

Hydrofoil-Related Student Projects

Descriptions, Advice, Sources of Information, and Requests For Help

(Last Update: 11 Nov 03)

See also the BBS archive: "[Build Your Own Hydrofoil](#)"

[Go to the Posted Messages Bulletin Board\(BBS\)](#) for more recent messages

Notice: IHS receives many cryptic inquiries to the effect of, "Send me information about hydrofoils." This is *No Good!* To help you, we need *details...* power or sail, large or small, surface piercing or fully submerged, recreational, commercial, or military... stuff like that! Oh, yes, and please remember to tell us your name! Thank you, thank you, thank you.

Suggestions: Describe your project and let us know your schedule and deadlines. Also, please ask specific questions so we can forward your request to experts who may have an answer! Feel free to contact any of the students whose inquiries appear here... their projects are probably finished now, and they could help you with "lessons learned." Finally, click on some of the other FAQ links such as the one on Hydrofoil Texts and Sources of Design Information.

Hydrofoil Rise and Fall

[2 Apr 02] I am currently doing an assignment on hydrofoils at Southampton Institute Of Higher Education and I was looking for information on the rise and fall of hydrofoils in commercial and military use, I was wondering whether you could send me the names of any other websites or reports on this subject. -- Nicholas Hayles (nickhayles@hotmail.com)

Response...

[5 Apr 02] Hydrofoils for commercial applications really 'took-off' in the late 50's and into the 60's and beyond. The decline in production has probably been since the late 80's or early 90's. You could track the production rates of different types of commercial fast ferries by consulting Fast Ferry International magazine which for many years has annually reported on production numbers of the different types of ferries, be they monohull, catamaran, hovercraft, hydrofoil, Surface Effect Ships, SWATH (these are usually slower) or hybrids of some form. Being a hydrofoil enthusiast, I wouldn't say that hydrofoils have 'fallen', rather they seem to have gone out of vogue at the moment. I think they will make a comeback! My personal view on why they have gone out of vogue is that operators these days probably consider them to be complicated craft and a 'simple' catamaran or displacement monohull is easier to operate. The same can be

said for Surface Effect Ships which looked like they would become the 'fast ferry of choice' in the 80's and 90's (many designers and shipyards had proposals available) but apart from a number of sales, nothing substantial eventuated. One of the folk at an Australian shipyard that had built a limited number of SES once told me that operators would prefer a ferry that is like a 'truck' rather than something that is high tech. In other words, they are looking for simplicity and reliability in operation. The tricky thing is to convince operators that hydrofoils can offer fuel savings over some other types of fast ferries of similar capacity and speed and that any additional effort to maintain foils is offset by the fuel cost savings. Unfortunately, I don't have the hard evidence to demonstrate that myself as I am not a hydrofoil operator. Another thing I find interesting is that many conventional catamarans and monohulls are having hydrofoil based ride control systems added to them to improve their seakeeping performance in waves (and so achieve reduced seasickness of passengers). These ride control systems seem to be accepted as not adding complexity to 'simple' catamarans and monohulls even though they are essentially just scaled down versions of the same types of foils that support pure hydrofoil craft. In fact, some designers offer catamaran designs with more substantial hydrofoil units fitted between both hulls to partially support the weight of the craft as these are stated to reduce the total resistance for a given displacement and speed and so reduce fuel consumption. Apart from the above, it would probably be fair to say that the manufacturing cost of hydrofoils (and SES and hovercraft for that matter) would be higher than for comparable displacement vessels such as catamarans. An operator would therefore need to invest more up front in purchasing the craft before the potential through life cost savings are achieved. If you would like to read some of the views on the future of hydrofoils while they were first becoming popular, I would recommend you hunt down journal papers written by Baron Hanns von Schertel (see IHS website for more details of this hydrofoil pioneer). These usually appeared in the Journal "Hovering Craft and Hydrofoil". One had the title "Future of the Commercial Hydrofoil" but I don't have details of which issue that was in, but it would have been the late 60's or early 70's. There is an interview with him in the October 1971 issue (Volume 11, No.1) with the title "The views of Baron Hanns von Schertel" where he also recalls some of the trials and tribulations of the development of hydrofoils. -- Martin Grimm (seaflyte@alphalink.com.au)

Student Project - Lateral Stability of Surface-Piercing Hydrofoils

[31 Mar 02] I am a final year student of Naval Architecture in Australia and am currently involved in doing a research thesis on lateral stability of SP hydrofoils. -- Nigel Lynch (masterlynch@hotmail.com)

Response...

[27 May 02] Are you a student at University of New South Wales in Sydney or at the Australian Maritime College in Launceston? I suspect the former because I first proposed a research project on this topic to Phil Helmore about two years ago, and I know he has offered it to students as a thesis option this year. I am of course delighted that someone has taken this project on if my assumption is the correct. Regardless, I would be keen to give you some suggestions on what can be done to make it a really interesting project for you. Anyway, I think you are off to a good start having found the IHS website. We probably have more hydrofoil information and references than any other single source. If you look under the section "[Technical References, Articles and Books](#)" and go to entry #86, you can download a short article I wrote on the subject for the IHS newsletter a few years ago (following details extracted from website): Grimm, Martin, "'Transverse Stability of Surface Piercing Hydrofoils,' IHS Newsletter, Summer



1998, pp. 7-9. The stability criteria presented in the IMCO Code of Safety for Dynamically Supported Craft, now superseded by the International Maritime Association (IMO) High Speed Craft Code, provides an equation for assessing foilborne metacentric height (GM) of surface-piercing hydrofoils in the design stage. An alternative method which addresses several limitations of this equation has been implemented in a short computer program, and representative results for typical foil designs are presented. A more extensive assessment of the results, a source code listing, and example input files are available from the author to those willing to examine this subject in further detail and share their findings." In closing, see the image of my model hydrofoil with a 'test rig' catamaran owned by a friend of mine (pictured). Actually, the catamaran has been used for solar boat races in recent years but is ideal for towing models. The idea was that this could be used to do experimental tests of transverse stability of the model while foilborne on a calm day. We just have not got far

enough with the idea yet!
Far more ideal of course
would be to perform the
tests in a towing tank! --
Martin Grimm
([seaflyte@alphalink.com.a
u](mailto:seaflyte@alphalink.com.au))

Student Project: Racing Hydroplane

[5 Mar 02] I am currently a student at Teesside University in England studying Computer Aided Design Engineering. As part of a project we have to improve on an existing hydrofoil design. The boat my team has chosen to improve upon is to be capable of racing in the 2002 Unlimited Hydroplane Series of which the boat *MISS BUDWEISER* is currently the title holder. Could you please advise me as to where I may find design specifications of such boats especially in relation to the cockpit area (safety) and the steering mechanism incorporated in the craft? -- Ben Coward (bencoward1@hotmail.com)

Responses...

[5 Mar 02] You have an interesting project, however our site is concerned mostly with fully submerged and with surface piercing hydrofoil designs. We have next to nothing on hydroplane racing craft. I am sending a copy of this response to Leslie Field (www.lesliefield.com/) and to Simon Lewis (www.simonlewis.com/) in the hopes that they can suggest a source the design specs you seek. You may have luck by contacting directly the racing crews of specific craft or the racing association. -- Barney C. Black (Please reply via the [BBS](#))

[15 Mar 02] The American Power Boat Association puts out all the specifications for the various classes of hydroplane racing crafts. *MISS BUDWEISER* is in the unlimited class. I believe they are presently headquartered in Detroit, Michigan. I had some discussion at one time with a former crew chief of a hydroplane racing team who wanted to put hydrofoils on the sponsons. I believe he proposed it to the APBA but was rejected at the time. -- Sumi Arima (arimas1@juno.com)

Student Membership Requirement

[2 Feb 02] I have one doubt regarding membership, that is, for which kind of membership I should apply. Being a PhD student I am not sure if student membership can be applied in my case or it is reserved for undergraduates only. A practical question: does IHS issue some kind of "diploma" as a proof of membership (equivalent to RINA, SNAME, IMARE, ASNE...)? -- Sasha Jovanovic (salespanac@serbiancafe.com)

Response...

[3 Feb 02] Student membership is available to anyone who is a full-time student, from children up to masters and doctoral candidates. The idea is to reduce the price for people who go to

school full time and therefore do not have a full time job. No proof of student status is required. Your word is your bond. All members receive a certificate of membership when they first join. -- Barney C. Black (Please reply via the [BBS](#))

Student Project - Foil History

[21 Nov 01] I'm a student in Spain, and I'm making my final project. I need information about: (1) History of Eppler foils and his geometry, (2) History of H105 foil, and (3) History of keels of windsurfer boats. Could you help me, please? -- Beatriz Marco Burguete (beatrizmarco@hotmail.com)

Response...

[25 Nov 01] Richard Eppler was a professor at University of Stuttgart, along with Wortmann and Althaus. You might say that Eppler was the theoretician, Althaus was the experimentalist, and Wortmann the applied designer because Wortmann designed many successful sections using [Eppler's computer code](#), and Althaus did the wind tunnel testing published in the Stuttgarter Profilkatalog. (Althaus, D., Wortmann, F.X., 'Stuttgarter Profilkatalog 1', F. Vieweg, Braunschweig, 1981.) However, Eppler was more than just a theoretician, having designed the world's first fiberglass sailplane, the *PHOENIX*. Try http://www.aae.uiuc.edu/m-selig/ads/airfoil_references.html for additional information. Together, the three of them revolutionized modern airfoil design and established the practice of using an inverse computer code to calculate the shape of an airfoil from its required aerodynamic characteristics, so as to create an airfoil precisely tailored for each specific aircraft design. The H105 section is my own design (data and coordinates at <http://www.nasg.com/afdb/index-e.phtml>). It started with correspondence between the late [David Keiper](#) and myself. I offered to design a section for Keiper and pay for the die if he would have extrusions made for use in his catamaran hydrofoil kits. I was looking to get some experimental feedback on the design. I intend to build an ocean-going sailing hydrofoil loosely based on Keiper's [WILLIWAW](#) (For details, see my paper: <http://www.basiliscus.com/CSYSpaper.pdf>), and I will probably use the H105 for my hydrofoils. The requirements for the H105 were:

- to be able to operate at low Reynolds numbers (300,000 and above)
- to be resistant to cavitation
- operate over a wider range of lift coefficients than the Eppler hydrofoil sections
- to have minimum drag comparable to the Eppler sections

My first designs put too much emphasis on high lift. High lift is not as important to a surface-piercing hydrofoil because the craft can operate with a much smaller angle of attack range, changing wetted area to vary the lift instead of angle of attack. The H105 design specifically traded off some high lift performance for better cavitation performance. The good low Reynolds number performance was obtained by using a convex velocity distribution on the upper surface. This was tailored to control the movement of the laminar separation bubble. The result was transition from laminar to turbulent flow in the boundary layer via a short laminar separation bubble that moved smoothly to the leading edge as the angle of attack increased. This allowed long runs of laminar flow at low lift coefficients, but ensured that the boundary layer was

turbulent at high lift coefficients, and eliminated the laminar separation which caused the sharp stall in the Eppler hydrofoil sections at low Reynolds numbers. Compared with Eppler's hydrofoils, my section is slightly more prone to cavitation at medium lift coefficients, but has better high lift and low Reynolds number performance. At low lift coefficients and high speeds the performance is nearly equal between the two. See [the CSYS paper](#) for a more detailed comparison. The emphasis on low Reynolds numbers was so that I could build a subscale model of the cruising hydrofoil and still obtain valid data. A section that is designed for low Reynolds numbers will generally work well at high Reynolds numbers, but one can rarely operate a section much below its design Reynolds number range. So by designing a section that would be suitable for the model, I created a good all-round section is not as critical as the Eppler hydrofoil sections. -- Tom Speer (me@tspeer.com) website: www.tspeer.com

Kart Engine Utility

[11 Nov 01] I am considering building a hydrofoil as a university project and I've already been looking into some of the practicalities. Today I have mostly been considering how to power a small hydrofoil and looking at lots of engine and propeller websites. One option I've been looking at is the widespread availability of Kart engines. Do you think a 28HP Kart engine could be geared down to provide propulsion for a lightweight hydrofoil say 12-15ft in length? It just got me thinking because kart engines are very lightweight and also surprisingly cheap. -- Mark Landers (mark.landiers@baesystems.com)

Hydrofoil-Assisted Take Off for Flying Boat

[1 Nov 01] I am student at the University of Southampton studying Aerospace Engineering. As part of our course we have been given a group project in which we are designing an amphibious flying boat. Our initial intentions were to design a 767 sized cargo plane. We then thought of adding a hydrofoil to reduce the takeoff distance. Having looked through your site we were wondering if you could provide us or direct us to where we could find some more detailed information such as different designs of hydrofoils and typical takeoff speeds of hydrofoils. -- Andy Fidler (fidler81@hotmail.com)

Responses...

[3 Nov 01] The most recent example of hydrofoil-assisted takeoff for aircraft that I know of can be found in *Air Progress Magazine* of Feb 1968. There is a cover photo of the magazine and an abstract of the article on [Popular Magazines page](#). The article has some good photos and technical info. You may be able to find some additional info about other experiments of this type on the [NACA website](#)... they have archived many hundreds of technical reports that are searchable by key word. A couple of other sites with some history: "[A History of Sea - Air Aviation: Wings Over the Ocean Part Three](#)" by John M. Lindley and www.curtisswright.com/history/1908-1919.asp -- Barney C. Black (Please reply via the [BBS](#))

[11 Nov 01, updated 10 Mar 02] I am providing the details and a short summary of a paper on "Sea Loiter Aircraft: Papadales, Basil S. Jr. (DTNSRDC) 'A Review of Sea Loiter Aircraft Technology', AIAA / SNAME Advanced Marine Vehicles Conference, Arlington, Virginia,

September 20-22, 1976. Paper No. 76-876. The interest in sea loiter concepts, namely aircraft that could float on the sea surface for extended period including in moderate sea state conditions, was prompted by their potential for extended time on station for such roles as Anti-Submarine Warfare (ASW), Command, Communications and Control (C3), and Strategic Deterrence. The paper reviews past work in the areas of take-off and landing hydrodynamics, sea loiter hydrodynamics (ie floating motion behaviour), and propulsor-water interaction (spray generated from aero propellers or jets). About two pages of the 11 page paper are devoted to reviewing previous work with hydroski or hydrofoil equipped sea planes. With the exception of the XF2Y-1 Sea Dart jet aircraft with hydroskis, all the other hydroski or hydrofoil test aircraft appear to be those described in the February 1968 issue of *Air Progress* you have already noted. The paper mentions hydroski tests on a Lake LA-4 amphibian aircraft (see attached photo) in which four configurations of hydroski were tested, and it is in these tests that it was found that the aircraft could operate in waves three times higher than the basic hull. The first modern application of supercavitating hydrofoils to a seaplane was on a Grumman JRF-5G Goose (see attached photo) which utilised the Grunberg foil configuration with the foil slightly aft of the aircraft centre of gravity and two small skis located forward of the bow. The skis served to trim the aircraft prior to lift-off and to prevent diving. The stainless steel foil had a loading of 1270 psf at full gross weight. Directional and lateral instability was encountered during planing and this created serious take-off problems. Further research on the concept was terminated. In 1966 the Thurston Aircraft Corporation modified a Lake LA-4 amphibian to employ a retractable supercavitating surface piercing hydrofoil. This had a loading of 3310 psf at full gross weight. The foil was a 6.25 degree aluminium wedge. It showed a 70% reduction in landing impact loads and a 30% reduction in take-off time could be gained with the foil and that it had a significantly better performance than any ski configuration. Other hydrofoil related references cited are:

- 'Preliminary Design Data for Water-Based Aircraft with Hydrofoils or Skis', Martin Company Report ER 9433, June 1957.
- Vagianos, N.J. and Thurston, D.B., 'Hydrofoil Seaplane Design', Thurston Aircraft Corporation Report 6912, May 1970.
- Vagianos, N.J. and Rhodes, W.B., 'Evaluation of the Hydrodynamic Characteristics of the JRF-5G Hydrofoil Seaplane', NATC Technical Report FT2121-35R-65, July 1965.
- Thurston, D.B., 'Flight Test of the Hydro Research Vehicle HRV-1 Equipped with Hydrofoil No.1 on Strut No.2', Thurston Aircraft Corporation Report 6702-3, February 1967.

-- Martin Grimm (seafite@alphalink.com.au)



LR-4 With Hydroski



JRF-5G with Hydrofoil

Planing Sailboard

[10 Aug 01] I am from the University of Natal and need assistance on the theory of planing. I am doing a dissertation on the hydrodynamics of planing sailboards. If you have any information on this it would be greatly appreciated. Would a copy of the 1994 Shanghai Conference proceedings be of any use? -- Gordon Cook (981189683@stu.und.ac.za)

Responses...

[10 Aug 01] Try the following two websites:

- <http://naca.larc.nasa.gov/reports/1958/naca-report-1355/>
- <http://personal.inet.fi/private/muu/plancat.htm>

Tom Speer (tspeer@tspeer.com) website: www.tspeer.com

[13 Aug 01] Planing theory has been covered in depth by many papers authored by Dan Savitsky at Stevens Institute. "High Speed Small Craft" by Peter Du Cane (Temple Press, London - 1964) is a good reference. The Heller-Jasper paper on this subject is a classic (SNAME, late 50s I believe). Joe Koelbel has also published some good basic small planing craft design guidance - in papers and magazine articles. -- Ken Spaulding (secretary@foils.org)

Patrol Boat Foil Design, Student Project

[15 Jan 01] I am a senior naval architecture student and for my final design project I am attempting to design a hydrofoil patrol boat. I was wondering if you knew of any papers on the design process on deciding foil shape, size, placement, etc. Thank you for any help you can give me. -- Earon S. Rein, MIDN USN (m015346@nadm.navy.mil)

Responses...

[15 Jan 01] I assume you are aware of the model of a HYSWAS design built by the Naval Academy and testing of same in the tank. See John Hill, if you haven't. I was there last Thurs to see it running. The Hydronautics Report TR-463-1 we sent you should be good for a conventional hydrofoil. Hope you can work your way through it OK. Some years ago we did a design of a HYSWAS Patrol craft for the Coast Guard. It was about 235 tons with long range and excellent seakeeping characteristics. -- John Meyer (president@foils.org)

[18 Jan 01] For my final year project at university I also worked on a patrol boat design but didn't want to try to develop a hydrofoil design as a student because I thought it would be too hard to do! I left my hydrofoil interest for a separate thesis project that looked specifically at the heave and pitch motions of a surface piercing hydrofoil in waves. In hindsight, I wish I did do a hydrofoil design as a project as well! At the time I worked on the thesis I collected a number of papers dealing with general hydrofoil design and foil layout. While I didn't need to apply most of those papers in my studies, here are some which may be useful for your design project:

- Walderhaug, H.Aa., "A note on seakindliness of hydrofoil vessels as influenced by foil characteristics and centre of gravity position.", I believe this was published in International Shipbuilding Progress but can't be sure.
- Pascoe, Norman P. and Hobday, A.W., 'A theoretical study of the relative behaviour of three fully submerged hydrofoil configurations with regard to dynamic longitudinal stability and incidence-cavitation boundaries', Hovering Craft and Hydrofoil, Vol. 2, No.1, pp31-35, October 1962.
- Jewell, D. A. "Hydrofoil Performance in Rough Water", Paper presented at AIAA/[SNAME](#) Advanced Marine Vehicles Conference, San Diego, CA, February 25-27, 1974.

Before reading those more detailed papers, I suggest you get a good overview of general hydrofoil design considerations but also including foil size and layout considerations by looking though the following books or journals listed on the IHS website:

- Hook, Christopher and Kermode, A.C., Hydrofoils - Without Formulae Series (No. 16?), Pitman Paperbacks, Sir Isaac Pitman and Sons Limited, London, 1967.
- Du Cane, Peter High-Speed Small Craft , David and Charles (Holdings) Limited, Devon, 1974, Fourth Edition, Chapter 3, pp 12-54, Eames, M.C., "Principles of Hydrofoils."
- Naval Engineers Journal, Volume 97, Number 2, February 1985. ISSN 0028-1425. Published by the American Society of Naval Engineers, Inc. (ASNE). This special edition features comprehensive reviews of a range of "advanced naval vehicles," including hydrofoils.
- Crew, P. R., "The Hydrofoil Boat; Its History and Future Prospects." Quarterly Transactions, The Institution of Naval Architects, Vol. 100, No. 4, October 1958 gives good background information.
- Bakken, Sigmund and Merritt, Richard G., "Hydrofoils - ideal for the North Sea", Navy International, Vol.82, No.3, March 1977 compares the seakeeping performance, namely sustained speed versus wave height, of hydrofoils with conventional naval surface ships.

There are also a number of previous questions and answers concerning foil design on the website which may assist you. Before considering the foil layout you also need to decide whether you want to develop a fully submerged hydrofoil design or a surface piercing design. The US navy hydrofoil developments culminating in the PHM were almost exclusively of the former type, though surface piercing hydrofoils were also operated by some navies mainly as coastal patrol craft. Examples of the latter are militarised Supramar / Rodriquez PT 20's and also Chinese patrol hydrofoils. The Canadian ASW hydrofoil (items 13, 17 and 18 of the IHS website deal specifically with this) was more of an ocean-going surface piercing hydrofoil design. Surface piercing hydrofoil designs are generally naturally stable in heave, pitch and roll. Fully submerged hydrofoil designs are reliant on autopilot controlled flaps etc to remain stable. If you are seeking good rough water seakeeping characteristics, I would suggest you opt for a fully submerged hydrofoil design with an autopilot system for maintaining the attitude of the craft as these are generally regarded as having better seakeeping performance than similarly sized surface piercing hydrofoils. I don't think you will be in a position to develop the autopilot design as part of the design project unless you are a real whiz kid. I think it would be sufficient to try to perform a resistance estimation for the craft from hullborne to foilborne condition as part of the project and assume that with a foil layout similar to other past fully submerged hydrofoils that it will somehow be possible to develop a satisfactory control system around it to keep the boat stable in waves. I don't know what size or capability of hydrofoil you are thinking about for your project but if I were in your shoes, I would probably search for any literature on the USN *PEGASUS* class Patrol Hydrofoils (PHM) and adapt your design from that! After all, naval architecture is an evolutionary rather than revolutionary business! -- Martin Grimm (seafite@alphalink.com.au)

Follow Up Question...

[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) I'd love to hear it as well. -- Earon S. Rein, MIDN USN (m015346@nadm.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)

The Future of Hydrofoils, Student Project

[12 Jan 01] I'm working on assignment on sea transportation. I really hope you will be able to help me out. What I was wondering is if you know who builds them, for whom, why do we need them, how are they made, where, when and the future? If you don't know these things, do you any good sites that I could find them out? I have had horrible luck finding any information on both the Internet and encyclopedias. -- Stephen Aiken <saiken@attcanada.net>

Response...

[12 Jan 01] I suggest first that you read the [Regional Ferry Plan San Francisco Bay Area - Final Report](#). Also, I have sent you a paper called Defining a Ferry Business. These sources will give you the idea of the various issues involved and the analysis required. As to manufacturers, look on the [IHS links page](#). Also look at the [BBS page](#). In the USA the "buzzword" for transportation design is "Intermodal" i.e. in designing systems for the transportation of passengers and freight, one mode of transportation can feed into or draw from another... the routes are coordinated, and the interfaces are compatible and optimized. The USA funds research and demonstration projects to promote this concept. For more info, search the internet for "TEA-21" and "ISTEA". If you have specific questions after reading these sources, please send them to me by email... the more specific you can make your questions, the better chance you have of receiving a useable answer. Also, look at [the FAQ page devoted to student projects](#) and feel free to correspond directly with anyone there you think might be of help to you. -- Barney C. Black (Please reply via the [BBS](#))

[18 Jan 01] I think there definitely are niches in which hydrofoils are the best craft for the application. The PHMs and other hydrofoils have shown how seaworthy and fast a small ship can be, and there will be future roles requiring such performance. Hydrofoil-assisted catamarans have shown how great a boost in speed can be obtained by adding a foil or two, as compared with just adding more power. The large number of surface-piercing hydrofoils operated on rivers and lakes in Russia and elsewhere have shown their comfort and reliability and good performance for a relatively low cost. It's a bit of a mystery to me why more companies requiring these kinds of performance aren't choosing hydrofoils. It's probably due in part to a misperception that the cost has to be high, or that the hydrofoils and control systems must be complicated and therefore insufficiently rugged. At this point I think I see a new reason for considering hydrofoils: the growing concern about wake and wash produced by fast marine vehicles. I think hydrofoils can naturally produce less wake and wash, with their energy going mainly into underwater turbulence rather than into surface waves. (What the negatives may be from that I'm not sure -- someone will think of a bunch, no doubt.) As for size, when we had our IHS panel discussion on the future prospects for hydrofoils, on the occasion of the IHS 25th anniversary, we reached a consensus that about 1500 tons seemed to be a practical upper limit. The upper limit on speed was set by foil cavitation and was thought to be about 55 knots or so, I think -- although more recently there has been comment about 70 knots being attainable. -- Bill Hockberger (hockberg@erols.com)

Model Sailing Yacht

[5 Dec 00] I am studying A-Levels in England at the moment and for my main project I'm building a model yacht (monohull). It is for a competition run by Strathclyde Uni. in Glasgow. There are few design restrictions and having spoken to the university I have confirmed that I can have a hydrofoil design. The restrictions that I have are as follows: Max LOA: 700mm, Max Draft: 300mm, Max Mast Height: 900mm, Min Mass: 2kg, Max Sail Area: 2000mm², Keel bulb must be no more than 55% of total mass, must be monohull in the true sense of the word. I was thinking of having a 'Y' shaped keel with the diagonals as hydrofoils as I can only have one keel. What I need is, one: Will it work? and two, What kind of hydrofoils should I use for the best results, if any. -- Philip Eltringham (phill_eltringham@hotmail.com)

Hydrofoil Construction Methods and Materials

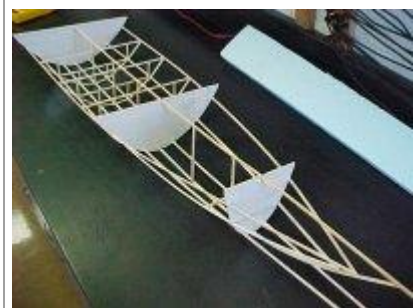
[19 Nov 00] I was wondering if it was possible for you to send me some information on the construction of hydrofoils. I am doing a college term paper on the construction of hydrofoils and I am having some trouble finding information on that topic. I'm mainly looking for material specs, type's of steel used to reduce weight, propulsion systems, foil systems, welding techniques, and hull considerations. I checked out the webpage and saw all the basic constructions but, if possible, I need some more specific information. -- Matt Ferruccio (matt300@hotmail.com)

Response...

[19 Nov 00] There are three pages of hydrofoil references accessible from [the main page](#) of our website: [Technical References](#), [Popular Magazines](#), and [Popular Books](#). Most of these are out of print, but many can be found in libraries, book sales, online auction sites, especially [Ebay](#). -- Barney C. Black (Please reply via the [BBS](#))

Student Project, Grade 12

[11 Nov 00] I was wondering if you could give my partner and me some tips or problems that might occur when building a hydrofoil boat. My partner and I are building a model hydrofoil boat for a physics project at school. It will be powered by 2 airplane engines. The hull structure is 36in long and 9in wide. It will be covered by thin sheets of wood, which will be coated with a special waterproof paint. Our hydrofoil concept design is a bit different compared to the one you did. There will be wings that extend directly from the port and starboard side. Directly below the end of the wings, will be the hydrofoils themselves. We are wondering whether this is a good design for a hydrofoil boat. How would this compare to other hydrofoil designs? -- Chris Chang and Warren Pringle Grade 12 (Christopher_Chang@sac.on.ca)



Hydrofoil Amphibian - Student Project

[11 Nov 00] I am an graduate student from India pursuing a project on creating a amphibian craft... a vehicle that can move both in land and water. After a wide area of thought we have considered using hydrofoils with wheels at the bottom to enable us to have not only a large wheel clearance but also lesser drag in the water. I would like to know if there is any information regarding such a project anywhere else in the world. -- Janak (ragus@netcracker.com)

Response and follow-up...

[11 Nov 00] In the 1950s and 1960s, the US Army, Navy, and Marines all experimented with hydrofoil landing craft. Some of these were amphibians, specifically: the DUKW (by AVCO Lycoming and Miami Shipbuilding Corp for the US Army) , LVHX-1 (by AVCO Lycoming for the US Marines), and LVHX-2 (by Food Machinery Corp for the US Marines). Photos and more information about these vessels can be found elsewhere on our site, specifically in the [History of Miami Shipbuilding Corp \(MSC\)](#) and in the [1950s section of the Photo Gallery](#). -- Barney C. Black (Please reply via the [BBS](#))

[18 Nov 00] I would like to know what difficulties were experienced, for such crafts seem to have completely vanished. Then too, the 1960s is a very long time ago. The DUKW and the LVHX2 both seem to have either retractable hydrofoils or fixed ones, the wheels being extendable. I was wondering if we could place the wheels directly onto the hydrofoils. That would give the rider a perfect birds eye view . Although such a craft would not be very road friendly, they would definitely be very useful near the shore and on the beach. Another idea was to use non submerging fans, like the ones used on hovercrafts for propulsion. That would enable us to have free moving wheels. If the wheels were also submerged, there would be no necessity for separate rudders, the wheels may itself act as rudders. That will help simplify mechanics. For added stability at low speeds, we are also thinking about using a trimaran type hull. Please let me know what you feel about these ideas. Knowing what went wrong with the 1960s projects may help us. We hope to first start with making a scale model. -- Janak (ragus@netcracker.com)

[19 Nov 00] The DUKW and LVHX craft were successful, although they were mechanically very complex and heavy for their payload capacities. Their amphibious capability is greatly exceeded by Air Cushion Vehicles (ACVs). Use of a trimaran hullform will add stability and reduce powering requirements. The design challenge is to obtain satisfactory cargo volume on a trimaran center hull that is more slender than a monohull of equal full load displacement. -- Mark Bebar (bebar@foils.org)

Drag Testing of Hydrofoils

[21 Nov 00, updated 2 Dec 00] I am currently working on a project that deals with tests the drag produced by two different hydrofoils. One would be a conventional hydrofoil and the other would be modified so that an electric field is produced (interacts with ions in the water). I am a Georgia Tech Aerospace Engineering student. We are currently working on presentations in a fluids laboratory and everyone has been assigned a topic. My topic deals with these two hydrofoils and the goal is to come up with the best experimental technique and present it to the

class. I found some info on the David Taylor Model Basins and they seem like a great idea for testing hydrofoils. It does not, however, elaborate on what type of measuring equipment is used. I'm only familiar with equipment used along with wind tunnels (i.e. LDA and PIV systems). Do you have any information on what equipment can be used to measure drag and investigate the boundary layer in water facilities? . I appreciate all of the feedback from members of your society and welcome anymore as it comes available. -- Lauren Ihrig (Lauren_Ihrig@excite.com)

Response...

[23 Nov 00, updated 2 Dec 00] I am very curious as to what prompted you to ask the question to include a hydrofoil with an electric field. There is good info on the reason for the electric field on [a website entitled Control of Flow Separation in Weakly Conducting Liquids by Means of Electromagnetic Forces](#). The articles on the site show very good improvements in foil flow separation and therefore drag reduction, and lift improvement. Question is how practical is it, how much electrical power is required, and a host of other questions and clarifications. Have you access to any technical papers on theoretical or experimental work along this line? Are they available to us? Wouldn't the tests have to be carried out in salt water? If so, tank tests are out. Testing of the foil system with and without the electric field would have to be done from an instrumented vehicle in a protected bay under calm conditions. Both lift and drag would have to be measured because the important issue is lift to drag ratio. This would not be the first time foils have been tested in open water. -- John Meyer (president@foils.org)

[23 Nov 00] Just based on fundamentals, I suppose that there might be a problem. Lift and drag are functionally related so I imagine that if this EM field method would reduce drag it would also reduce lift. Jim King (KingJH@nswccd.navy.mil)

[2 Dec 00] I don't know what is meant by an "electric field is produced (interacts with ions in the water)". There's been some work done on electromagnetic turbulence control where local EM fields have been produced that interact with the boundary layer (in sea water) to produce a Lorentz force. If done correctly this has been shown to lead to substantial reductions in friction drag. Scaling to high Reynolds numbers hasn't been demonstrated although DNC computations suggest it should work. DARPA had funded some work in this area that was mostly proprietary. NUWC has done some work and could likely provide some published data that could be forwarded. In response to the comment about this affecting lift, the phenomena I described above all takes place in the boundary layer so lift is (to first order) unaffected. -- Stan Siegel (stansiegel@aol.com)

Hong Kong Hydrofoils

[8 Sep 00] I have a couple of questions that your page does not answer. I've lived in Hong Kong, and I've seen the hydrofoil ferries, they looked pretty big (at least 500 tonnes) to me. Yet somewhere on the IHS page, it says those only weigh 35 tons. So I'm wondering if you know their displacement, and whether or not there had been a missing zero. With the current technology (composite material, new turbine engine, etc.), what is the maximum speed, weight and range for an hydrofoil? And what will the fuel economy of this ship be like, e.g. how many passengers can it take? (in other words, is it possible to build a 1000-tonne ship with max. speed

of 60 knots that can go for 500 miles at 40 knots, and the ticket still cost half those of a jetliner? -
- Kenneth Chan (panzerkommand@hotmail.com)

Response...

[8 Sep 00] Maybe the hydrofoil ferries you saw looked big, but they weren't 500 tons. The largest hydrofoils to date were the Russian military built *BABOCHKA* at 400 + tons, and the US Navy built *PLAINVIEW* at 315 tons (long time out of commission). On the other hand, 35 tons would be a very small hydrofoil. You probably saw the Boeing built Jetfoil, which is about 100 tons. There are pictures on the IHS web site Photo Gallery. As to 1000 tons? That would take some doing and a VERY large investment. Also it would be more state of the art to stay with 50 knots and under. The 500 n miles at 40 knots should be no problem with hydrofoils 150 tons and up. Range is tied to payload or passengers carried, and one would have to set up a calculation to figure this all out. -- John Meyer (president@foils.org)

Student Hydrofoil Project

[31 Aug 00] I am doing my Mech Eng. final year from V.I.T. under Pune Univ. As a part of curriculum, we have to present a seminar. I am very much interested in "Hydrodynamics" so I selected my topic as "Hydrofoils". So could you please e-mail me the detailed info about Hydrodynamics giving stress on basics, mathematical relations, etc.? -- Suraaj Doshi (suraaj_doshi@rediffmail.com)

Observations About Marquette's Solar Powered Hydrofoil

[6 Mar 00] I was at the Solar Splash competitions against the Marquette boat. It was a good concept and based off of one of the entries by Kanazawa Institute of Technology, Japan. The only ironic thing is that the boat did better without the foils than with them. I have seen them race that boat 4 times and every time they had the same problems, dynamic stability when on foil. On the flip side the Kanazawa boat had a stability system that was rock solid. As a monohull alone the Marquette boat did fine though, in endurance. Most of the slender monohull types didn't fare well in the sprint competition. If you want the hands down overall best design look at the KIT boat. Check out the [Solar Splash Site](#) . Over all, Marquette has probably one of the better all around teams at the competition. They regularly support multiple boats at the competition. Something that no other school does on a regular basis. Their entire university on the whole does a great job supporting the tech project cause. The tech teams are an active part of their curriculum. They are also one of the major reasons for the existence of the competition as they have been the host of the event since its inception. -- Anthony Scott Daniels (adaniels@engin.umich.edu)

Cavitation

[25 Feb 00] I'm a French student working on a project, and I'm searching information about the phenomenon of cavitation or ventilation that occurs when a boat lifted with foil goes fast enough. Is there any solution for those problems, or could anyone tell me something about the subject? -- L. Pério (loicmush@easynet.fr)

Spanish Student Develops a Project

[18 Feb 00] I am a Spanish student of naval engineering, and I want to do my final degree project about a hydrofoil. But I don't know how and where I can start to do it. Could you guide me in this work? Could you advise me how I can do it and from which books can I get this information? -- Belen Vega Mesa (bunny_d@email.com)

Response...

[18 Feb 00] Please spend some time exploring our website, including the sections on links, references, and frequently asked questions. Then, if you have specific questions, IHS can find a better answer for you. Your question is so general that I can provide no better answer. After all, a hydrofoil could be a radio-controlled model weighing a few pounds up to a ferry or warship weighing hundreds of tons. Choices of power range from human-powered, to motor driven, to sail powered. As you realize, there is a variation in the information needed, depending on details of the hydrofoil that interests you. Note also that student membership in IHS costs only \$US 2.50 per year. [Click Here](#) for information on how and why to join. -- Barney C. Black (Please reply via the [BBS](#))

Solar Powered Hydrofoil Design Info Wanted

[19 Jan 00] I am a senior engineering major at Cedarville College. Part of my senior year is being devoted to developing a hydrofoil system for a solar powered boat. I am trying to research the pros and cons of a fully submerged system versus a self-stabilizing design. My Senior Design Team is modifying a 19' canoe type hull to enter the Solar Splash competition. Our hope is to put hydrofoil on the boat in a manner that gives us the least amount of drag, adequate maneuverability, and good stability. Let me clarify my design constraints: Directly from the website: SOLAR SPLASH is the World Championship of Solar/Electric boating. It is an international intercollegiate competition which takes place over five days. The first two days are Technical Inspections and Qualifying and the final three days are on-the-water competitions. Points are awarded in 6 events including the newest which is called the SOLAR SLALOM. The various events stress system design and both short distance speed and long distance endurance. The Event this year will be held in New Orleans, Louisiana. SOLAR SPLASH is a practical educational experience which helps to develop teamwork and inter-disciplinary skills. In recent years, a few highly qualified High School teams have joined the Event as a natural educational path from secondary school to college. The Event combines the fun of competition with education in a way which is not a major disruption to the student's academic schedule. The project can be accomplished at a relatively low cost. Feel free to look around on www.sunrayce.com for information about solar splash as well as other competitions. You can also check out www.cedarville.edu/student_org/solsplsh/ and find out about Cedarville's past team and sponsors. It has not been updated for this year yet (2000 team). Would you be able to provide me with any information about various design concepts and their various characteristics? Perhaps there is a website featuring your papers and articles that I could reference? I would be grateful for any aid that you could provide. -- Derek Chandler (S1178082@cedarnet.cedarville.edu)

Response...

[21 Jan 00] I strongly recommend a self-stabilizing (surface piercing) foil system. Fully submerged requires technical sophistication (height sensors and automatic control system) that are not warranted for a recreational hydrofoil application. -- Mark Bebar (bebar@foils.org)

2nd Response...

[21 Jan 00] I am afraid I must respectfully disagree with Mark Bebar here. Fully submerged hydrofoils need roll control and height control systems, but control systems are now so small and cheap that I feel that the benefits outweigh the costs. Fully submerged hydrofoils have better seakeeping than surface-piercing systems. On surface-piercing hydrofoils it is often necessary to have the foils set very far apart to give enough roll stability, while fully submerged foils can often be kept within the hull width. I would like to know more about what sort of boat you will be making. I think that one of the biggest problems will be getting enough power to overcome hull drag at take-off. Here the foil design is of little importance, except in the take-off speed required. -- Malin Dixon (gallery@foils.org)

3rd Response...

[18 Feb 00] I worked on the Massachusetts Institute of Technology *DECAVITATOR* project, and I just wanted to respond to some of the questions that were being raised.

- We tried for 2 years to use a surface piercing V foil on our project. The obvious advantages of this configuration are automatic depth and roll stability. However, we found that there was no way to control ventilation. We tried fences and dramatic sweep angles with no avail. If you have lots of power to spare, then just plan on the foil cavitating all the time. Of course, with human power, we didn't have this luxury. We ended up with a large and small foil directly under the pilot. The large foil could be retracted at higher speeds.
- Pitch stability came from the skimmer/small horizontal surface in front. Having one on each pontoon gave us enough roll stability by required serious bracing to keep the pontoon/cockpit frame rigid enough. The pilot controlled depth with a lever that set the angle of attack of the main foil.
- We used a 3-axis CNC machine to make our foil molds. The foils themselves were solid carbon fiber.
- Sizing the foils is pretty complicated. You have to be able to go fast enough to 'take off', but you don't want them so big that your top speed suffers. There is a lot more information about our design available at: <http://lancet.mit.edu/decavitator/>.

I hope this helps. -- Marc Schafer (spaceboy@sgi.com)

More Responses...

[1 Mar 00] Regarding difference in surface-piercing foil effects on propulsion: This of course relates to lift/drag ratio for the particular size foils you would be using and the speed you will be

running at. I and most of the hydrofoilers have dealt with much larger weights (like tons instead of pounds) than you are concerned with. There is an impact of the small scale you are designing with which I have had very little experience, but you can probably expect a small larger difference in power required from the surface-piercing foil. I would still like to know how much power you expect to be able to put into an electric motor from the sun. What efficiency do you expect from the motor and prop? What is total weight of craft? Will it be manned? How fast do you expect it to go? It sounds like some students worked on this before, so you should have this information. -- John Meyer (jmeyer@erols.com) ; [1 Mar 00] I would intend to agree with John on drag differences - it will depend on the number of elements in the surface piercing foil geometry. Doing a quick wetted area comparison might tell you something. A fully submerged system will generally yield a higher aspect ratio foil overall which should have a better lift/drag ratio. -- Mark Bebar (bebar@foils.org)

Follow-Up Question...

[18 Feb 00] Would a hydrofoil system consisting of a fully-submerged rear hydrofoil and a surface piercing front foil be subject to porpoising? Would the surface-piercing foil naturally damp that out? -- Derek Chandler S1178082@cedarnet.cedarville.edu

Responses...

[18 Feb 00] I see no reason that such a system would be prone to porpoising. There will be an influence based on the weight distribution. Will you have an airplane configuration with a majority of the craft's weight on the forward foils or a canard arrangement with most of the weight on the aft foils? One of the issues with an airplane configuration is making sure the aft system has enough weight on it to keep the foil fully loaded. Also, how do you intend to maintain control of the aft foil submergence? -- Mark Bebar (bebar@foils.org)

[18 Feb 00] I realize this is a far cry from a solar powered hydrofoil, but you might find it interesting to know that a combination of surface- piercing and fully-submerged foil has been done before - by the Russians. Here is an extract from my book, *Ships That Fly* about the *SARANCAHA*. I'm also attaching a two-view drawing. However, for a solar powered hydrofoil with severe weight limitations, a surface-piercing system for and aft (without the need for an automatic control system) would be preferred in my mind. Please tell us more about the size of the vehicle that you plan to build. How much power are you counting on from the sun? We would like to hear more about the project which might make a good article for the IHS Newsletter. -- John Meyer (jmeyer@erols.com)

[25 Feb 01] As well as the large Russian *SARANCAHA* hydrofoil, towards the other end of the size scale the 11.45m long Supramar PT 4 hydrofoil with a passenger capacity of around 12 was another example of a hydrofoil craft with a surface piercing bow foil and fully submerged aft foil. There is a photo of one on the IHS website. -- Martin Grimm (seafite@alphalink.com.au).

Student Project in Glasgow

[24 Dec 99] I am a student of Naval Architecture at the University of Strathclyde in Glasgow, Scotland. My current final year project involves the design of a detachable hydrofoil kit for the Hobie 16. I wondered whether you currently have overseas members, and also whether I would be able to gain anything toward this project by joining the International Hydrofoil Society? Furthermore, I wondered if there may be any opportunities opened up by joining the society, for work as a trainee naval architect when I graduate, with any companies currently involved in the design and/or production of sailing hydrofoils? I also hope to be able to offer a new invention as an addition to the aeroplane configuration, which I am currently developing, which I hope will further smooth out the wave interaction characteristics of the aeroplane configuration. I feel that the IHS would be a good starting point to look for some partnership from an experienced foil designer, who may be able to aid me in the development of this device as a saleable product. -- Michael Mirfield (michael@mmirfield.freereserve.co.uk)

HYDROPTÈRE Lessons Learned

[13 Oct 99] I'm a French student in classes which prepare me to become an engineer, and I have to search information about the hydrofoil system of *HYDROPTÈRE*. I already checked out the hydroptere homepage, but I couldn't find what I was really searching for: technical graphics and explanation of the system. I'm looking everywhere for scientific studies of the foil and the detail of how in hell it's working!!:) What I'd like is: (1) equations, (2) hydrodynamics lessons, (3) in-depth explanation of the phenomena. I'm looking forward to get this important information within the month. -- loicmush@easynet.fr

Solar Powered Hydrofoil, Student Project

[26 Sep 99] We are mechanical engineering students at the College of New Jersey and are currently working on a hydrofoil design for a monohull solar powered boat (approximately 16ft long, 2ft wide). We are starting the calculations but are a little confused on where to start. If we know the approximate velocity, weight, and power, what calculations can we use to determine the size of the hydrofoils. Also are there any good software programs out there that might help us in our design. -- Gregg Bonstein (bonstei2@tcnj.edu) and Mandy Newman (newman@tcnj.edu)

Propulsion System For Solar

[19 Aug 99] I'm a Mechanical Engineering student at the College of New Jersey and I'm helping design and hopefully build a solar electric boat. My personal design is of the propulsion system. I'm looking into counter rotating propellers in a sleeve (a sort of jet propulsion system) but I'm not sure if this system would greatly increase efficiency at such low speeds. We (as a team) are at the primary stages of our design and would greatly appreciate any advice, brochures, technical documents, etc. that may help us in our project. -- Oliver Cueff (cueff2@tcnj.edu)

Response...

[23 Aug 99] The least expensive and most available CR propellers are available from Volvo Penta on their outdrive units. These are relatively simple designs that might be adapted for your application. You will need to look at the mechanical losses in such systems as they are designed

for much higher powers than you will have in a solar application. You may not see a big gain in propulsive coefficient in this low power application since there is not much swirl in the wake of a relatively large diameter low speed propeller. Whatever gains may exist could be offset by mechanical losses in the CR drive. -- Mark Rice (mrice@mapcorp.com)

Hydrofoil Efficiency

[7 Aug 99] As a part of my engineering degree I am conducting a study into "greener" transportation. Do you have any information to support any claims that hydrofoil boats could be more efficient than a boat without hydrofoils? The type of information I would be interested would be power loadings and travelling speeds for the 2 types of boat with the same load so that a direct efficiency comparison can be made. It seems that most boats with hydrofoils are built for performance and not efficiency. I am wondering whether with the underside of the boat lifted out of the water it may be that drag could be reduced to use less fuel. -- Martin Crotty (martin.crotty@balliol.oxford.ac.uk)

Response...

[7 Aug 99] Sorry, but there is no free lunch. Best ship efficiency is a huge length-to-beam ratio... slo-o-o-w, make that VERY SLOW ship (e.g. supertanker). Although hull drag on a foilborne ship is low, foil drag (induced, friction, flow, wave, etc., is high). -- Nat Kobitz (Hynat@aol.com)

Building a Bigger Wake. (link only; click here)

Student Project - Foil Calculations

[31 Jul 99] I am a senior at New Jersey Institute of Technology. I am trying to find equations for calculating the most efficient hydrofoil for my senior project, specifically for lifting forces and wave coefficients. Do you know of any book or publication that has these formulas? -- Scott Spinoso (d.spinoso@worldnet.att.net)

Student Needs Advice on Engine Installation Design

[26 Feb 99] I am a student at the University of New Orleans. I'm working on my senior design project. I am interested in knowing more information about the LM6000 Gas Turbine. we are trying to build a fast sea lift with the dimensions of: L=950 ft, D=65, T= 27, B=110, V_k= 36 knots. I chose the LM6000 to be my engine but I have to go from this to sizing the intake and the out take system for the engine and all the Auxiliaries for the ship. I looked all over to see or to have a look at a ship with the LM6000 in it but there was no luck. GE Marine were not that helpful. Please provide me with the information needed to design my machinery. -- Hamad A (SmQQthxyz@aol.com)

Response...

[14 Mar 99, updated 3 Nov 02] First, take a look at the Fast Sea Lift design described by [Chris McKesson](#) at www.hurricane.net/~chrism/sealift1.html (this design uses several LM6000 engines. Then, since you are in New Orleans, how about contacting the public relations departments at Avondale Shipbuilding and also Ingalls Shipbuilding (in Pascagoula MS) to see if they can get one of their engineers to spend a few minutes on the phone with you to help: Avondale Industries, Inc.; 5100 River Rd.; Avondale, LA 70094; <http://www.avondale.com>; Phone: 504-436-2121; Fax: 504-436-5304; Litton Ingalls, P.O. Box 149, Pascagoula, MS USA 39568-0149; Physical address: 1000 Access Road, Pascagoula, MS USA 39567; <http://www.ingalls.com>; Telephone: 228-935-1122; Fax: 228-935-1126 -- Barney C. Black (Please reply via the [BBS](#))

Student Needs Advice For Market Research

[21 Feb 99] Hello, I am a student of Enschede University in the Netherlands and I am currently doing a market research for hydrofoils on (sailing)-catamarans and trimarans. I would like to know some things for which I think at this address I'll get the most response. I trust ;->. In my search for hydrofoils on the market I only found the Hobie Trifoiler and the Windrider. Can anybody tell me how many people sail these crafts in the US (and worldwide)? Are there other manufacturers, because I find two models on a whole world to be very view! From a Duth catamaran-importer I heard that most catamaran-sailers are not too keen on the cockpit-style Trifoiler and Windrider because they don't have to 'work so hard'. Could this be the reason why so few hydrofoils are on the market? Surely, the higher speeds will make up for a lot! Browsing through the IHS-pages I stumbled on the add-on-hydrofoils like the DAK-Hydrofoils. I asked myself whether maybe manufacturers of catamarans offer add-ons themselves, for the types of catamarans they sell. Can somebody help me with an answer to this question? I know some people are making great efforts to construct hydrofoils themselves (Of course for some people constructing hydrofoils may be as much fun as sailing them) but I can imagine that many more people just want to click them on their catamarans and sail away. Would there be many people who are interested in this? *Now for a more technical note:* Going through some patents I saw some interesting hydrofoils, mostly they are surface-piercing or otherwise surface-bound (floaters to control pitch of hydrofoil). Just a few patents had manual pitch-control; for example patent US 4,027,614 by Jones Clyde. I can imagine that with manual pitch drag can be lower because for lower speeds you can choose the pitch to be zero (low drag). When a sufficiently high speed has been achieved the pitch can be altered manually, triggering the lift-working of the hydrofoil. Much better than surface-bound hydrofoils which have more trouble coming to speed before the hydrofoils work as they are meant to work! Are there some drawbacks to the use of these manually-controlled hydrofoils so that not everybody is using this system! Please help me out with any information! Thank you, Piet Kamma (edward@e-co.nl)

Photos, Drawings, and Basics

[19 Feb 99] I need pictures and drawings of water, wind, and human powered hydrofoils as I have to improve on existing designs and then make a model (is it possible to make a functional model because I am already a model aircraft enthusiast and am very interested in hydrofoils). I would like to know about how a hydrofoil works and how the density of the water affects the size of the foils. I would like to concentrate on smaller designs of hydrofoils as my main interest

is to use hydrofoils for recreation purposes. I have already found the drawings on the decavitator and have found them very interesting. -- Mark Manley in Zimbabwe (jamanley@usa.net)

Response...

[19 Feb 99] Suggest you explore the IHS website thoroughly... there is quite a bit of information there. Specifically, try the [photo gallery](#) for pictures, especially the model section. Also, try the [links page](#) to other sites for models, for hydrofoils you can build yourself, and for hydrofoil tutorials. Also, IHS has a tutorial on basics. Multihull Magazine and the Amateur Yacht Racing Society (AYRS) publish technical articles on hydrofoil design, and back issues are available. IHS has a link to them. Also, the IHS site has [lists of popular and technical references](#), books, journal and magazine articles about hydrofoils. Finally, look through [the posted messages section](#) to find people with similar interests as well as answers to frequently (and not-so-frequently) asked questions. -- Barney C. Black (Please reply via the [BBS](#))

[6 Dec 98] I am contacting you regarding membership of your society, with a view to sourcing the latest hydrofoil technology and developments. I am currently studying for a BEng Marine Engineering at Plymouth University in the UK, and am looking for up to date hydrofoil technology information for my final year dissertation. -- Jonathan Morley
jemorley@plymouth.ac.uk or r.morley@virgin.net

[7 Nov 98] I'm studying a degree in product design at Swansea Institute, in the UK, and my final year project is a conceptual jetski based on the hydrofoil. Can you could send me some information on the Yamaha OU-32 hydrofoil jetski or any other info that could help me develop my project? -- Eoin Richard Bailey (P27190@exchange.sihe.ac.uk)

Response...

[24 Oct 02] Yamaha has a webpage devoted to the OU-32. It includes photos and a movie clip. Go to: <http://www.yamaha-motor.co.jp/ep/challenge/expansion/ou32/ou32.html>. - Barney C. Black (Please reply via the [BBS](#)) [*Unfortunately Yamaha updated their website and in so doing deleted the OU-32 information - Webmaster, 9 Sep 03*]

[19 Oct 98] I am a student at the National Institute of Applied Sciences in Toulouse (France) and I am finishing my studies in mechanical engineering. Presently, I lead a project based on the study of wave effects and on the dimensioning of a yacht hull structure for Guy Couach Plascoa. This interesting study leads me to seek an internship in naval design and construction. I will be able to bring you my passion for boats and my specific technical knowledge. Lastly, my working period (internship) would start on 15 June 1999 and will be 6 months long. If you are interested in my proposal, please contact me for a résumé. -- Bertrand LARRIEU (blarrieu@etud.insa-tlse.fr); 116, rue Manon cormier; 33000 Bordeaux ; France; Phone: +33 (0)5 62 17 17 20 (Answer phone); Fax: +33 (0)5 61 55 97 00

Modeling HYDROPTÈRE

[15 Oct 98] Hello I'm a student in model making.I'd like to do the *HYDROPTÈRE* for my end of year project.That's why I need some informations on the subject.I'll be very happy if you could help me. I hope you will answer me. -- Sébastien CLARKE (0951810b@Versailles.men.fr)

Response...

[16 Oct 98] IHS has no information "in house" about Hydroptère. I do know of one website devoted to this sailing vessel. The URL is <http://perso.wanadoo.fr/terrasse.web/>. -- Barney C. Black (Please reply via the [BBS](#))

HYDROPTÈRE Website

[21 Sep 98] I send you this message to give you the address of my web-page about the *HYDROPTÈRE* (<http://perso.wanadoo.fr/terrasse.web>). It's a famous French hydrofoil which was built by Eric Tabarly and Alain Thébault. Please send me your comments! -- Gabriel Terrasse (gabriel.terrasse@wanadoo.fr)

[18 Aug 98] Subject: Can a student cooperate with you? Hello everybody, I am an italian student of mechanical engineering at the University of Modena. During my five years of studing I have been concentrating on structural mechanics, and in this last year I have been dealing with fluid dynamics. In particular I have been working with the software package FLUENT. For my final thesis I would be very interested in working with a project of yours. If there are projects that could be developed and carried out by a young and enthusiastic student, please just send me some more information. -- Paolo Levoni (levolevo73@hotmail.com).

[01 Oct 98] I am doing a dissertation at Liverpool John Moore University on hydrofoils. I would be grateful for any info, contacts, or advice you may have. The following is a draft proposal for the dissertation:

Summary of Aims. 1. Investigate current practice in assessing strength, stability, and performance of sail powered Multi-Hulls. 2. Compare and contrast design and performance of sail powered Multi-Hulls and Monohulls. 3. Determine possible influences of recent European Community Recreational Craft Directive. Examine legislation's assessment of requirements for different EC categories, e.g. Ocean. Offshore, Inshore. Assess the advantages and disadvantages of safety requirements which are specific to Multi-Hulls, e.g. means of escape after capsized. 4. Look at key variances, between standard and assumptions used for sail powered craft and commercial vessels. Examine the rationale behind these variances. 5. Examine how European, United States and other nations standards may vary, and the implications of this. 6. Many Multi-Hulls are built by amateurs for their own use. Determine what influence legislation may have on them.

Summary of Proposed Work: 1. Obtain technical data and relevant information from specific craft, books and journals, ECRC Directive, Multi-Hull designers, Clubs and Societies, and

Underwriters. 2. Compare and contrast data from above sources. 3. Apply this information to the six aims of the project. 4. General Conclusions. 5. Identify areas for further investigation. -- Chris Edgar(ETMCEDG1@livjm.ac.uk)

[29 Jul 98] This is a request for help on behalf of Dimitri Lehner, who is currently writing his thesis at the University of Sports at Cologne. The subject he's researching is "Sailing on Catamarans", especially "Offshore sailing and Cruising on Beach Cats". To get deeper into the matter - and to experience himself - he sailed from Scharbeutz (North of Luebeck) to Saint Petersburg in Russia in May and June this year. He converted a serial Nacra 6.0 to meet all expected circumstances, as strengthening of hulls, bulkheads, adding wings, reefs, safety and navigation aids as used in cruising. Dimitri kindly asks to get more info on:

- cruising and long distance sailing with beach cats
- beach cats used for extreme tours
- converting of beach cats to meet the above requirements.

So far he researched on the following:

- Crossing the U.S. North-West Passage on a Hobie 18 in 1986-88,
- Duncan Roos sailed to the Amazonas source (no literature found),
- Charity race on HC 16 from Durban to Cape Town in '96 (no literature)
- Atlantic crossing of Bourgnon-Giraldi in 1986 (no literature found)
- Several "raids" in France and the annual "Worrell 1000" race.

His theory is, that cat sailing is subject to ongoing variations, as cat-safaris, club-races, freestyle sailing as the "Bacardi Blast" during the Tornado Worlds on the Bermudas, etc., similar to canoeing on rough waters, oceans, para-gliding, cross-country skiing, etc. According to Dimitri (and I second that ...), there's very little specific literature, videos and reports available on the above topics. He will receive "Multihull Magazine's" book and video catalogue, and the list with every article published since foundation in 1975. As a journalist I am sure, more has happened than the multihull press has ever heard of - Dimitri needs that ! On behalf of Dimitri I kindly ask you to check your mind, files, archives and computer hard disks for info on his studying subject "Cruising and long-distance sailing on beach cats". His address is: Dimitri Lehner; Gutenbergstrasse 2; 50823 Koeln, Germany; Phone and Fax +49-221-522 457. I shall be very pleased, if the worldwide multihulled community could give Dimitri a little help to reach his studies aim. No question, all your expenses will be covered. For your convenience, you may also use my email address. -- Chris Plaass (plaass@foni.net) phone: +49-431-36 800

[12 Jun 98, updated 24 Feb 01] I am the Technology Instructor at the Topeka Education Center a school in the Topeka Public School System Unified School District (USD) - 501. The center was established to help kids at risk. In the past five years sense we opened the technology program we have done some exciting activities. Due to our limited budget, our students have donated their time and effort to build all of the cabinets and furniture in the Technology Center. Local

companies have donated computers and other hardware. For the 1998 - 1999 school year we will be planning to build a hydrofoil sail boat. As you can imagine this will be a large undertaking. If you or your organization would be capable of offering technical assistance or materials it would be greatly appreciated. We have in the past taken on such projects with success; check it out at <http://www.networksplus.net/elliott/jetengine>. Our student population is made up of inner city youth many of which have had a brush or two with the law and many of the females are parents or are pregnant. The goal of our little school is to help these students become useful people in today's society. Thus a lot of time is spent on teaching social skills, not only that it is important to get along with others but to be responsible for yourself. This includes holding down a job and paying taxes. Many of our students receive social assistance, and it is also our goal to help these student become self supporting. We have started a program in which students are paid by local companies to work in their businesses two or three hours a night doing a variety of jobs to gain experience. We are very proud of this program because when a student has a job that is meaningful to that student usually we see a jump in the student's morals and quality of school work. Although many of these students are not college bound, it is important to help them be all that they are capable of being. -- James Elliott (elliott@networksplus.net), Technology Instructor, Topeka Education Center, Topeka, KS 66604; Home Page: <http://199.240.184.3/elliott> *[Editor's Note: unfortunately the web and email links cited here have ceased to work. There is no mention of of the Topeka Education Center on the website of the [Topeka Public School System](#), so we have been unable to find a current status and address for Mr. Elliott or the Topeka Education Center.]*

[21 Mar 98] I would like to build a hydrofoil for science class. My grandmother said she saw a man on TV who was showing a fairly inexpensive project that could support the weight of one person. It used a motor from a vacuum cleaner and required an electrical supply (Big Extension cord) and 2 plywood circles. She could not remember what else but I thought you might be able to help me with this info or perhaps tell me where I can find it. I don't have a lot of money but I can pay your dues if you have this info I just don't want to spend on something that cannot help. (I hope you understand) -- R. Fisher, 8th grade (rlfisher@kih.net)

[20 Mar 98] I am a French student in engineering and I am going to make studies about the fences of the foiler catamaran *TECHNIQUES AVANCÉES*. So it would be kind from you if you could tell me where I can look for information (websites, books, articles ...) And if you need information about our catamaran, I would be pleased to give you some. -- (marly@ensta.fr), website of the catamaran: <http://www.ensta.fr/~dsim/>.

Response...

[20 Mar 98, updated 28 May 01] The best source of technical information on sailing foil designs is reprints of articles from the Amateur Yacht Racing Association and Multi-Hull Magazine. For a full index, go to <http://www.webstrand.org/yachts/aindex/index.shtml>. *[Note: this index site is no longer active -- anyone who knows where it went is invited to submit the new website URL... thank you! - Webmaster]* You should also explore the [links on the IHS website](#) -- Barney C. Black (Please reply via the [BBS](#))

[20 Mar 98] I'm French and my English is poor. I'm 19 years old and I'm in a scientific university to become an engineer. To pass my exam, I need your help! With my friend, we want to do some research about hydrofoils. Please, can you give us some technical and scientific research about this. -- Julien Mabile (jmabile@nordnet.fr)

[20 Mar 98] I was searching through the net for some info on the "Aerodynamic and Hydrodynamic Design of a Hydrofoil" and your page came up. I am doing an in depth discussion of the design and operation of a Hydrofoil for my aerodynamics course. I have never really looked at hydrofoils until now. They are really interesting machines. If you have any other info not posted on your site that may help me I'd really appreciate it. Keep up the good work! -- Tristan Lee Andrew (tlandrew@learn.senecac.on.ca)

HYSWAS Roll Stability

[20 Mar 98] I'm a 2nd Year Naval Architecture student in UCL. I'm interested in the control systems for the HYSWAS roll stability. I would be grateful if you could send me some references that I could refer to. -- Yama (c.seow@ucl.ac.uk)

Response...

[21 Mar 98] Our specific HYSWAS control algorithms were developed under U.S. Navy funding and are not available for release. However, I can tell you the following:

1. Everything in the transverse direction is driven by the loads that you calculate based upon your hull geometry. For example, your strut area projected in the athwartship direction will have a large influence on the loads.
2. Your roll control algorithms must be fast as you want to counter the applied moment before inertial loads become a big factor.
3. Calculation of the roll center is critical and this should include added mass effects.

-- Mark Rice (mapc@access.digex.net) Maritime Applied Physics Corp., 9010 Maier Road; Laurel, MD 20723

Supercavitating Hydrofoils

[2 Dec 97] I am a Ph.D. Student at the University of Stellenbosch. I am looking for information on super cavitating hydrofoils (base ventilated and fully cavitating) for possible application to hydrofoil supported catamarans. Could you provide me with references if you know of some? -
- Günther Migeotte (gunther@cae.co.za)

[2 Dec 97] We do not have a handy long list of the many papers written on this subject, but a good place to start is the [IHS References Page](#). Reference no. 62 refers you to Young Shen

(shen@oasys.dt.navy.mil). He is an expert in this field and can lead you to a lot more material. He is at the Naval Surface Warfare Center, Carderock. Perhaps you could contact him and give him more specifics regarding your particular project. -- John Meyer (jmeyer@erols.com)

[8 Feb 98] Re: super-cavitating hydrofoils. The best effort in this field in my opinion was undertaken at Grumman when we designed transiting foils for testing on *FRESH 1*. The big problem was to make a smooth transition from sub-cavitation to super. We thought we had a solution but it was never really tested. Our lead hydrodynamist was Ray Wright. He is now retired and living up in Georgia. If you like we could probably contact him and see what he remembers about this effort. -- [Bob Johnston](#)

Developing a Regional Ferry Transportation Management Plan

[14 Oct 97] I am a student in an English university, and my Strategic Management Project is about passenger hydrofoils; I would like info about the advantages and disadvantages compared to other means of transport, analysis, specific magazines about hydrofoils, and how I can join IHS. -- Mike Koronaios (kg758027@stmail.staffs.ac.uk)

[18 Oct 97] 1. [Fast Ferry International](#) in England is the premier source of information about fast ferries. You may be able to find the FFI magazine in a library such as at a university with marine-related programs. FFI's email address is info@fastferry.co.uk. Their phone is +44 1580 766960. Their mailing address is FFI, Milrose House, Sayers Lane; Tenterden, Kent TN36BW; UK. The URL of their web site is <http://www.fastferryinfo.com>. 2. Marine Log's magazine is another source, and recently they have had better coverage of hydrofoils than FFI. Their web page location is <http://www.marinelog.com>. 3. To find out how to become an IHS member, go to <http://www.foils.org/member.htm>. 4. For an example of a study, take a look at the U.S. Department of Transportation's Report "Regional Ferry Plan For the San Francisco Bay Area." This is available on the world wide web at URL: <http://www.fta.dot.gov/library/planning/RF/RF.html>. The study will not apply to you specifically, but you can see what the questions and trade-offs are. -- Barney C. Black (Please reply via the [BBS](#))

[20 Mar 98] I am going to America soon, maybe in July. I am admitted to Ph.D. program by University of Michigan Ann Arbor (Naval Architecture and Marine Engineering), California Institute of Technology (Mechanical Engineering), UC San Diego (Oceanography), Johns Hopkins University (Mechanical Engineering) and some others. Caltech is the most famous, but University of Michigan is very attractive too. Do you know what is the situation in shipbuilding industry in the USA? Could I find a job having a Ph.D. degree from University of Michigan? -- Konstantin Matveev [15 Aug 99 UPDATE: Konstantin Matveev has arrived in the USA and is attending California Institute of Technology (CALTECH).] email: (matveev@cco.caltech.edu) (website: www.hydrofoils.org).

[updated 16 Mar 98; originally 2 Sep 97] I have decided to receive Ph.D. degree at American university. Earlier I planned to make a career in Russia. 70% of hydrofoils were produced in USSR and here were many opportunities for work. But now situation has changed and there is practically no production of hydrofoils due to lack of finance. In August activity of High-Speed Ships Bureau (with which I worked) stopped. Prospective projects exist, but they will not be accomplished. To continue working in the sphere of hydrofoils I will apply to some American university. Maybe you have connections with professors. I would be very grateful if you advise me several professors and universities where are programs on high-speed ships. Now most Russian designers and managers of high-speed ships believe that the USA will become the world leader in this sphere in the nearest future. I agree with them. There is money in development of high speed ships, and there are geographic features (Great Lakes, Caribbean Islands, sea coastline) which enable to hydrofoil to be the fastest and cheapest kind of transport in some areas. -- Konstantin Matveev, Moscow, Russia [15 Aug 99 UPDATE: Konstantin Matveev has arrived in the USA and is attending California Institute of Technology (CALTECH).] email: matveev@cco.caltech.edu (website: www.hydrofoils.org)

[3 Sep 97] There is some limited high speed ship research in the US at the Massachusetts Institute of Technology (MIT), Department XIII (Ocean Engineering and Naval Architecture at the graduate level and Stevens Institute of Technology (SIT) in Hoboken, New Jersey has a history of supporting high speed planing hull research. Currently, the center of high speed craft (wave piercing catamaran) development for commercial ferries is in Australia. The University of New South Wales has had some research efforts; I'm not sure of the details. I'm including Dr. Colen Kennell, of U. S. Naval Surface Warfare Center, Carderock Division (the 'model basin') on copy of this message. He may be able to add some additional information and send it to you. Best of luck in your academic pursuits! -- Mark R. Bebar, Director, Surface Ship Concepts Division, Naval Sea Systems Command (Code 03D1) (Bebar_Mark@hq.navsea.navy.mil).

[24 Aug 97] I am a naval architecture student at the Technical University of Berlin, Germany. At the moment I am working with an engineer in Australia, far away from all my smart books. We have a problem designing a hydrofoil assisted catamaran ferry. We would be interested to gain wisdom on standard profiles selected, design procedures, and cavitation and performance prediction. It would be very helpful, if you could name some websites or other sources dealing with these problems. -- Sebastian Bade (bade@cadlab.tu-berlin.de).

[5 Nov 97] I'm looking for all informations about hydrofoils. I'm a French student leading a project about the "Hydroptère." The title of the project is "The Hydroptère, Hydrodynamics of Foils." Because this project has to be done in a scientific way, my task is to do some calculus with these foils. So please help me in finding this information (I can't locate it anywhere!) -- Sebastien Thellier (sebastien.thellier@hol.fr)

[5 Nov 97] According to veteran IHS member Sumi Arima (arimas1@juno.com): In answer to your question on text books, there is no one good book on foils. Most of the hydro types use Horner's books *Fluid Dynamic Lift* and *Fluid Dynamic Drag*. When we bought a set, the only source was from Horner's widow. College libraries generally have it, but local libraries do not." There is also *Principles of Naval Architecture*, which is a two volume set published by the

Society of Naval Architects and Marine Engineers ([SNAME](#)). IHS maintains [a list of hydrofoil-related articles and papers](#), but most are hard to find. Another suggestion, the [Amateur Yacht Research Society](#) publishes quite a few technical papers, and there is an index of titles on their site... you may see something that addresses your specific need and can contact them for a back issue of the journal containing articles in which you have interest. You should also explore the extensive technical links at the [Links for Yacht Designers](#) web site. Finally, if you have specific questions, I can try to forward them to technically oriented members that can discuss them with you. Also I can post questions on the IHS website and solicit responses from all who visit the site. -- Barney C. Black (Please reply via the [BBS](#))

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