

Black Cat

- first of a new breed

This article describes the radius chine plywood method of boatbuilding as developed by Dudley Dix to build his 38ft boat, *BlackCat*, in 1994/95. That design is named the Didi 38 and it has since been followed by the Didi 26, Didi 34 and now the Mount Gay 30. All are suitable for amateur boatbuilders or professional and are available as stock boat plans.

Marine plywood was once the most popular material for boat construction by amateurs. It was knocked aside by ferro-cement, which thankfully did not hold the No 1 spot for very long. Now most amateurs buy a GRP hull and deck to fit out while those who want to build from scratch themselves generally choose steel.

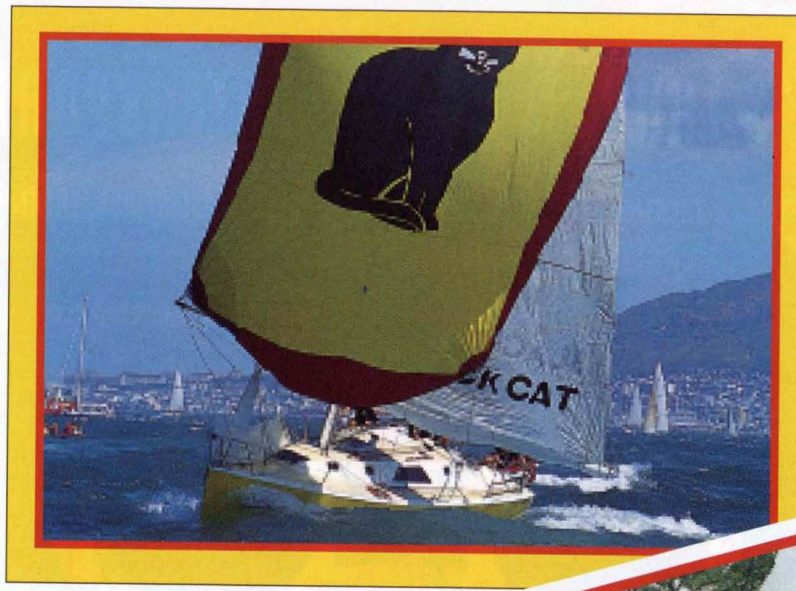
Most people still believe that wooden boats are guaranteed to have rot problems. What has slipped by them unnoticed is that most of the wooden boats which they see are pretty old, often from long before the days of GRP. Many far newer GRP boats are in worse condition, with osmosis, gelcoat cracking or delamination.

Modern Materials

Modern epoxies provide a means to increase the life expectancy of a new timber boat. They seal out moisture and very effectively prevent rot, giving a finish as hard and smooth as GRP. Most wooden boats afloat today were built before epoxy resins were introduced as marine coatings. Think how long they will last if coated with epoxies when new.

The effectiveness of epoxy coatings means also that the rather costly marine fastenings of bronze or stainless steel are no longer needed as long as they are buried inside the coatings. Brass screws will not "dezincify" into brittle porous cop-

per, nor galvanised ring nails rust, if salt water cannot get to them. The relative importance of these fasteners has reduced as well because the adhesives in use today are generally stronger than the timbers which they are bonding.



Economical Construction

With my DIDI 38 design, I set out to come up with a way for the amateur to produce an economical round bilge performance hull mainly from sheet plywood and epoxy resins. I did not want it to just be a "soft-chine" design such as has been designed in the past by myself and others. I also did not want to rip plywood sheets into strips and double-diagonally plank the hull. That

defeats the purpose of using a sheet material and one could then just cold-mould the hull. The alternative method of skinning with a single layer of plywood

strips covered with GRP, can present fairing problems, accompanied by increases in labour, materials and weight.

I started with the radius chine hull shaping principles which I have found successful for steel hulls and modified them until I had a shape which would work for the lighter, hence shallower, plywood hull. The result is a single chine hull with a constant radius to the chine from the transom to the mast area and progressively tightening from there to the bow.

The radius takes up about 1/3 of the total hull surface area. That means that 2/3 of the hull can be skinned at a relatively fast rate because it is applied in sheet form. Panels vary in width from a narrow wedge for the forward bottom panel to a little more than a full sheet for the topsides at the bow. They are generally wider than found in multi-chine designs so there is less wastage. The radius is also

not particularly slow to do because it is only about 1m girth at its maximum with very little spiling necessary.

I will very briefly run through the construction of the hull and deck. Many of the basic procedures are as for other methods of building a plywood boat but the resulting hull shape is rather different.

Simple Construction

The hull is built with stringers over bulkheads in a similar manner to building a balsa model aeroplane, bulkheads being quicker and easier to make accurately than frames. The bulkheads are accurately drawn on plywood using computer-generated offsets or traced from more costly full-size patterns, then cut with a jigsaw. Other options would be to buy either a pre-marked or pre-cut bulkhead kit from a third party supplier or to purchase the information on a computer disk for cutting on a CAD/CAM laser cutter where such a service is available.

The completed bulkheads include all cut-outs for doors, access openings etc, notches for stringers, backbone etc and cleats to receive all of the interior joinery. The stringer notches are cut with a router and a simple jig, producing neat and regular notches, ready for the timber to go in with a push-fit.

The bulkheads are set up accurately on legs bolted to the building stocks. A centreline cord and plumb bob over the stocks and a dumpy level or waterlevel are used to get them plumb and level.

After bracing the bulkheads to the stocks, the longitudinal framing can start going on. The backbone is scarfed into one long length from shorter pieces, a simple operation with a hand plane. It also needs to be tapered both ends, best done with a skill saw then cleaned up with a plane.

At the same time the stem must be set up to establish the forward endings for the longitudinals. Glued up from two thicknesses, it is roughly pre-bevelled with a power saw before setup. Plywood knees are bonded into grooves in the timber to tie the backbone to stem and transom.

After planing the stem down to its final taper the sheer clamps are fitted, diagonally across the corner between hull and deck. They are first roughly pre-bevelled along both edges with a power saw to reduce the amount of hand planing in position. Pre-scarfed into the required lengths, they are screwed and glued to the stem and hardwood clamps on the bulkheads and transom.

The backbone, stem and sheer clamps are hand-planed to form the flats to which the skin will be glued. In the case of the backbone and stem these flats are also used to accurately line up the forward endings of the stringers so they need to be done in tandem with fitting the stringers.

The stringers are glued into precut slots in the stem, bulkheads and transom. Tangent stringers are 12mm shallower than the others but are set in slots of the

same depth. The difference is then made up with 12mm plywood doublers 100mm wide which are used to give a gluing surface for the intersection between the radiused and sheet sections of the skin. Doublers on the bulkhead faces at all stringers strengthen the intersections and can be fitted either before or after the skin is done.

The laminated floors are formed in position rather than on the workshop floor. Strips are clamped against the stringers and backbone, with glue between the strips but not against the hull structure. After curing, the floors are moved to the bench for cleaning and planing to final

shape before installation.

Spacers are fitted next between the floors, followed by the keelson. Together with the backbone they form the I-beam which spreads the ballast keel loads fore and aft in the hull.

Fit out during or after hull construction

There are two possible routes to follow for fitting out. You can fit as much of the interior joinery as you want before fitting the skin or you can leave it for after turning the hull. I built in all of the berth bearers, the lockers of the forecabin, heads and aftcabin, the settees, the gas locker

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The hull is built upside down. Here, all the longitudinals have been fitted, and the laminated floors and engine bed are also in place.



The skin is complete, and leaning against the hull is a hardwood shoe which will receive the keel.

and the cockpit well before skinning the hull, much of it being done even before the stringers were fitted.

The benefits are that it is easier to fit shelves from the outside than the inside despite working upside down and epoxy fillets between horizontal joinery items and the skin can be done on the upper surface with the hull upside down then again on the upper surface after turning. The drawback is that some parts of the skin become difficult to access to do epoxy coatings or bulkhead fillets with the lockers in place. This can be partially remedied by pre-coat-

ing any areas where you can see problems.

The sheet areas of the skin come next, with transverse joints between sheets scarfed in preference to butt-strapping. The scarfs are labourious rather than difficult but can be speeded up by cutting off most of the timber with a skill-saw and jig then handplaning to the final surface.

Before fitting the sheets, each must be prepared for the junction with the radiused skin. This involves routing a rebate 25mm wide and half the skin thickness in depth for the overlap of the second layer of the

radius. The sheets are glued to all contact surfaces of other members, i.e. sheer clamp, backbone, stringers, tangent stringers, bulkheads and joinery.

Skimming the radius

The radius is skinned in two layers of plywood working from the stern forward as far as the mast and in three layers from there to the bow. The first layer is glued to the stringers and tangent stringers between the side and bottom plywood, with the follow-up layer/s overlapping the routed rebates of the side and bottom ply-

wood to form a stepped joint.

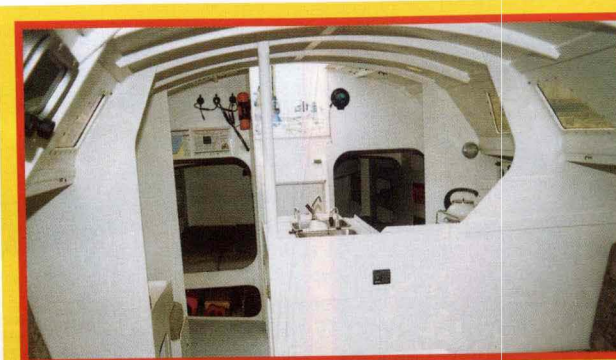
I experimented with the width of plywood strip to use for the radius and found that 250 to 300mm wide strips are the easiest to fit when working single-handed and give faster coverage than wider ones. This is primarily due to the need to hold the panel accurately in place around the curve while also inserting the fasteners. Two people working together may find wider panels to be more convenient. The girth of the radius results in relatively efficient material usage as well because only about 200mm length is lost to wastage from each strip.

For fasteners I used temporary screws for the first layer because of the problem of bounce experienced if you try to nail or staple stringers without someone on the other side to apply resistance. Follow-up layers were applied with temporary staples and some permanent ring nails into stringers. Two people working together can successfully use staples or nails to the first layer as well.

After completion of the hull skin, the stern is trimmed back to its final shape and the cut-out for the transom hung rudder done. The skin at the bow is planed flush with the front of the stem and

covered with a capping piece.

A centreline flat is planed onto the bottom plywood the full length of the underbody and the lost timber replaced by a



Looking forward at the open layout interior from the companionway. The engine is below the sinks.



Looking aft at the port and starboard berths.

strip of plywood glued on, with scarfs between lengths. This is then planed back to the V-shape of the bottom plywood. The object of this exercise is to introduce transverse grain into the skin on centreline, linking the two sides of the skin together and eliminating a weak longitudinal joint.

After sanding and filling of fastener holes the hull is ready for epoxy coating and any fairing that you feel necessary. My hull was not perfect but was close enough so that it just needed touching up in areas where I was a bit careless with the belt sander. The final finish with minimal labour is good enough for her to be mistaken for a GRP boat by most who see her.

An alternative method of finishing would be to cover the hull with a layer of glass cloth but I emphasise that it must be set in epoxy, not polyester resin for effective protection. This method will require some fairing afterwards to produce a smooth hull but will add surface hardness.

Turning the Hull

The hull turning we made into a social event because it is a major milestone. It was done with a chain block suspended from a scaffold tower alongside the hull.

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Turning her over before work commences on the interior and deck.



She's ready to launch. Note her clean lines and modern underwater appendages.

After lowering the hull to the ground and dismantling the building stocks, it is lifted on one side in stages while it is walked towards the tower until it is on edge alongside the tower. It is then lowered the other way to complete the turn. It only weighs about 600kg at this stage so a couple of strong guys can alternately walk the bow and stern across to move it sideways.

A word of warning - be prepared to cover up the hull. I have proven that the weathermaker watches for hulls being turned and has seen mine three times out

of three. It has always rained the next day and previously turned my hulls into swimming pools. This time I was ready with covers and they were necessary.

Deck Construction

Deck construction goes fairly quickly because there are not many transverse deck beams, each needing to be carefully shaped, set to the proper level and notched into the sheer clamps. The stringers and carlins drop into pre-formed notches in the bulkheads and automatically give the required shape and levels. Laminated beams are needed at the bridgedeck to support the mainsheet track (laminated in position) and to the cabintop (laminated on the workshop floor).

The foredeck and cabintop are made of two layers of 6mm plywood glued together but the rest is a single layer of 12mm. Cockpit coamings are built off the deck, with the seats being part of the main deck skin. This again gives quick construction and a simple solution as well as useful cubby holes for winch handles, sandwiches, sunscreen etc. The deck edge detail uses a plywood capping over the sheer clamp, introducing transverse grain to tie the hull and deck skins together.

Interior

The interior joinery of my boat is built almost entirely of 6mm plywood, the exception being the settees which are more heavily constructed because they form a side and top of integral water tanks and the base of the saloon table which forms the fuel tank.

Optional strength increases for cruising

For those wanting to build this concept for cruising, the interior joinery can be built from 9mm plywood and the hull skin thickness can be increased to 18mm for increased damage resistance. If this is done by increasing the thickness outward rather than inward then the extra structural weight is carried by the increased hull

volume so she will not sit deeper despite greater strength.

A tolerance of imperfection

A principle which I applied throughout in designing this concept was to increase the glueing surface area compared with that of traditional detailing, while reducing structural weight where prudent. This has the effect of increasing the tolerance of the system to imperfect workmanship. It is no good reducing weight and then requiring the perfect workmanship of a top class professional to hold the structure together. I see myself as an averagely competent amateur and would not expect more from non-professional buyers of my plans.

The concept includes other aspects intended to ease work for the amateur builder and keep costs down. The transom hung rudder is built of plywood with a hardwood spine which acts as a shaft to carry the loads. It hangs on a pair of oversized custom pintles which can be fabricated in the garage of mild steel then galvanised. I had mine made in stainless steel by a specialist. Alternative shaft-hung inboard rudders are also available for those who do not like transom-hung rudders.

Build the keel in your garage

The keel is a deep delta bulb configuration which gets the ballast CG low down where it is needed. It is fabricated over a leading edge bar and a pair of internal thick wall tubes which provide a very rigid structure over which to plate the foil. The tubes also make for simple plug welding of the skin onto the structure in place of the more normal problems of plating over and welding onto the edges of floppy internal transverse plates. This keel is within the abilities of a competent amateur with welding experience. Mine was built in my garage without any mechanical plate-forming equipment. The lead ballast we melted in a cast iron pot over an open fire and ladled into the steel casing.

Sailing performance

My boat was launched and first sailed late in 1995. Within three months she had sailed nearly 10000 miles, including two South Atlantic crossings. The downwind crossing from Cape Town to Rio took 21 days, with a best day's run of 240 miles and a best speed of 17 knots, with five on board. Only one yacht of similar size beat us to Rio, a 38ft composite trimaran. The smallest monohull to beat us across was an IMS 42 racer. The return was double-handed, much of it in heavy windward conditions which sank one boat and brought down two rigs.

The following year we sailed in a coastal cruise regatta with two couples and my nine-year-old daughter as crew. In a wide range of sailing conditions we managed line honours in every race of the series. My Didi 38 has proven to be fast, strong and a joy to sail.

Economical Construction

The material cost of my hull, deck and interior structure built in 1994/95 was R30 000 (US\$7 000). That included all timber, adhesives, epoxy coatings, interior and exterior paints, fasteners, building stocks and all temporary framework braces etc as well as 14% VAT. When I say interior structure, that includes all interior joinery built to a performance boat standard, i.e. no fancy trims or finishes but comfortably fitted out. Seldom was I able to negotiate discounts better than the average man in the street on structural

materials so my costs would be fairly representative.

My overall cost including rig and electronics was approximately R200000 (US\$45000). That translates into a lot of boat for the money.

I had felt for a long time that steel was the least costly material for boatbuilding but this project proved otherwise, by a long way. There was also little expense on fairing the hull, as required for a quality metal hull, because plywood sheet is largely self-fairing. This method of construction can hardly be beaten in terms of the most boat or the best speed for your buck.

Rapid Construction

The labour input was also extraordinarily low, luckily so, or I would not have had her complete for her intended South Atlantic crossings. From start of construction to sailing she took approximately 3000 hours of labour, most of it single-handed and in my spare time. From start to finish she took 24 months of work.

You can do it

We all complain about the spiralling costs of boating and many use that as an excuse for not committing themselves to getting onto the water. I built my first keel-boat in the 1970s for a total cost of 40% of the price of an equivalent production boat and this was not much different. It proves that a practical person can get afloat at a reasonable cost. However, don't

underestimate the overall cost in terms of time and personal commitment. An owner-building project will not succeed without uncompromising drive and dedication to the project. After my 3rd self-built big boat project I should be well qualified to say that it must not be taken lightly.

On the other hand, if you have the necessary drive then do not be overawed by the complexities of building a big boat. Each step along the way, from buying the first piece of timber until launch, there is a logical next step. Once into the project you will always see clearly what the next step should be.

Designer Backup

A reputable designer will also always be at hand to assist you when in doubt during construction. The price of the plans is the wrong place to be reducing costs when building a boat because the designer then cannot afford to put time into backup service. Before buying, make sure that your designer does provide backup because few other designers will be prepared to bail you out when problems arise. Modern communications now allow almost instant communication to far corners of the world. If the design which you like is from a distant designer he can still provide rapid backup, as if he were across the city. The cost of the plans will be a small part of the overall cost of your boat. If you buy on price only, the plans could be the cheapest part of a costly mistake. ⚓

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