Sigma

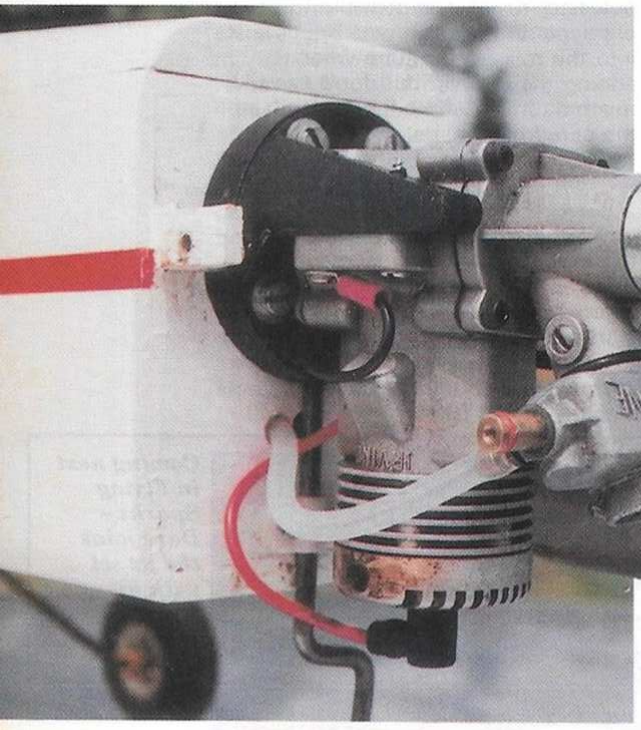
Introducing plans for a 53 inch shoulder wing sportster from Tim Goodwin

Sigma is the result of the desire to design a model that had a scale like appearance and a good sport aerobatic performance. I also wanted to move away from the traditional low wing format. This was for a number of reasons; first, the majority of models are of this format and although it offers a number of advantages I wanted to design and build something a little different. Secondly, going for a mid wing layout the undercarriage could be permanently attached to the fuselage, therefore making the model easier to maintain. Lastly I just liked the idea of a mid wing model.

Tim designed Sigma to take .40-.45cu in motors. His Irvine .40 proved to be an ideal match for the prototype model.

Building the wing

Start by making the two sets of ribs by the sandwich method. The sandwich is made up of one 1/8" root rib and the ten 1/16" ribs. The blanks should be fastened together by drilling a 1/8" hole through all the ribs and templates and fastening them together with two 6 B.A. nuts and bolts. At this stage only cut the main spar slots in the ribs; the trailing edge slots are cut in situ due to the angle of the trailing edge spars through the ribs. When the ribs are the correct shape mark a centre line along the leading edge for future reference. It is also a good idea to mark the top of each set of ribs relative to the templates. This is so that if there are slight differences in the symmetry of the templates both sets will be the same!



The wing panels are made separately and joined later. To help keep the ribs aligned thread 12 s.w.g. lengths of piano wire through the two holes already made. The ribs are then mounted on the bottom spar. Use another spar to support the trailing edges of the ribs and ensure that all the ribs are horizontal using the centre lines marked earlier. When all is square, cyano can be run into the joints. The top spar can now be fitted, again ensure all is square before gluing. The leading edge is fitted next, this is slotted for each rib and is best fixed using PVA. This is the last chance to make sure that the wing is warp free so check the alignment of the ribs before leaving to dry.

The other wing panel can now be assembled. The two wing panels are joined together, with the ply bracing added after the glue has set by cutting appropriate slots in the centre section ribs. The ply will bend quite easily to take the slight angle between the spars and leading edges. It is important at this stage to ensure that there are no incidence differences between the two panels.

The trailing edge spar slots are cut and the spars fitted, followed by the lower trailing edge and lower leading edge sheeting. The ailerons are then cut away from the wing and completed separately. The top trailing edge sheeting can now be fitted, together with the lower centre section sheeting and the filling between the t.e. spars where the ailerons have been removed. The sides and back of the servo bay can also be made.

On the prototype the aileron servo was fitted using a servo mounting clip supplied by the radio manufacturer. This is glued to a piece of 1/32" ply that is a snug fit in the servo bay so that the loading from the servo is dispersed. The aileron bellcranks are mounted on 1/16" ply. Care should be taken so that the bolt head does not protrude below the rib capping strip. Once the servo and bellcranks are in position the snakes can be fitted. A tip to ensure correct alignment is to draw a line across the top of the ribs between the servo output arm and the hole on the bellcrank. The distance from the top of the rib to the centre line of the bellcrank at the clevis position is then transferred to the plan. This is marked from the spar towards the trailing edge at the bellcrank position. Repeat this process for the servo. A line is drawn between these two points and where it crosses each rib it indicates the distance from the top of the rib to the position of the snake. Drill the ribs and fit the snakes.

To build the ailerons the tip riblets are added, these are copied from the ribs still attached to the wing. Then fit the front sheeting. This is initially one piece of balsa cut to the length of the aileron but about twice the depth of the ribs. Slots are cut in the rib positions and the sheet is glued in place with the correct angle set with a template. Once the glue is dry the excess balsa can be removed and the diagonal ribs fitted. Offer up the aileron to the wing and mark the position of the control horn, this can then be fitted with balsa surrounding it to hold it in place. Now fit the aileron top sheeting ensuring that the assembly is flat whilst the glue dries.

Onto the fuselage

Start by producing a kit of parts of the formers, sides and doublers. Glue the doublers to the sides taking care to produce a left and right side! Glue the spruce longerons to each side and then fit F2, F3 F4 and F5 to the right hand side. Note that F2 incorporates 1.1/2 degrees of downthrust. The other side can be fitted and when dry fit F6 and the tail posts. Make up the elevator bellcrank and pushrod and fit them to the rear of the fuselage. Take care that the bellcrank is square and moves freely. The rudder snake is then fitted,

along with the servo mounting rails and throttle snake. Fit the wing retaining plates and when the glue has dried offer up the wing and drill the bolt holes. The dowel holes are then drilled through F3 and the wing leading edge. A good tip here is to measure the distance from each tip to the rudder post to ensure that the wing is square on the fuselage. Once the dowels are secure in the wing the top sheeting can be added.

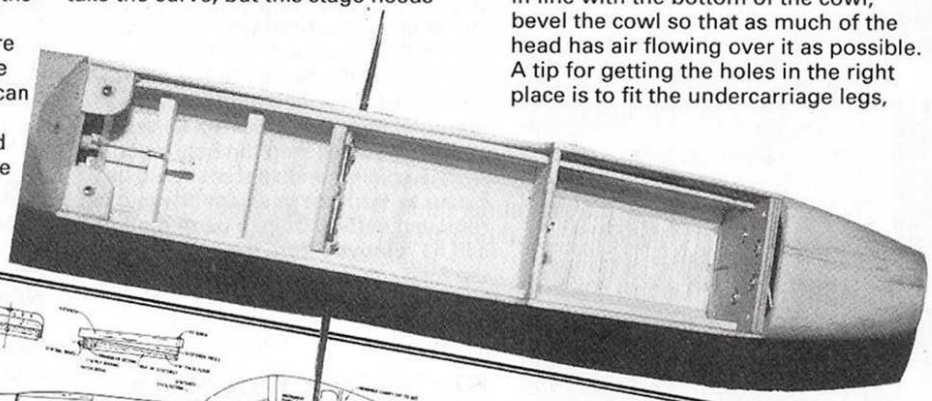
The assembly of the tailplane and fin is probably the trickiest part of the whole model. Great care is needed to ensure that everything stays square and true whilst the glue sets. In fact a dry run is thoroughly recommended before gluing. Remember to chamfer the top ends of the spruce doublers as this prevents the components snapping where there is a sudden change in strength. If the tailposts and leading edge of the fin are fitted to the tailplane first, once these are square then the centre post and the top of the fin can be added. The right hand fin sheeting can now be fitted followed by the 1/16 balsa ribs. Now fit the left hand sheeting above the tailplane. Do a trial fit of the elevators with the horn attached so that the pushrod and clearance holes can be made. When totally happy, the tail is glued in place with the pushrod for the elevators already in place. It is quite a good idea to have the wing attached at this stage so that the tail can be squared up to the wing. The left hand bottom sheeting on the fin can now be fitted.

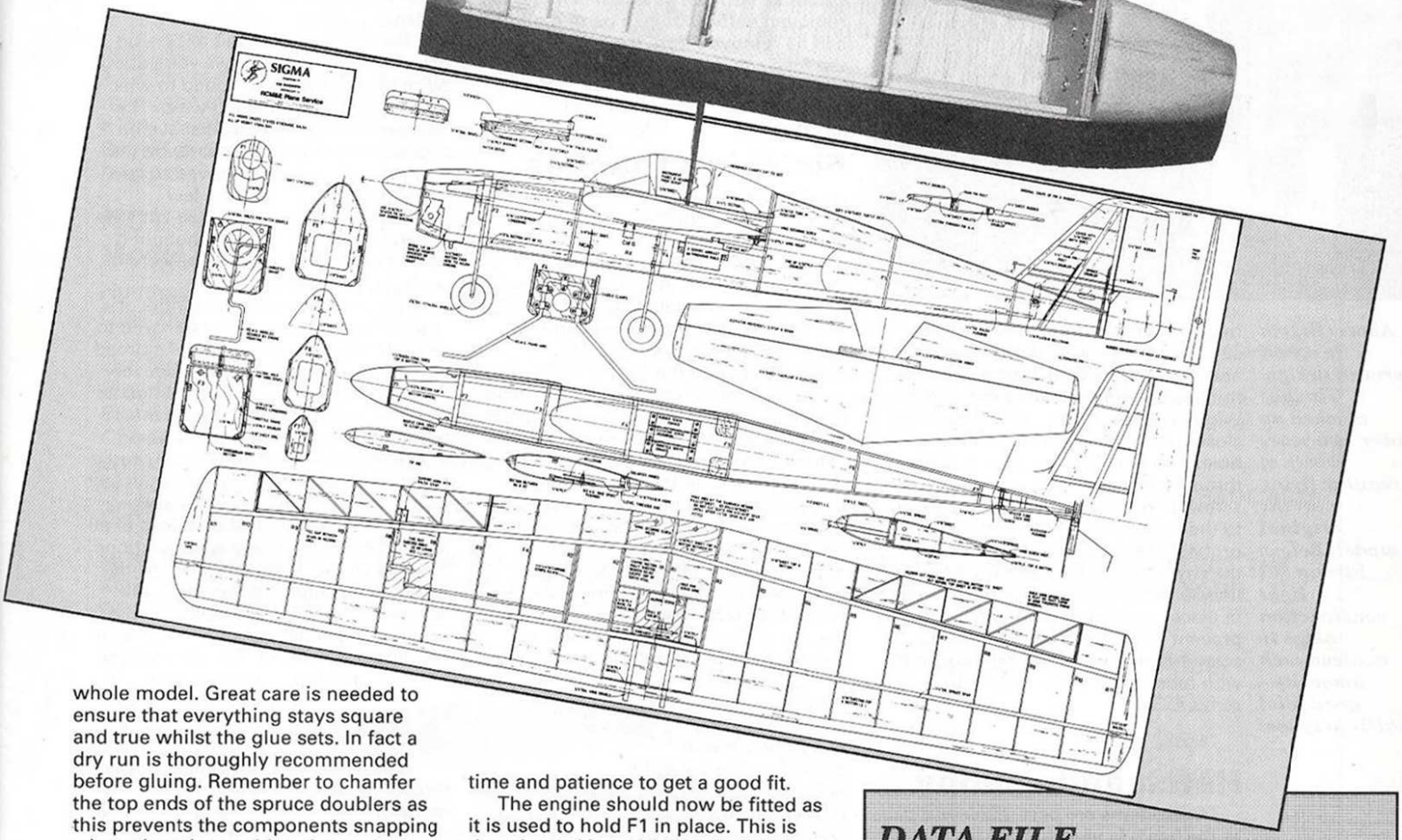
Shaping up

The various bits of triangular section can now be fitted along with the bottom sheeting. The top decking is made in three pieces. First the central piece is fitted along the top and shaped around the fin and then the side pieces can be added. If the balsa is moistened on the inside and gently bent it will take the curve, but this stage needs time and patience to get a good fit.

The engine should now be fitted as it is used to hold F1 in place. This is done by making a 1/16th ply disk the same diameter as the spinner, with a hole in the centre that is a snug fit over the propshaft. A spinner with a back plate that fits behind the prop is best for this operation as the disk is now lightly tacked with cyano to the spinner on one side and F1 on the other. A conventional spinner could be used with a spacer to represent the prop between the ply disk and the spinner back plate. The result of this is that F1 is now square with the engine and in a position that will allow slight changes in thrust angle if this should prove necessary. In the early stages of fitting the sides to the cowl remove the carb from the engine and block up all holes! The side plates will require slots cutting in them to clear the longerons. These slots should make a tight fit on the longerons as they are used to hold the cowl in place. The four sides of the cowl are glued together with 1/2" triangular section in the corners. Once dry, carve and sand to shape. The carb and silencer are fitted to the engine and the necessary slots cut in the cowl for clearance. The area behind the cylinder head is left open as an exit for the cooling air. If the cylinder head is in line with the bottom of the cowl, bevel the cowl so that as much of the head has air flowing over it as possible. A tip for getting the holes in the right place is to fit the undercarriage legs,

Separate radio and tank bays help to keep the electronics dry in the event of a tank leak.





DATA FILE

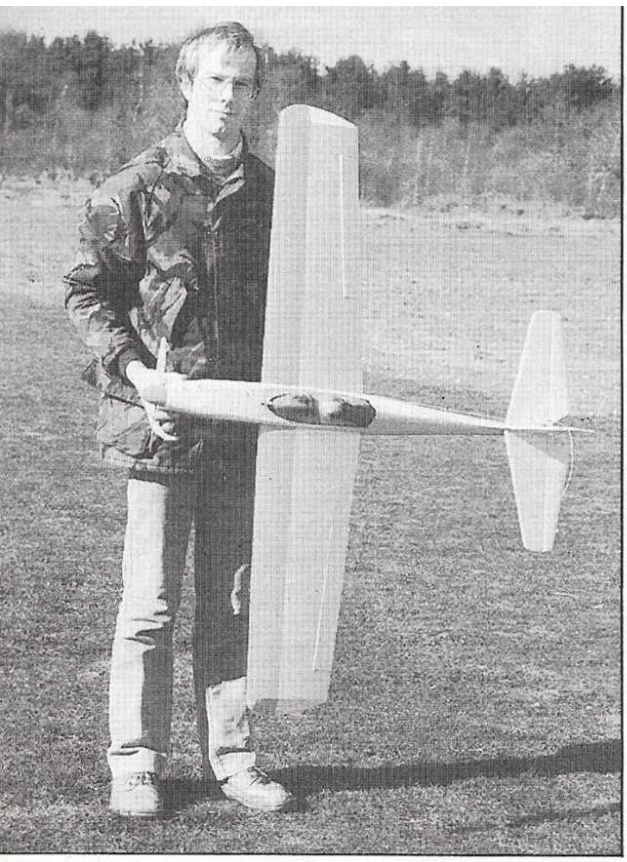
SIGMA

Plan Specifications

Designed by	Tim Goodwin
Type of Aircraft	Sport Aerobatic
Wingspan	53in
Total Wing area	477sq in
Aerofoil	NACA 0015
Dihedral at each tip	None
Fuselage Length	79in
Tailplane Span	22in
Tailplane Area	105sq in
Tailplane Section	Symmetrical
Rec. Engine Range	.40-.45cu in
Fuel Tank Size	8oz
Rec. No. of Channels	Four
Control Functions	Rudder, elevator, aileron, throttle

Materials Used in Construction

Fuselage	Balsa, ply, spruce
Wing	Balsa, ply, spruce
Tail Surfaces	Balsa, spruce
Weight, Ready to Fly	5lbs
Wing Loading	24oz/sq ft



Above: Sigma is a well proven design. Tim has clocked up over two years worth of regular flying with the original model. Below: Strong but light construction helps to achieve such longevity – good pilot skills help too!

measure from the building board to say the needle valve, then fit the cowl and mark the same height. The same thing is then done measuring from F1. Where the lines intersect will be very close to the correct position for the hole. The cowl is retained with bolts through the cowl and longerons and screwed into nyloc nuts that are glued to the inside of the longerons. It will probably be necessary to cut slots in the cowl to clear the needle valve (the needle valve is fitted once the cowl is in place) and the throttle arm. To prevent the balsa around the fixing screws being worn the holes are lined with tube that is a slip fit over the screws.

Hatch and canopy

These items are best made as a pair as the hatch is used to hold the canopy in position. Start by making the 1/16" balsa 'square' for the hatch. This is done by assembling the frame inside the fuselage with the minimum of cyano; remember this is not a permanent fixture so keep the cyano off the fuselage! I found it easier to make the frame about one inch deep initially and cut it down to size later. Remove the frame from the fuselage and fit the false bottom. This makes the final assembly more rigid and helps keep the square in shape. The top sheeting can be fitted, remember that this overhangs both formers. The frame is cut down to the finished size, at the same time drill out F2 and fit the locating dowels, these need to be kept to about 3/16" long or the hatch cannot be removed. The hatch is retained with a screw through the top and fastened into a threaded tube that is glued to F3.

Make the base for the canopy by shaping the two 3/4" triangular sides to fit over the wing; these can be left too tall at this stage and cut down to size once the floor is in position. Glue the sides to the floor remembering to allow clearance for the wing bolts at the rear and aligning the front with the hatch top. Fit F5a and the parts at the front that locate with the hatch. The rear of the canopy is located with a dowel through F5a and into F5. Again a piece of tube in F5 will stop the hole wearing.

The spinner and spacer should be cut away from the cowl and the engine removed before. Quite a bit of material can be removed from the bottom of the fuselage, giving a nice rounded shape.

Finishing touches

I coated the areas vulnerable to attack by fuel with Clearcoat; two coats is normally sufficient. A secondary advantage of coating with Clearcoat is that it hardens off the balsa and makes it less prone to small dents. The inside of the engine compartment and cowl were then painted with Solarlac to match the rest of the finish.

To keep bleed through of the airflow on the ailerons to a minimum, Solartex hinges are used. These are made by cutting two pieces of Solartex 2" wide and 1/8" less than the span of the ailerons. Draw a line down the centre of one piece on the adhesive side and then stitch the two pieces together adhesive sides out with a sewing machine. The hinge is then ironed onto the aileron with the stitch line along the top surface so that the hinge will end up flush with the top surface of the wing. Before the aileron is attached to the wing cover it with Solarfilm. The Solarfilm is butted up to the hinge top and bottom, the same is done on the wing when that is covered. Also cover the ends of the aileron recess in the wing as these parts are difficult to get to with the aileron in place. The aileron can now be attached to the wing. The result of using this method is that the aerodynamic performance is improved, and this is borne out in that the ailerons do not move a great deal yet control is maintained at low speed, whilst there is no ugly 'V' in the top of the wing. I then covered the whole airframe with Solarfilm.

The completed aircraft should weigh less than 5 lbs. On the original the wing weighed 15 ozs and the fuselage 1 lb 7 ozs, the rest of the weight being made up of the engine, radio etc. Set the control throws as indicated on the plan. The ailerons and elevator are very effective so don't exceed the movement stated for the first flight. Keep the C of G to the indicated position; on the prototype the C of G came out as planned without any extra weight needed.

Take off!

Now to the bit you've been waiting for. The first flight proved to be a bit hairy as the aileron throws were about twice those now used, added to which was a very strong gusting wind. The net result was a very close shave on take off as one wing tip nearly hit the ground and the model proved to be extremely twitchy. I tried a few manoeuvres and was pleased with the general performance but I thought it best to land the model and adjust the control movements.

Over the last eighteen months of regular flying the model has proved to be fairly robust and capable of a broad range of aerobatics. Initially, recovery from spins was a bit slow so I fitted an enlarged rudder and this cured the problem. This also means that the model will now knife edge (just!) and it has made snap rolls spectacular, in fact full throw on rudder, elevator and aileron results in almost total loss of all forward speed and very wild gyrations. The model will do consecutive inside and outside loops, figure eights and cuban eights. Spins are quite fast but recovery is almost instantaneous when the rudder is centred. The stall is fairly gentle and there is normally plenty of warning as the ailerons become less effective.

I have had one major disaster when I managed to crash the model on takeoff. Damage was limited to the turtle deck splitting and one of the 1/4" by 1/8" tip spars snapping. I was particularly pleased that the tail stayed intact as I had suspected that this may have been a bit vulnerable.

I hope that you will have a go at building Sigma and that you get as much pleasure out of her as I have. If you don't like my design have a go at designing your own, I have certainly had more pleasure out of this model (and a good few frustrations) than any model built from a kit. There is no doubt about the thrill of seeing your own design airborne! Happy landings.