Author's pretty daughter with pop's Avenger at Northrop Corp. grounds, Palos Verdes, Calif.

Third in a series taking two years to develop, our Areobatic Slope Soarer lives up to all its promises: very effective performance!

The Avenger

BY JACK W. HEADLEY

• The Avenger is the third in a series of models built over the past two years to explore the possibility of producing a sailplane suitable for both Slope Soaring and Aerobatics.

My experience before beginning these models was mainly with Slope Soaring, but I'd reached the stage where I wanted to do a little more than just soar around the sky, with a few loops and spins thrown in now and again, so I thought that a more or less standard slope soarer with aileron control might be a bit more lively. And it was!

A model was designed and built which had almost full span ailerons, no rudder, and a normal elevator. After a few practice sessions, it became very obvious that the aileron control did indeed give considerably more maneuverability. During the past two years the model has been flown many, many times; recently a friend modified it to coupled aileron/rudder control, and this seems to have increased the agility of the model even more.

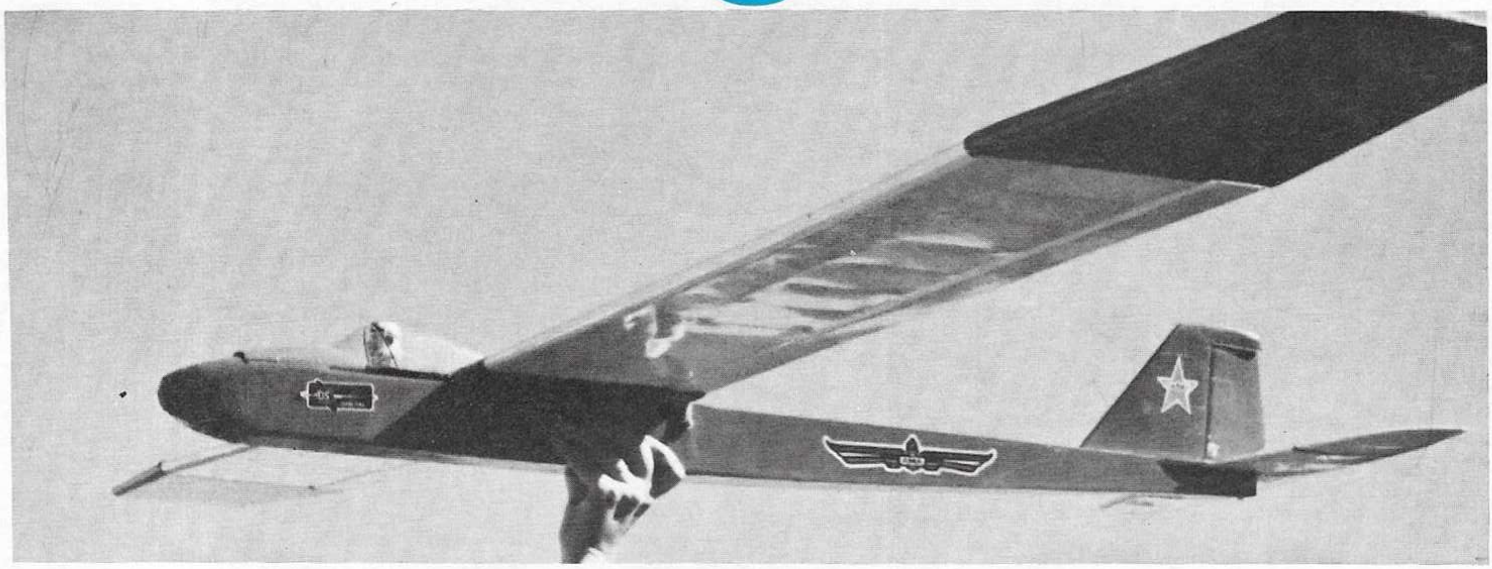
We'll draw a veil over the next model, which was supposed to be even more acrobatic, but didn't turn out that way, and come to the current design. Here we went back to the basic layout of the first model, and made the following changes to increase the performance:

1. The wing area was increased to reduce the overall wing loading.
2. Slightly larger ailerons were used to increase the rolling power.
3. The wing was stiffened to increase the flutter speed.

In addition, an all-moving tail was added, mainly because I'd not tried one before.

The resulting model, called the Avenger, is the design we present here. It's now been flying for a couple of months and shows considerably promise. If you're looking for a slope soarer with a difference, this is it!

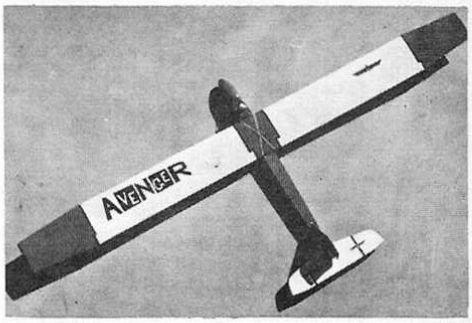
FUSELAGE. The fuselage is constructed mainly from ¼" square stock, so first select a few lengths of good quality wood, then



Maybe not the prettiest Soarer in the business, but it is functional, simple to build, strong and, of importance, does what it is designed to do.

Making some simple aileron adjustments.

Now checking out the aileron adjustments!



Adjustments completed and now ready to fly.

And fly it will, as author readies to hand-launch the Avenger out over the Pacific Ocean.

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begin by making the fuselage sides. At this stage put in only the ¼" square pieces (the cross-bracing comes later). When the two fuselage sides have been completed, sand away the surplus cement, then join together using the various frames. You'll note on the plan that some of the frames have holes for the control runs. These may be satisfactory for your particular radio or they may not, so be prepared for some possible revision later on.

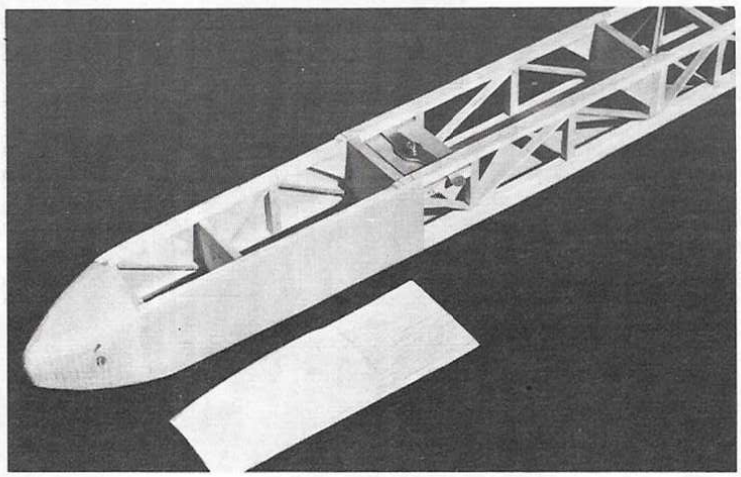
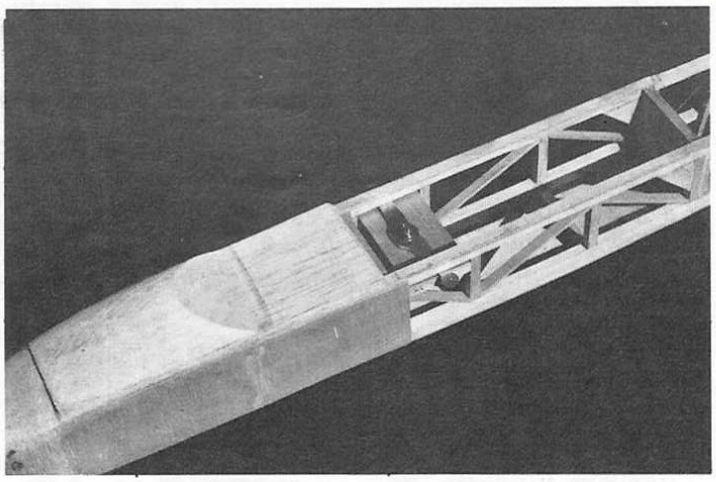
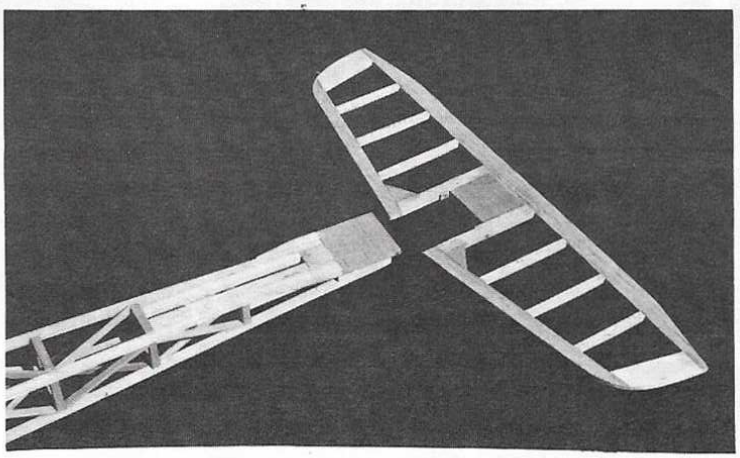
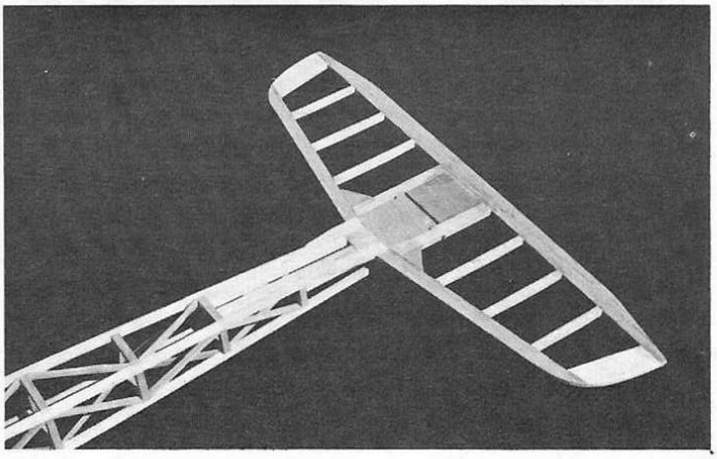
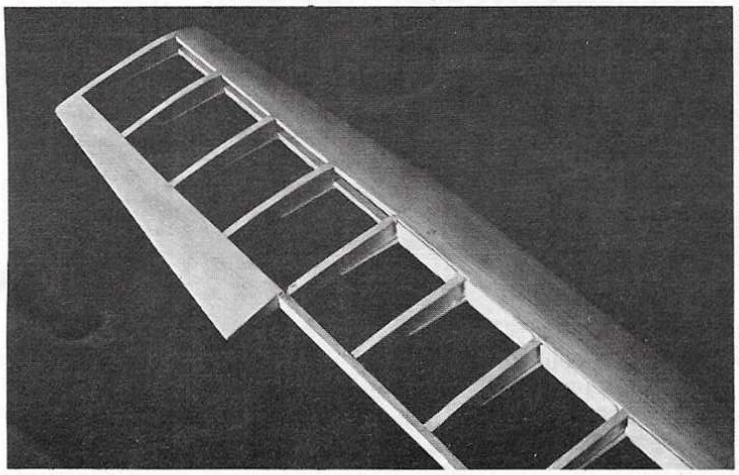
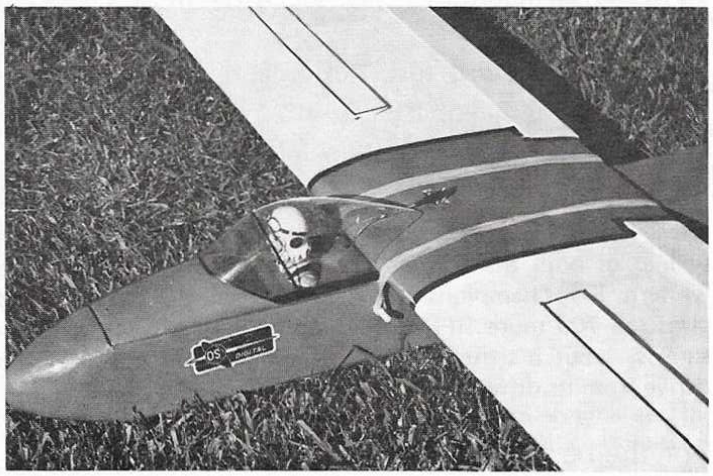
The top line of the fuselage is flat, so that joining the sides can easily be done on the plan, with the body upside down. When all the cross pieces have been put in place, a further light sanding of the joints will prepare the body for the next step, which is to cement on the 1/16" ply floor, and the 1/16" sheet piece behind it. Then remove the body from the building board, and install the ¼" X 3/32" cross-bracing, and the 1/16" sheet sides. The nose block is made from hard balsa, and can now be attached. To reduce wear in the wing region two strips of ¼" X 1/16" ply are cemented to the top of the longerons.

Add the bellcrank mounting plate, which is made from ply. Next, at the aft end of the fuselage, we need to provide the slot for the fin, and also the tailplane mounting. Strips of ¼" square are used for the fin support, and ¼" sheet for the tail mount. Before installing this support be sure to put in the 1/16" tube which provides a hinge for the tailplane. The photos and plan show this a little better than I can describe it. Add the wing dowels, and that's about all for the fuselage.

WINGS. Now for the wings; here we'll just talk about the plain wing, no spoilers. In later paragraphs we'll discuss the modifications necessary to include the spoilers in the wing, and also how to build the ailerons.

The plans show the right wing only (I'm a conservative); the left wing is built on the back of the plan in the usual manner. Each wing half basically consists of two sections (although it's built as one piece), these being the inboard parallel chord section, and the tapered wing tip. The parallel chord piece is the more strongly constructed, with a full "D" section leading edge, and capped ribs for both torsional and bending stiffness. The wing tip is more lightly constructed, with smaller spars to help reduce the rolling inertia.

Construction begins with pinning down the lower leading edge sheet and the tip trailing edge sheet to the plans. Make the spars next; the main spar is ¼" square spliced to ¼" X ⅛" at the tip, and the trailing edge spar is ¼" X ½" spliced to an ⅛" sheet tip spar. Cement these in place when ready, followed by the 1/16" X ¼" lower cap strips, then the wing ribs R2-R6. Now add the upper main spar, also ¼" square spliced to ¼" X ⅛", then the ⅛" X ½" false leading edge, followed by the tip trailing edge sheeting. Make and glue into place the ¼" wing joiner, and the forward 1/16" ply dihedral brace. The forward portions of ribs R1 can next be installed, followed by the upper

Photos above show the Avenger in various stages of construction up through the fuse, flying stab and cockpit details; note spoiler linkage.

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leading edge sheeting, and the cap strips on top of the ribs. At this stage we stop construction of the right wing, and turn our attention to the left wing. Begin again at the beginning with pinning down the sheeting etc., then continue until you get to the addition of the wing joiner.

Now is the time to join both wings together, so with the right wing propped up at the correct dihedral angle, cement the forward ply brace and the ¼" sheet joiner onto the left wing. Complete the sheeting on the left wing, and add the remaining ply wing joiners.

All that now remains is to add the remaining rib pieces, then the centersection sheeting, and the true leading edge. Sand all over, then cover as required.

LIFT SPOILERS AND THE MODIFIED WING. To incorporate the lift spoilers into the wing, a small cavity has to be provided in the upper surface, and to do this we have to modify the local structure of the wing in the spoiler region. Begin building up the wing as discussed in the earlier paragraphs, then install ribs R2A instead of R2 in the spoiler area. This is shown on the plans in one of the sketches. The spoiler cavity is now made by installing a 1/16" sheet floor across these ribs with a strip of ⅛" square at the aft end. Scrap pieces of wood are used to fill in the ends and complete the cavity.

The only other item to install is the ¼" square hinge block between these two cavities. This ¼" square is notched (as shown in Section A-A) at the forward edge for the hinge tubing.

Finish off the wing construction now and cover all over, except for the slot just discussed.

The spoilers themselves consist of sections of trailing edge stock, joined together with 1/16" wire. Begin by selecting a suitable piece of 1/16" wire, then make and solder into place the small control horn which actuates the spoilers. Slip onto this wire the two pieces of 1/16" I.D. tubing, then bend the wire ends at right angles for insertion into the spoilers.

Cut the spoilers from 1" X 3/16" trailing edge stock, then epoxy them onto the wire. Cover the spoilers at this stage. To install onto the wing, first push the tubing into the

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notch in the ¼" square piece, then iron a strip hinge of Solarfilm (or equivalent) onto the wing and the top of the spoiler. Test these hinges to make sure they operate satisfactorily, then epoxy the hinge tubing into place in the notch. A small strip of covering material is now ironed over this joint to finish off the installation. Don't, however, forget to leave a small hole in the covering for the control horn.

TAILPLANE. You'll probably have already noticed from the plans and photos that the tailplane is of the all-moving type. This type of control has, I think, some advantages over the more normal tailplane/elevator system; it seems to be a more sensitive control, it comes out lighter than the equivalent two-piece system, and also it's a little easier to build (I like that one best).

Anyhow, enough of the rationalization, and on to the building. The perimeter framework is first cut from 3/16" sheet, then cemented together, and pinned down to the plans. The ribs are made from pieces of ¼" square, except the root ribs, which need a little more explanation.

The root ribs carry the tubing on which the tail hinges, so select some good quality ¼" sheet for these items. Now cut to size, then make and cement into place the 1/16" ply reinforcers. When dry, drill the hole for the 1/16" I.D. tubing, then insert the tube and epoxy into place. Cement the root ribs into place now, together with the ¼" sheet spacer. Make quite sure that the tubes are aligned correctly before the glue dries! After it's all set remove from the plan, sand away the steps between the ¼" and the 3/16" items, then contour the leading and trailing edges and also the tips.

Installing the tail comes after the body has been covered, and the tail has been covered on the top surface only. I found that the best way to install the hinge wire was to first push it into the fuselage tubing until it all sticks out on one side. Now ease the tailplane onto this wire until it touches the body. With the tail now in its correct location, push the hinge wire back into the tubing on the other side of the tail. For safety a small washer can be soldered onto each end of the hinge wire. Check to see if the tailplane moves reasonably freely (it needn't be sloppy), before finally covering over the bottom side.

COCKPIT/RADIO HATCH. Begin by cutting the floor from 3/16" sheet to the same shape as the forward fuselage top. Cement a small block of balsa to the front of this floor, then shape as indicated on the plans. A fighter-type canopy was used on the original, plus a suitable painted pilot, and this is fine for the two-channel version, but if you're planning to use the three-channel setup, then it's probably best to omit the pilot, as he gets in the way of the push rod for the lift spoilers.

A small hook, epoxied underneath the floor, plus a small rubber band holds the cockpit unit in place.

AILERONS. To save a little weight the ailerons are built up from sheet stock, rather than carved from block. Select two sheets of 1/16" X 4" X 36" reasonably hard balsa, then trim both of these sheets to 32¼" long. From each of these cut strips 1¾" wide, 1⅜" wide, and ½" wide. From the small offcuts make all the required ribs, and from scraps of ¼" sheet make four end ribs. Cement all these ribs down to the 1¾" wide strips at the correct stations, then leave to dry.

Add the 1⅜" strip onto the top of the ribs, and after this has dried trim the forward edge to the right bevel for the ½" wide strip, which can be cemented into place next. Sand all over, then cut the control horns from 1/16" ply and glue them to the inboard end ribs.

FIN AND RUDDER. I haven't an awful lot to say about these items. The fin is made mainly from ¼" X ½" strips, the only exception being the tongue which keys the assembly into the fuselage which is made from ¼" sheet.

The rudder is cut from 3/16" sheet, sanded to a wedge shape at the trailing edge, and rounded at the nose. Both items can be covered, and the hinges installed before assembly to the body. However, remember not to cover the tongue area, as this is where the glue goes on assembly.

CONTROL SYSTEM. The plans show two different setups for the control system, so that either a two-or-three-channel radio can be used.

The two-channel system is ailerons/rudder coupled and elevator; the three-channel version having these two hookups plus lift spoilers for landing.

The first thing to do is pick whichever system you want to use, and then read the following appropriate paragraphs. One small thing we could also point out at this stage is that the two-channel version should give a lighter model, hence a lower wing loading. If your interest is mainly in Slope Soaring then choose the two-channel; however, if you're more interested in Aerobatics and spot landings, then go for the three-channel setup.

TWO-CHANNEL SYSTEM. A brick-type system is shown on the plan. Battery pack is located in the front nose compartment, with the brick in the next one. The aileron servo is hooked up to the 3" bellcrank, which then drives both the ailerons and the rudder. The plans show typical locations for the push rod ends. The elevator is driven direcly from the appropriate servo.

THREE-CHANNEL SYSTEM. Here we use three separate servos, (two of these are in the nose), and these drive the aileron/rudder bellcrank as on the other system and also the lift spoilers. Note the cutout in the hatch cover floor for the spoiler push rod. The third servo is placed aft of the receiver, and drives the elevator via a short push rod. The receiver is fitted under the bellcrank mounting plate, and the battery pack again is in the nose compartment.

FLYING. When I first started flying models with aileron control I expected that it would be just the same as rudder steering, and so it is for casual soaring around the sky. However, there is another mode of flying, not possible with rudder flying, where the model is flown somewhat faster. The maneuverability is then vastly increased, very tight turns can be made, and the flight characteristics become very similar to that of a power model. (I realize that this may not be an improvement to some people!)

This mode of flying needs to be learned, and I'm still working on it, but it's worth the effort. So if this is your first aileron model, a few practice sessions will be needed to extract the maximum performance from it. ■