Design Brief

Modeled and Tweaked

A Moloka'i Strait motoryacht is steel (hull only), round bilged, expedition style, and series built. As a bonus, the quintessential design also lends itself to enlargement.

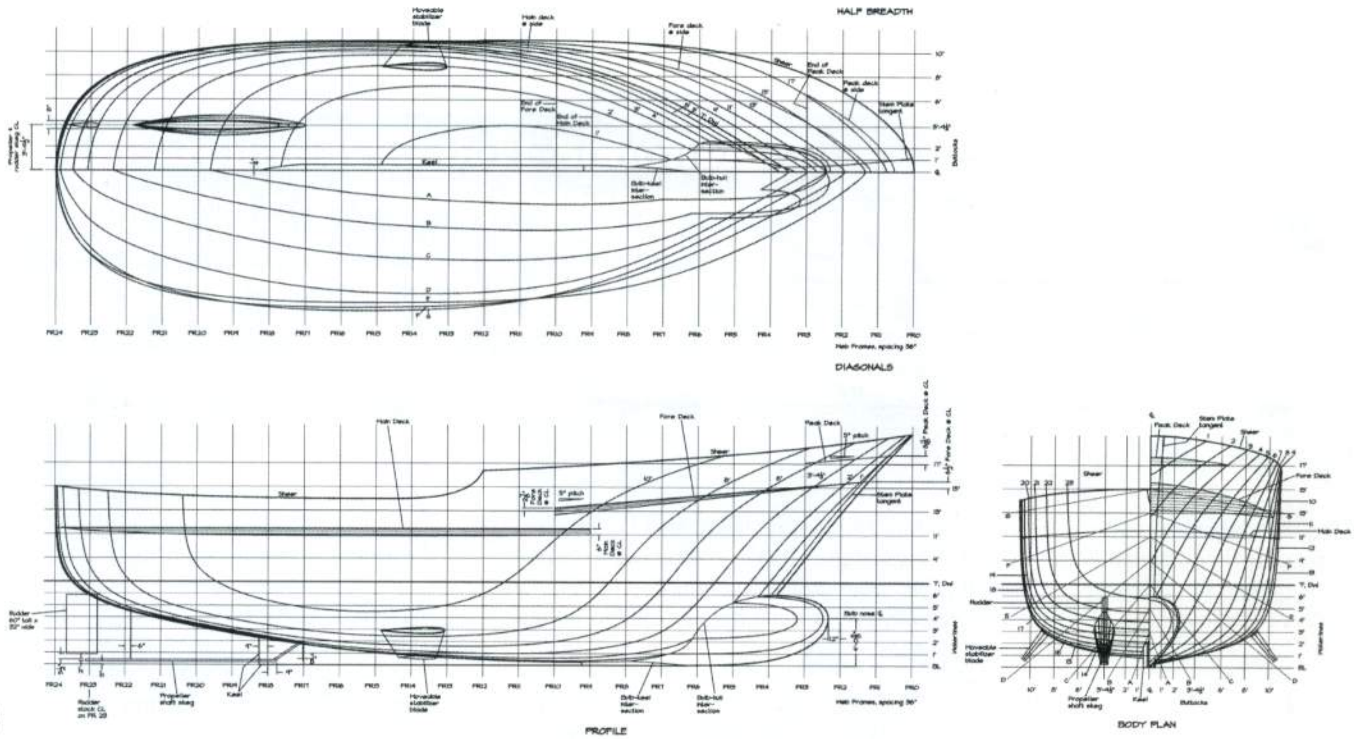
by Eric Sponberg

Above—*Hercules is the 75' (22.9m) model of the Moloka'i Strait line of long-range motoryachts, designed by the author.*

The Moloka'i Strait concept is the brainchild of Geoffrey White, a former owner of Hans Christian Yachts in Taiwan. Traveling nearly every month for years between Annapolis, Maryland, and Asia brought him through the Hawaiian Islands, known for their boisterous waters—especially around the island of Moloka'i.

To Geoff White, an offshore-capable motoryacht built of steel that can get to and through the waters off Moloka'i would be just the ticket for a proper semi-production passagemaker. The brand name for the boats he envisioned? *Moloka'i Strait.* There is, by the way, no actual strait with that name.

Here's some further background. White had previously partnered with Lee Cherubini to build a composite trawler yacht called the Independence Cherubini 45, the molds for which White retained from Hans Christian Yachts. *[See* Professional BoatBuilder *No. 112 for a full account of the Cherubini boatbuilding clan—Ed.]* White and Cherubini hired me to lengthen their 45-footer (13.7m) to 50' (15.2m), and a number of those boats were sold. White then told me about his vision for a Moloka'i Strait series of motoryachts, and in January of 2000, we started a preliminary design for a 60-footer (18.3m) that evolved into the Moloka'i Strait 65 (19.8m), of which two were built.



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We did preliminary designs for other models as well: the two-deck MS 58 (17.7m), its three-deck MS 60 sistership, and the MS 85 (25.9m). We found a customer for an MS 72 (22m), and that model later became the MS 75 (22.9m). The first 75, christened *Hercules*, is owned by Jeff Druek, managing director of Moloka'i Strait Marine.

All the MS motoryachts are round-bottom steel-hull designs with rounded sterns reminiscent of so-called Romsdahl (Norway) trawlers—vessels noted for their seaworthiness in the North Sea. MS superstructures are aluminum.

Moloka'i Strait motoryachts also have bulbous bows. To make sure we got the shape of the bulb right, we went to a towing tank for a comprehensive resistance analysis, testing the MS 65 with and without a bulb.

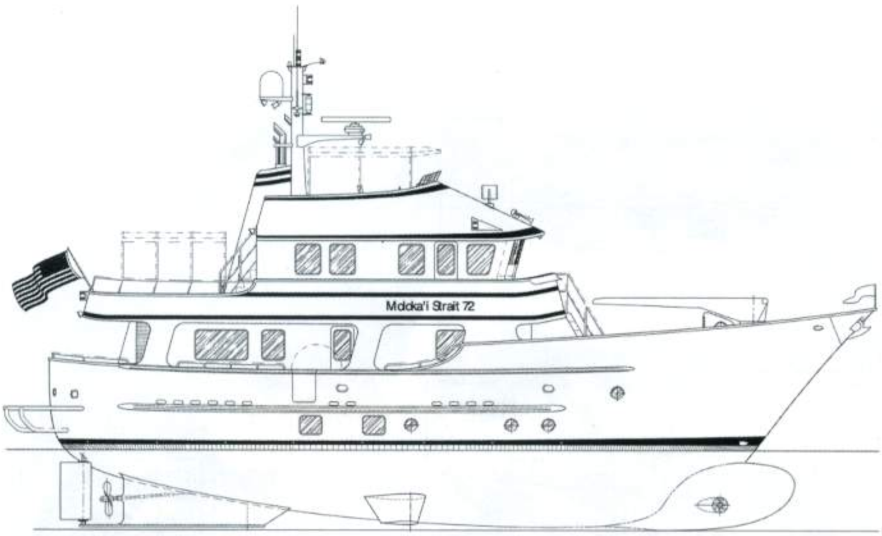
About the Bulbous Bow

Bulb design is tricky. The only way to determine a bulb's correct size and shape is to conduct model tests. A bulbous bow creates a second bow wave that is directly out of phase with the normal bow wave. The two cancel each other out, hopefully with little to no bow wave remaining. This of course reduces resistance, and that fact translates into less installed horsepower, or faster speed. The absolute best resistance reduction that you can expect is 12%–15% for a well-optimized bulbous bow design, but this usually works only at a narrow range of speeds. The norm is probably 6%–10% resistance reduction.

The primary determinants of bulb design are: its cross-sectional area longitudinally and transversely; the

MOLOKA'I STRAIT MARINE

Top—*The lines of the Moloka'i Strait series (here, a 72'/22m) were inspired, in part, by Norway's round-sterned Romsdahl offshore fishing trawlers, but with relatively large volume to accommodate modern amenities and lifestyles.* ***Above***—Atlantic Ranger, *65' (19.8m) LOA, was the first Moloka'i Strait motoryacht built. Whereas* Atlantic Ranger *is a single-screw design,* Hercules *is twin-screw. (Customers tend to like the reliability and built-in redundancy of two shafts and props.)*



The original sheer on Hercules (and the MS 72, shown above) *had the break placed farther aft than in the early drawings of the Moloka'i Strait 65. Shortly after construction began on* Hercules, *the sheer break was returned to the more forward position, and this sheerline has become a trademark of the MS series.*

length, breadth, and depth of the bulb; and its location in proximity to the waterline. If you don't get it just right, the bulb can actually *increase* resistance. In 2001, we tested an MS 65 model in the Institute for Marine Dynamics' tank at the Memorial University of Newfoundland, through Oceanic Consulting, the commercial arm of IMD. The result? Thanks to the bulb design, we achieved about a 6% reduction in resistance on the basic MS 65 hull.

The other important purpose of a bulb is its effect on pitching motion. MS motoryachts have a nabla-style bulb, so named because the transverse sectional shape of the bulb resembles the symbol nabla, ∇, from the Greek name for a Hebrew harp, which has a shape similar to an inverted delta. As the bow pitches down in a seaway, the V-shaped bottom cleaves through the waves, lessening the shock of impact. On the upward return motion, the broad top of the bulb has much more drag, and the boat pitches up more slowly than when it pitches down. This difference in pitching speed between the upward and downward motions is called the damping effect. The greater the damping effect, the more quickly the pitching motion disappears, and the more comfortable is the ride. In the real world, this works really well.

During the preliminary design phase for the Moloka'i series, we examined the bulbous bows on similar expedition-style motoryachts. Most were simply round barrel shapes with spherical caps stuck indiscriminately onto yacht stems, sometimes accompanied by grandiose claims of 20%–25% resistance reduction. Since then, such hype has toned down, claims of resistance reduction appear to be more realistic, and I am seeing nabla-style bulbs cropping up more often.

Model Testing

The major benefits of model testing are the data you acquire; in our case, it was for power prediction and accurate propeller specifications. With the MS 65 project, I programmed the model test data—resistance coefficients, to be specific—into NavCad, which I consider to be the premier speed/power/propeller software. The program gave me full-scale predictions on power requirements, and matched the propeller characteristics to the hull and engine. This is not second-guessing; to the contrary, it's spot-on accurate.

With the MS 65, we discovered that we would need the higher-rated version of the 3406C Caterpillar diesel; instead of 400 hp (300 kW) at 1,800 rpm, we went for 440 hp (330 kW) at 2,100 rpm. The propeller spec'd out at 38″ (97cm) diameter by 24″ (61cm) pitch. During sea trials, the MS 65 met her predicted speed of a little over 10 knots at full power. A perfect match.

Most useful about the MS 65 model test data is that the data are scalable to a larger version of this hull, the MS 75, since these are geometrically similar hullforms. With full-scale MS 75 dimensions and new engine-power curves—here, twin Cummins 350C diesel engines at 350 hp (263 kW) at 2,500 rpm—we came up with propeller specs of 35″ D x 21″ P (89cm x 53cm). Again, we achieved our spot-on speed prediction with that power

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Left—Hercules, *finished out by St. Augustine (Florida) Marine, is shown here in primer. Note the nabla-style bulbous bow.* ***Above***—*Model testing at Oceanic Consulting and the Institute for Marine Dynamics, in Newfoundland, was one of the most worthwhile and important exercises in the design process. It clearly defined the resistance characteristics of the Moloka'i Strait hullform, which translated directly to the MS 75* Hercules.

and propeller size. On neither size vessel did we have to go through any trial-and-error match-ups to get props right for the yacht.

Round-Bottom Design

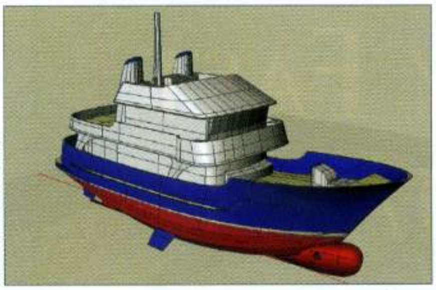
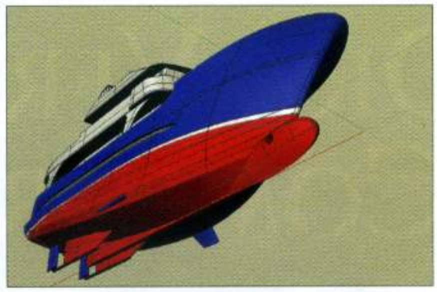
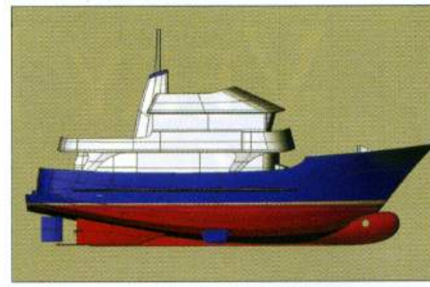
Two design features distinguish the Moloka'i Strait motoryachts: a round-bottom hullform, and steel construction. Most similar yachts are chined hullforms, usually a single chine, and commonly built in fiberglass. A round bottom in steel is unusual. Steel's obvious advantages are its superior strength and stiffness, and the fact that it can be repaired just about anywhere in the world in an open-to-weather construction environment.

The round bottom makes for a better rolling motion: that is, a slower rolling speed with reduced accelerations. The amplitude of roll, on the other hand, is relatively large. A V-bottom hullform has a faster rolling speed with higher rolling accelerations and decelerations, although less roll amplitude. It's the high accelerations and decelerations that make you seasick.

I had an interesting personal experience with this comparison on the first MS 65, *Atlantic Ranger*. Our crew was on board, testing motions and handling in the seas off Morehead City, North Carolina. We had just removed the bilge keels (more on that later), and we wanted to test the handling of the boat without them. Out in the ocean there was a stiff onshore wind and short 5′–6′ (1.5m–1.8m) seas. With seven of us in the pilothouse, our skipper brought the engine back to idle and let *Atlantic Ranger* drift in the waves. The yacht soon came broadside to the waves, and according to the inclinometer on the helm console, we were rolling about 18° side to side. I was standing at the back of the pilothouse watching everyone else. No one was holding onto anything! We all just simply rolled with the yacht, hands free, shifting our weight from one foot to the other. On a hard-chined vessel, we would have been grappling with two hands to hold on to something.

Moloka'i Strait 75 Particulars

LOA	75'6" (23m)
LWL	64'5.5" (19.7m)
Beam	22'0" (6.7m)
Beam at rubrails	23'4" (7.1m)
Draft, design	7'0" (2.1m)
Draft, actual	7'7" (2.3m)
Displacement, actual	326,173 lbs (147,756 kg)
Lbs/inch immersion	5,523 (986 kg/cm)
Fuel capacity	6,620 gal (25,057 l)
Water capacity	1,072 gal (4,069 l)
Black water and gray water capacity	310 gal each (1,173 l)

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Left*—The new MS 79 (24m) deckhouse is essentially the same as** Hercules*'s, but this hull is triple-chined, rather than round-bottomed, to make construction easier and less expensive.* ***Center*—*The hull plating and keel structure on the MS 79 are heavier and thicker than on the MS 75, so little to no internal ballast is needed. Steel is cheaper than lead, and it adds strength and stiffness to the hull. ***Right*—*The hull, lengthened at the engineroom bulkhead by one frame space, thereby extended the main saloon and upper deck.***

Bilge Keels

Some designers and builders of long-range motoryachts specify large bilge keels so their yachts can take the ground unassisted in regions of great tidal change or wherever shipyards cannot be found. The idea is that you can park the boat on dry land to inspect the bottom in out-of-the-way places. This seemed like a smart idea for the Moloka'i Strait series. I placed our bilge keels in line with the active stabilizers, and we included them in the model test program mentioned above, with a flow test to identify their best location and to assess their added resistance.

The vendor for the stabilizers, however, advised that the bilge keels had to be placed well away from the active fins, much farther apart fore and aft than we'd seen on other boats. So we designed a tie-bar structure connecting the bilge keel tips to take a hard-point grounding. But being the sailboat designer that I am, I fashioned the bilge keels much like sailboat keels, and lo and behold, they generated a great amount of lift—enough lift that steering the yacht became a problem.

Ultimately, we cut the bilge keels off. Later, we heard anecdotal stories of other yachts experiencing the same problem. Fixed bilge keels were henceforth discarded from Moloka'i Strait motoryachts.

Steel Construction

As appropriate as steel may be for an expedition yacht, it is more expensive to fabricate into a round-bottom hullform than is a V-bottom design. At first I didn't believe the shape made that great a difference, because our hulls and deckhouses are cut by computer numerical control, or CNC. After I created the hullform and superstructure in ProSurf (a 3D surface modeling program), and the 2D structural drawings in AutoCAD, another naval architecture firm combined these into a 3D structural model in ShipConstructor. That model was "exploded" into the separate parts and nested onto areas mimicking flat steel and aluminum plates of different thicknesses—meaning, all of the compound-curve elements were flattened to their respective flat shapes, and each part was designated with reference marks and part numbers for easy assembly.

A complete set of assembly drawings was also provided for the MS 75 *Hercules*, so it was easy to see the "Tab A, Tab B" assembly. Lofting, therefore, was completely eliminated—a huge cost savings. The shipyard still needed my 2D structural drawings because they contained critical fabrication and welding notes; the 3D assembly drawings don't have that information.

Yet, despite all this technology, round-bottom designs are still considerably more expensive than V-bottom hulls to build. (I don't have hard-and-fast numbers to substantiate this, only anecdotal comments from shipyards.)

Why are they more expensive? I've seen the process by which flat plates are bent into compound curvature to comply with the shape of the hull framing, and it does take extra time and special fabrication skills. But, for a hull like the MS 75, there really isn't much compound-curved plate, and what there is takes up only a small fraction of the total labor to complete the yacht. Chined hulls enjoy exactly the same benefits of CNC cutting, so by comparison, round-bottom hulls require more labor time to fabricate.

The *talent* to create a round-bottom hull, in my opinion, has nearly

CUSTOM STEEL BOATS

Custom Steel Boats (Merritt, North Carolina) built Hercules, *seen here when the aluminum deckhouse was placed atop the hull. The butts and seams in the hull plating are clearly visible. Elliott Bay Design Group (Seattle, Washington) created the 3D structural model, with the computer program ShipConstructor.*

MOLOKA'I STRAIT MARINE (BOTH)

Far left—*Interior design for* Hercules *is by Jeff Druek, a partner in Moloka'i Strait Marine and the boat's owner. The saloon, dining area, and galley are all one long space. Cabinetry in the center hides the stack for the main engine exhaust going up through the funnel.* ***Left***—*The galley, located at the front of the deckhouse, features opening portlights looking out over the foredeck.*

disappeared in this country. The shipbuilding industry in the United States used to be substantial, and round-bottom fabrication was everywhere.

But the big U.S. shipyards have shrunk to mere shadows of their former selves, suffering from the competition posed by second-tier developing countries with low-cost labor coupled with significant investments in modern automation. Low cost is the name of the game. As the big U.S. shipyards disappeared, the smaller U.S. shipyards grew in number and size, and are now quite busy. Since the 1970s and '80s, though, when this transition began and before the advent of desktop computer modeling, virtually all the small domestic shipyards stuck to V-bottom hullforms—they're cheap and easy to build, especially without computers. The talent for fabricating round bottoms atrophied, and it is a rare small U.S. shipyard today that can—or is willing to—fabricate a round-bottom metal hull, even with the aid of CNC. Indeed, it is rare that a small U.S. metal shipyard *considers* building a *yacht*. The reason for that reluctance? Most of our domestic shipyards cannot readily handle the degree of finish involved.

That said, Custom Steel Boats in Merritt, North Carolina, performed excellent metal fabrication for *Hercules* and the other Moloka'i Strait yachts.

The MS 79

The MS 75 has now evolved into the MS 79 (24m). At *Hercules*'s debut at the Fort Lauderdale (Florida) International Boat Show in November 2006, Moloka'i Strait's Italian broker said to me, with plenty of expressive hand gestures and body language, that the MS yacht would be "more