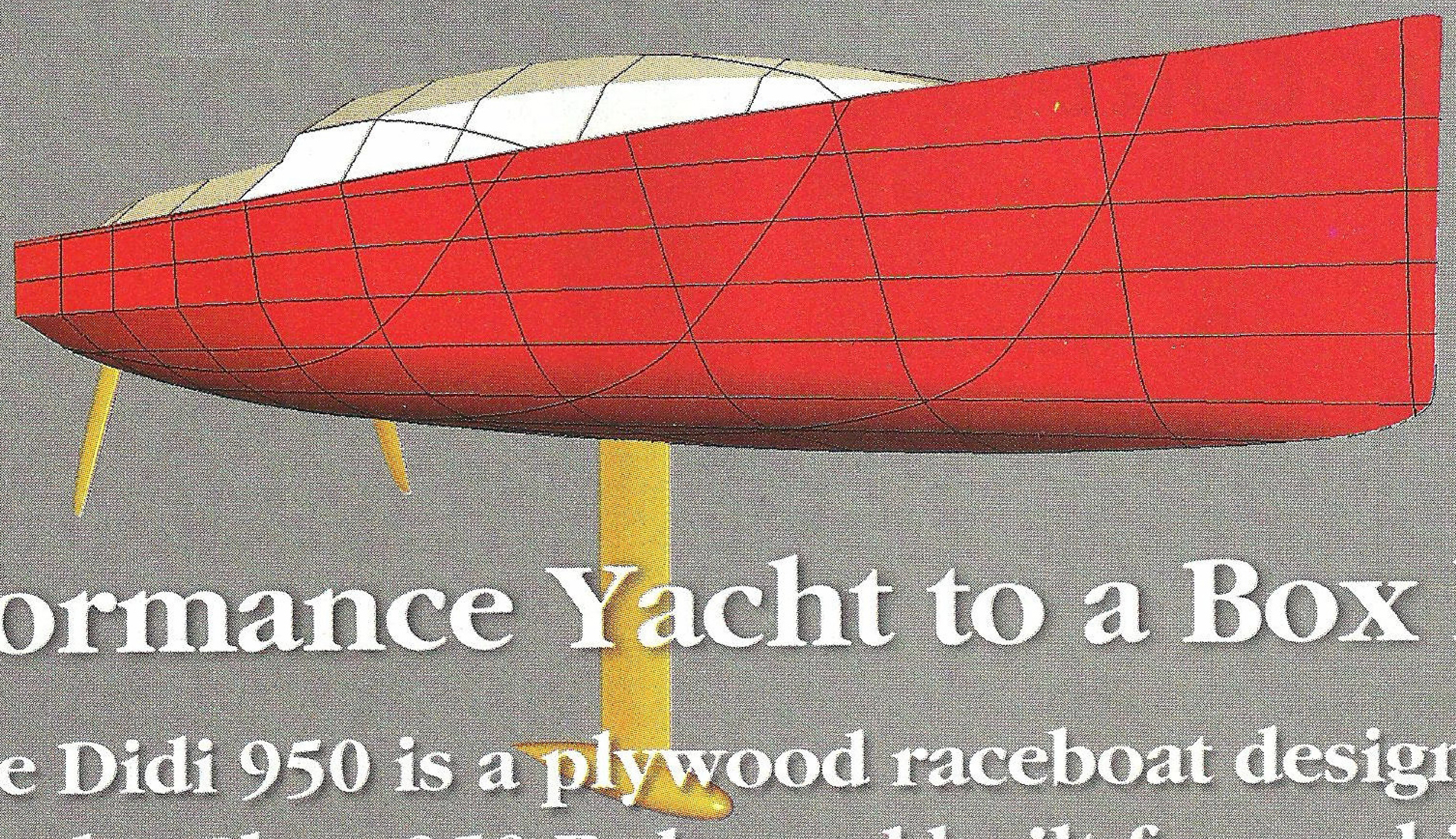


Performance Yacht to a Box Rule

The Didi 950 is a plywood raceboat designed to the Class 950 Rule, and built from a kit.

Text and graphics by Dudley Dix

The first boat I designed and built was shaped from a rectangle of galvanized sheet steel my dad had salvaged from an old water tank. For that project I leaned heavily on his experience building tin canoes, a skill he had no doubt learned from my grandfather in his own childhood. I nailed the sheet of metal to a hand-sawn wooden stem and transom, and it took on a rough boat shape—pointed at one end and blunt at the other. But the finer details of its shape were dictated by the nonstretch nature of the sheet material. I sealed it with pitch melted over an open fire and poured into the open joints against the wood. Though I was not yet a teenager and my boat was hardly longer than I was, it could carry my dad for a while in flat water, paddling with the rectangular ends of a pine peach box. It wasn't pretty but it cost next to nothing, and it provided lots of fun for my friends and me, not to mention my dad. Most importantly, I had built it and it was mine.

It was also my first step in building boats with sheet materials. Every boat I've built since has been made from plywood rather than sheet metal, but the two materials behave in a similar manner, their nonstretch characteristics limiting the shapes they can yield. Each boat I've built has taught me a bit more about manipulating sheet materials to produce nice-looking hulls. I progressed from hard chine and tortured plywood, through multichine plywood, to the radius-chine plywood Didi 38 (37′9″/11.5m), of which my own *Black Cat* was the test bed for the construction, performance, and seaworthiness of the new concept I had developed.

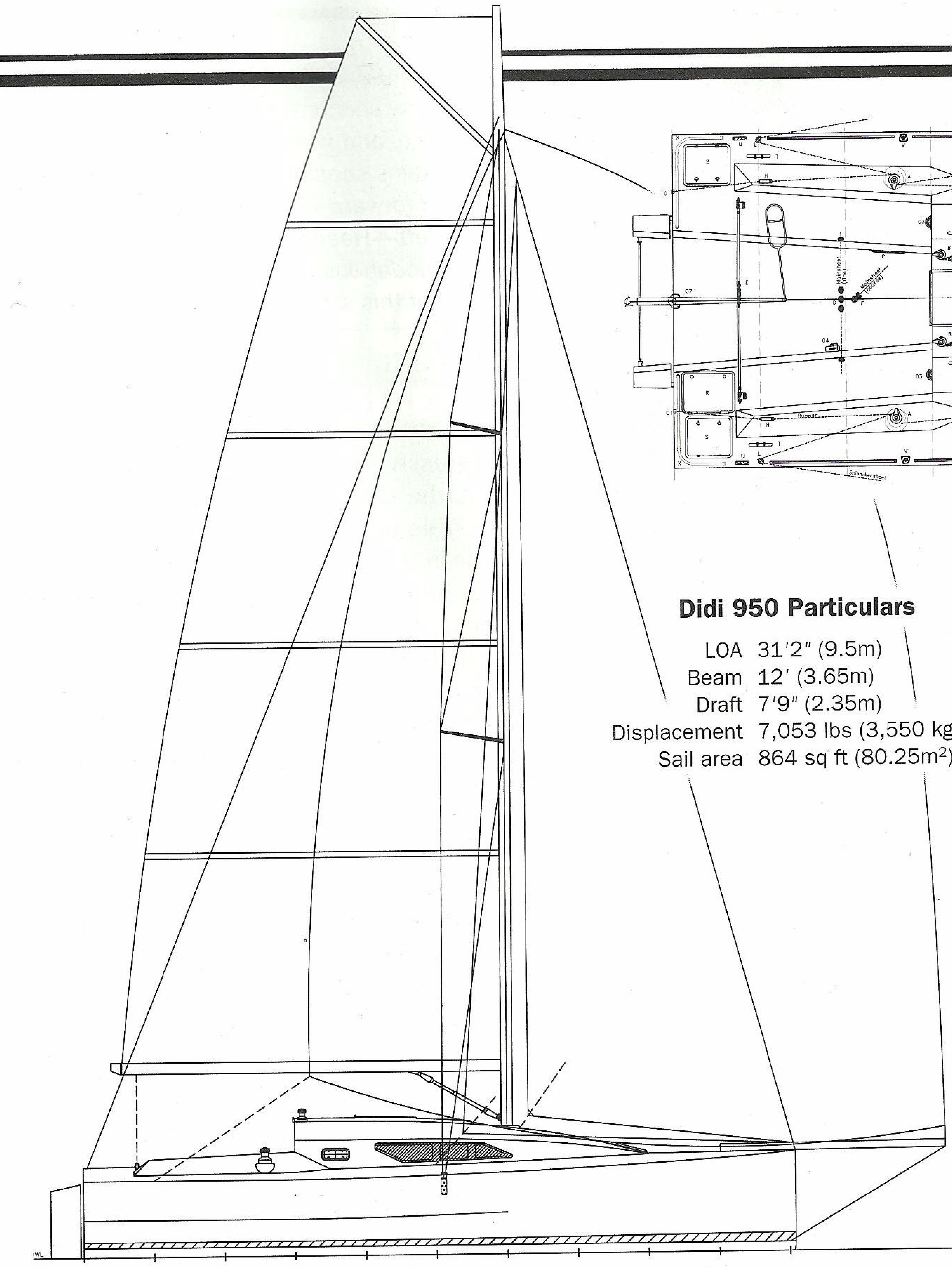
***Above** and **facing page**—Expanding on his Didi line of kit-built radius-chine plywood ocean racers, yacht designer Dudley Dix created the Didi 950 (31′2″/9.5m) to the Class 950 Rule.*

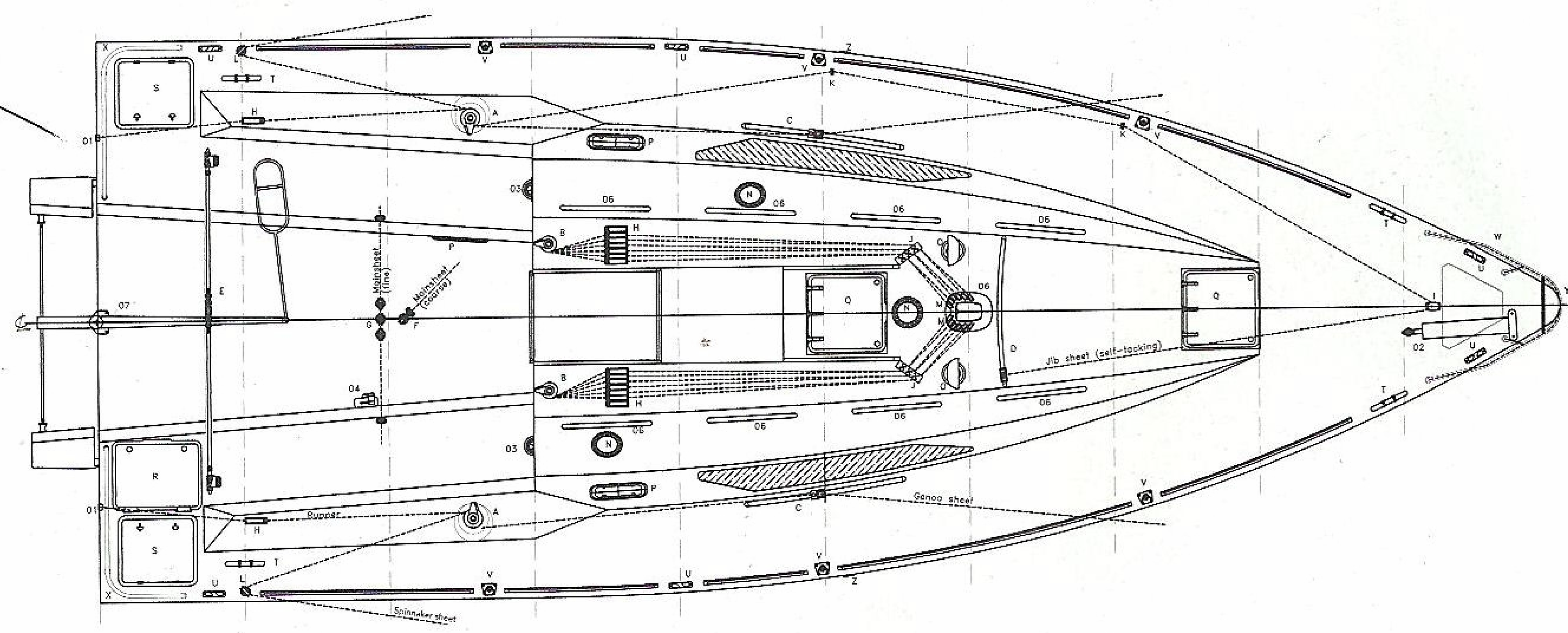
The Radius-Chine-Plywood Concept

I had worked to develop a method to build a plywood boat that approximated the shape of a fully round-bilge-fiberglass equivalent. The idea was to help amateur builders build boats that didn't obviously look amateur-built and so would be more attractive in the resale market. For many decades the general perception was that chine hulls were inefficient, due to increased turbulence in the water flow, and greater drag. Production builders of fiberglass boats fueled this perception by amplifying and broadcasting that chines were slow, ugly, and amateurish. It was my hope that the radius-chine-plywood method would overcome those arguments.

The Didi 38, it seems, fooled everyone, even other boat designers, into thinking that it was fiberglass. Better still, it performed well, equaling and often out-performing fiberglass boats. It proved to be extremely fast in light conditions and lots of fun in heavy power-reaching and surfing conditions. The one thing it didn't do was to equal the planing ability and top-end speed of my previous multichine plywood 34-footer (10.4m) in the strong-wind coastal racing often experienced around Cape Town, South Africa. It supported my thoughts that a round-bilge shape is faster overall, but a chine or multichine shape, with efficient planing surfaces, is faster in strong-running and surfing conditions.

The Didi 38 concept caught the attention of amateur builders worldwide, and a string of smaller and bigger sisters followed, and eventually multihulls. The smallest was the 21′ (6.5m) Didi Mini, designed to the Mini 650 Rule, and the largest the 55′ (16.8m) DH550 catamaran. All could be built from plans or plans plus Mylar bulkhead patterns. All were also available as CNC kits in some form: the bigger boats as bulkhead kits, and the smaller ones including backbones and all the flat-skin panels.





Didi 950 Particulars

LOA	31′2″ (9.5m)
Beam	12′ (3.65m)
Draft	7′9″ (2.35m)
Displacement	7,053 lbs (3,550 kg)
Sail area	864 sq ft (80.25m²)

In recent years, chines started to appear on top-end box-rule racing boats, including the Volvo Ocean Race boats, Open 60s (18.28m), and Mini 650 Transat racers. The chine helped these boats gain righting moment on a hull that must fit into the maximum beam permitted by the box rule. It allowed cleaner and more powerful quarters for faster power-reaching and running in strong winds, without increasing beam. The drawback can be stickiness in light breezes due to dragging the stern, with its large wetted surfaces.

For generations, trends for cruising boats have followed the racing fleet—with good and bad results. If the trend is driven by performance or seaworthiness improvements, then it can be good, but racing trends are not always sensible for cruisers to mimic. The IOR spawned some rather unhealthy trends, and it made no sense at all for those to migrate into cruisers, but some of them did just that.

In short order, chines began appearing on production cruiser/racer sailboats, whether they were a benefit or not. The same production builders who once criticized chines scrambled to ensure that their new models sported topside chines. The flat surfaces and angles previously considered oh so ugly became beautiful and acceptable—in other words, fashionable. While chines can have a structural, performance, and seakeeping benefit if well placed, fashion is the worst reason to incorporate any design feature into a boat.

Class 950 Basic Rules

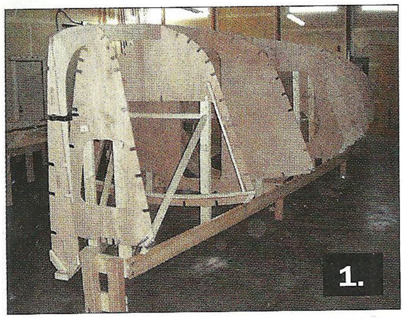
Monohull sailboats aimed at coastal, semi-offshore, and offshore racing, under International Sailing Federation (ISAF) rules:

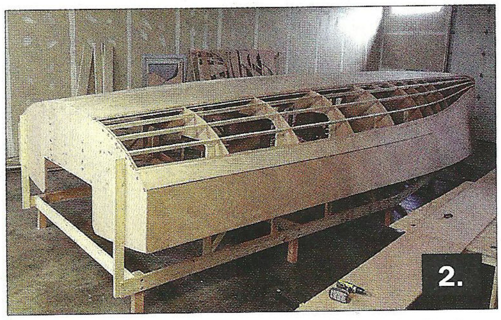
LOA: maximum (max) 9.5m (31′2″)
Beam: max 3.7m (12′2″)
Draft: max 2.4m (7′10″)

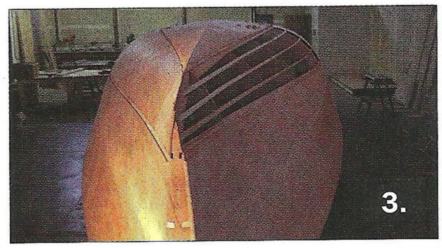
- Freeboard average: minimum (min) 1m (3′3″)
- Mass (displacement in measurement trim): min 2,700 kg (5,952 lbs)
- Water ballast: max 450 liters (119 U.S. gal) each side
- Mast height controlled by upper black band: max 16.5m (54′2″) above waterline
- Sail area (mainsail and headsail): max 80m² (861 sq ft) actual area
- Sail head height average for main, jib, and spinnaker: max 15.5m (50′10″) above waterline
- Mainsail foot length controlled by black band: min 0.5m (1′8″) forward of aft end of hull
- Bowsprit length: max 2m (6′7″) projection from forward end of hull
- Keel: can't be milled metal; must be fixed when sailing
- Twin rudders permitted
- Daggerboards, canards, trim tabs, and flaps not permitted
- Coach roof compulsory: min 1.8m (5′11″) headroom over min 2m² (22-sq-ft) floor area
- Inboard propulsion to meet ISAF Offshore Special Regulations (OSR) requirements
- Carbon, aramid, and S- or R-glass fibers and Nomex or aluminum honeycomb cores prohibited in hull, deck, interior, keel, rudder, and steering system. No prepregs in hull, deck, or interior
- Lateral standing rigging must be steel
- Stability controlled by a 90° hold-down test within a range of load values based on mast height.

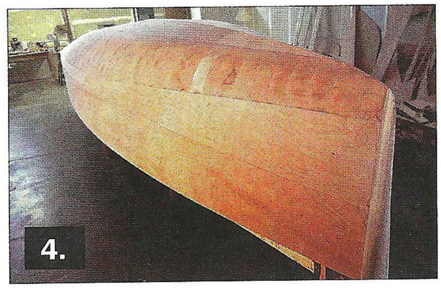
(**Note:** Imperial values are approximate due to rounding off to the nearest inch. Read the full rules for additional requirements.)

—Dudley Dix









1—Construction of the first Didi 950 started with a computer numerically controlled (CNC) cut backbone, 9mm-plywood bulkheads, and doublers interlocking. 2—Solid longitudinals let into the bulkheads support the plywood hull skins. 3—In way of the chine radius, the hull is skinned with two layers of cold-molded plywood strips laid transversely. 4—The completed faired hull awaits its epxoy coatings before being turned upright.

in the region of the waterline forward of the mast—the part of the boat most likely to be damaged in collision with flotsam.

Bulkheads are also 9mm plywood, with doublers in high-load areas. These interlock with the backbone, which is in the form of longitudinal [illegible] nesses of 12mm plywood. In bow and stern, the backbone is a single girder on centerline. Amidships in the engine and keel area, the backbone is a pair of girders spaced to accommodate and support the combined engine beds and keel-support structure. Around the maststep, the single and double girders overlap, providing three girders to spread the mast loads longitudinally and laterally into the hull. This whole central area is reinforced inside and out with glass/epoxy. This laminate is continuous over all internals for a strong and resilient structure to carry the keel, rig, and engine loads.

The combined engine beds and keel-support structure mentioned above are a fabricated steel box that fits neatly between the two longitudinal girders and between two transverse bulkheads, bedded and sealed in epoxy and through-bolted to all those members. The top edge carries the engine bearers that support the engine over the box. The keelbolts pass through from below and sandwich the hull skin between the bottom of the box and the top plate of the keel. A lifting-keel design variation positions the engine under the companionway hatch, with a sail-drive leg and the keel lifting through the central galley locker.

The keel itself is a steel weldment skinned with a steel plate over a skeleton of schedule pipes sized and accurately positioned to produce the [illegible] tee for Aeronautics (NACA) foil shape. This strong keel structure supports a lead beaver-tail torpedo bulb through-bolted to the lower keel structure.

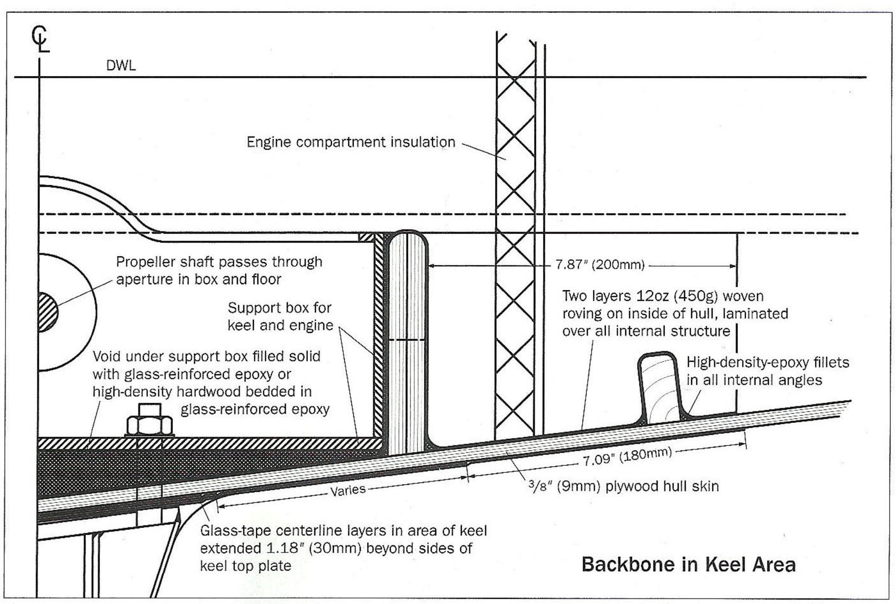
The twin semi-balanced spade rudders are hung on custom gudgeons and pintles linked to a central tiller by flexible mounts and an adjustable-link bar.

The Didi 950 is powered by a tall but robust double-spreader fractional rig. It has full-width swept spreaders, and chainplates bolted to the outsides of the hull. It has a square-top mainsail, small headsails, and asymmetrical spinnakers flown from a 2m (6′7″) carbon bowsprit.

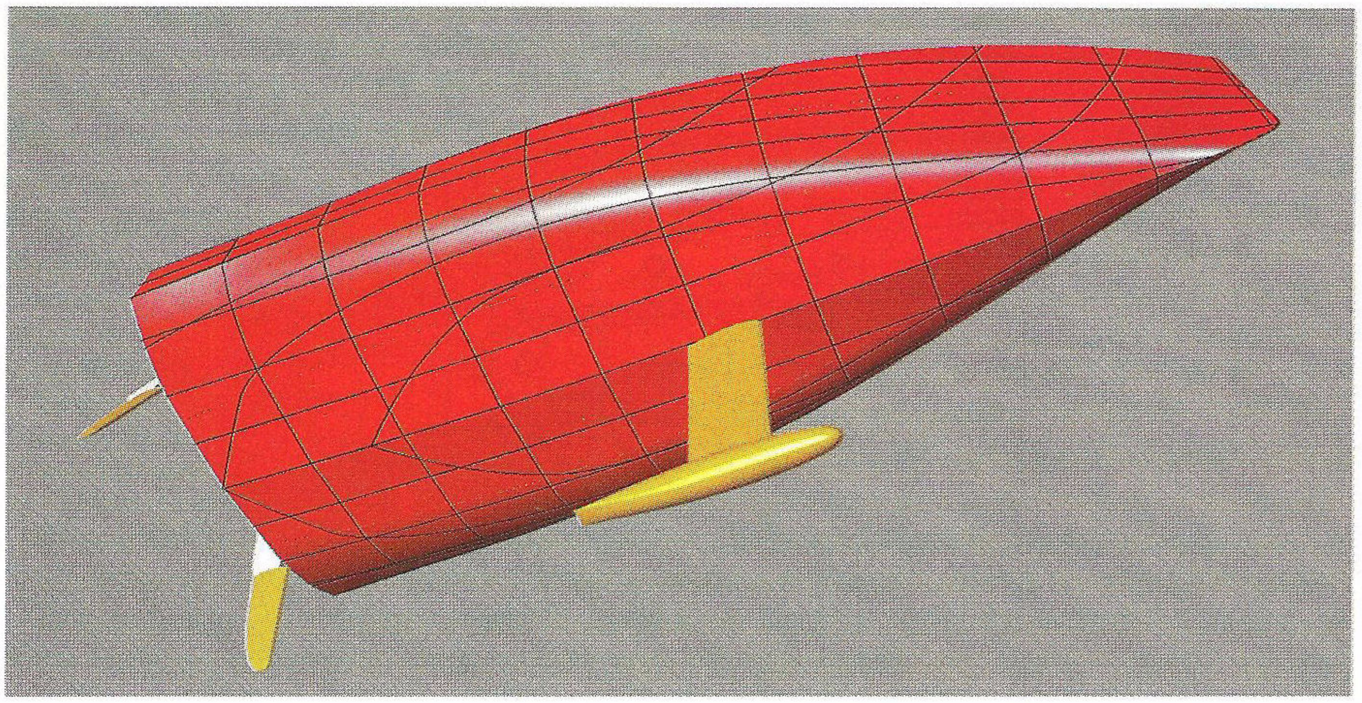
The boat requires a good deal of stability to stand up to this rig. The high-aspect fin keel and ballast bulb are only part of this. The Didi 950 [illegible] board tanks in the quarters (equivalent to five or six crew on the rail), brought aboard for strong-wind beating and power reaching, then dumped overboard when no longer needed. (We'll take an in-depth look at calculating stability with water ballast in a future article.)

The Kit

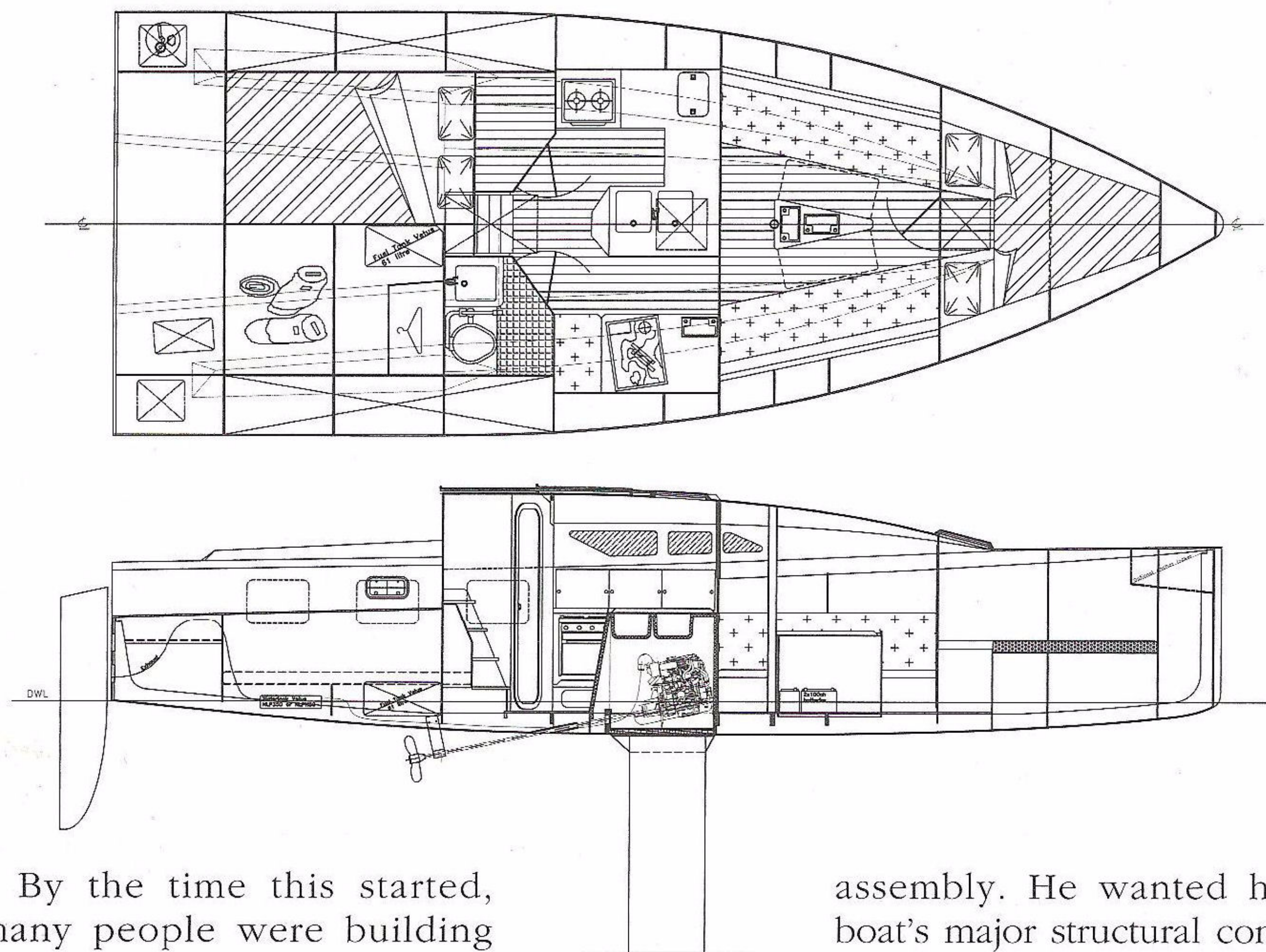
Building on experience with our other plywood designs, we planned from the outset to supply the Didi 950 as a CNC-cut kit.



A fabricated steel box fitted, epoxied, and through-bolted provides support for the keel attachment below and the auxiliary engine above.



Left—*The Didi 950's plumb stem and hollow bow sections provide limited resistance, and while the relatively flat hull remains shallow, V-shaped bottom sections forward will limit pounding.* ***Below left***—*Headroom is limited, but accommodations are ample for a racer/cruiser of this size.*



By the time this started, many people were building our radius-chine, round-bilge plywood designs and were happy with the results. The builders of cruisers and racer/cruisers remained happy, but I received requests for a chine variation of my radius-chine Didi Mini. I eventually developed the Didi Mini Mk3, which has a radius-chine hull with a normal turn of the bilge married to a topside chine from transom through to the mast, where it disappears into the topsides. It proved to be a fairly elegant solution.

The Didi Mini Mk3 concept was spotted by Michael Vermeersch, of Ohio, who was researching designs to build a Class 950 raceboat. He liked the Class 950 box rule concept because it is grounded in producing fast raceboats that are also safe, roomy, and comfortable, to serve as fast cruisers as well. He wanted a plywood boat he could build himself, supplied as a CNC-cut kit for accuracy and ease of assembly. He wanted his boat's major structural components to arrive in a big package, ready to unpack and start assembly.

Vermeersch commissioned the Didi 950 (9.5m/31′2″) as a bigger sister to the Didi Mini Mk3, designed to fit into the Class 950 Rule (see the sidebar Class 950 Basic Rules, on the previous page). Vermeersch is tall (6′6″/1.98m). Happily, he wasn't expecting full-standing headroom for himself, but he needed at least one longer-than-normal berth as well as sufficient headroom over the saloon settees.

The interior layout drawings tell their own story, so I'll concentrate on the structural and construction aspects of the design.

Didi 950 Structure and Construction

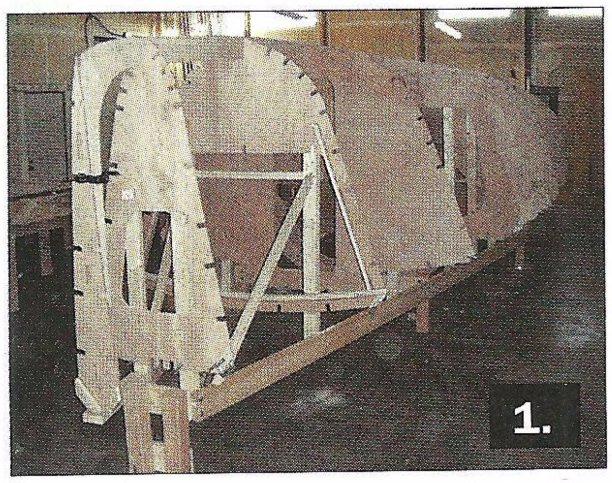
The hull has a single hard-chine shape forward of the mast, with the chine rounded to a variable radius, tight at the forefoot, and opening up progressively farther aft. Aft of the mast, the shape gradually morphs into a double-chine shape, with the lower chine rounded at an increasing radius through to the transom. The bottom has a slight dihedral all the way through to form a slight V-bottom that forms soft-riding bow sections. The bow shape is fine and slightly hollow at the waterline. It flares out in the topsides for reserve buoyancy, creating a shape that cuts through waves easily but has enough lift to be driven hard downwind.

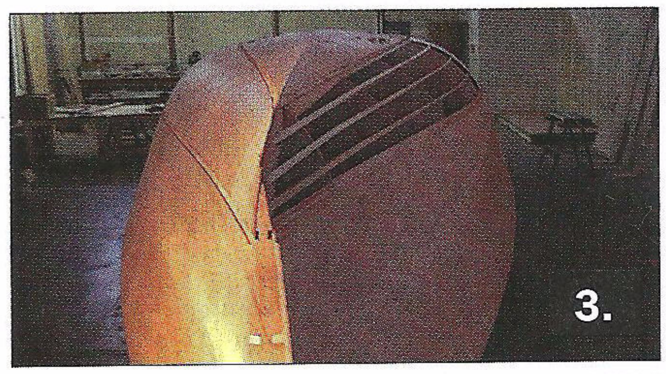
Maximum beam is carried all the way aft to the transom. In this case, we kept the maximum beam slightly under the limit of the box rule because of state road-transport regulations where Vermeersch lives.

This is all built with sheet plywood of a single thickness, except for the radius, which is skinned in two layers of cold-molded-plywood strips laid transversally. The standard hull-skin thickness is 9mm (3⁄8″), but a 12mm (1⁄2″) option can be employed by anyone planning to cruise, rather than race competitively. Vermeersch chose the 12mm skin.

The decks, cockpit, and cabin are 9mm sheet plywood. The cabin is a multichine form for ease of construction, and similar detailing is applied in the cockpit to soften the corners for crew comfort.

All the chine angles of the hull, cabin, and cockpit are glass-taped with standard stitch-and-glue methods for simple construction and clean surfaces inside and outside the boat. All panels are stiffened by timber stringers that carry the skin loads into the bulkheads. The junction between flat- and radiused-skin panels is made with a stringer and plywood doubler in a T-form, with a lapped joint made on the skin over the doubler. To shape the radiused surfaces, the required stringers provide a very strong structure





1—Construction of the first Didi 950 started with a computer numerically controlled (CNC) cut backbone, 9mm-plywood bulkheads, and doublers interlocking. 2—Solid longitudinals let into the bulkheads support the plywood hull skins. 3—In way of the chine radius, the hull is skinned with two layers of cold-molded plywood strips laid transversely. 4—The completed faired hull awaits its epxoy coatings before being turned upright.

in the region of the waterline forward of the mast—the part of the boat most likely to be damaged in collision with flotsam.

Bulkheads are also 9mm plywood, with doublers in high-load areas. These interlock with the backbone, which is in the form of longitudinal girders laminated from multiple thicknesses of 12mm plywood. In bow and stern, the backbone is a single girder on centerline. Amidships in the engine and keel area, the backbone is a pair of girders spaced to accommodate and support the combined engine beds and keel-support structure. Around the maststep, the single and double girders overlap, providing three girders to spread the mast loads longitudinally and laterally into the hull. This whole central area is reinforced inside and out with glass/epoxy. This laminate is continuous over all internals for a strong and resilient structure to carry the keel, rig, and engine loads.

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The boat requires a good deal of stability to stand up to this rig. The high-aspect fin keel and ballast bulb are only part of this. The Didi 950 also has water ballast in port and starboard tanks in the quarters (equivalent to five or six crew on the rail), brought aboard for strong-wind beating and power reaching, then dumped overboard when no longer needed. (We'll take an in-depth look at calculating stability with water ballast in a future article.)

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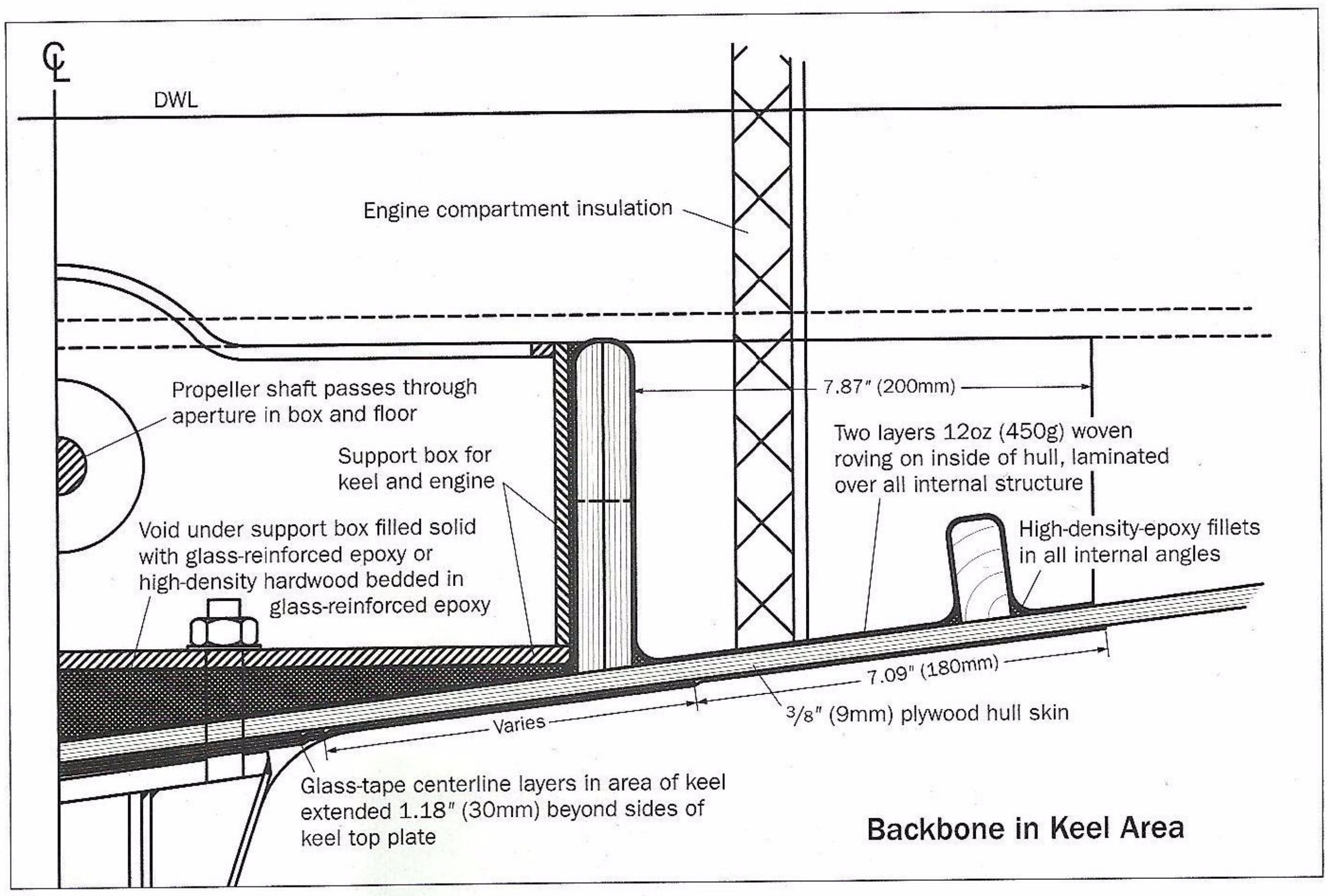

A fabricated steel box fitted, epoxied, and through-bolted provides support for the keel attachment below and the auxiliary engine above.

We introduced one basic change, switching from stepped scarf joints to jigsaw joints. In the past, our kits generally had the long panels cut from standard plywood sheet lengths, which were then joined with stepped scarf joints. However, the cutting companies have developed their own custom methods to improve the accuracy of alignment and to speed the assembly of the joints, from pinning with wooden dowels to machining interlocking features into the joints.

This change was prompted when we chose a different U.S. kit supplier—Chesapeake Light Craft (CLC) in Annapolis, Maryland (for a profile of the company, see "Easy Pieces," on page 24). CLC has used jigsaw joints for thousands of small-boat kits.

While it was a good opportunity for us to develop in a new direction that would also benefit our builders, some aspects of the method concerned me. The main one was that CLC cut the joints with little or no built-in tolerance, so the two parts fit close against each other, locking tightly. Epoxy is applied to the mating edges; then they are assembled with the assistance of a rubber mallet. That is reasonable with thin plywood but could be a problem with thicker material. In my experience, for maximum strength, epoxy joints should have some epoxy between the glued surfaces, rather than tight wood-to-wood contact, so some tolerance in the joint would also make a small space for that epoxy layer and a potentially stronger joint.

Also, I kept in mind that amateur builders often work alone, so this limits how large a panel can be manhandled. When building my Didi 38, *Black Cat*, I cut and handled every piece of wood in the completed boat unassisted. I had to plan for others who work the same way.

John Harris, owner of CLC, and his staff have built some reasonably large plywood boat projects, including a 30′ (9.1m) proa. To join the long hull panels, Harris said they had assembled the panels in the workshop and allowed them to cure. Then a group of staff carried each panel to the hull and held it in place for clamping and fastening.

That process will work for a professional builder if there is a large enough flat surface on which to glue the panels together. However, many hands must be available to handle the assembled panels—not possible for a small professional yard or for an amateur builder who cannot round up a bunch of extra staff or neighbors and friends each time a long panel has to be moved and fitted up to the hull or deck. They need the ability to fit long panels in sheet lengths, gluing the joints in the process, on the structure. Assembling tight joints on the hull skeleton and hammering on them with a mallet is likely to present some problems. A tight fit would also be intolerant of minor fitting errors. If the first sheet is installed fractionally out of correct alignment, that error could be a large enough misalignment at the other end of the boat to present a major construction problem if there isn't some wiggle room.

My solution was to design a tiny tolerance into each joint, to give space for the epoxy adhesive and to allow a small amount of movement in the joint. This allows the jigsaw joint to be pushed into position by hand or light clamping pressure rather than being forced by impact or high pressure. The amount of tolerance needed depends on what is being joined. Joints in bulkheads and backbone components that will be assembled on the shop floor or table can have minimal tolerance, but those assembled in place on the hull need a bit more wiggle room while being accurately fitted and clamped.

Experience tells us how much to allow in these things, so the initial trial and error taught us what tolerances work best. Where we found that the joints were either too tight or too loose, we adjusted the tolerances to optimize the fit.

The kit for the Didi 950 design contains 61 sheets of plywood. This includes, in order of installation, all plywood components for transverse bulkheads, transom, reinforcing doublers, backbone, hull flat panels, deck, cockpit, cabin sides, and roof.

The CNC-cut kit for the Didi 950 comprises 61 sheets of plywood, shipped on two 1,000-lb (454-kg) pallets.

Vermeersch's kit was packed on two pallets of about 1,000 lbs (454 kg) each. Some suppliers crate their kits for shipment; this is particularly important for protecting the components if the kit is to be shipped internationally. For big kits like this, a forklift or other piece of heavy-lift equipment is normally required for off-loading.

While Vermeersch was building his Didi 950 from the kit, Fred Grimminck in Australia was building in parallel from plans without a kit. The building methods are identical, except that an owner building from plans must draw and cut all the panels himself and will make scarf joints on the large panels, instead of having the jigsaw joints pre-cut into the kit.

Kits such as the Didi 950's benefit professional builders by considerably reducing the build hours, cutting down dramatically on the time spent on hands and knees for measuring, drawing, and cutting components. Amateur builders don't factor their labor hours into the overall cost of their projects, but the time saving can make all the difference to the viability of a project. PBB

***About the Author:** Dudley Dix is a South African yacht designer now living in Virginia Beach, Virginia. A graduate of Westlawn School of Yacht Design, he does business as Dudley Dix Yacht Design at www.dixdesign.com.*