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The birth of a new boat **PART 2**

Making the mould



PBO is following the building of the new Cornish Crabber 26 from scratch. This month David Harding shows how the plug is finished and the mould is made

Tooling up for the production of a glassfibre yacht starts with the building of a plug, as featured in PBO last month. Traditionally made in timber, it's crafted into a perfect form of the finished hull – but only so that a mould can be produced from it. After that the plug is destroyed because it becomes redundant: it's in the mould (the female form of the hull) that the hulls themselves will be laid up.

When we last saw the Cornish Crabber 26 plug, it looked pretty much like a wooden boat with a bit of filler here and there. What happened next was the application of copious quantities of high-build filler, followed by hours of sanding down and finally a good wax to achieve a high-gloss finish.

The high-build filler – the consistency of double cream – was applied by foam radiator-rollers except the last (fifth) coat, which was brushed on. Although of relatively thick consistency, it wasn't simply slapped on because the more accurate the application the less sanding is needed afterwards.

Different colours were used for each coat

so that as it was flatted down the emergence of the colours would reveal how much had been removed. Cornish Crabbers started with black as a base coat on top of the wood, then followed with grey, purple, a near-black and, finally, a different grey. As the colours were all fairly dark and some not that dissimilar to each other, the plug-builders needed to concentrate during the sanding down to make sure they could see which layers they had gone through.

It would be easier with lighter, brighter and more contrasting colours but then the fairness of the plug would be harder to assess. As any boat-owner knows, a dark-coloured hull is less forgiving of any imperfections in the moulding: ripples, hollows and high-spots stand out that would be hidden in white.

Even with five coats of filler applied, the total thickness on top of the wooden plug

was only around 1mm ($\frac{3}{64}$ in).

Then came the flattening-down. Long-board sanders were used initially with 80-grit followed by 120-grit paper. Air-powered orbital sanders came next, fitted with progressively finer grades of abrasive: 200-, 400-, 600- and 800-grit. Finally, five coats of wax were applied to give the high-gloss finish necessary to highlight any imperfections and ensure that the mould could be released when the time came.

Smoothing over

Because plywood is rarely perfectly smooth, some imperfections in the shape of the plug will inevitably be discovered during the sanding. The most obvious are high-points, where all the filler will be removed and bare wood revealed. A few patches like this don't matter too much because wood can take a good polish. Neither is the odd dimple anything to worry about: it will become a pimple in the mould, which can be flatted down and polished out.

The odd blemish notwithstanding, a perfect finish is the objective. And in many ways that's harder to achieve with a hull of simulated lapstrake construction like the

FINISHING THE PLUG



The plug is finished, but before the mould is laid up on top of it a couple of cradles need to be made for supporting the hulls



What a line: the boot-top is masked top and bottom with the help of a laser theodolite and an accurate eye. Extra care is needed at the chines



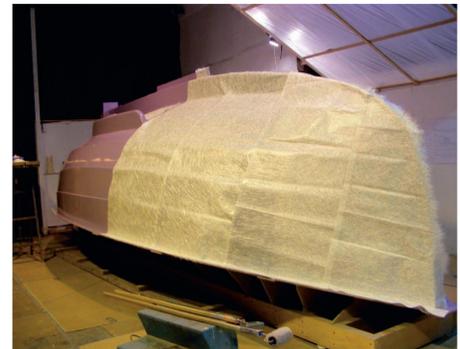
Filled, faired and waxed: the plug in its finished state. The high-gloss finish and dark colours help draw attention to any imperfections



1 Stirring stuff: mixing the gel coat for use in the mould. It needs to be different from any colour offered for the hulls



2 Pretty in lilac: the waterline has been gelled first, then two coats of the lilac gel coat applied over the rest of the plug



3 After two coats of gel coat, the skin coat (first layer of mat and resin) is applied. This is 50g/sq m (1.5oz) chopped strand mat

Crabber's than with a round-bilge hull-form like that of the previous boat developed at the yard, the Mystery 30 (formerly known as the Link).

While the Mystery's compound curves present their own challenge and the flat planks of the Crabber might be easier to fair in some respects, the latter presents plenty of tricky areas such as the long keel, the bilge runners and the overlaps between the planks.

An even shape was ensured in the concave curves by the use of a piece of wood with a 6mm (1/4in) radius wrapped in the appropriate grade of abrasive paper. A router with a 6mm (1/4in) bit was used to round the outside corners.

As well as smooth curves, another vital visual element is an even waterline. Cornish Crabbers will be laminating the hulls with a boot-top in a contrasting colour and, rather than etching scribe-lines into the mould, they chose to use a different colour of gel coat for clarity when masking up.

David Thomas's design drawings showed where the waterline should be, and a laser theodolite was used to indicate the level of the bottom of the boot-top along each side



4 As the heavy lay-up continues, the lilac gel coat is obliterated. About a ton of mat is used in the mould

of the hull. Masking tape was run from bow to stern and worked around each overlap between the planks to create a line that would appear smooth from an eye-level above the waterline. The top of the boot-top was then masked by eye, the distance between the two strips of tape varying from 75mm (2.5in) amidships to 100mm (4in) forward and 150mm (6in) aft. This variation ensures that the boot-top follows the sheerline to a certain extent and is also sufficiently broad under the flatter sections close to the transom.

Ready to mould

Cornish Crabbers' work schedule was planned to allow the mould to be laminated before the two-week Christmas break, so it would have plenty of time to cure and achieve its maximum strength before being lifted off the plug. Rigidity is vital with a mould: it has to be handled extensively over several years and, during its lifetime, might be used for laying up several hundred boats. Repairs cost valuable time and a mould shouldn't start to lose its shape.

The hulls themselves need to be kept in shape, too. When a hull comes out of the mould, with its bulkheads and stiffening members in position, it needs to sit on

something that will provide good support – ideally something of exactly the same shape – so Crabbers laid up two sets of cradles over the plug.

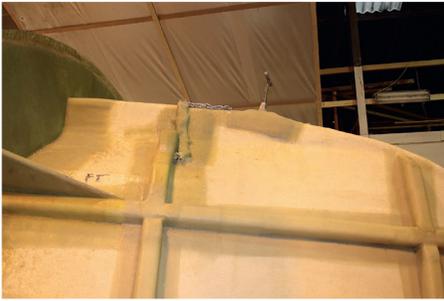
One last job before the lamination of the mould could get under way was to position the release plates on the plug. These are metal plates on screw threads built into the mould at strategic points. After being laid up, a new hull has to be popped out of the mould. Although a release agent is applied before the application of the gel coat, some extra help is invariably needed. This is when the plates are wound down to start the separation process.

Only after these vital stages could the laying up of the mould begin. It starts with the gel coat and, as with the filler on the plug, colour plays a crucial role. It's important to use one unlike any that's offered as a choice for the hulls because it would be hard to see where you had applied, for example, red gel coat inside a mould of a similar red. A fetching shade of lilac was chosen in this case – so any prospective owners wanting a lilac-coloured Cornish Crabber 26 will be disappointed.

The boot-top was done first, in orange, between the strips of masking tape. Then the tape was removed and, when the



Curves and corners have been carefully shaped with a consistent radius. This is the forward end of the starboard bilge runner



5 On top of the basic structure come the foam stiffening, the rotating wheel, the release plates and the lifting chains



6 Finished at last: the mould is completed and it's time to lift the whole assembly off the floor and wheel it outside



7 We have lift-off: Crabbers' big hoist is used to lift the mould off the plug, which has served its purpose and now becomes redundant



8 Time for a roll-over: having been built upside-down, the mould now needs to be turned the right way up...



9 ...and set down safely on the ground. The section missing at the aft end of the keel is the removable back-box



10 Looking inside – and all appears as it should. Note the gelled-in boot-top, the bilge runners and the centreplate slot

orange gel was hard, the lilac applied over the rest of the plug. Gel coats for mould-making are a special formulation: harder than standard varieties to resist damage, and not designed for immersion in water. A double layer provided the thickness to sand out any imperfections transferred from the plug.

Over the gel coat went the skin-coat: 50g/sq m (1.5oz) mat with vinyl ester resin, which is harder than polyester resin. A different type of resin formulated for tooling was used for the rest of the lay-up. Shrinking less than standard types and not getting quite as hot, it allowed four layers of 1.5oz mat to be applied and wetted out straight on top of each other. This was done a further three times, giving an all-over laminate weight of 815g/sq m (24oz). A further 200g/sq m (6oz) was applied over the keel, the bilge runners and the stiffening flange around the gunwale. It all added up to a lot of weight: about a tonne of resin and 600kg (1,300lb) of mat went into the mould.

Finishing off

When the basic laminate was completed, it was time to reinforce the mould by glassing in 75mm (3in) square sections of foam to act as frames and stringers.

Two plywood 'wheels' were also built around the mould to allow it to be rotated when sitting on rollers on its metal dolly. The mould was then drilled through and screw-threads fitted for the release plates.

Finally, after a couple of lifting chains were glassed in, it was time to lift the mould off the plug. The release plates were given a couple of turns the night before the whole assembly was wheeled outside to Crabber's big hoist. Much to everyone's relief, the mould and plug separated without drama and the mould was wheeled back inside in readiness for the laying up of the first hull.

Making the back box

Before starting on a mould, there's one crucial question the builder has to bear in mind: when we've laid up the hull, how's

it going to come out? For example, a return flange on the gunwale to which the deck moulding is joined will necessitate the use of a split mould (one that joins down the centreline) because you can't lift the moulding straight out, whereas a one-piece mould will often work with a conventional 'biscuit tin' hull-to-deck joint.

The Cornish Crabber 26 is designed for a 'biscuit tin' joint but the shape of the aft end of the keel means that the entire structure can't be moulded in one piece. Geometric considerations apart, it would be impossible to lay up mat and resin in such a deep, narrow corner.

Crabbers' solution, as adopted with the Shrimper, is to build a small, removable section of mould, known as the back box, for the aft end of the keel. Most of that section will be laminated in the sub-mould when it's still separate; then the two moulds will be bolted together and the laminating completed over the join.

■ **Next article: making the deck plug and laying up the first hull**



MAKING THE BACK-BOX



A flange constructed in plastic forms the edges of the mould for the back-box



Laminating the back-box. It extends along the hull abaft the keel so it becomes a stable shape



All ship-shape: the finished back-box mould butts up against the main hull mould