

GAÏA Debugging a Novel Catamaran Design

By Joseph Norwood, Jr. and Louis Dionne

In the March/April 1985 issue of *MULTIHULLS*, I described a canard catamaran design that is intended to combine the best features of catamaran and trimaran.

The accommodation is contained in a large central pod that is carried a few inches above the static waterline and has a concave bottom to minimize pounding.

The rig is a high-aspect full-battened pyramid rig carried on a carbon-fiber mast, mounted in the stern and capable of 360° rotation. Steering is by a single skeg rudder in the bow of the pod.

As designed and built, *Gaïa* had an overall length of 49 feet (Fig. 1). Early last summer, on the day when Louis first dropped the boat into the water, I received a frantic phone call. *Gaïa* was down on her lines, more at the bow than at the stern. A quick trip to Quebec, and some detailed measurements, showed that the boat was heavier than I had estimated and needed to have its center of buoyancy moved forward. Our solution was to cut the hulls at the maximum section and insert a new hull section of eleven feet, eight inches. This added 1,762 pounds of buoyancy per hull, put the center of buoyancy where it belongs, and extended the bows to provide a drier boat. The displacement/length ratio went from 22.8 to 15.9, a definite improvement. The overall length of *Gaïa* is now 60 feet, 8 inches. In order to drive the new and larger *Gaïa*, the sail area was increased from 900 sq. ft. to 1,160 sq. ft. by increasing the aspect ratio of the rig from 4 to 4.5. The new 'stretched' *Gaïa* is shown in Fig. 2-3 shortly after relaunching in late 1986. She now floats right on her lines with the pod keel a uniform 4" out of the water. Figure 4 shows *Gaïa* with the carbon-fiber mast in place. Auxiliary power is provided by twin 25hp Suzuki outboards.

Gaïa's first trials took place in June of 1987. In light airs she made wind speed, or a little more (about 8 knots) closehauled, and was decidedly underpowered going downwind. Louis noted that the windward performance was at least as good as a good monohull. This is, so far as I know, the first pyramid rig to be efficient closehauled. It goes to show what full battens and a high aspect ratio can do. Louis further noted that the windward performance was very sensitive to the angle of attack of the rig. One 'click' of the winch got you two knots, and the next 'click' lost you three knots. Further, the boat suffered a weather helm which the rake of the centerboard did not relieve altogether. Finally, the boat was impossible to tack without

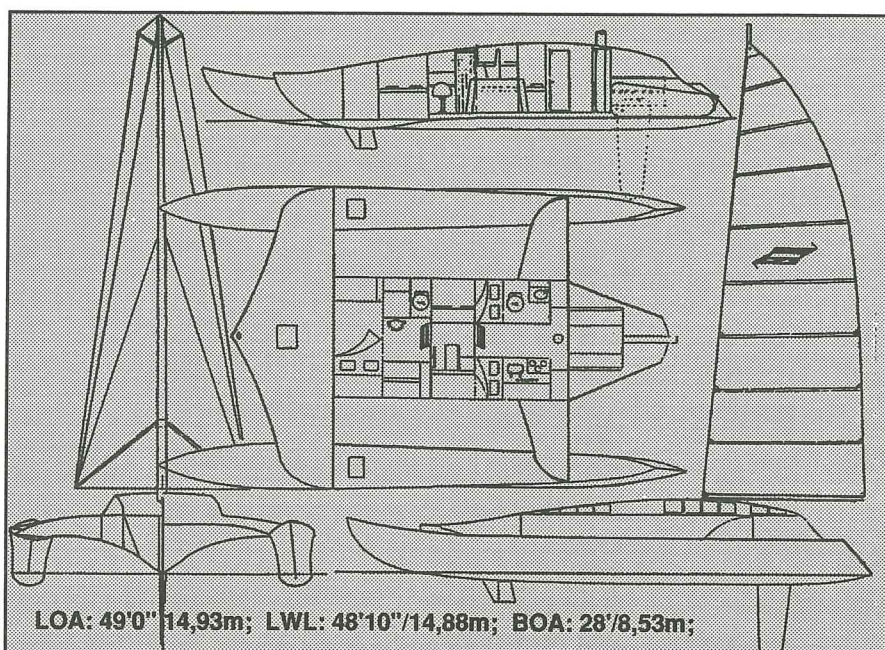


Figure 1: *Gaïa* as originally designed and built. Details were published in the March/April 1985 issue of *MULTIHULLS*.

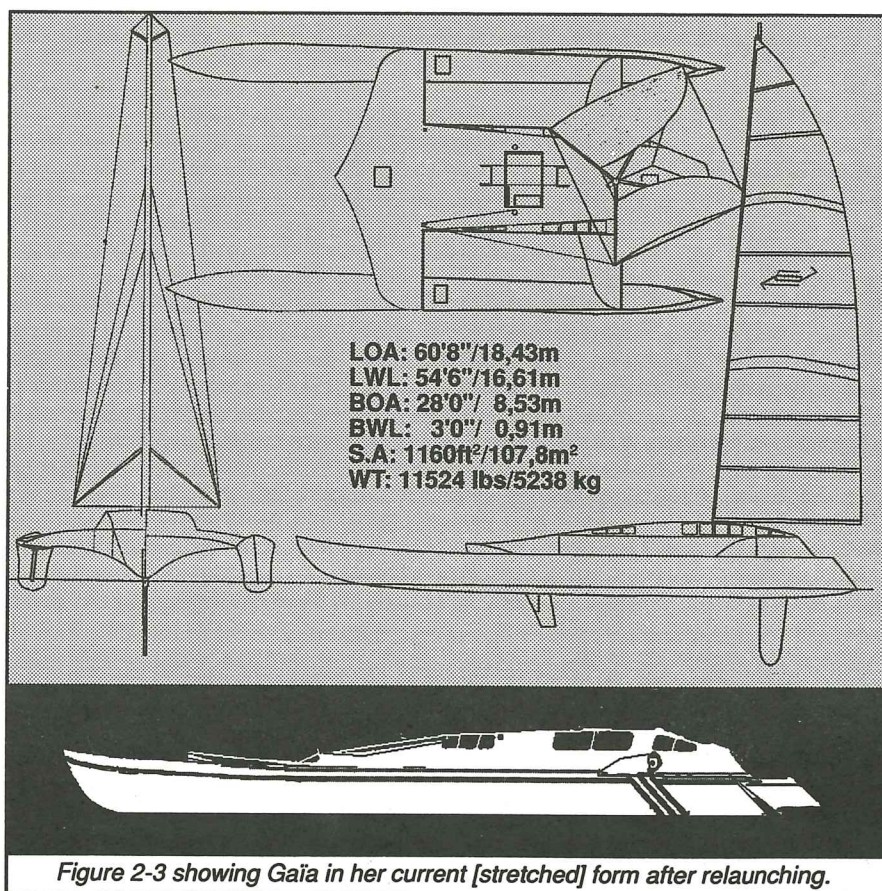


Figure 2-3 showing *Gaïa* in her current [stretched] form after relaunching.

help from the motor. On the last day of trials, the wind was 25 knots and the mast broke about 15 feet from the head; fortunately, without damage to the sails or battens. The mast breakage was caused by the fact that we lengthened the original design without adding another shroud. This has now been corrected.

It is quite gratifying that the boat goes so well to windward. We are planning to add spinnakers to augment the performance off the wind. The handling problems were not altogether unexpected and the cures are reasonably straightforward.

The hypersensitivity to angle of attack is caused by the fact that the leading edges (forward 25%) of the sails are too flat and, therefore, stall at small angles of attack. The full battens serve to prevent luff wire sag if they are stiff enough, however making them stiff enough to accomplish this, prevents the attainment of adequate sail curvature forward and concentrates most of the curvature in the middle of the sail. The sails were designed to use two CamberSpars (invented by sailmaker Dave Bierig) per sail. The CamberSpars, effectively half-wishbones in a pocket, are even stiffer than battens, however they have adequate curvature forward. This shaping is effective over a wide range of wind speed, which is just what we want for the pyramid rig. Louis decided to see if the battens alone would do the job and it would seem that the answer is no. My recommendation to him is to install CamberSpars. My own catamaran, *Xerxes*, is roughly a quarter-scale model of *Gaia* and I find with *Xerxes* that the angle-of-attack sensitivity is definitely reduced when the CamberSpars are in.

The weather helm is caused by the fact that when we increased the sail area by 29%, we did not make a corresponding increase in the centerboard area. Additionally, the pod keel dips into the water at the bow to alleviate rudder ventilation. The overall effect is a center of lateral effort that is too far forward, and a centerboard that is too small to affect the balance by raking aft. It is also possible that we are getting some ventilation on the board, although I have not seen this on *Xerxes*. The solution is to cut away the bow keel aft of the rudder and add about 35% more area to the centerboard, mostly toward the bottom.

The inability to tack a boat with a bow rudder and stern centerboard was experienced by Phil Bolger in his pioneering work on bow rudders (see 1985 MM article). I saw the same effect on *Xerxes* before *Gaia* was launched. One answer is to gybe the boat, which works well enough and is a fairly relaxed maneuver with a pyramid rig. However, this does not constitute a proper answer to the problem for all situations. The presence of two high-aspect vertical hydrofoils (board and rudder) at either end of the boat, constitutes an ideal configuration for heaving to, especially with the windage of the rig in the stern. When one combines this with the rapid loss of momentum experienced by a multihull when the driving force is turned off, then the boat can hardly do other than fall into irons. There are three possible cures that I can think of.

You can do a rapid retraction of the centerboard as the load comes off in a tacking maneuver and then redeploy when you are through the eye of the wind. I have had *some* success with this technique on *Xerxes*, although the timing is tricky. This is probably not an attractive option for a 60-footer, unless one were to go to hydraulics for the board actuation.

A second option, and in many ways a very attractive one, is to let the centerboard serve as a large spade rudder at the stern. This board could be fixed at a small angle of attack, say plus or minus 4°, on either tack and allowed to weathercock when coming about. I shall probably modify *Xerxes* to try out this option which also has the advantage of balance trim and leeway elimination. If it works well, we can then modify *Gaia* in this way.

The third option has the overwhelming advantage of simplicity; we simply add a small foresail in the bow of the pod. In our canard configuration, this will serve much the same function as the mizzen on a yawl. The foresail can be backwinded to bring the boat about. It will serve to move the center of effort forward

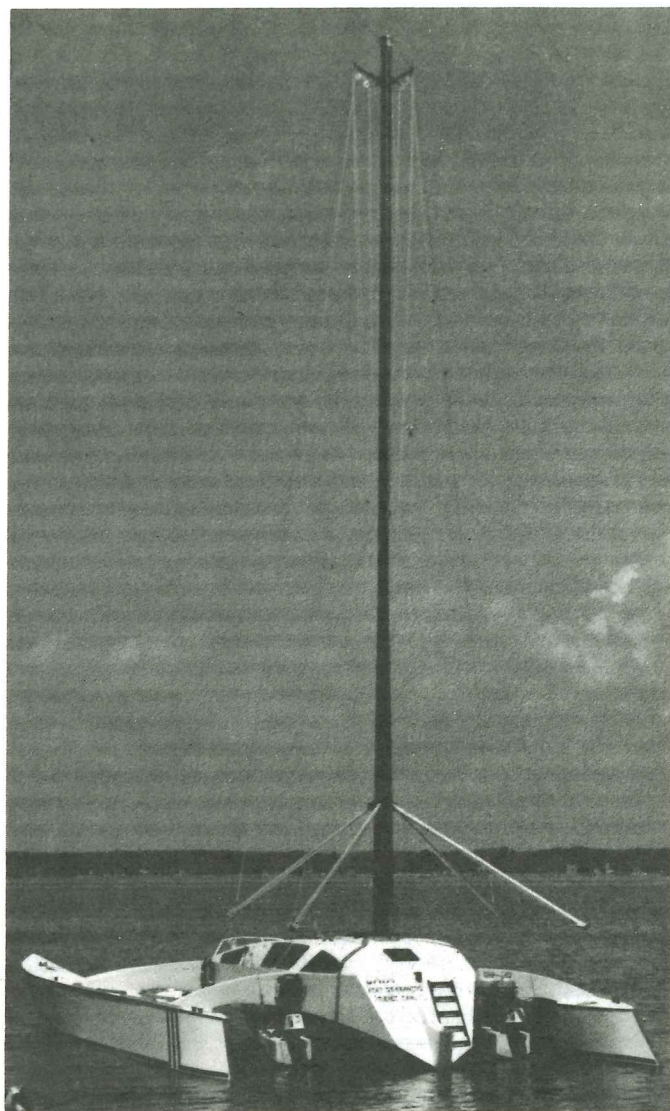


Figure 4: *Gaia* with her carbon fiber mast, showing the twin retractable engine pods.

and can be used to balance the helm on all courses. Dave Bierig has suggested that the thing to do is to invite a windsurfer out for the day aboard *Gaia*, and ask him to bring his rig along. Just provide him a maststep in the bow of the pod and let his instincts take it from there. If this works as I expect it to, then a foresail of about 10% of the area of the pyramid rig can be installed. This should not affect the airflow over the mainsails and should leave adequate room for the spinnaker in between.

All in all, I am quite pleased with *Gaia*. Since the windward performance is there in abundance, the basic aerodynamics are right. The problems discussed above are not too serious, especially when considering the radical configuration of the boat. Louis has been a perfect client, intrepid builder, and absolute gentleman throughout *Gaia*'s development, and I like to think that he will be rewarded with a unique sailing yacht.

It might be interesting to develop a pure racing machine along these lines. That is something to think about.

I would like to express my appreciation to Dave Bierig for his interest in the project, for building such good sails for *Xerxes*, and for his many useful suggestions.

Designer Joseph Norwood, Jr. and *Gaia*'s owner Louis Dionne will be at the WORLD MULTIHULL SYMPOSIUM in Newport, RI. June 27-29