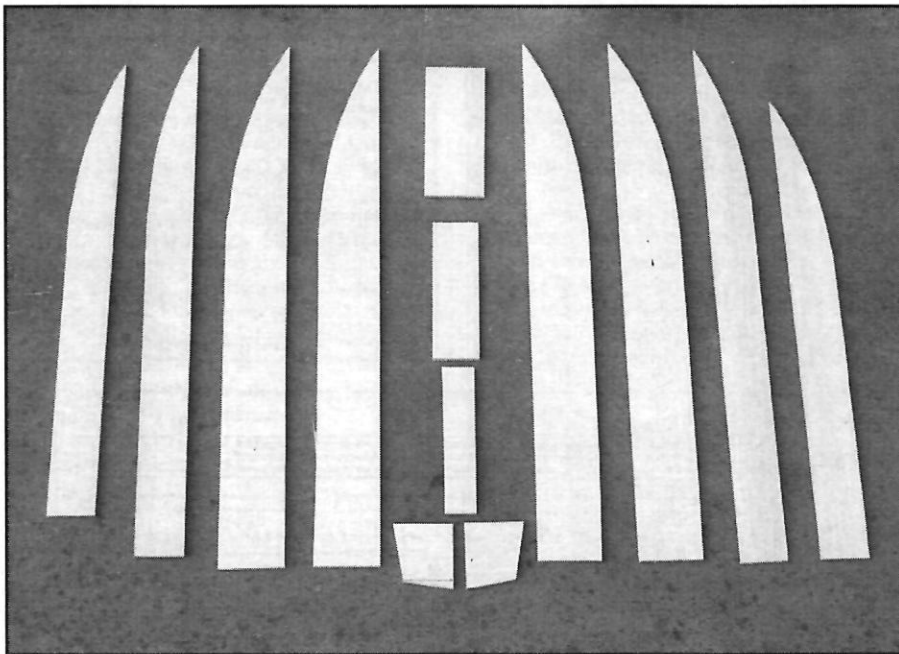


Mantis showing a good turn of speed. All photos: Glynn Guest.

After one false start I finally succeeded with one of the surface piercing outdrive units by designing a conventional mono hulled model. The speed and equally important, running time of such models, can be very good. This led my local club to hold a series of races for the members which resulted in a wide range of models being entered. A few were based on the tunnel/catamaran type of hull and stimulated me into designing the next model along these lines.

The first sketches were based around the Graupner Hydrospeed 7022 unit that was so successful in the mono hull. There was little difficulty in designing a suitable hull form; the wide beam of these hulls produces a generous amount of space for internal items. The main problem encountered was just where to place the propeller. Too low in the water and it might stay in the fully submerged condition and place an excessive load on the motor. If too high then it risks 'aeration' where the prop makes lots of noise and spray but fails to provide any

Stage 1. Hull structure parts cut out from 1/8" balsa sheet.



Mantis

Glynn Guest's Full-size

Plan is a fast Electric

Tunnel/Catamaran

drive force. This was the problem with my first Hydrospeed powered model (Scorpion in RCBM July/Aug. '89), at least in its original form.

Because of these doubts this design remained in limbo until fate, in the form of Robbe's Unlimited kit appeared. This model, reviewed in the July/Aug. '91 issue of RCBM, was a semi-scale fast electric hydroplane and used a fixed surface piercing prop. Steering was provided by a

single rudder fitted to the transom and offset to the side of the prop. The high performance of this model and its good steering gave me the idea to use a similar set up in my design.

First Trials

My original layout was based on using direct drive between the motor and propeller. It was hoped that the use of a 40 diameter prop, a shade smaller than the 45mm one supplied with the Hydrospeed unit would avoid the need for reduction gears. A stock 540 motor was used for the first trials.

After a slow speed run to check that the rudder would work, the model was pointed out towards the middle of the lake and full power applied. Much to my delight the model promptly accelerated onto the plane. The speed was very good and first impressions were that it rivalled my mono hulled model. The rudder, despite being out of the direct line of the prop, was very effective and gave a progressive and predictable response. The grin on my face was lost when after only two to three minutes the fully charged pack of sub-C nicad cells began to die. More trials with other nicad packs failed to increase the duration of the powered run. The motor was also found to be hot, very hot indeed, after each run. All this pointed to one inescapable conclusion; direct drive was simply overloading the motor.

It might have been possible to find a more suitable motor with torque/speed characteristics to match direct drive in this model. However, the club's rules were based on using 540 type motors which clearly needed some means of 'unloading'. A smaller propeller was an obvious answer but these are just not available in the form needed for surface piercing operation. I did in fact try as many props as possible but any which could get the model onto the plane always overloaded the motor.

Back to Gears

The only answer seemed to be the use of reduction gears. A couple of suitable motors with integral gearboxes were tried in the hull but there was just not enough space to mate up with the propshaft. After some hesitation: the original prop tube and motor mount were removed from the model and a new drive system installed.

The motor and upper end of the prop tube were fitted through a plywood bulkhead, the position of the motor and prop tube holes being determined by the size of the gears used. In my case a couple of suitable R/C car type gears were found to give the desired 2:1 reduction. The bulkhead, with attached motor, gears and propshaft was then installed in the hull taking care to get the prop back to its original position.

The next sailing session revealed no significant change in the model's performance. The speed seemed much the same as before and the rudder was equally effective. The duration was however greatly improved and full speed runs lasting several minutes were now possible. Further testing then followed with slightly larger surface piercing props. No improvement in speed was recorded, in fact in most cases a noticeable reduction was apparent. The best propeller seems to be the original 40mm type, a Graupner product - Order No. 2314/40.

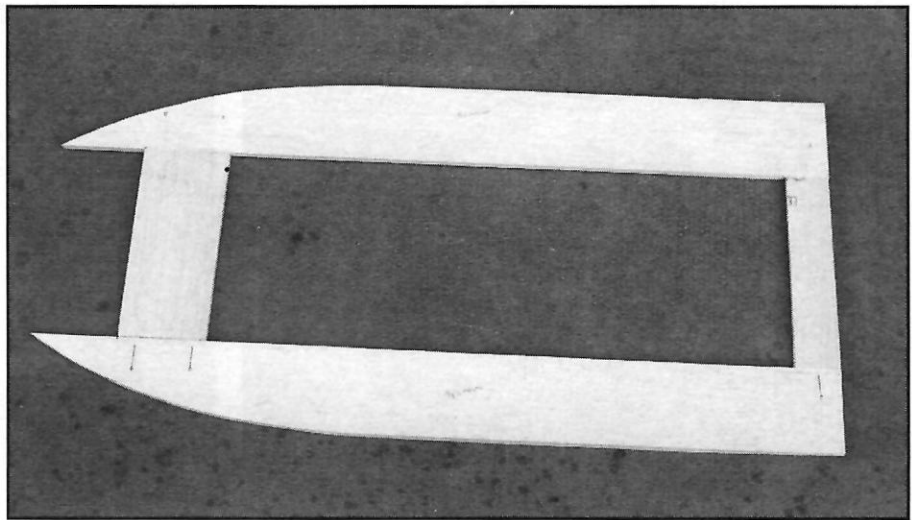
Mono V Tunnel Hulls

At the moment the Mantis model is equipped with a RipMax Spirit 600 motor and a six cell (7.2 volt) nicad pack to suit our club racing rules. This also allows direct comparison with the identically outfitted mono hull model.

The speed of these models was measured by racing around the triangular course we use for club races. Fortunately this is permanently left in the water, giving me the chance to sail in the odd free lunchtime. The Mantis model could record lap times of around 22 seconds whilst the mono hull gave 24 seconds. This is not a great difference and could easily be accounted for by errors in timing, even driving wider around the buoys could mask the true difference. So, I am reluctant to say if the tunnel hull has any significant speed advantage, at least as far as my two models go.

However, the Mantis model is noticeably smoother and more stable when racing. The turns are also safer, the model having never spun in a tight turn. This is something mono hulls can be prone to do, which can easily lose races. Application of full rudder does not cause any great loss of speed at first. But, if the model is kept in a tight turn then aeration of the prop eventually occurs to rapidly slow the model. This is never a problem; just release the rudder when the model is pointing in the right direction and it will accelerate back onto the plane.

It is hard to decide between tunnel and mono hulls for racing. The tunnel may be slightly faster, either inherently or due to its better stability, but the mono might be better in rougher conditions. A mono hull seems to be able to cut through waves whereas the larger size of the tunnel can be slowed down. To avoid having problems deciding which model to sail I simply take both to the lake. This does allow me to



carry out comparative trials under more or less identical conditions. At least that's my excuse when someone beats me in a race. I'm just racing to test the models, not to win, but no one believes me!

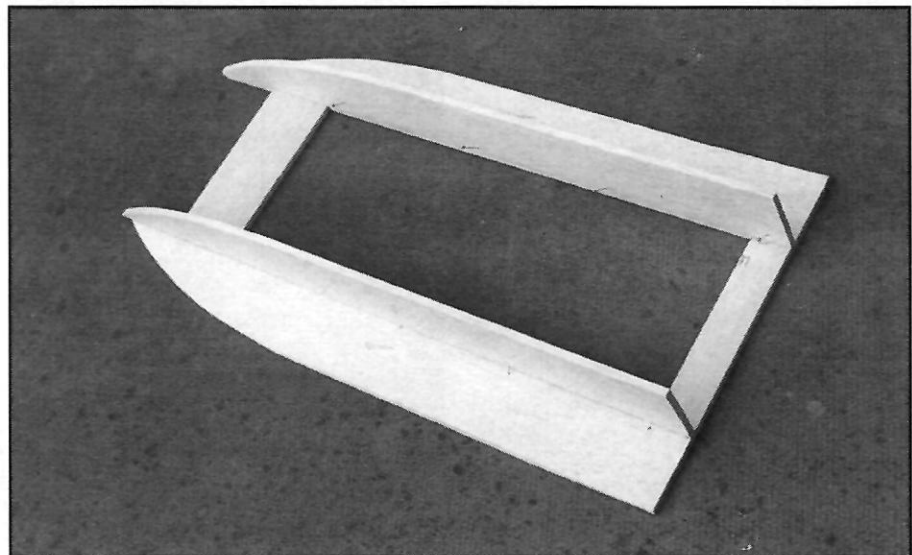
Building Materials

Balsa is the main construction material for this model. Its low density means that thick sections can be used without risking any weight penalty. Thick sections also means the structure will be stiff and tough. The mono hull model employed similar construction and has withstood several high speed collisions with plastic kit models.

Medium grades of balsa are ideal, too hard and you simply make construction difficult as well as adding needless weight. Very soft balsa might save some weight but runs the risk of weakening the model. Occasionally you can encounter some light and stiff grades of balsa sheet which are brittle and can snap with little warning. Needless to say, these should never be used in a model like this. My own balsa selection is simply based on avoiding any extremes of density whilst picking out sheets which display straight, uniform grain patterns.

The main hull structure is made from $\frac{3}{16}$ inch (5mm) thick balsa sheet. One sheet of 4 inch (100mm) wide and two of 3 inch (75mm) wide balsa ought to supply all these parts. The hull is then covered with

Stage 4. Sponson insole pieces glued to deck.



Stage 3. Deck pieces glued together.

$\frac{1}{8}$ inch (3mm) balsa; two sheets of 4 inch (100mm) wide are sufficient.

A piece of plywood is needed for the motor mount. A thickness of $\frac{3}{16}$ - $\frac{1}{4}$ inch (5-6mm) is more than adequate. The two spray strips are made from a length of $\frac{1}{8}$ inch (3mm) square hardwood strip. The hatch and coaming can be made from card, balsa or thin plywood as you prefer.

A quick drying PVA woodworking glue was used for all the structural joints in this model. A 'waterproof' type might appeal to you but be warned, the small print says they are just water-resistant!

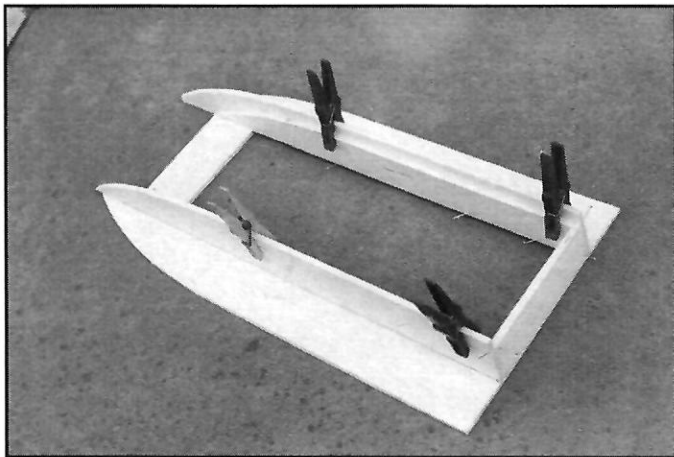
Construction

As with most models it is best to write the construction notes in a numerical sequence. This helps you to build the model in the correct order and minimises the risk of missing something vital!

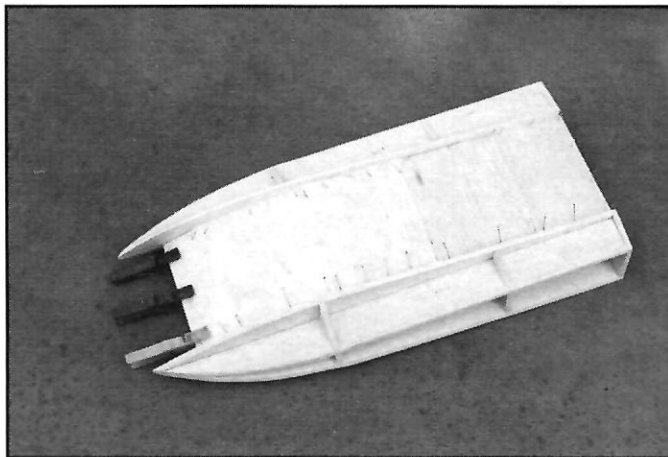
1) The structural parts are cut out of $\frac{3}{16}$ (5mm) sheet. Where two or more identical pieces are required, the first one can be used as a master for the other(s). It is important that corners and edges are cut squarely to produce good joints.

2) It is a good idea to have a trial run at building the hull structure using pins rather than glue. It could avoid embarrassing mix ups with some parts!

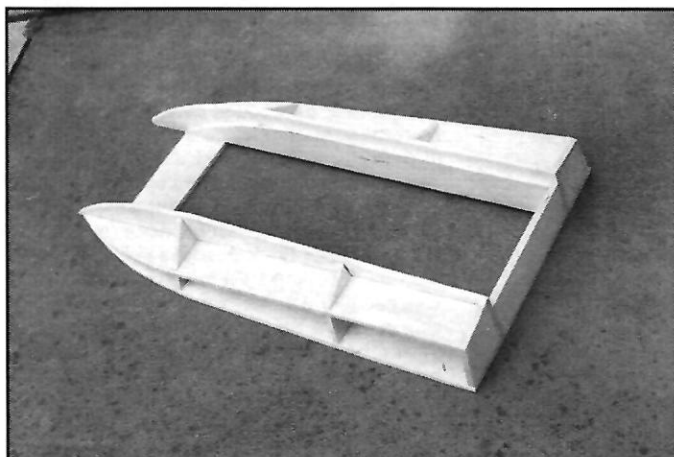
3) The hull is built upside down on a flat surface. I used my desk top in the study, placating my wife's worries by first



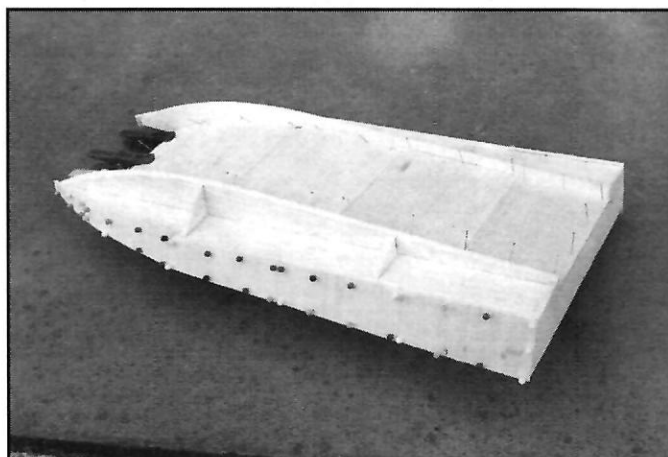
Stage 5. Transom and sponson inner pieces glued in place. Top edges held by clothes pegs.



Stage 9. Sheeting the hull bottom between the sponsons. Pegs again ideal to hold the sheet.



Stages 6-7. Sponson, transom and chine pieces added. Note extra pieces to sub divide sponsons.



Stage 10. Sponson sides are sheathed.

covering it with a thin plastic sheet. The first step is to glue the deck pieces together, the sponson decks being joined by two crosspieces. It is vital that you get everything square and then pin and leave it until dry.

4) The sponson inside pieces are then glued along the edge of the deck pieces. It is again vital that these parts are square to the deck. There will be a little overhang at the extreme bows, but do not worry as this gets sanded off later.

5) The transom and sponson inner pieces can then be fitted. Clothes pegs are handy for holding the upper edges of the inners in place.

6) The two sponson transom pieces are added next, again taking care to get them square and in line. After this the chine pieces are glued to the sponson transom and side pieces.

7) I took the opportunity to subdivide the sponsons with small pieces between the chine and deck pieces. This adds a little extra strength and minimises flooding if a sponson is damaged.

8) The edges of the sponsons are then sanded to receive their sheeting. A sanding block is the only safe way to do this.

9) The 1/8 inch (3mm) sheeting is first applied between the sponsons, taking care to make it sit firmly on the inner pieces. The balsa grain must run across the hull. It is best to start at the transom and work forwards.

10) The sponson sides are then sheathed using slightly oversized strips of 1/8 inch (3mm) with the grain running vertically. Again it is best to start at the transom and

work forwards. When dry the excess sheet can be cut and sanded away, taking care to match the sponson section.

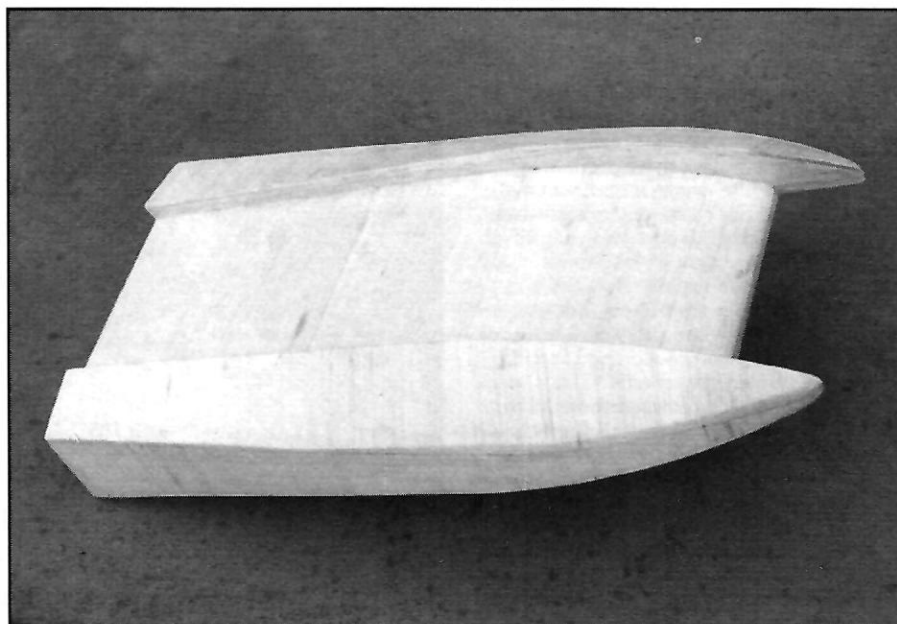
11) The bottom of the sponsons are sheathed in the same fashion as the sides. When sanding the edges it is important to keep them sharp. The 1/8 inch (3mm) square spray strip could be glued to the edge of the sponsons at this stage. I found it easier to add this strip after sealing the balsa surfaces.

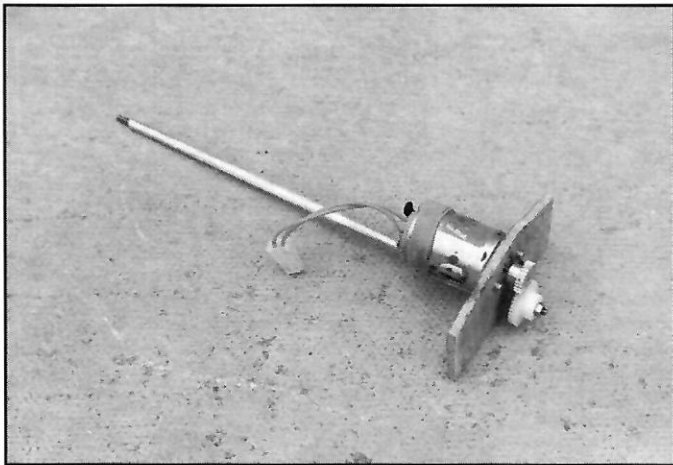
12) The transom must be sanded to a

flat surface whilst keeping the edges sharp. Any defects can be rectified with filler then sanded smooth. It is worth checking the inner junction between the sponson inners and bottom sheeting. As a precaution I ran a fillet of glue along this joint.

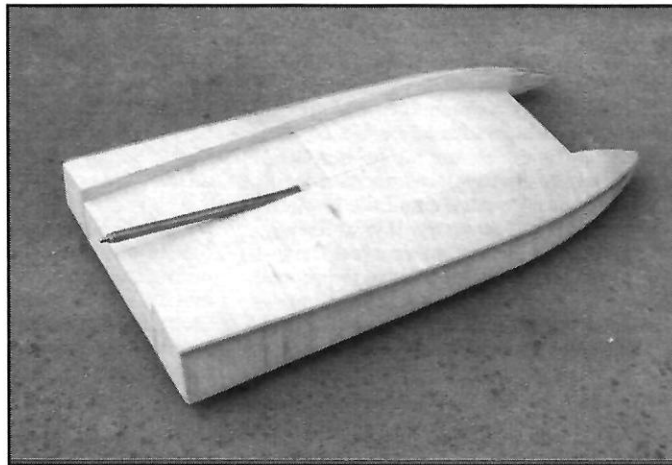
14) The junction between the bottom sheet and forward deck piece needs gently radiusing. Do not be too heavy with the sandpaper or you can weaken the glue

Stages 11-12.





Drive unit, prop tube and motor fitted to ply bulkhead.



Prop tube fixed to hull. Note spray strips on edges of sponsons.

joint. If this happens then some reinforcement must be added to the inside of the joint.

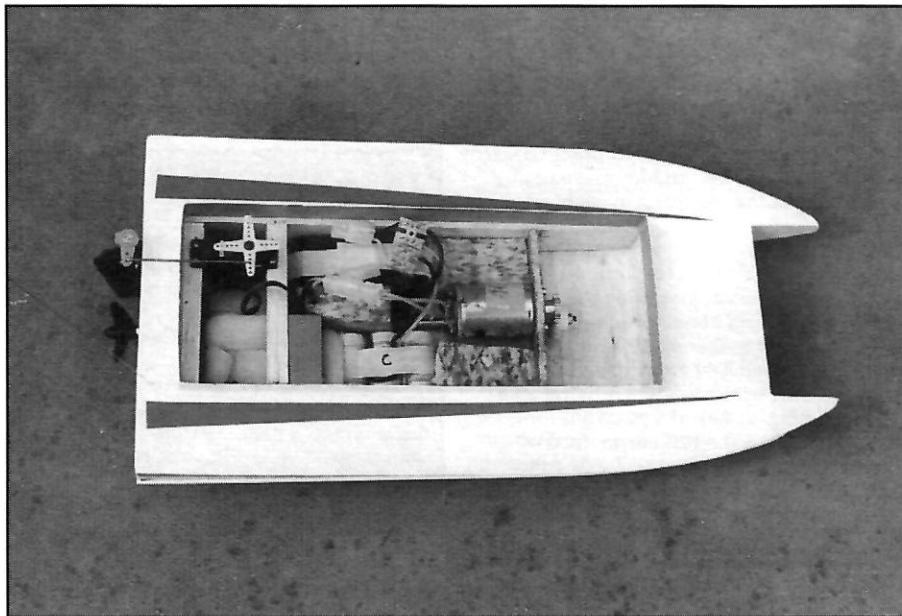
15) Bulkhead 1 can be fitted after chamfering its lower edge to match the bottom sheeting. It might be best to leave the second bulkhead until you are ready to install the radio gear.

is a good idea to overlap the tissue around any corners. This might call for the tissue to be cut or slit before it will accommodate the corner and lie flat.

Any bubbles between the balsa surface and tissue must be removed. Small bubbles can often be forced out by simply pressing firmly with the dope brush. With

larger bubbles it can be better to slit the tissue before using the dope brush. A couple of thinned coats of dope, with a light sanding between each ought to then produce a sound surface for the final coat(s) of paint.

I added the spray strip to the prototype's hull at this stage. To get a good bond with the doped surface, cellulose based balsa cement was used. A few pins and elastic bands held the strips in place whilst the cement dried. A couple of coats of dope sealed the strip surfaces.



Above, ready to sail. Battery packs held in place with stiff foam packing.

Surface Sealing

It is best to start this task before the drive system has been installed. I have always found that the lightest and easiest way to toughen and seal balsa surfaces is to use cellulose dope and model aircraft tissue.

The external surfaces are first given a coat of slightly thinned dope. When dry a light sanding will remove the 'fuzz' from the surface. The model is then covered with tissue by breaking it down into a series of flat or reasonably flat panels. A piece of tissue is cut to be slightly larger than the panel. It is carefully laid over the panel to avoid creases then dope is brushed into it to bond it to the hull. If you start at the centre of each panel and work outwards then wrinkles and creases can be avoided. If any occur then the tissue should be lifted off the surface to remove the defect, then relaid.

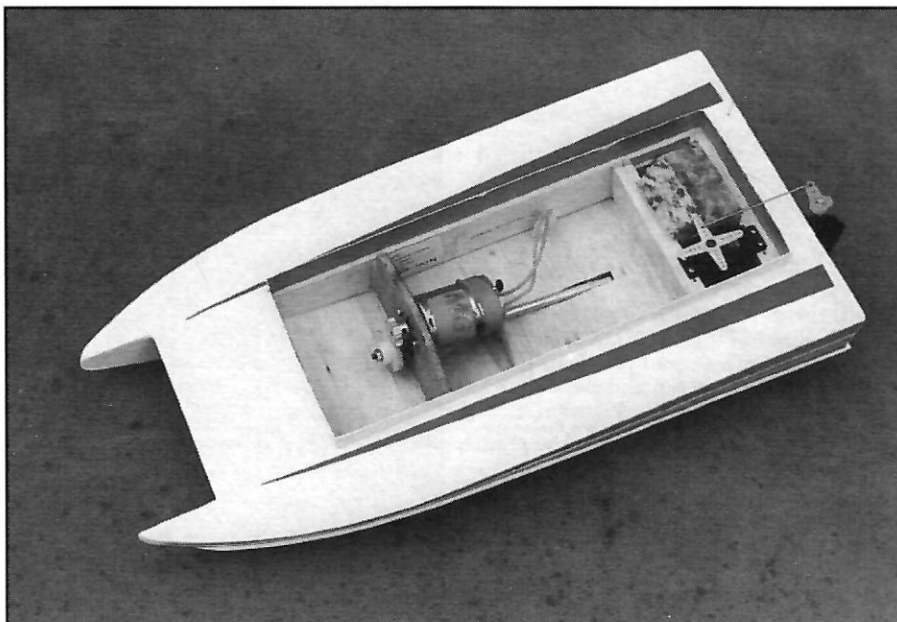
By starting with the simple flat surfaces, like the deck and transom, the skills needed can be quickly developed. It

Drive System

The plywood motor bulkhead needs cutting so that it will fit snugly in the hull. Small gaps could be filled with glue and balsa packing but the bulkhead must not deform the hull structure. The size and position of the prop tube and motor holes depend upon the items used. I found it best to place the two gears, suitable R/C car type gears giving a reduction of 2 to 3:1, on the bulkhead. When happy with their position, remembering that the lower gear on the prop shaft must clear the hull bottom sheeting, the centres of the gears were marked.

The hole for the prop tube was drilled taking care to keep the drill vertical. The hole to accommodate the motor bearing

Below, motor and R/C installation.



housing was larger than my biggest drill bit. As this does not need to be precisely made I could simply open out the drilled hole with a round file.

The two holes for the motor securing bolts must be made with a fair degree of accuracy. I was lucky and my holes were more or less correctly placed and needed only a little work with a small file to allow the gears to mesh correctly. If your first attempt does not seem to be correct then scrap it and start again. Failure to produce an accurate motor mount will result in a model that can never achieve its full performance potential.

Only when totally happy with the bulkhead should the prop tube be glued to it. I recommend the use of slow, i.e. 24 hours to set, epoxy, it does seem to penetrate and adhere better than the fast types. Any final adjustments to the motor position can be made by carefully opening the bolt holes into suitably shaped slots, the aim being for the gears to rotate easily with minimum free play.

Fitting the drive system into the hull needs care on two counts. Firstly the prop shaft must be on the centreline of the hull. Any deviation from this will result in the model fighting a permanent turning effect. The second important thing is the position of the propeller. In the prototype the top corner of the tube was placed in line with the lower corners of the sponsons. The end of the prop tube should also be in line with the transom.

The best way to install the drive system is to draw a centreline along the hull bottom sheeting. The hole for the tube is made along this line, its position being found from the plans. The hole can be gradually opened up into an elliptical shape whilst checking the position of the tube. Only when totally happy with the arrangement can the ply bulkhead and tube be stuck into the hull. I used PVA glue for the bulkhead joint and epoxy on the prop tube where it passed through the bottom sheeting. This joint was further reinforced with a patch of epoxy coated fabric on the inner surface.

The coaming needs fixing around the deck opening. I simply used strips of stiff card about 3/4 inch (20mm) wide. The hatch was made from card and balsa, being built over the coaming to ensure it was a good fit. Both hatch and coaming surfaces need sealing, again a couple of coats of dope were adequate.

Painting

Paint is best applied at this stage before the rudder unit is fixed to the transom. I simply gave the model a couple of coats of white paint. Provided the preparation of the hull surface has been carried out correctly, this should produce a smooth and tough finish.

A little extra colour was added with some self-adhesive tape strips. A driver was suggested with a small plastic ball. You could have a little fun and use a 'toy' figure but do not add too much weight.

Rudder

The prototype used a Robbe rudder unit which happened to be available. It has proven to be ideal giving a positive response without being too powerful when at full speed. The plans show how to construct your own rudder unit from metal

sheet and rod. Brass or aluminium sheet can be used for the rudder blade, the latter being somewhat lighter. A brass rod can be used for the rudder shaft, its lower end being slotted to accept the blade. Shaft and blade can be joined with epoxy or, in the case of an all brass unit, solder can be used.

The rudder is fixed to the transom by a simple 'U' shaped bracket. This is held to the transom with four suitable screws, noting the offset position. The rudder must move freely but with the minimum of 'slop'. The tiller can be a commercial unit or a home-made item. A suitable spacer tube, possibly plastic, will be needed to keep the tiller at the correct height to match the rudder servo arm.

Radio Installation

Unlike some fast electric models, there is a generous amount of space in which to fit your radio gear. A method of mounting the rudder servo is suggested in the plan. The servo can be secured to balsa blocks fitted beneath the deck and on the rear of the second bulkhead. If you use this method then fit the balsa under the deck first. Then hold the servo in place whilst you find the correct position for the bulkhead.

The wire link between servo and tiller arm should be as straight as possible. It will just clear the coaming but a slot will need to be cut in the rear of the hatch. You ought to aim for a rudder throw of no more than 30 degrees either way. In practice you may find that less rudder movement gives you smoother steering at high speeds.

This arrangement provides more than enough space to fit the receiver and its battery pack, if used, alongside the servo. Most of my models use a vertical whip aerial made from piano wire fixed to the rear of the model. The connection to the receiver aerial wire being via a flying lead and small plug-socket. If you do not fancy this method then the R/C car method of routing the aerial wire up a plastic tube fitted to the model could be used.

The drive battery packs, 6-7 'sub-C' nicads are recommended, are fitted between the bulkheads and motor

mounting. My models usually use blocks of stiff foam plastic to hold the batteries in place. The prototype model employed a small electronic speed controller which also fitted into the battery space. As this unit included a BEC system, no receiver battery pack was needed.

However you install your R/C gear do check that it is safe and reliable in operation. Radio failure is embarrassing in any model but this one is just too fast to sail without 100% confidence. A good idea is to lubricate the motor and propshaft bearings before you test the model; dry bearings quickly become worn bearings!

Sailing

Provided you have sailed fast electric models before then Mantis ought not to create any problems. Be warned though, its speed can be deceptive since the model runs with less water disturbance than many mono-hulls. If you are a novice in this area then be sensible and sail on suitable large areas of water and keep out of everyone else's way!

My experience with these surface piercing drives is that they are generally very stable and insensitive to changes in the model's centre of gravity. It is still worth experimenting since the performance can often be improved by the correct combination of CG and propeller which matches your sailing style.

Last Idea

A couple of fellow club members have experimented with putting I/C motors in fast electric hulls. They have obtained very high speeds with no serious stability problems. A plywood version of Mantis might therefore be an idea.

If the model's size was unchanged then a 10 (1.5cc) motor would seem suitable. It is possible that a 15 (2.5cc) motor could be used by the brave and skilful. Anything bigger than this and the model might have to be 'flown' with 35 MHz radio gear!

