control and Stability. The banked turns would require some mechanical input to initiate. Attitude control would be automatic and may require a separate set of holes from the banked turn set. The line of holes on the top surface of the starboard side of the foil would be connected through the hollow foil to a corresponding set of holes in the side of the strut on the port side of the boat. At slow speeds all of the holes in the strut would be below the surface. As the boat gains speed the strut raises out of the water and the first of a serious of holes is exposed to the air. The low pressure of the wing sucks the air down through the hole and reduces the lift slightly. As the boat speeds up more holes are exposed and the lift is reduced even more maintaining equilibrium in altitude. Having the air lines cross from port strut to starboard foil and vies versa would aid in banked turns.

There are a few problems /questions in my mind. 1) Is there enough suction on the top surface of the wing to suck the air down the tubes and blow out the water that would be there already? Would you need compressed air?.(the Italians used compressed air and some complicated sensors from what I remember) 2)The hole's orifices would need to be sized and located very carefully. Not to big and not too little. 3) Would there be a big lag time as the water is pushed out of the struts and hollow foils. 4) At slower speeds water would circulate through the strut and foils holes, would this effect lift? 5) Would the boat right its self after completing a banked turn?

I would appreciate some feedback and may try some simple experiments on my Volga next year if it is warranted. What do you think, does it have merit or is it flawed? I never even took Physics in high school so go easy on me.

Grant Calverley
","2005-08-24","Grant Calverley","nopswd","
","grant@sanjuantimberframes.com","2"

"34","872638","2","wsome Re; Re; Re; **FOIL SHAPE AND AN**||872638","Awsome answer. Thank you Tom.
I have already experienced much of what you have discussed. I actually started with a low angle, and found that the drag of the foils actually pulled the boat down. I compensated by doubleing the front angle, and that helped. I had already preset the rear foils at an angle of six degrees. So by end of testing on the first day, it came down to

the fact that my jet pump could not supply enough thrust.
I have doubled the size of the pump, and have created a four bladed impeller. I also have an output reduction cone built to see if reducing the output diameter doesn't increase the speed of the output.
I have several things to try including two more motors.

I was hoping to get 12mph, and the first pump failed miserbley.
I don't think I will have any chances at the pond till next weekend

Thank you

","2005-08-06","Umi_Ryuzuki","nopswd"," ","umi_ryuzuki@hotmail.com","872597"

"35","872597","2","Re; Re; **FOIL SHAPE AND ANGLE**||872597","You have the basic idea, but I think you're missing a couple of things. You do get the area by assuming lift = weight and dividing by the dynamic pressure and design lift coefficient. But you have to use consistent units.

The factor F in your formula is the fluid density divided by 2. For water, the density is (using your English units) 1.939 slug/ft^3, so the Factor F should be 0.9695 for fresh water, or pretty close to 1.

The velocity has to be in ft/sec to be consistent, so I'll take the "12" in your calculations as being 12 ft/sec (same as 8.2 mph or 7.1 kt). The velocity has to be squared, which I'm not sure you did to come up with your final result.

So at a speed of 12 ft/sec and a lift coefficient of 0.5349, I get an area of 0.067 sq ft or 9.64 sq in for the required area. Since each of your wings have an area of 7.5 sq in, getting the 5 lb of lift from 6 of them is not a problem. The extra area will let you fly at half the design speed of 12 ft/sec.

However, while the average lift coefficient may be 0.5349, that doesn't mean the local lift coefficient will be the same over all parts of the wing. For your swept foils, the tips will be loaded more heavily than the root. This is due to the downwash in the wake of the hydrofoil and how it affects the conditions along the span.

And the angle of attack of the foils will not be 2.25 degrees as indicated by the two-dimensional section data. Those data are for a foil of infinite span, so it produces an infintessimal downwash. The shorter the span, the greater the downwash to produce the same lift, so the angle of attack has to be increased to offset the downwash. Your foils have an aspect ratio of 4, and at a lift coefficient of 0.5349, an additional 2.44 degrees of angle of attack will be needed because of the downwash. So the incidence of your foils will be more like 4.7 degrees than the 2.25 given by the section data for the same lift coefficient.

But more than that, the downwash will increase the drag substantially. You should allow for an additional drag coefficient of 0.0228 because of the lift-induced drag. This is 0.21 pound of additional thrust required. The induced drag goes down by the square of the span, so if you make your foils wider they will be much more efficient. But this runs into problems of strength and stiffness, so the span is always a compromise. The induced drag goes DOWN with speed (squared), so flying at too slow a speed can actually require more power than going fast.","2005-08-05","Tom Speer","nopswd","","me@tspeer.com","2"

"36","872572","2","Re; **Cheap ready made hydrofoils?**||872572","Take a look at http://www.fastacraft.com/moulded_foils.html","2005-08-05","Tom Speer","nopswd","","me@tspeer.com","2"

"37","872569","2","Re; **Question on fully submerged foils**||872569","It's not enough to balance lift against weight. You also have to balance the moments that want to turn the craft, tip it over, or pitch it. And the problem with balancing the lift is the lift is constantly changing as a function of speed, the attitude of the craft, and the disturbances from waves, gusts, thrust changes, etc. So when it does change, there has to be a means of returning it to its original value. If you hold a broom upside down on your hand, it's easy to compensate for the weight of the broom. But the moments are unstable so you can't maintain that balance without actively compensating for any change.

There're also the problems of regulating the flying height, maneuvering and accommodating different amounts of payload.

Lift at a constant speed and attitude does drop off as the foils get close to the surface. It's possible to use this effect to stabilize the craft if you are operating in flat water. But this also robs the fully submerged foil of much of its performance advantages.","2005-08-05","Tom Speer","nopswd","","me@tspeer.com","2"

"38","862463","2","Re; **Cheap ready made hydrofoils?**||862463","There were some articles published in the late 1950s - early 1960s in hobbyist magazines as to how to make wooden hydrofoils and add them to runabout-type boats. For example, Popular Science June 1960 has an article, "How I Fitted Oak Hydrofoils To My 14-Foot Runabout." Science and Mechanics Feb 1960 has a similar article, with foil design for boats up to 18 feet length. Take a look at the magazine descriptions on the IHS website in the Hobbyist section of this page: www.foils.org/popmags.htm.

You can buy copies of old magazines by searching for them on eBay and/or google.com. Sooner or later, just about everything shows up on eBay. Google will find you magazine sellers who sell directly. I have used the Canadian company "Smelly Old Books" http://members.ebay.com/aboutme/sobooks/(contact: John Muxlow jj.muxlow@ns.sympatico.ca) to obtain reasonably priced copies of articles back to the 1920s and earlier (S.O.B. has an almost complete collection of Mechanix Illustrated, Popular Mechanics, and Popular Science). It has been a while since I contacted them,

so I hope the URL and email address are still good.","2005-07-18","Barney C Black","nopswd"," "," ","0"

"39","861182","2","Re; **FOIL SHAPE AND ANGLE**||861182","So No help or confirmation on the previous calculations?
","2005-07-15","Umi_Ryuzuki","nopswd"," ","umi_ryuzuki@hotmail.com","0"

"40","860748","2","Re; **Question on fully submerged foils**||860748","Maintaining a close enough balance between weight and lift without feedback control to allow a flight for more than a few seconds is currently not possible. Suggest you consider a mechanical feedback controller. The Rave, Hobie Trifoiler, and the height control on Talaria IV all use mechanical surface sensors with linkages to their foils to maintain a balance between lift and weight. ","2005-07-14","Harry Larsen","nopswd"," ","htdr.larsen@verizon.net","0"

"41","860689","2","Re; Question on fully submerged foils||860689","Thanks! That puts me very close to the goal.

Andy","2005-07-14","Andy","nopswd"," "," ","0"

"42","860646","2","Re; Question on fully submerged foils||860646","If you are using fully submerged foils for main lift, you can have a 25 to 35% lift stabilizing, surface piercing foils to supplant an autopilot. I do not know of any all fully submerged foil systems that are self stable.","2005-07-14","NAT KOBITZ","nopswd"," ","kobitzn@ctc.com","0"

"43","860356","2","Question on fully submerged foils||860356","I have read that fully submerged foils require flight control. My question is whether this is strictly necessary, or if I could design a submerged foil for a specific boat through experimentation that would be functional without flight control. The idea being to balance the lift against the weight of the boat.

Thanks,
Andy
","2005-07-13","Andy","nopswd"," "," ","0"

"44","856862","2","**Cheap ready made hydrofoils?**||856862","Forgive me for my ignorance- I'm only just starting to embark on a project to add hydrofoils to a 12' boat. I've been searcing for ready made aerofoil sections that could be used, and of course there are none specifically for hydrofoils-other than sailing ones, which are still expensive and probably unsuitable. When I searched under 'aluminium aerofoil section extrusions' I came up with extrusions intyended as sun blinds, see page 14 for an example :http://www.productselector.co.uk/docs/4/02274/external/COL02274.pdf

I realise the sections avaiable would not be the most efficient, but would using these extrusions provide a cheap and reasonably efficient way of getting foilborne?

Any comments?

Cheers, Roland

r.wilson@bath.ac.uk","2005-07-07","Roland Wilson","nopswd","
","r.wilson@bath.ac.uk","0"

"45","855770","2","Re; Re; FOIL SHAPE AND ANGLE||855770","Let me see if I read all this correctly.

S = L / F U^2 Cl

S = 5lbs/ (2.09)(12©÷)(0.5349*) *assuming a 2.25¡æ angle of attack.

S = 5lbs/ 160.9835

S = 0.310591 sq ft

Therefore S = 44.725104 sq inches divide by 3 for each foil

Each wing needs an area of 14.908 sq inches
¡î14.908 = 3.861 square plate cut diagonally

Am I correct in assuming a six wings o