

International Hydrofoil Society Reprint...

The Miller Hydrofoil Sailboard

For racers of the future, this design provides fast acceleration and a smoother ride on choppy seas

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<new!> Rich Miller's free 28-page Illustrated Technical Paper: [Click Here](#) (Adobe Acrobat file)

<new!> Sam Bradfield's, Harken Board Sailing Hydrofoil Pictures, Product Catalog and the Harken Hydrofoil Flight Manual courtesy of a current owner Jonathan Levine. He reports that it was made only briefly by Harken, appearing in their 1986 catalog. They recently told him that they sold somewhere around 50 of them.: [Click Here](#) (Adobe Acrobat file) (wnw070911update)

See also: [Hydrofoil Sailboards, Windsurfers, Surfboards](#)

(Last Update 11 Sept 07)

Since the beginning, board sailors have been talking about putting hydrofoils on a sailboard, flying up out of the water, getting rid of lots of drag, and going really fast. A few people have taken the idea beyond discussion, writing patents and building prototypes. During the mid-eighties, a hydrofoil designed by Sam Bradfield was sold by the Harken Company. That design consisted of an entire small airplane that was mounted on a fin that attached in the centerboard slot of the original Windsurfer. Although some of the prototypes and the Bradfield-Harken hydrofoil were able to lift the board and rider clear of the water, none delivered performance that even equaled that of the conventional sailboards available at the time.

Now there is a hydrofoil sail-board system that may turn the fantasy of great hydrofoil performance into reality. Developed over the last six years by Rich Miller and friends, the Miller Hydrofoil delivers a smooth and very stable high-speed ride. Steering is extremely precise. In short board conditions, it planes up very quickly, then undergoes terrific acceleration, to speeds often exceeding those attainable on conventional boards. It points extraordinarily high when working to windward, and the ride on bearing off to a beam reach is breathtaking.

The Miller Hydrofoil was designed to handle just like a conventional sailboard. It works with standard sails and harness systems, and all the controlling movements are what you'd expect. It is steered by rolling, and trimmed by raking the mast in the usual way. Jibing, too, is conventional, except that the jibing maneuver must be preceded by a simple manipulation that



is described further below. The board remains flying throughout the jibe.

The Miller Hydrofoil system consists of a main foil assembly, mounted in the fin box, and a “canard” foil assembly mounted in a special frame that is glued into a hole cut in the board near the tip. The canard is a controlling, rather than a weight bearing, foil. The main foil, mounted almost directly under the sailor, supports almost all the weight of the board and rider. It is designed to remain submerged at all times, and it is guided in doing so by the canard foil, which pops to the surface before board take-off, and generally remains there during subsequent operation. The key to the high performance of the Miller Hydrofoil is the reliability with which the canard foil tracks the surface. Secure surface tracking in the Miller design leads to pitch stability, which is important for keeping the board flying in puffy wind and when overtaking waves on broad reaches, and is also crucial to automatic height control, which is essential to high-performance hydrofoiling. Without automatic height control, foilborne operation inevitably degenerates into “porpoising,” where the foils alternately fly into the air and dive too deeply, leading to very inefficient motion and poor control.

Testing early in the development of the Miller Hydrofoil showed that a special type of foil is needed if the canard is to remain reliably on the surface. The type is called “supercavitating” and doesn’t look at all like a standard wing. Rather than having the usual tear-drop shaped section, it has one more like a narrow wedge, with its point facing forward. The result is a foil reminiscent of a meat cleaver with its business end in front. The earliest version of the Miller Hydrofoil consisted of just a conventionally shaped submerged main foil and a surface-tracking supercavitating canard, both mounted symmetrically with respect to the keel plane of the board. The board took off easily and was sailed flat. However, when sailors tried to lean out to power up the rig, they found that the rear fin, which was necessarily exposed to the air at its top, ventilated, and the board spun out. To get more power, and at the same time avoid spinning out, they had to roll the board to windward.

The more the roll, the more they could power up, and the faster they could go. Unfortunately, it also happened that as the roll increased, so did the tendency of the board to round up into the wind. To keep the board going straight, it was necessary to hold the sail far forward of the usual place, which couldn't be done from a comfortable resting position in the harness. Of many ideas to overcome this sail-balance problem, hinging the canard and "unrolling" it relative to the board was the first to work. To date, it is the only good solution that has been found. As long as you sail on one tack, unrolling is a perfect solution, leading to a fully-powered and, at the same time, balanced ride. However, since the canard needs to be unrolled in opposite directions on opposite tacks, the canard assembly requires a hinge, together with mechanisms for shifting and locking it, which add notable mechanical complication. And, the manipulation of these mechanisms adds to the sailor's task while jibing. Before the jibe, the canard needs to be moved to its centered position, and afterward unrolled for sailing on the new tack. To try to avoid the complication of a hinged canard, various fixed canard arrangements have been tried, but none has been very satisfactory: they typically behave very badly in the jibe and in waves. Thus, because of the terrific performance it allows, the extra complication of the hinged canard is amply justified.



A final note: Many people who first see the hydrofoil in flat water ask if it can handle waves. The answer is emphatically yes! An important rationale for the use of hydrofoils in general (not just on sailboards) is that they don't "see" waves smaller than the foils themselves, and thus effectively smooth out the water, allowing higher speed operation than is possible on surface craft that constantly slam into seas. This general fact holds true for the Miller Hydrofoil as well, which handles chop much better than conventional boards. If you can sail a short board, you'll find it easy to learn to fly the Miller Hydrofoil. You can arrange a free lesson and demo ride by calling (510) 525-8006 or by approaching Rich Miller when you see him at one of the local sailing sites. He's easy to find — he's the one sailing just a little above the water.

Correspondence About the Miller Hydrofoil

Miller's Foil

[6 Apr 03] I am looking for some general information about surface planing foils such as the bow foil on a Miller hydrofoil windsurfer. Are they flat? angle of attack and surface area to carry how much weight? -- John Ilett (john@fastacraft.com)

Response...

[6 Apr 03] I have corresponded with Rich Miller a few weeks ago on this same topic. He is using a surface running super cavitating foil about 400mm wide by 100mm deep, supported by a round stainless strut. The foil has a sharp leading edge with hollow underside curvature back to a 12mm thick square back trailing edge. My own experiments confirm this is much better than a normal foil or even a flat surface for this purpose. At about 3-5 degrees angle of attack. Should work well on the Moth. I have a new version of my Moth under construction using exactly this arrangement with the foil already built. Will post some details when I have it working. -- Ian Ward (ianward@ozemail.com.au)

Updates and Notes from Rich Miller

[21 Dec 00] Since this article appeared in 1997, I have made a number of changes in the design, most notably the replacement of the inverted T main foil by one in the shape of an inverted Y with anhedral angle of 35 degrees on each side. This rather improbable change led to startling improvement in performance. In addition, I have gone to very high aspect, constant chord wings, again with significant gain in performance. I am not personally a very good windsurfer, but the hydrofoil advantage is so great that typically no conventional sailboard can stay with me on any point of sailing. And, the worse the chop, the greater my advantage. Unfortunately there is no real production of my hydrofoil kit, although I have made foil sets available to the few people who have shown interest. Now that the design is working so well and in fact is quite easy to learn to sail, I would like to make it more generally available. -- Rich Miller (rich@ski.org); 640 Colusa Avenue; Berkeley CA 94707 USA; phone: 510-525-8006

Comments From Sam Bradfield

[30 Dec 00] He has added exactly what it was lacking in the canard surface tracking pitch sensor...very simply and elegantly... I think it's terrific! I hope he makes a lot of money with it! -- Sam Bradfield <http://members.aol.com/HYDROSAIL/> E-mail at (HYDROSAIL@AOL.com)

Comments From Ian Ward

[22 Nov 02] We should not forget the amazing development by Rich Miller of the first true and only "monofoiler," a high performance sailboard with just one foil in the water... like a unicycle! -- Ian Ward (ianward@ozemail.com.au)

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