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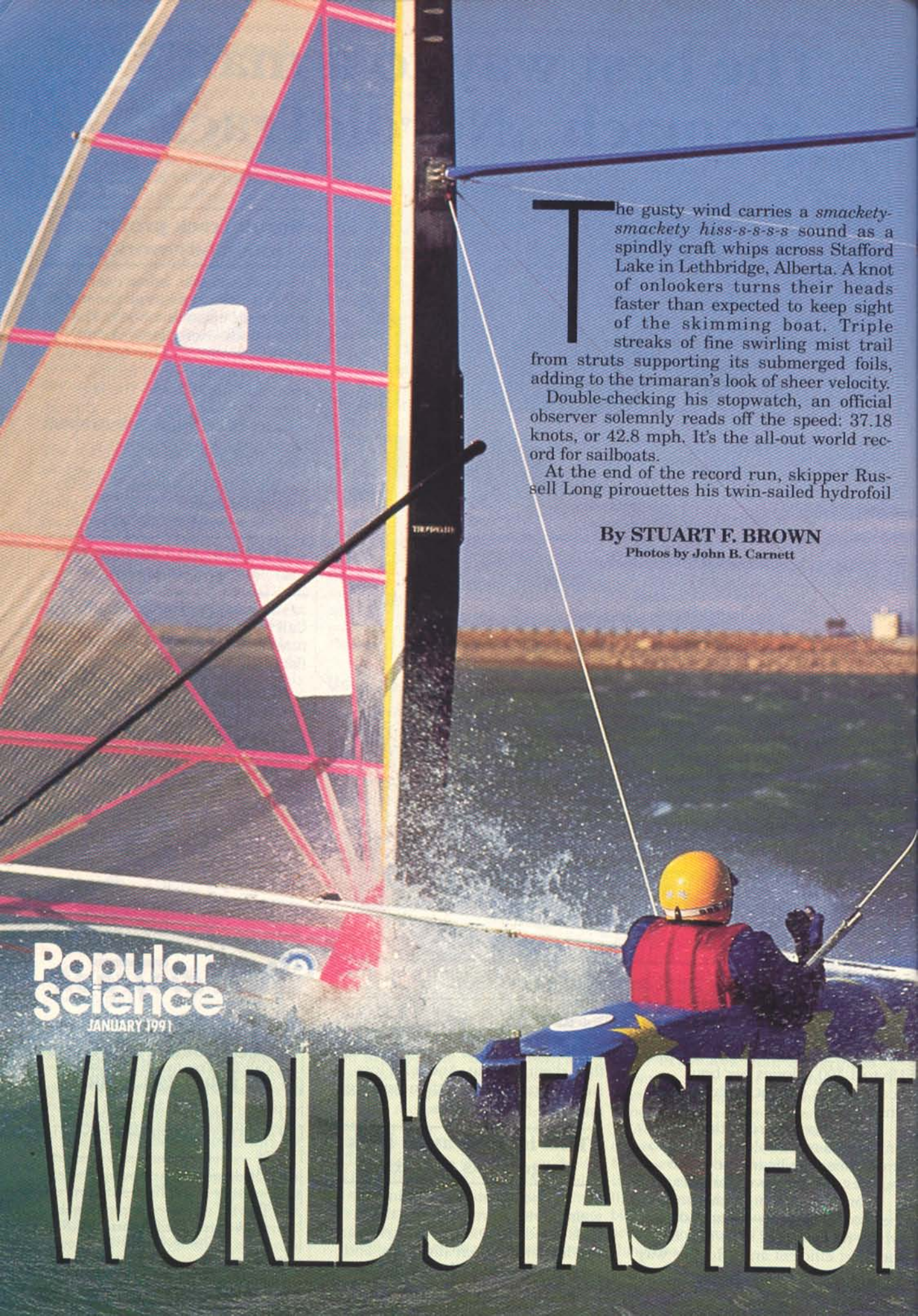

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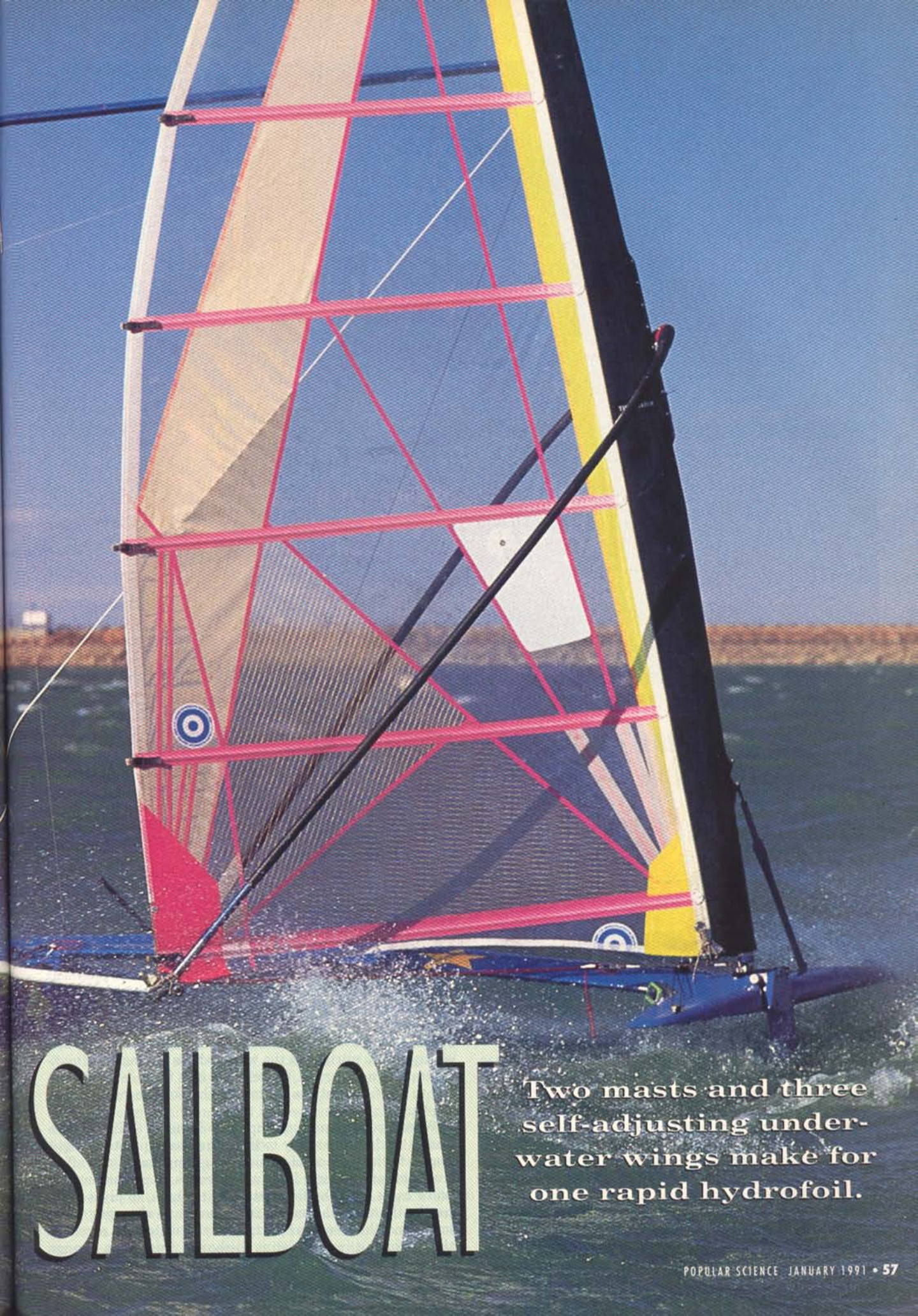
WORLD'S FASTEST

The gusty wind carries a *smackety-smackety hiss-s-s-s-s* sound as a spindly craft whips across Stafford Lake in Lethbridge, Alberta. A knot of onlookers turns their heads faster than expected to keep sight of the skimming boat. Triple streaks of fine swirling mist trail from struts supporting its submerged foils, adding to the trimaran's look of sheer velocity.

Double-checking his stopwatch, an official observer solemnly reads off the speed: 37.18 knots, or 42.8 mph. It's the all-out world record for sailboats.

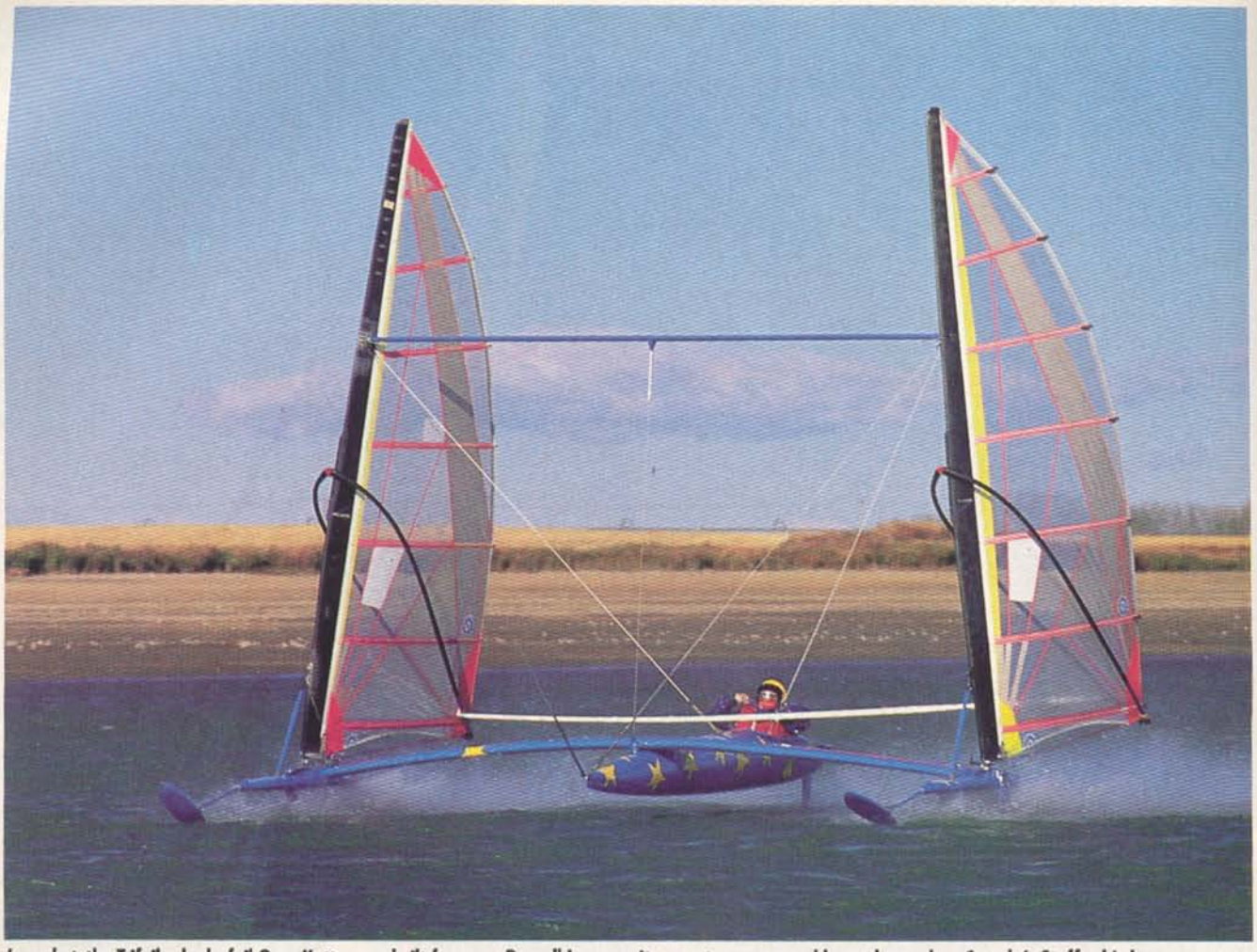
At the end of the record run, skipper Russell Long pirouettes his twin-sailed hydrofoil

By STUART F. BROWN
Photos by John B. Carnett



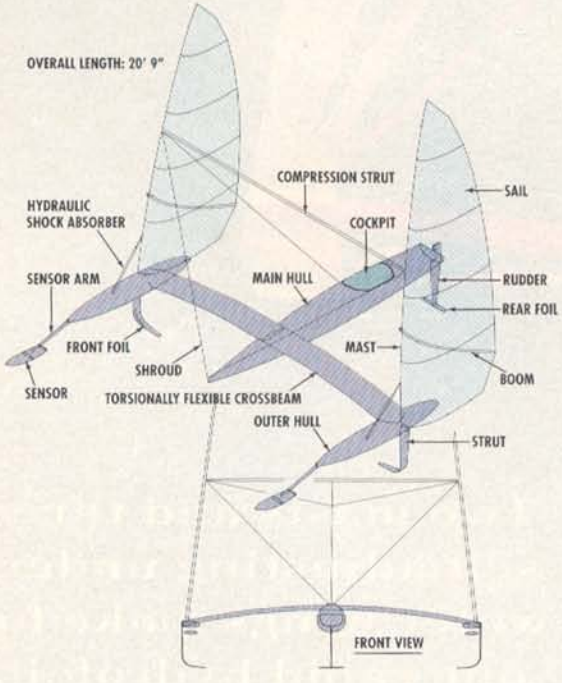
SAILBOAT

Two masts and three self-adjusting underwater wings make for one rapid hydrofoil.



Longshot, the Trifoiler hydrofoil Greg Ketterman built for racer Russell Long, on its way to a new world speed record on Canada's Stafford Lake.

TRIFOILER TRIMARAN HYDROFOIL



Sensors forward of the outer hulls hug the water's undulating surface, constantly adjusting the pitch of the hulls and main foils to maintain stability and minimize drag. Foot pedals control the rudder.

smartly into the wind. Its masts remain upright while the triple hulls and foils stay flat in the water during the jibe. There's no heeling over with the wind in this boat, therefore Long can stay nestled in the 201-pound speedster's cockpit.

"Sailing our hydrofoil is much more akin to driving an open race car in the rain than it is to conventional sailing," the champion sailboat racer says half-jokingly. "We've just got to put a windshield in the boat; I always end up like a drowned rat. But seriously, this craft does beautifully at high speeds. And I'm confident that with the right wind conditions we can go even faster."

The swift new boat design is called Trifoiler. It's the invention of Greg Ketterman, a soft-spoken engineer from Long Beach, Calif., who likes to compare his hydrofoil's sailing and turning performance with another type of quick and level-sailing craft: an ice boat. One of the reasons an ice boat is fast, he explains, is because its sail always stays upright in the wind, where it generates maximum forward thrust. These boats owe their level cornering to the fact that the ice braces the outside runner during turns.

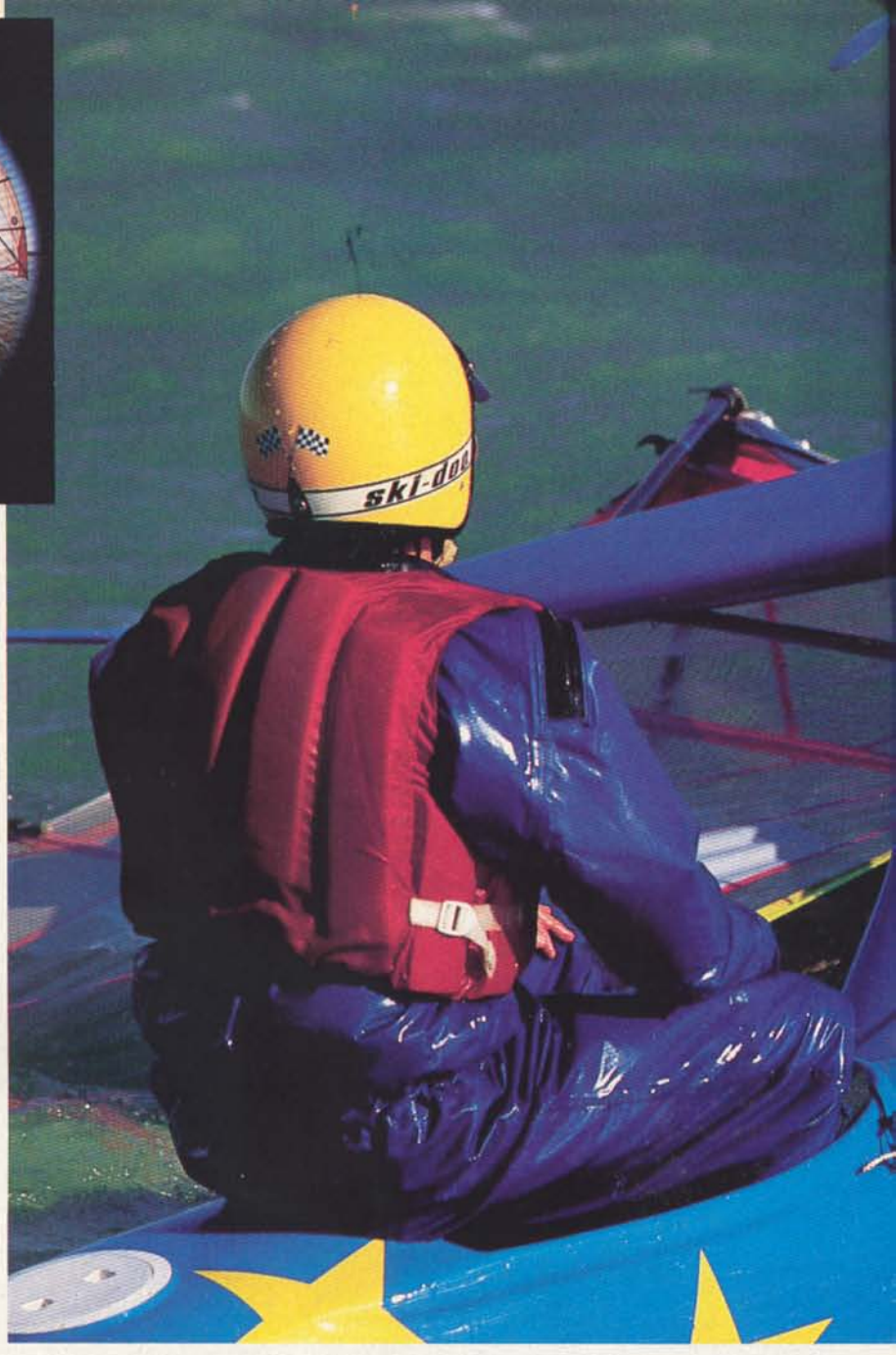
Water provides no such support, of course, so Ketterman had to find another way to keep the boat's masts at right angles to the surface. He calls his uncomplicated and effective solution dynamic leveling. It works by permitting the outer hulls, and the foils attached to them, to pivot independently a small amount in response to changing wind loads and the irregular surface of the water. As a result, the Trifoiler's inward-facing L-shaped front foils change

A fish-eye view from above shows the trio of misty wakes generated by *Longshot*'s foils. The slim cockpit has room for the pilot and little else.

their angle of attack slightly in the water, causing the boat to right itself automatically.

There's not a single speck of silicon circuitry on board the Trifoiler; all its "smarts" reside in the bending and twisting behavior engineered into the trimaran's carefully tailored composite structure. The boat receives inputs from the ever-changing wind and water through a pair of mechanical "sensors" resembling miniature surfboards (see drawing previous page) that are connected to the outer hulls by springy glass-fiber struts. The sensors track the water's surface, constantly optimizing the angles of the outer hulls and foils in response to waves, much like the independently pivoting skis used in the front suspension of a snowmobile. A glass- and carbon-fiber-reinforced crossbeam joining the outer hulls allows them a limited degree of twisting motion relative to each other, while preventing any bowing up or down.

"When a traditional sailboat is heeled over," Ketterman says, "its sails dump a lot of driving force. As the wind picks up, the sail loses area, and therefore its effectiveness. This is a sort of governing mechanism that maintains the boat's stability and prevents it from tipping over—but at the expense of losing forward thrust. If the sails on my boat begin to heel it over, the windward sensor descends to stay on the surface of the water just as the windward hull starts to lift slightly," he continues. "This causes the angle of attack of the windward foil to become negative, so it digs into the water and prevents the boat from heeling over any further. During all of this the boat looks perfectly level, but it is actually heeled over



"Ketterman definitely has the handle on sailing hydrofoils. His is the fastest and most functional one so far."

just enough to create that small negative angle of attack."

The idea of fast-sailing hydrofoils is one that has fascinated Ketterman since he began building radio-controlled boat models as a teenager. When he studied mechanical engineering at California State Polytechnic University in Pomona, he wrote a computer program that determined the critical dimensions needed to achieve maximum speed with a sailing hydrofoil.

"I wanted to build a high-performance scale model that wouldn't tip over like a regular model catamaran will unless there's someone on board to control it. The idea of a foil that gets pulled down to a lower angle of attack when the boat heels over seemed like the answer, and that's what got me going," he recalls. "I asked my velocity-prediction program if the improved stability due to the down force on the weather side was worth the drag it added. The answer was yes; the stability would more than make up for the drag. The computer said the boat would just keep accelerating until it disintegrated. So I knew that controlling the incidence of the foils was the way to go really fast."

Working on a shoestring budget with his brother, Dan, Ketterman built his first full-scale boat, which proved fast and relatively easy to handle. During testing two years ago, the brothers' craft caught the eyes of engineers from Yamaha's recreational-product development group, which acquired the right to use Ketterman's patents to produce a consumer version of the Trifoiler. Yamaha hasn't yet committed to manufacturing the boat, but it has built two prototypes that are now being tested. The second one is a two-place model with the sailors seated canoelike in the center hull, according to Nick Larson, a development engineer at Yamaha Research and Development California in Cypress.

"Our approach to the boat isn't ultimate speed. In fact we've done quite a bit of work trying to get it up on the foils at as little as eight miles per hour of wind, which is close to the average wind speed in a lot of areas. That's a much lower speed than Greg's record-setting boat needs to get on its foils. We think low-end performance would be more valuable to the consumer, who wants to have fun even though the wind may not be strong," Larson says.

Fast experimental boats are ultralight and sometimes fragile. Pilot Long (left and above) surveys the aftermath of a snapped crossbeam. Nobody fretted too much—he was returning upwind from his sixth and fastest run when it broke.

GUARDIANS OF THE RECORD BOOK

The man shown above on the left sharing jubilation over stopwatch readings with Russell Long and the Ketterman brothers, Greg and Dan, is official observer Richard Clark. Clark represents the Royal Yachting Association of England, the sanctioning organization to which boat designers apply when they hope to see their names written in the world record book. Until a formal notice arrives from England, Ketterman and Long are required to describe their speed record as "pending ratification by the RYA."

Aspirants to a world sailing speed record must provide the following at their own expense: an RYA-approved observer, a surveyor's measurement of the prescribed 500-meter course, calibration of all stopwatches by a jeweler, and two radio-equipped timers at both the starting and finish lines. The boat's sail area is also measured. The current world sailing-vessel records stand at:

- 49.4 mph—Under 10-square-meter sail area (wind surfers)
- 42.8 mph—Class A, 100- to 150-square-foot sail area
- 39.7 mph—Class B, 150- to 235-square-foot sail area
- 31.7 mph—Class C, 235- to 300-square-foot sail area
- 41.4 mph—Unlimited class, 300+ square-foot sail area

Ketterman and Long set the official Class B record of 39.7 mph in Corpus Christi, Texas, late last June. RYA ratification of their 42.8-mph record run in Canada will confirm them as builder and skipper, respectively, of the world's fastest sailboat.—*S. F. B.*

Ketterman's designs have won him considerable respect from Yamaha's American and Japanese engineers. "Greg has a tremendous amount of empirical and analytical knowledge. He definitely has the handle on sailing hydrofoils," says Larson. "His is the fastest and most functional one so far. He figured out an elegant solution to the complex problem of controlling the incidence of the foils."

Others have taken notice too. Ketterman says he's had serious inquiries from people who want him to build bigger hydrofoils, including a 60-foot version for a California-to-Hawaii record attempt. His strategy is both cautious and ambitious. "First I want to sort out some of the component breakage problems we've had on the high-speed boats and help Yamaha make their boat as safe and easy to use as possible for the weekend sailor. Then we could build a thirty-five-foot boat designed for rougher water." He pauses for a moment, then adds, "And I still want to go faster. I'm sure we can get past fifty miles per hour in a strong, steady wind, which we haven't had yet during our record runs. The wind surfers' record is 49.4 miles per hour, and I'm sure we'll get them one day." PS