# The NEWSLETTER

**International Hydrofoil Society**
**P.O. Box 1130, Severna Park, MD 21146**

**Fourth Quarter 2016**
**Editor:** Scott Weidle
**Contributors:** Mark Bebar, Harry Larsen, Ray Vellinga, Worldwide Hydrofoil Community


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## DISCLAIMER

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## PRESIDENT'S COLUMN

This is the second newsletter to be read by a large number of new members of the International Hydrofoil Society. There have been several significant changes to our policies since assuming the privilege of being the President in June of 2016. Mark Bebar stepped down after serving 3 1/2 years as acting and full President. Mark followed 21 years of leadership by John Meyer. By stepping aside, Mark graciously granted me the opportunity to try some new ideas. With the support of a few prominent members including Martinn Mandles, changes were made. Presently, Mark has assumed the extraordinary role as the best Vice President anyone could hope for.

The motivation to change was inspired by the observation that IHS was losing ground in the rapidly growing hydrofoil universe, as illustrated by the extraordinary leap forward in technology demonstrated by the America's Cup sailboats. The racers installed hydrofoils and exceeded 50 mph in 24 mph winds, and excited the sailing world with exhibits of nail biting competition. Recall in the last race in San Francisco, the Americans were down 1 - 7 against the Emirates Team New Zealand. The Trophy would be awarded to the first to reach 8 wins. Amazingly, the Americans prevailed by winning 7 in a row using advanced hydrofoiling techniques! The IHS had an inside man in the America's team! Correlation? We may never know, because the Emirates Team now has an IHS member to match.

Some of the IHS changes were controversial. At the time we had a shrinking number of dues paying members. Some of us believed that the $30 per year dues was a significant barrier to potential new members. So I redefined "Member" as someone who qualified due to his profession, education, or demonstrated a real interest in hydrofoils. Dues are now no longer a requirement. We embarked on an aggressive program to award membership to these newly qualified individuals. New members are welcomed onboard but sincerely invited to decline the membership if for any reason they choose to do so. In this way, the membership roll was increased from the low hundreds to 2,105.

The new members include a distinguished list of naval architects, maritime engineers, aeronautical engineers, university professors, designers, prototype makers, racers, ship or ferry people, and those who just like hydrofoils. The results are encouraging. We've had just one person request "out": He is a friend and a former aviator who resents other boaters whizzing past his lumbering 65- foot motor yacht. It's also encouraging that over a dozen people have responded with a "thank you" and some have shown the willingness to contribute time and resources to the IHS.

The plan for the future is to carry on with our expansion of membership, but at a more leisurely pace. We will continue to work with the volunteers and the new supporters of IHS. Those who chose to be passive members will simply be receiving a newsletter a few times each year, but everyone will have full access to the most extensive hydrofoil library in the world, and some of the greatest reference materials to be found anywhere. For example, go to www.foils.org and click on the "Photos 7700+" button. There you will visualize just how extensive and venerable the hydrofoil movement continues to be.

Likewise, the IHS has expanded its role as a truly international society with new members in Australia, Canada, China, Denmark , Equador, France, Germany, Greece, India, Malaysia, Myanmar, Netherlands, Newfoundland, Russia, Singapore, South Africa, Sweden, Switzerland, Tasmania, Thailand, Turkey, United Arab Emirates, United Kingdom, and more. One example of the value of the expanded membership list is that we have 545 university professors including a few students that will soon be receiving invitations to sponsor a competing team in this year's Mandles Prize. As in the last 3 years, Martinn and Connie Mandles will be awarding $4,500 in cash prizes for students presenting outstanding academic papers focusing on hydrofoils

Presently, the primary goal of the IHS is to become the hub of the hydrofoil world. This means more than military hydrofoils. Today we have members active in ships, ferries, America's Cup sailboats , Moth sailors, human-powered, motor powered recreational, surf boards, body boards, windsurfers, kite boards, all revolutionized with hydrofoils. There is a rapidly developing new technology effort out there and the International Hydrofoil Society is postured to be the focal point for these innovations.

Thanks to all of you for remaining or becoming International Hydrofoil Society members. We pledge to be here for all: those who joined 46 years ago, and those new this year.

Sincerely,
Ray Vellinga

## DUES ARE HISTORY

As a key part of the incoming new administration, annual dues have been eliminated. The new program is to rely on Sustaining Memberships and donations from members who volunteer to make tax deductible contributions. Advertising in the Newsletter, Web Page, Facebook and Phanfare will be made available for nominal contributions. Please inquire with Ray Vellinga to place an advertisement.

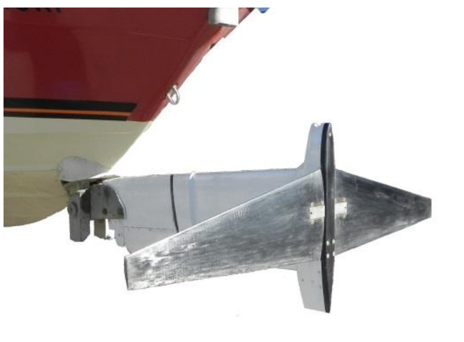
# TALARIA IV UPDATE

*By Harry Larsen*

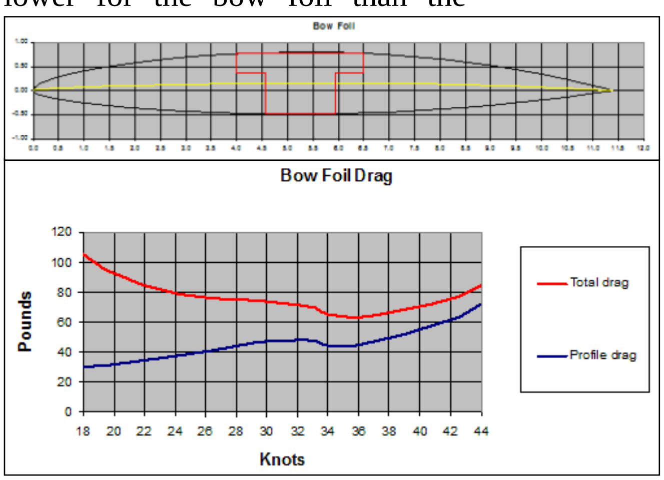
*"Flying" Talaria IV on foils*

## Bow Foil

A design objective is a takeoff speed less than the boat's hump speed, and secondarily, to maximize top speed. The design options for the bow foil are: foil area, aspect ratio, thickness, and section. The material is unidirectional carbon fiber with a fiberglass core.



The bow foil is very lightly loaded at the beginning of a takeoff run. As the stern lifts it becomes fully loaded. Consequently the lift - area requirement of the bow foil occurs at a higher speed than that of the stern foil. Thus it can be more heavily loaded. In addition, for pitch stability, the derivative of lift versus angle of attack should be lower for the bow foil than the stern. For a takeoff speed below hump speed the loading of the aft foil is 577 lb/ft$^2$. The bow foil's loading is 619 lb/ft$^2$.




The bow foil is articulated in angle of attack. It is pivoted on a shaft just forward of its center of loading. The size of the shaft and thus its bearing block are dictated by 1700 lb loading on the bow foil. The bearing block's thickness is 1.25", constraining thickness of the bow foil.

Within the constraints of loading, thickness, and material stiffness, the section was designed with XFOIL, ncrit = 3. The formula,

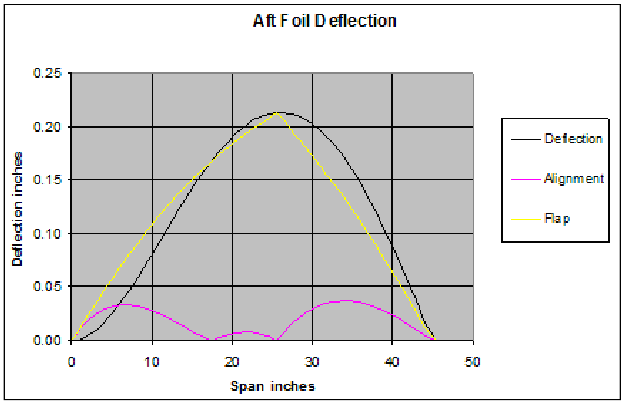
$$y(x)= t\, x_a\, (1-x_b)$$

was used to generate the symmetric sections. Where y(x) = +/- thickness, x = cord (0-1), t = thickness parameter (0.1045), a (0.52) and b (2.1) are shape parameters. Camber was generated using the same formula, (0.0245), (0.54), (2.4).

With a minimum drag at maximum speed section the center thickness determined the center cord, 11.75". With that and stiffness the span and aspect ratio were largely determined.

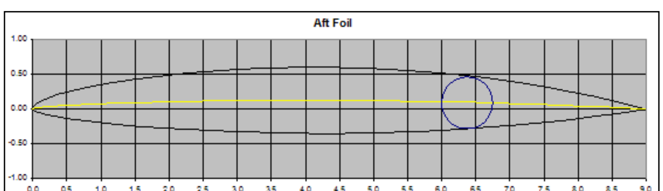
## Aft Foil

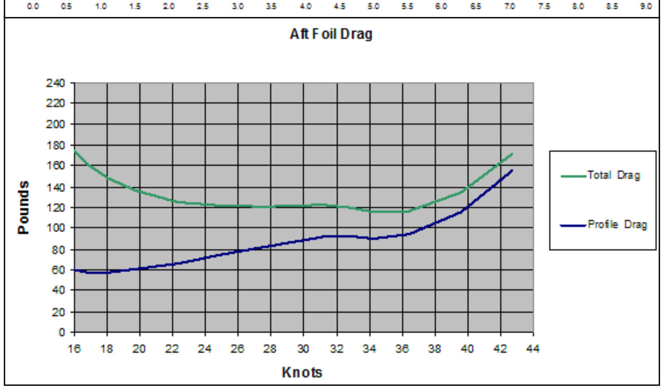
The aft foil performs two functions, roll authority and lift. The design objective to keep the foils within the beam of the boat limits roll authority. To maximize roll authority the full span flaps are 1/3 of cord. With the span at the boat's beam, 8', and the takeoff speed below hump speed the foils area is determined. Its loading is 577 lb/ft$^2$, cord 9', and total span 95".




The aft foil has hinged flaps with 3 hinge bearings, each end and near the center. The flaps are actuated from the center pod by hydraulic cylinders with a 2" throw actuating a 2.6875" bell crank. The torque is thus transmitted through the flaps from the center to the outboard end. Carbon fiber inboard flaps were found not to have the necessary torsional stiffness. Welded 316 stainless steel inboard flaps were constructed. The outboard flaps are of carbon fiber.

A design requirement is that flap - foil interface not significantly diverge. Thus the bending of the foil versus the flaps must be minimized. This imposes a stiffness requirement on the aft foil. Below, the purple line shows the absolute divergence of the foil and flap with a plus one G load. The maximum divergence is .0373". Also, the center hinge is located at 25.55" of the 45.4" span to minimize the divergence.




As with the bow foil, the design objective is takeoff below hump speed and then the maximization of top speed. To maintain pitch attitude over the speed range the flaps are biased as a function of speed. Relative to 36 knots, the flap bias at takeoff is 3.3degrees down.

Give the loading, flap setting, span, and takeoff speed the cord can be determined. Section thickness, with a small impact on drag, and carbon fiber skin thickness (cost) are traded to make the foil thickness choice. Its thickness is .95" and cord 9". Using the same section generating formula as the bow foil its symmetric section parameters are: 0.0990, 0.53, 2.1. Camber parameters are: .026, .48, 2.0.

The foil has 10 degrees anhedral. This is primarily to lower the foil tips to reduce the likelihood that they will broach during a banked turn in waves. It also increases roll authority slightly.

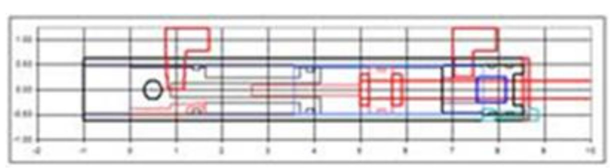
## Foil Construction

The dominant structural requirement for Talaria's struts and foils of is longitudinal stiffness and sometimes strength. The loads and dimensions are such that the unidirectional carbon fiber must be thick, generally more than .25". Unidirectional carbon fiber is very dense and does not infuse well without a flow medium. An imbedded flow medium, of course, reduces the fiber content of the layup. I found via experiment that I could not reliably infuse unidirectional carbon thicker than .125".

The layup procedure I adopted was to set up the mold for infusion, hand layup the carbon fiber with resin, lay in the woven fiberglass core dry, seal the mold, establish the vacuum and let the excess resin infuse from the carbon into the core. Then infuse the remaining dry core. It worked best to layup each side of the strut or foil separately and glue them together after the initial cure.

## Aft Hydraulic Cylinders

The aft hydraulic flap cylinders have an ID of .94", rod of 3/8", and a throw of 2'. They include an embedded position sensor. The sensor is a coil of 6000 wraps embedded in epoxy around an Acetal spool. A 1600 Hz square wave, at +/- 15 volts, drives the coil. The circuit terminates with a 500 ohm resistor to ground. The square wave is attenuated by a steel rod attached to the cylinder's piston rod. As the piston is retracted the



attenuation increases. The attenuated wave is rectified, smoothed, and read by the flight computer's analog digital converter. The piston slides in a stainless steel (SS) sleeve pressed onto a 316 SS cylinder end block. The block holds a 1/8" pipe flare fitting, a bronze bushing, and the rod seal. The piston is of Acetal. The SS sleeve overlaps the end O-ring of the spool. This seals the hydraulic oil from the coil. At the other end of the coil is an O-ring that seals the coil from the outside water. The body of the cylinder is carbon fiber epoxy rather than a metal. The coil's transmission is attenuated by metal, thus its output variation is would be decreased by using a metallic cylinder body.

### Bow Hydraulic Cylinder

The bow foil actuation cylinder has an ID of 1", rod of ½", and throw of 2". It is machined from an aluminum block and anodized. Its design is similar to the aft cylinder but does not include the coil spool.

Talaria IV Website

## QUADROFOIL UPDATE

### Quadrofoil Q2S Electric

Past issues of the IHS Newsletter have covered the Quadrofoil Q2S and Q2A. Recent improvements include: design and functionality of the hydrofoils and new electric motor. Website Link Also check out their new promotional video: YouTube Video

## IHS/SD-5 JOINT DINNER MEETING

### WaveCraft SES Development and Operational Experience

*J. William McFann, President*
*Island Engineering, Inc.*

The offshore wind power industry is extensive and growing rapidly off the coastlines of western Europe, the UK and Scandinavia. As wind farm size and distance offshore have have increase, demand has also grown for crew transfer vessels (CTVs) that are both faster and able to operate in wave heights exceeding the general operational transfer limits of ~ 1.5m (Hs).

*Umoe Mandal Wavecraft*

In response, Umoe Mandal, Norway, leveraged their extensive expertise in the design and construction of naval SES together with some novel low-speed dynamic heave control technology investigated for the USN (ONR) T-Craft program in which they had participated. The result is the Umoe WaveCraft, a 26m, 40 knot wind farm CTV with better than 2m (Hs) capability. The first entered service in 2015, the third will be delivered later this year.

Presented at the Army Navy Country Club in Arlington, VA on October 13, 2016.

Link to presentation

## IHS NEW PROJECTS

IHS has embarked on a wide range of initiatives aimed at increasing awareness of hydrofoil and hydrofoil related technology developments around the world.

We are fortunate to have a Board of Directors that has devoted much time and effort over many years in moving these initiatives forward. The best way for you to support the Society and become a future Board member is to pitch in and become involved in one or more of these initiatives:

*Newsletter:* Offer to become our new Editor, or assisting such an Editor with collecting material for future issues, preparing articles and editing.

*Martinn Mandles Prize for Hydrofoil Excellence:* Work with Mandles Prize Co-Chairs, public relations/use of social media to promote the prize, establish/maintain college and university contacts, solicit entries for the Prize, Judging Team

*Website:* Work with the Webmaster, explore potential website improvements and coordinate content updates, respond to posted messages.

*Membership:* Work with the Membership Chairman, new member outreach, update and maintain membership list, coordinate and provide membership packets to new members.

*Program:* Assist in identifying guest speakers for IHS/ SNAME Panel SD-5 Joint Dinner Meetings

*Permanent Hydrofoil Exhibit at Washington Navy Yard Museum:* Assist with collection of material for and development of the exhibit

*Phanfare Photo Site on IHS website:* Assist in posting photos, editing/describing the content, and collection/compilation/indexing of hydrofoil (and other AMV) technical papers and data.

Many of these activities can be done at home over the internet or phone and can be at any level of engagement that you are willing and able to provide. We urge all of you to consider where you might help in furthering these efforts. Please contact Ray Vellinga (IHSpresident2016@gmail.com) or Mark Bebar (mark.bebar@csra.com) if you're interested. There is much to do and your active participation is critical to a successful future for the International Hydrofoil Society.

## IHS MANDLES PRIZE FOR HYDROFOIL EXCELLENCE

*WIN $2,500 OR $1,000*
*Entries Due May 1, 2017*

The International Hydrofoil Society is pleased to announce that thanks to the generosity of Mr. Martinn Mandles, a long-time member of IHS and his wife Connie, IHS will once again sponsor the Mandles Prize for Hydrofoil Excellence competition. The competition, now entering its 4th year, includes up to $4,500 annually in IHS hydrofoil achievement prizes for students, with a $2,500 First Prize and up to two $1,000 Honorable Mention awards.

In order to open the competition to a wider spectrum of qualified entries, submissions by students based on work completed since 2012 will be eligible for the Mandles Prize. The due date for Application Forms is May 1st, 2017.

This is an outstanding opportunity for the next generation of hydrofoil developers to be acknowledged for their efforts to advance the state of the art in hydrofoil and hydrofoil-assisted craft engineering, design and construction.

Background on the Mandles Prize and Rules for the competition can be downloaded from the IHS website (link)

Based on the 2016 entries and award winners, we anticipate a very exciting competition and look forward to receiving many high-quality entries. Questions on the Mandles Prize can be e-mailed to Ray Vellinga (IHSpresident2016@gmail.com) or Mark Bebar (mark.bebar@csra.com) if you're interested.

## SAILORS PAGE

### FOILING CATAMARAN

Team Falcon completed its mission to "fly on water" across the 662-mile-long open ocean in November. It took them 66 hours to cross from New York to Bermuda in a custom-designed 46-foot hydro-foiling catamaran named the F4. The expedition was led by Jimmy Spithill, ORACLE Team USA's helmsman and two-time America's Cup winner. "Given how big the

*The F4 literally flies over the water. Credit: Matt Knighton / Rob Tringali / Amory Ross* sea state was building and predicted to build, it was very concerning," Spithill said. "We went from pushing the boat for performance into survival mode. These were biggest waves I've been in in a multihull. Some of the wind we had was squalls at about 45 knots, and then you would get rogue waves. At night we didn't have a moon, so it was very difficult trying get through this.

"Then some of the waves were breaking, which made it very challenging and extremely dangerous. We had a few close calls at night, but the fact is you always see the best team and people in the worst situation, and this team was amazing."

Red Bull Article and Videos
Forbes Article

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## GREENHALGH REPEATS AT MS AMLIN INTERNATIONAL MOTH REGATTA

*By Sean McNeill*

*Briton does it again on final day; fends off Fletcher-Scott for championship and $5,000*

**HAMILTON, Bermuda** — England's Rob Greenhalgh is a hard man to bet against when there's money on the line. Just ask Chris Rashley or Dylan Fletcher-Scott.

For the second consecutive year, Greenhalgh came through when it mattered most and successfully defended the MS Amlin International Moth Regatta hosted by the Royal Bermuda Yacht Club. "I'm satisfied with the win. It's been hard, so I'm pleased to win," said the 39-year-old Greenhalgh. "Last year I was never leading until the last day, but this year's been a very different regatta. Last year the weather was more consistent, either windy or light. This year we've had every season in one day. It's been very complex, been tough. I haven't sailed perfectly, haven't always had the right gear up. So it was good to come out today and do it. It was difficult."

Last year Greenhalgh entered the final day trailing Rashley by 1 point. He then went out and won four races to score an 8-point victory.

This year Greenhalgh led Fletcher-Scott by 3 points at the beginning of today's racing, and then the heavy lifting started. After the first two races Fletcher-Scott held a 1 point lead by virtue of a second discard being calculated into each skipper's scoreline. Fletcher-Scott, in fact, appeared on his way to overall victory in the third race, holding 2nd to Greenhalgh's 5th at the beginning of the run to the finish. But then the wind dropped out, the race was abandoned, and Greenhalgh had new life.

"It was intense," said the 28-year-old Fletcher-Scott. "I finished just ahead of him in the first race. He finished just ahead of me in the second race. And in the third race, which got abandoned, he was sort of 4th or 5th when I was 2nd. I was upset because if that had held I would've been in good stead."

When the third race was restarted Greenhalgh employed match racing tactics and started to windward of Fletcher-Scott as both came off the pin end. They sailed out to the left side of the course with Greenhalgh blanketing Fletcher-Scott. The younger skipper tried to wriggle free to tack away, but Greenhalgh matched every move.

Greenhalgh drove the pair back in the fleet after the first lap. A poor finish would hurt Fletcher-Scott more. Beginning the second upwind leg Greenhalgh broke off to the right while Fletcher-Scott continued left. At the finish line about 15 minutes later Greenhalgh was 2nd and Fletcher-Scott 4th. That gave Greenhalgh a 1 point

*Rob Greenhalgh (right) leads Dylan Fletcher-Scott on an upwind leg during the final leg of racing at the MS Amlin International Moth Regatta, Credit: Beau Outteridge* lead.

"In that third race we both thought it would be the last race, so it was a full on match race," said Fletcher-Scott. "He was a little quicker than me. He did a good job covering me up the first beat and pushed me back. Then we had another race and it was who beats whom. He did better than me, he was just quicker. I was hiking as hard as I could, doing all I could. But he was able to stay in front of me and make my life really hard."

Greenhalgh finished 3rd in the final race to Fletcher-Scott's 5th and scored a 3-point victory. Greenhalgh won $5,000 of the $10,000 prize purse and Fletcher-Scott won $2,000.

"Dylan's been going very well in the breeze, and a lot of sailing comes down to speed," said Greenhalgh. "He was quick in the breeze and I was struggling. Today I sort of sorted that out. I had a different mast, foils and battens, and it was a better setup. But then it went light. It's tricky. You can't always get it right. But in the last two races when the breeze was up I was going well."

David Hivey of the U.K. placed third with 34 points and won $1,500. He was followed by Ben Paton in fourth with 47 points, good for $1,000, and James McMillan in fifth with 64 points, for $500.

The 12th place finisher was reigning Moth World Champion Paul Goodison of the U.K., who finished with 117 points. His scoreline included three 1sts, four 2nds and two DNC's at 51 points each. Goodison, the backup wing trimmer for Artemis Racing, a challenger for the 35th America's Cup, missed the races because of practice commitments with Artemis Racing. Minus that commitment, he could've played a huge role in determining the overall winner.

The MS Amlin International Moth Regatta attracted a field of 50 Mothists from 10 nations. MS Amlin representative Charles Penruddocke, a Senior Class Underwriter at MS Amlin Bermuda, said the event fits MS Amlin's goals of giving back to the Bermuda community and fostering a relationship with international competitors.

"It's thrilling that the MS Amlin International Moth Regatta came down to the last day of racing once again," said Penruddocke. "I'm pleased to announce that we are committed to another year of the regatta. So see you all next year."

MS Amlin is a leading insurer and reinsurer, part of the global top-10 insurance group MS&AD, with operations in the Lloyd's, UK, Continental European and Bermudian markets. With a 300-year record and more than 2,000 people in 26 locations worldwide, MS Amlin delivers continuity for businesses facing the most complex and demanding risks. MS Amlin's role places it at the forefront of the Property & Casualty, Marine & Aviation and Reinsurance markets. Additional sponsors include the Bermuda Tourism Authority, Gosling's, the Official Rum of the Regatta, and Kaenon Polarized.

Race Details & Results
Scuttlebutt Sailing News
Preview Video - YouTube

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# FROM THE ARCHIVES

## GERMAN NAVY PROVES HYDROFOIL BOATS UNFIT FOR PEACE OR WAR

*By Robert J. Johnston*
*(deceased - Past President, IHS)*

*For information on Mr. Johnston, go to:* http://foils.org/bobjohns.htm

"For military purposes a boat designed on this [hydrofoil] principle is therefore unsuitable. It even appears questionable whether the pursuit of the principle after the war has any point at all... The problem will be running against the swell, and it will never be overcome." Among my papers is a report on the trials conducted by the German Navy on various hydrofoil boats during World War II. This report is an English translation summary of the German Navy's conclusions from trials conducted during 1940 to 1944 on various designs. The report was written by operational officers of the German E-Boats who studied the development and participated in the trials of this new type of high speed motorboat.

I am not completely certain just who gave me this report, but I believe it came out of my1953 visit to Sachsenberg and von Schertel as discussed in the Summer 1996 IHS Newsletter. I recall their discussions at that time regarding these trials and the attitude of the

German Navy toward the use of hydrofoils. The E-Boat commanders loved their high speed craft and could not visualize these beautiful planing boats being replaced by hydrofoils. The hydrofoil concept was primarily accepted by the naval engineers and the designers who supported the continued development of the hydrofoil. Similar attitudes were evident in the German Navy as late as the 1970s.

The report does reveal the following sea problem of the early von Schertel hydrofoil designs. This was solved much later when Rodriquez installed flaps on surface-piercing foils controlled by an automatic system. Also, this problem was one of the reasons that the U.S. Navy adopted fully-submerged foils on all of their hydrofoil designs.

Anyway, what follows is the English translation (not made by me, and in fact I don't know who made the translation) slightly edited for clarity:

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The following information was extracted from various papers dated 1940 to 1944 which covered development and trials of this new type of high speed motorboat. To record as much as possible of the German experience, the available information has been translated and included in this report.

Papers dated June 1940 contain lists of the following experimental E-boats fitted with hydrofoils:

- TS 1-6 (six units formerly namedTW 1-6) - based on the Sachsenberg/von Schertel system and being built at the Sachsenberg Yard. One of the TW boats was built to the following general specifications: Weight - 5 tons, Speed - 40 knots, Endurance – 36 hours at 25 knots, Drive - 250 hp, and Use - Norwegian fjords.

- VS 6 (formerly named VT 1) - built on Sachsenberg/von Schertel system at Sachsenberg Bros., Dessau - Rosslau.

- VS 7 (formerly VT 2) - built on Dr. O. Tietjens system at the Brandenburger Dredge & Shipbuilding Yard, K. Siebert, Berlin-Spandau. Trials were held at Schleswig.

*Schertel/von Sachsenberg Hydrofoil VS 8*

Further records, dating up to November 1944, show the following types:

- VS 8- developed by Engineer Wankel at Sachsenberg Bros., Dessau -Rosslau.

» This type was first designed in 1940 as an invasion tank-landing craft for the Army. The boat had an open well stern that would accommodate floating pontoons. It was estimated that this craft would achieve 45 knots on hydrofoils with its two 2500 hp. engines. Load was to be 20 tons.

» In 1941 the project was taken over by the German Navy for development of a fast mine-layer, torpedo-boat, and air-sea rescue boat. Only two MB 501 (2000 hp each) engines could be provided for trials. To make the most of this inadequate horsepower, the propellers were given less pitch, resulting in a top speed of 37 knots (instead of 45), and a maximum engine performance of 1250 hp and 1150 RPM.

- VS 10- No information.
- VS 14- No information.

After the trials of VS 8 in August and the VS 6 in October 1944 it was decided to suspend work onVS6, 7, 10, and 14 immediately, and that "every drop of fuel expended on further trials would be regarded as wasted." If continued, it would have required 1-1/2 to 2 years to prepare as a combat weapon. It was, however, generally agreed that trials should resume after the war.

## Trial of the VS 8 on 8 Jan 1944

"After putting out, the boat was brought onto its hydrofoils between the beach-heads, i.e. in calmer water, and then proceeded out into the bay of Danzig, into the open sea north-east of Hela. With the wind NE, strength 5-6, swell 4, sometimes more, the boat proceeded on hydrofoils against the sea and was stable, and there was no spray, whereas an ordinary E-boat would have been buffeted about and shipped water. That created a very good impression and is a great recommendation for the sea-going characteristics of the boat. When the boat was turned slowly in a slight sea, 10-12 degrees abaft the beam, it dropped from hydrofoils. The attempt to bring it onto hydrofoils again, when heading the boat in all directions, failed in a calm sea as well as with a swell. The boat, therefore, only rose on to its hydrofoils once during the whole trial. The reason was said to be the insufficient performance of the engines. The trials therefore were brought to a close, and the results yielded nil.

## Subsequent Trials of the VS 8

Wind Force 5-6, Sea Force 3-4. When running against the sea or during sharp turns, the VS 8 always dropped down from its foils. However, it was proved that a hydrofoil boat of this size could maintain a 35 knot speed in sea force 5, and could probably increase this performance to 40 knots under similar conditions if proper engines and propellers were provided. The craft was remarkably stable even in sea force 3 from ahead. However, even with two 2500 hp. engines it was considered doubtful that the craft would stay on hydrofoils with the rudder turned hard in either direction; a five-degree turn seems to be the maximum rudder for staying on hydrofoils.

To test the speed when hydrofoils were damaged, it was found that 20 to 21 knots was absolute maximum on both motors because of the braking action of the submerged foils. Technically, this is not due to drag but mainly to the lack of a variable-pitch propeller suitable for running both on and off hydrofoils.

*von Schertel/Sachsenberg Hydrofoil VS 6*

At the end of trials, it was decided to abandon VS 8 in favor of VS 6, which had an improved hydrofoil. The craft itself was subsequently stranded at Stolpmunde after engine failure. It was planned to cut off the hydrofoils and lay up the hull at Maureb, Swinemunde.

## Trials of the VS 6

VS 6 was tested in Bay of Travemunde on 24 and 25 October 1944. “Wind 1 - 2, swell 1!” The boat rose on to its hydrofoils, in all directions, in 6 -10 seconds calculated from a medium speed. That means that the hydrofoils principle with this [gentle] swell is

solved, and that the engine installations and the performance attained from them, was not only sufficient but very high (2 engines totaling 1300 hp!)."

A second trial showed that the boat became foilborne in 14 seconds from a start with engine cut and helm turned 10 degrees. When the helm was turned hard over, and remained thus, the boat rose onto foils with difficulty.

On the 25th October, the following results were recorded with wind 2 – 3 from the NE and swell 2: “On courses against the sea, and with the sea running abeam, the boat rose on hydrofoils and was buffeted badly by the heavier seas. The performance of the engines was completely sufficient, and the boat rose onto foils in approximately 15 seconds, calculated from a low speed.

“When course was set with the sea, in not one instance was it possible to bring the boat back onto the hydrofoils. As soon as the forward part of the boat came just in front of the crest of a wave, and the stern in the trough, the boat rose for a brief period on to its hydrofoils, and when the stern was lifted by the next wave it dropped completely from the hydrofoils again, and even caused the boat to pitch down to a certain extent. In these cases the revolutions had to be decreased immediately to prevent the bow from submerging completely because of the braking effect of the hydrofoils.”

"It is established that the boat, which has a displacement of approximately 13 to 17 tons maximum with 2 engines totaling 1300 hp, sets out the most favorable conditions for the proof of the hydrofoil principle. According to a report of the Representative of the Sachsenberg Yards, all the latest developments of the hydrofoil principle are included in this boat. The trials ought, therefore, to be pursued fully."

"It has now been established that the hydrofoil E-boat can only be used in favorable weather (swell 1). For military purposes a boat designed on this principle is therefore unsuitable. It even appears questionable whether the pursuit of the principle after the war has any point at all.

"The Navy Department and Ships Construction Commission, from which Departments a representative was sent to take part in these trials, do not concur. "The problem will be running against the swell, and it will never be overcome. A seaplane, for instance, cannot land or take off against the swell. The incline of a hydrofoil boat to the sea depends on the wave crests and troughs. As soon as the stern is lifted by the wave the boat always drops from its foils and threatens to dip. This failing will never be offset by increasing engine power. The hydrofoils will always tend to go into a dip no matter how many alterations aligning the foils are tried to control the movement of the forward part of the ship, when the stern is lifted by the swell."

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## IN MEMORY OF BILL BUCKLEY

*By Mark Bebar*

It is with great sadness that I report that long-time IHS member Bill Buckley passed away on November 21st, 2016 at the age of 92. Bill was a senior scientist in the Ship Structures Department of the Naval Surface Warfare Center – Carderock Division (NSWC-CD) for many years. He supported the Navy's hydrofoil R&D efforts that led to the Patrol Hydrofoil Missile (PHM) acquisition program. IHS member Phil Yarnall, also a former employee of NSWC-CD, provided the following insights on Bill's outstanding work for the Navy:

Bill Buckley made many contributions to the PHM Program. One of the more significant (and least recognized) was the Energy Absorbing Tiller Arm between the top of the forward strut and the steering actuator. By way of background, during its operational life in the 1960s and early 1970s, there was an incident when PCH-1, HIGH POINT struck a floating log (dead head) near an outer tip of her forward foil and rotated the forward strut rapidly. The force of the rotating strut was so great that it tore out internals of the steering actuator leaving the ship hullborne, with the forward strut at a 20+ degree angle, and only able to steer with the hullborne controls. To prevent this from happening again, Bill invented the Energy Absorbing Tiller Arm, two rings mounted on top of one another. The upper ring was connected to the steering actuator. The lower ring was attached to the king post at the top of the strut. The two rings were bolted together. However, the bolt holes were a series of different length slots. Upon impact, the rings would rotate relative to one another, with the bolts failing sequentially at the end the slots. This would absorb the energy of a forward foil impact, and at the same time, maintain the integrity of the steering actuator-to-forward strut connection and the ability to steer the forward strut.

The Navy did not think Bill's invention was worthy of a patent, but they did put one on each PHM. Then Boeing put a similar mechanism on their commercial JETFOILs and got a patent. Boeing claimed they had made modifications to Bill's invention. Once Boeing was granted a patent, Carderock's legal department then applied for a patent on Bill's behalf. Bill Buckley was granted a patent on the Energy Absorbing Tiller Arm.

A larger and farther reaching contribution of Bill's was the Foil System Structural Criteria. Bill lead a team of Carderock, NAVSEA, and Boeing engineers which combined operational experiences with earlier hydrofoils, structural analysis methods, and material properties to develop the Foil System Structural Criteria. This became the PHM Foil System Structural Criteria to which the PHM foil system was designed. During evaluation of PHM-1, USS PEGASUS, Bill was involved in collecting the strain gage readings throughout the ship, which included the hull, struts and foils to verify the theoretical versus actual measured loads.

In addition to his superior analytical efforts in support of the Navy's hydrofoil program, as a specialist on sea loads as applied to marine structures, Bill devoted many years on his analysis of extreme seas. Two of his notable reports are:

- Technical and Research Report Number 57 "Extreme Waves for Ship and Offshore Platform Design" Published by The Society of Naval Architects and Marine Engineers – 2005 Report - SNAME
- "Analysis of Wave Characteristics in Extreme Seas" Published by David Taylor Research Center – 1991 Report - DTIC

Bill will be sorely missed by all of us at IHS. His obituary can be viewed at: Pumphrey Funeral Home

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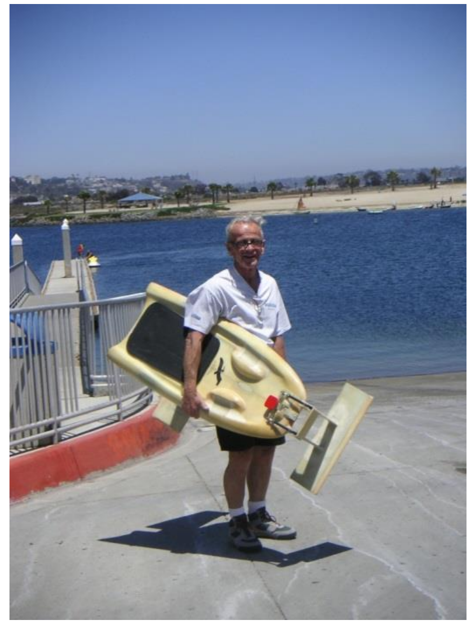
## TERRY HENDRICKS A RETROSPECTIVE

*By Ray Vellinga*

Terry Hendricks was a good friend. On the IHS website there is a brief obituary following his June 2003 departure, but Terry was a colorful guy and deserves to have more of his story told. Starting In the 1990s, Tareah John Hendricks was one of the original guys on our San Diego based human-powered hydrofoil team. There was Dwight Filley and Steve Ball with human-powered hydrofoils. I was into small powered recreational hydrofoils. Terry's Choice was knee-boards. Ray Johnson was our mathematical adviser, retired from the aerospace industry (our rocket scientist). We were building prototypes and testing every two or four weeks. Observers might believe Terry was the youngest of us all. He was compact and wiry like a high school wrestler, but in fact he was approaching 80 at his final surf ride.

One testing day Terry asked me why I was less interested in my original passion, aviation, in favor of hydrofoils? "It's because there is not much room for innovation in the mature science of aircraft, and it's a bonus that you can't kill yourself testing hydrofoils". Perhaps I spoke too soon about the second assumption.

Terry obtained his Bachelor of Science degree from the University of California at Berkeley with highest honors in physics. He obtained his PhD from the University of California at San Diego for research into high-energy, elementary particle physics. After



*Terry Hendricks before a test of his board, June 22, 2007*

receiving his degree, he carried out experimental studies of mass transfer in reverse osmosis from 1967 to 1970 in the Applied Mechanics and Engineering Sciences Department (AMES) at the University of California, San Diego. In 1970, He was named the National Science Foundation Fellow in 1967. The Southern California Coastal Water Research Project employed him for some 23 years. Following his retirement, Terry's passion was for knee-board surfing.

Terry had at least one patent. Here is an example: Hydrofoil surfing board, patent number: 7144285, December 5, 2006; Google patents link

Terry was a true intellect, very adventurous, secretive, and willing to take a risk to guard his secrets. It's not that he was foolhardy, but he was genuinely serious about protecting his discoveries.

*Hendricks on his foiling surfboard*

For those of you who don't live in coastal California and don't surf you may be surprised to hear that the tiny body-boards are especially dangerous. The boards are short and fast, and unlike surfboards, one lies prone as he speeds along the steep waves as high as 8 or 10 feet. If a rider is that high and the board noses into the surf, he's propelled headfirst for a long drop.

For reasons of secrecy, Terry added spice by choosing to do his prototype testing off Swami's (just off shore from the namesake, Self-Realization Fellowship Hermitage & Mediation Gardens) Encinitas, California at three and four in the morning when no one else could watch. There are probably safer places to body-board. Swami's has coral reefs that are dangerous to surfers and body-boarders alike. See the attached photo

*The reef at Swami's in Encinitas, California*

There are other hazards besides the coral reefs. For example Terry had the distinction of being one of the few Surfers bitten by a harbor seal. When asked why such a docile animal would attack, Terry replied they get excited when stepped on in the dark.

Surf riding at those early hours has other unpleasant possibilities. On his last ride Terry crashed, and although wearing a helmet he was rendered unconscious and was washed up on to the beach. At daybreak a surfer found him partially covered in sand and seaweed. Terry was hospitalized with, I suspect, possible lung damage that was unshakable. About a month later, he visited us at our test site in Mission Bay, and he did not appear to be his normal energetic self. We received tragic news of his passing about two weeks later.

The surfing community of Encinitas held a memorial for Terry that drew 150 people at Swami's and there they embedded a permanent plaque in the sidewalk in his dedication. [YouTube Video]

We all miss him. His Brilliance, enthusiasm, and inventiveness have been lost to all of us. Ironically, due to his secrecy no one was left to carry out experiments on his advanced prototypes. The only ones not-distressed were the snoozing harbor seals.

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## ON THE WEBSITE

Check it out (click on link):
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*OUR ASSOCIATE, [THE FOILING WEEK]. SEE THIS VIDEO:*

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## THE NEXT ISSUE

Remember, if you enjoyed reading articles in this issue of the Newsletter, they were provided with thanks to fellow IHS members. If you are able to share news on new projects or research work and, better still, prepare an article for the Newsletter, please email the [editor]