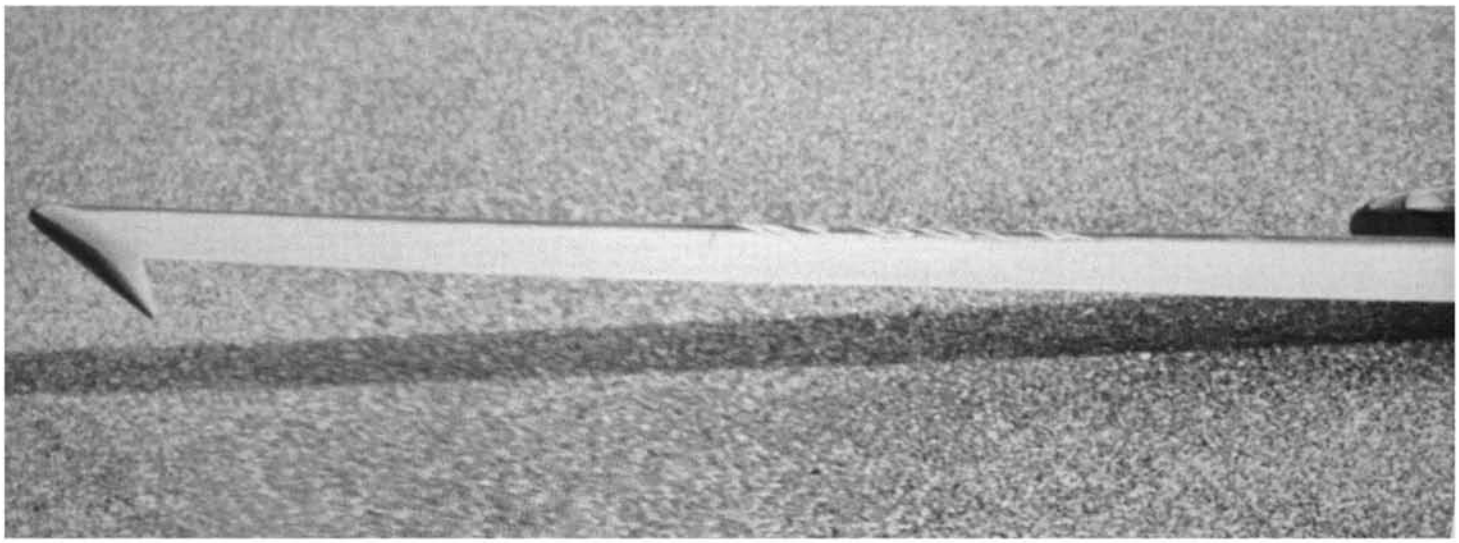
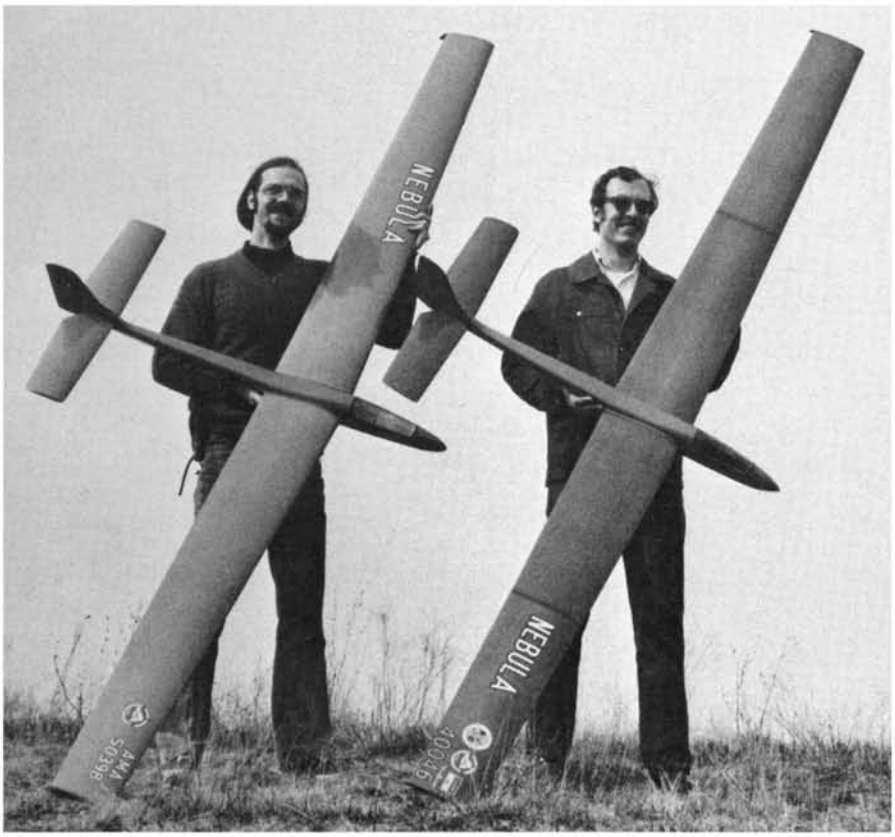
Nebula



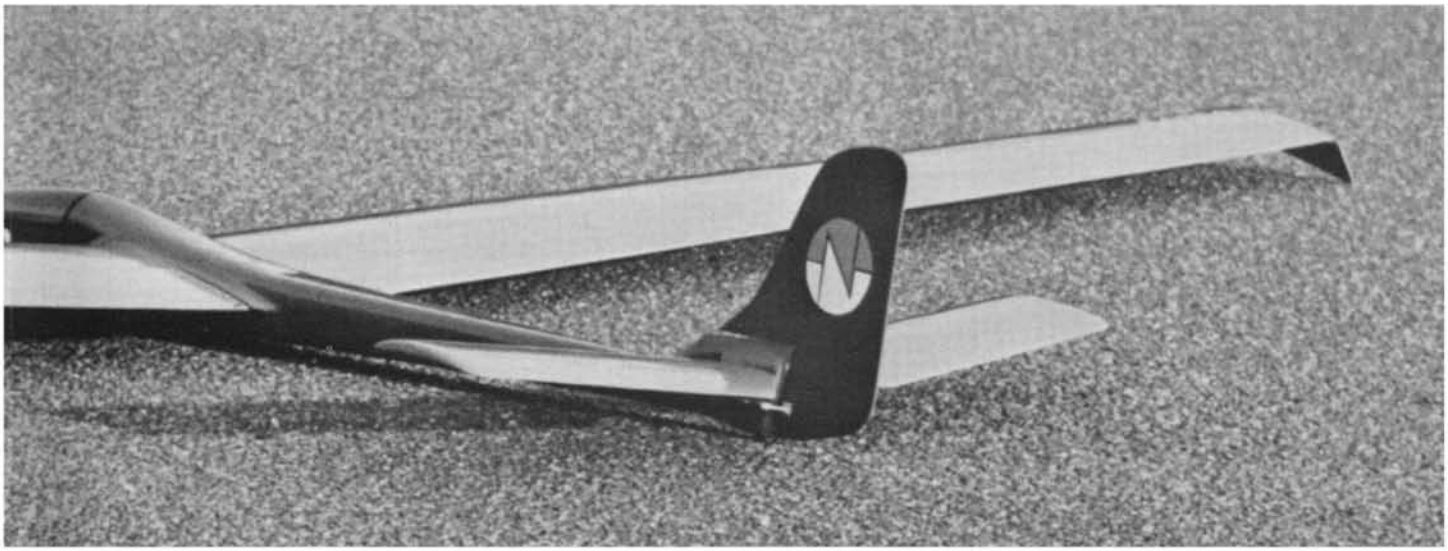


Coauthors with two nice new Nebulas. Dick's bird (right) sports polydihedral; Arni finds that the straight wing version is more his style.

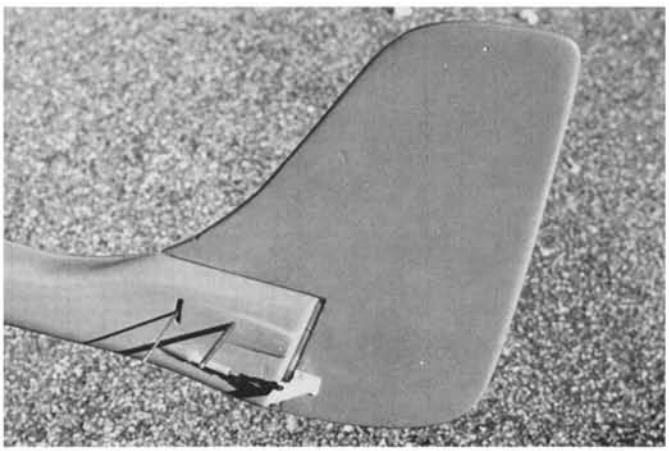
This sailplane is the result of a real team effort by two friends. Many, many hours were spent discussing, arguing, sketching, cutting and building. The labor expended in those hours was amply repaid when the Nebula was launched into its first flight and it looked like we had a winner. When the fifth flight lasted over ten min., from a hi-start launch, we were sure that the total effort had been worthwhile. Here, we explain the design theory behind the Nebula's configuration and construction.

Our most important goal was, of course, good contest performance. Also desired was a realistic, modern appearance and an easy, quick construction method. To achieve good performance, we had to have a conservative, conventional design approach. We're not trying for a radical breakthrough—just a good (hopefully optimum) combination of proven design features. Based on our experience with other designs plus observations at contests, we settled on certain features—the airfoil would be an Eppler 387 with a flat bottom. Every design must be a compromise for weather conditions and other variables, and we felt the airfoil chosen is the best all-around performer for wind penetration and still air floating. To keep floating ability, we want plenty of wing area—the Nebula has 930 sq. in. We are convinced that, for our model sizes, a low aspect ratio is better, so our wing here has an a.r. of 13 to 1—low compared to many current designs.

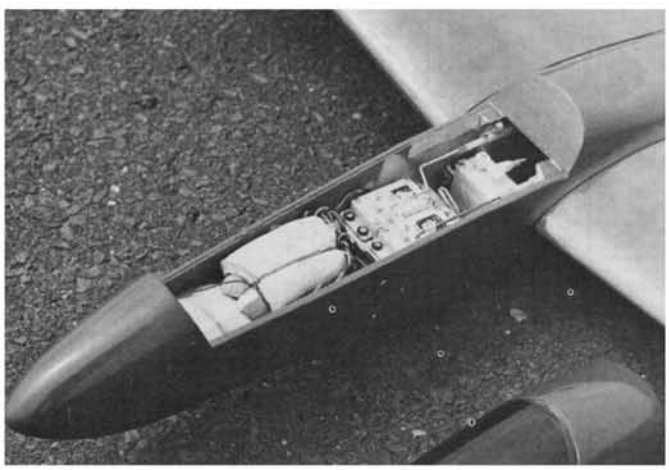
This contest glider is for thermal flying, but there's also plenty of maneuverability and strength for the slope. It is all-balsa with foam cored wings. Special feature is the optional flaps system. / by Dick Sarpolus and Arni Pederson

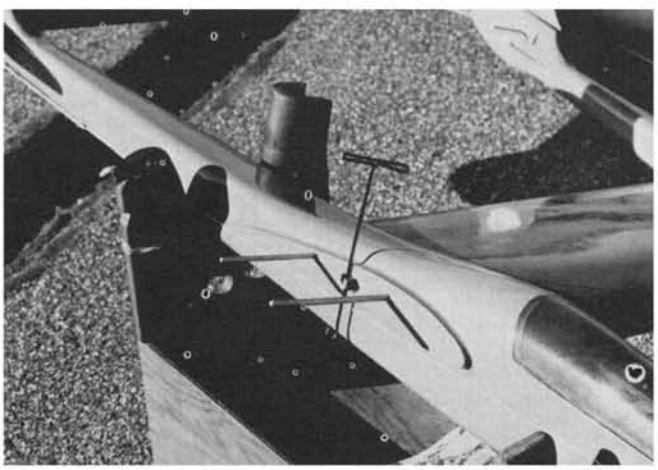


Photos by the Authors



LEFT: Full flying tail surfaces for best control. Note slight fairing for stab seat. Clean lines minimize drag and yield better performance. BOTTOM LEFT: Efficient use of space with plenty of room available. Note that triangular corner stock ends just inside the canopy compartment. Third servo rotates flaps to suit flying conditions. BELOW: Little gadgets make modeling easier. This simple hook device is ideal for grasping those elusive rubber bands while mounting the wings.





The stab airfoil is also flat bottomed; that allows a more rearward balance point and lets the stab share the work of flying the model. Full flying stab surfaces are used to reduce the drag of a separate stab/elevator setup. The dihedral in the stab is there only to protect the surfaces when the model lands. The plug-in stab panels also make the model easy to transport. The rudder is sheet balsa for simplicity, large in area to insure adequate control. Shape of the rudder was juggled to get a pleasing, individual appearance.

The tail moment is fairly short simply because a long tail moment is not necessary for performance; the shorter the fuselage, the easier it is to balance the model. The nose moment is long enough for balance and for housing the radio equipment. The shape of the fuselage is a compromise between realistic appearance and ease of construction.

We have built and flown models with straight dihedral and with polyhedral. The straight dihedral definitely looks better as far as realism is concerned. However, we feel polyhedral may be better for model thermal circling performance. Take your choice. The small tip plates may help tip stall characteristics, protect the wing somewhat, and look good.

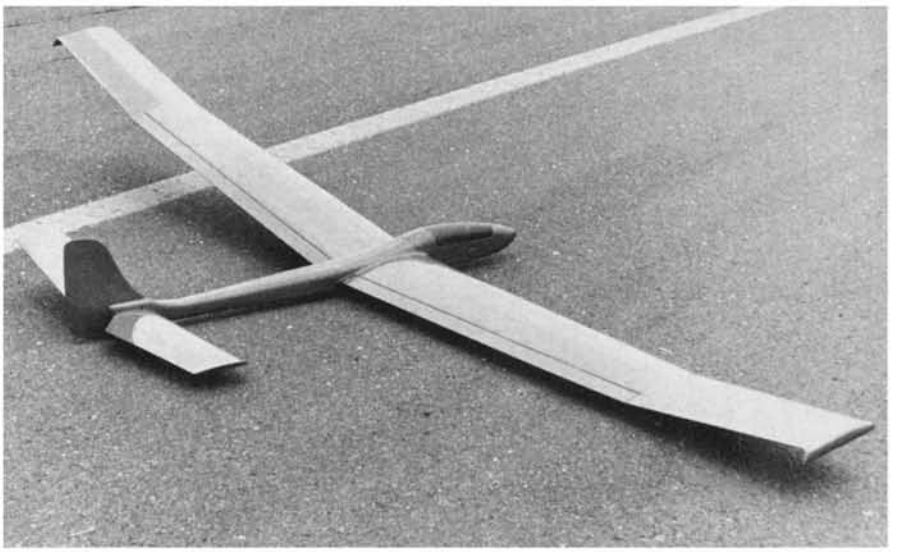
The wings plug into the fuselage for the cleanest, lowest drag configuration. Two 3/16" wire rods are used for the wing attachment, with standard rubber band/screw eyes in the wings to hold them securely.

When we had agreed on the overall configuration, we began to work on construction methods. Starting with the fuselage, we used balsa/plywood in a basic box, with triangle strip stock in the corners to permit a rounded shape. We only needed three blocks: The nose block, of course, and two more top blocks, sized to permit what we feel is a streamlined fuselage. The plastic canopy adds a lot to the appearance; we carved a plug and vacuum-formed the canopy, but flat sheet plastic could be used. Fiberglass fuselages are, of course, nice, but for a quick, easy job, we wanted to stay all-wood.

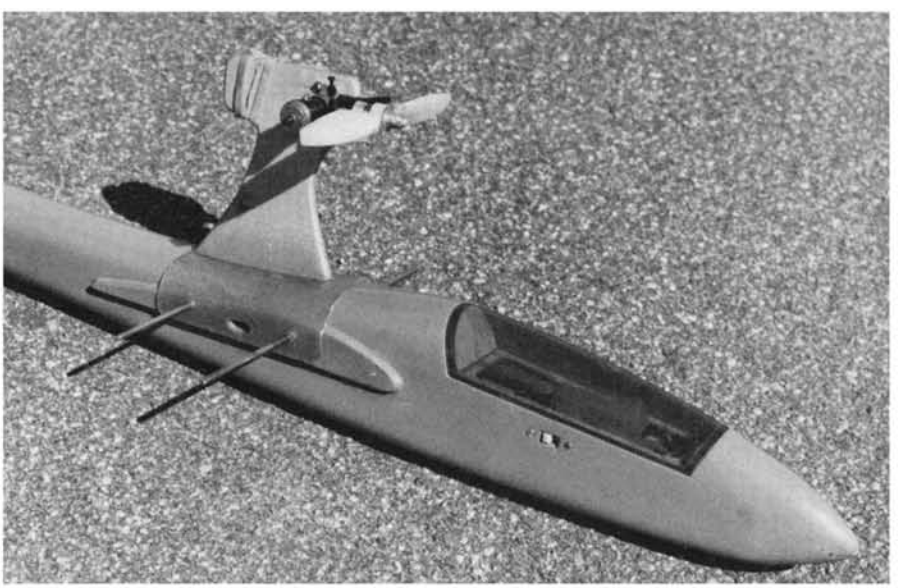
The wing and stab are foam cored. This eliminates cutting ribs, capstrips, multiple spars, planking, etc. (Most areas and RC clubs now have people who can cut foam cores. They are becoming more common all the time.) We feel the weight may be greater, but airfoil shape consistency, strength, and speed of construction make foam cores the way to go. A full depth 1/4" balsa spar is used, with plywood doublers and a sandwich construction used to hold the wing mounting tubes at the roots. Planking is 1/16" balsa—1/32" balsa could be used on the stab if desired.

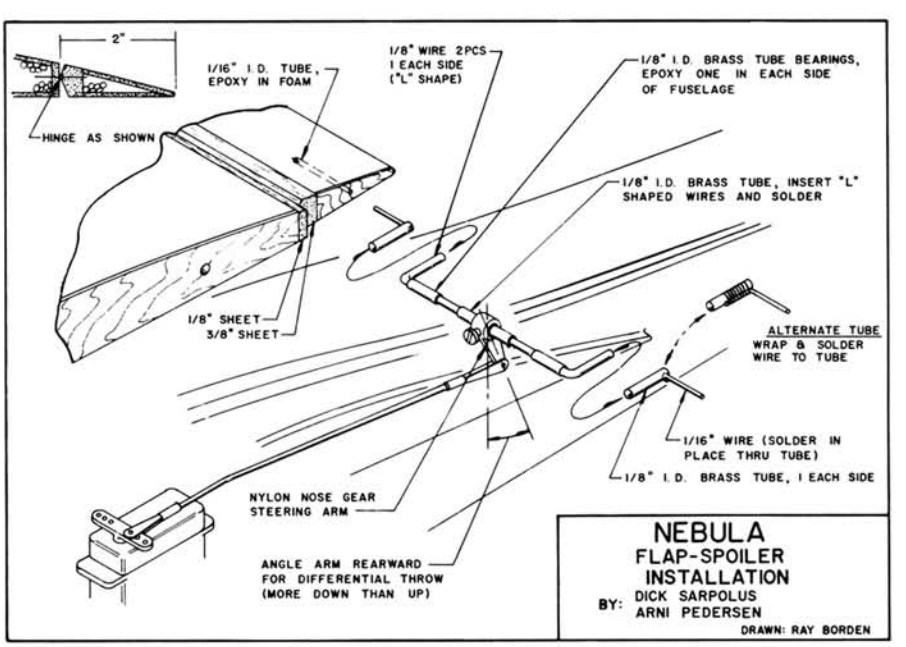
For finishing, we suggest Solarfilm or MonoKote on the wing and stab, and paint on the fuselage. Any type of towhook may be screwed or bolted to the fuselage bottom. We have very successfully flown the Nebula with a Cox 09 on a power pod. The base for the pod was three layers of fiberglass formed

Plan on following page
Text continued on page 74

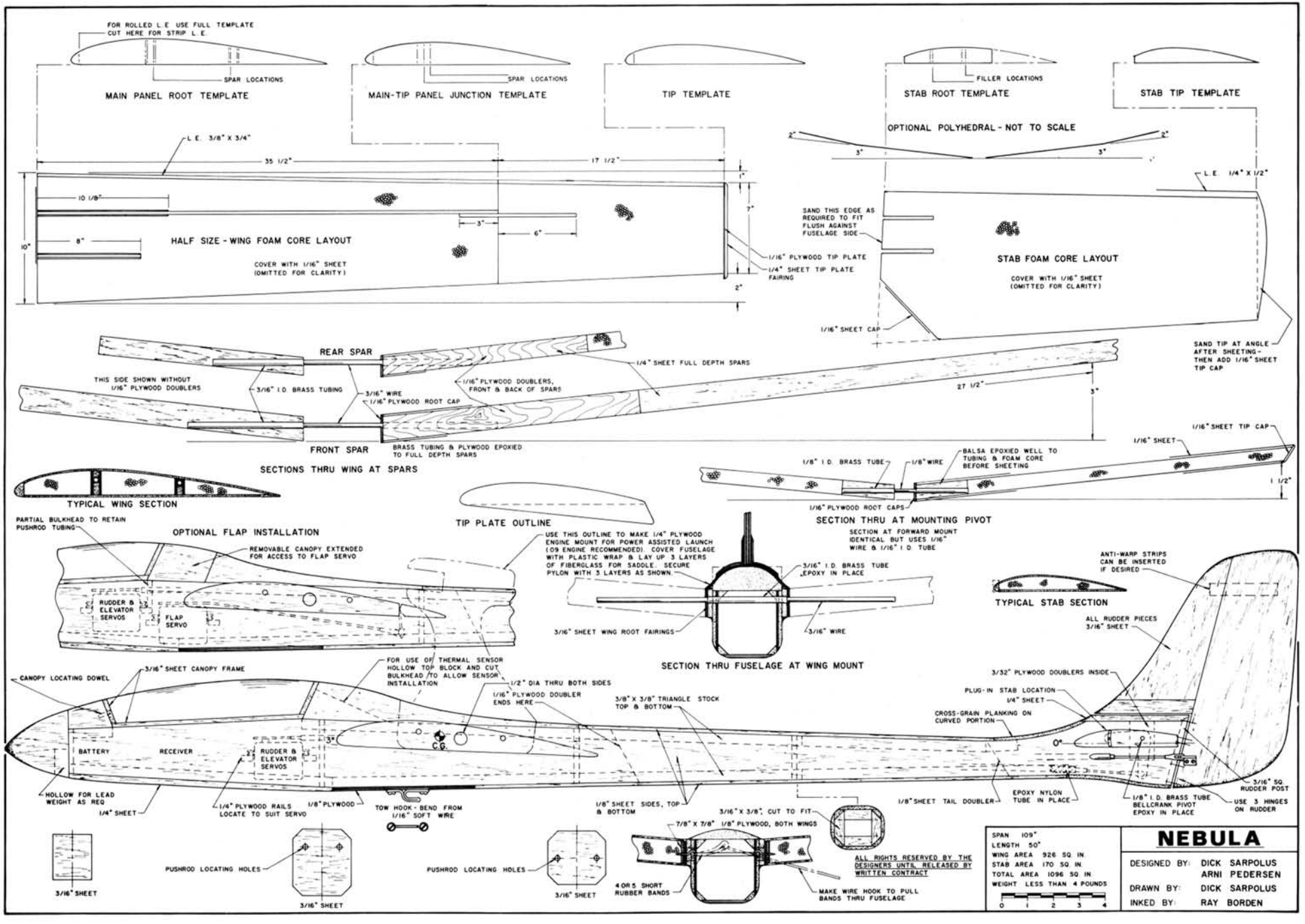


ABOVE: Flaps should have a very close hinge gap and continue the general airfoil contour as smoothly as possible in the neutral position. Dihedral stab gives some ground clearance when the glider rests on a wing tip. BELOW: Text explains how to make this simple power pod system. The Cox 09 really pulls the plane aloft.





FULL-SIZE PLANS AVAILABLE--SEE PAGE 84



NEBULA

(Continued from page 31)

over the completed fuselage, using plastic wrap as protection for the aircraft. The fiberglass extends to the bottom edge of the wing root fairings. The engine mount is cut from 1/4" plywood and fiberglassed to the pod base. It is held on by the two 3/16" wing mounting rods.

We have gone into quite a bit of detail on the following building instructions to make the work as clear as possible.

Construction

FUSELAGE: Laminate plywood nose doublers and balsa tail doublers to sides. (We recommend epoxy.) Cut and glue down all triangle stock as per plans, cutting triangle stock to step over doublers. Use formers as gauge for proper spacing. Add a plywood stab pivot reinforcement. Glue the two main bulkheads to one side; when dry, glue the other side to bulkheads, making sure the sides are parallel. Pull sides together and glue to front bulkhead. At the rear, glue the sides to 3/16" sq. balsa tail post. Add nose block, forward top block, 1/4" balsa nose section bottom, 1/8" plywood bottom piece. Add top block and 1/8" sheet top covering. Before enclosing the tail, drill hole for 1/8" ID brass tubing bellcrank pivot. Make tail bellcrank from pattern on the plans out of 1/16" thick sheet nylon or epoxyboard. Cut slots for stab linkage by putting pivot tube in place with bellcrank on outside of fuselage. Move up and down and mark radius for slots. Install bellcrank by epoxying the brass tube pivot into fuselage. Install the stab and rudder nyrod. Glue on remainder of the fuselage sheeting. The fuselage shaping really makes the project. Go heavy on the sandpaper and really round off the corners, exposing about 3/16" of the triangle stock. The wing root fairings and wing mounting tubes will be added later.

Make up canopy floor ends, using fuselage as the base. After drying, sand to shape slightly smaller than opening to allow for thickness of canopy. Install canopy latching dowel as per plans, gluing securely to canopy base front. Glue a square of scrap balsa near both sides of rear canopy base to keep it from shifting sideways. Two small wires hooks, one glued to base and one glued midway down interior fuselage side, with a rubber band between act as a catch. A section of the floor can be cut open to allow room for radio equipment if you have a larger radio. Apply your favorite finish and any cockpit details to canopy base. Cut the ends from the canopy and tape it in place over fuselage. Use masking tape to outline correct shape and trim the canopy. Glue it to base with contact cement or other suitable glue. Trim tape can be used to cover the cement. If you use an electronic thermal indicator, it should fit just behind the servos. Hollow top block and cut bulkhead enough to allow its installation. For the variable camber/flap installation, the removable canopy section is extended enough to allow access to the flap servo. The large Midwest control horn can be used or one can be fabricated from 3/32" music wire and brass tubing.

RUDDER: Working on flat surface over wax paper, epoxy the three sections of rudder together. Allow to cure and sand off excess glue. Sand rudder to streamlined shape. Cut slots for hinges in rudder and fuselage per plans. Attach hinges with epoxy after finishing.

SURFACE SHEETING: To butt join balsa sheets, trim edges of sheeting with X-acto knife or razor blade and straightedge so seam will meet as closely as possible. Lay sheeting to be joined on FLAT SURFACE edge to edge and run masking tape over the length of the seam. The sheet is then turned over and held underneath so that the seam opens up and slow-cure epoxy is run down the length. Lay the sheet on flat surface. Scrape and wipe away any excess glue that has squeezed out. Weight should be used to keep sheeting flat until dry. Then sand smooth with sandpaper block. Using this method, make four sheets of 36 x 10". Each sheet is assembled from one 4 x 36" piece and one 6 x 36" piece. These are the root panel wing skins. Make four sheets, 18 x 9" from one 6 x 18" piece and one 3 x 18" piece. These are the tip panel wing skins. For the stab skins, use four sheets 18 x 6". All sheeting is 1/16" balsa.

STABILIZER: Cut grooves into the foam cores to permit installation of the brass tubing mounts. The front tubes are 1/16 ID, the rear tubes are 1/8" ID. From the full-size section on plans, cut the wedge shape balsa pieces to size and epoxy them to the two-in. long brass tubes. Epoxy these assemblies into foam, using the 1/8" and 1/16" wire joiners to align the halves. Check to be sure you have the correct dihedral. Sand away any excess balsa flush with the foam cores. Be sure that the distance between the tubes lines up with the holes in the bellcrank control. Assemble the stab halves to the fuselage and bevel the root ends to fit closely against the fuselage sides. Lightly sand off any imperfections. To retain the stab halves, put a small kink at the ends of the 1/16" wire so it is a force-fit into the tubes.

To skin the cores, we recommend Southern's Sorghum Cement or any hobby product sold for this use. It is always better to try a new cement on a piece of scrap foam so as not to risk melting the foam cores. Apply cement to 1/16" balsa sheeting and bottom of foam core as per manufacturers' instructions. Place balsa skin on FLAT SURFACE and tape down edges if necessary to make skin lie flat. Carefully align core over skin and lay core down starting with trailing edge. Press core down firmly but do not mar the foam. Remove core from table and trim away excess balsa from leading edge, root and tip. Using a straightedge, trim sheeting at trailing edge 3/16" away from foam to allow for bevelled joint with top skin. (See typical stab section on plans.) Place stab, skin down, with trailing edge on edge of table. With sanding block, bevel balsa to conform with curve of airfoil. Apply cement to cores' top surface and top stab skin. Place skin on table; temporarily pin or tape down if necessary. Align core over skin. Press trailing edge of core on skin. Remove tape or pins and roll core toward leading edge. Remove excess balsa, use straightedge to trim stab trailing edge even with bottom skin. Repeat with other stab half. Add leading edges, root caps and tip caps.

WINGS: Spars with their brass tubing and plywood "sandwiches" are assembled first. Working over plans, trim root ends of balsa spars to allow for insertion of 3/16" ID brass tubing. Epoxy 1/16" plywood doubler to one side of spar. Epoxy brass tubing and balsa wedge trimmed from spar as per plans. Epoxy on other plywood doubler to complete sandwich. Repeat with other spars. Epoxy spar assemblies into the foam cores on a flat surface. Do NOT join tip spar to main spar now. Sand away any excess wood flush with the cores. Skin the root and tip panels following method detailed for the stabs. Add and shape leading edges. Join the root and tip panels with epoxy on stub spar and edge of cores. Then use a one-in. wide light fiberglass or nylon cloth and epoxy over the joint. Squeeze off excess epoxy to make the joint less visible. If polyhedral is desired, the wing may be cut and reinforced with fiberglass and epoxy.

Bevel wing roots so they will butt against fuselage wing root fairings. In center of root, midway between tubes, insert small 1/8" plywood square, level with surface of foam. Glue with epoxy. Drill 3/16" holes in plywood root caps to align with brass tubing in cores. Coat 3/16" music wires with a thin film of vaseline; insert into tubes in one wing panel. Using wires as guides, epoxy root caps to core. Repeat with other panel. Laminate balsa and plywood tip plates. Epoxy tip plates to wing tip and round off balsa.

WING MOUNTING (CRITICAL): Drill two holes in balsa wing mount fairings to match the ends of the finished wings. Locate the two fairings on the fuselage by measuring from plans. Temporarily pin or tape them in place. When you are sure they are correctly located, use them as guides to drill the four holes into the fuselage for the 3/16" ID wing mounting tubes. Insert the tubes, the 3/16" mounting wires, and slide the wings in place. Check to make sure the wing is square with the tail, incidence the same on both sides, etc. If necessary, enlarge the holes in fuselage and shim them as required to line everything up. Then epoxy tubes in place. Place wing mount wires, lightly coated with vaseline, through fuselage; thread on

wing mount fairings, then wing panels. Before sliding wings in all the way, coat fuselage sides of fairings with epoxy. Slide wings and fairings to fuselage. Keep the fairings against wing root and allow epoxy to set. Remove wings and wires. Fill any gaps between fuselage and fairings with epoxy. Fillet around fairing with epoxolite, DAP, microballoons, etc. Sand to blend with fuselage. Drill and file a slot about 1/4" high x 1/2" wide centered between wing mount tubes for the rubber band joiner.

After the first few Nebulas (Nebulae? Ed.) were flying, we decided to try a version with positionable wing flaps. Our first thought was to use them as a spot landing assist, but it was also obvious that drooping them slightly should give us the benefits of an undercambered airfoil. We have seen other sailplane fliers at various meets using flaps; the benefits seemed worthwhile. We also wanted to try positioning the flaps upward, with the expectation that they would have an effect similar to spoilers, and so would serve two purposes—variable camber airfoil and spoilers.

To construct the flaps, first build the complete wing and then cut out a 2-1/8" wide section along the trailing edge, 36 in. out from the root. Use polyhedral as shown on the plans. Cap the rear of the wing section with 1/8" balsa, cut 1/2" off the front of the flap, and add 3/8" balsa to the flap section. The 3/8" balsa is planed and block sanded to the crosssection shown on the plans to allow more down than up movement.

A control-line type of horn is made up for the fuselage from 1/8" wire. The horn is made in two pieces so it can be inserted into the fuselage from each side and is joined in the middle by soldering each piece into a section of 5/32" brass tubing. Prior to soldering, a short piece of 5/32" tubing is epoxied in each fuselage side to act as bearings, and a Carl Goldberg nylon nose-wheel steering arm was positioned over the horn. The nylon steering arm set screw enables it to be tightened onto the 5/32" tubing joiner. Position it as shown on the plans to give differential throw; more down travel than up travel.

To couple the horn output arms to the flaps, it is necessary to have a universal type connection. Fabricate two "joiners" from 5/32" tubing and a short piece of 1/16" wire soldered together as shown on the plans. A piece of 3/32" tubing is epoxied into the root end of each flap to receive the joiner.

A third servo is installed in the fuselage and a pushrod made to connect with the flap actuating horn. Adjust the lenth and throw for approximately 1/2" up movement and one-in. down movement, measured at the flap trailing edge.

For flying, we used the throttle stick to activate the flaps. Neutral flap position was about 2/3 toward high throttle; high throttle gave up flaps, or spoilers, and moving to low throttle dropped the flaps.

Winch launches were made with neutral or slightly down flaps; searching for thermals was done the same way. Too much down flap cannot be used even in thermals as too much drag results. Up flap really increases penetration and speed of the model. Full down flap helps greatly for on-the-spot landings. Trim changes due to flap position can be compensated for with elevator trim.

FINISHING: We suggest using Solarfilm or MonoKote on wing and tail surfaces and painting the fuselage. Pry open two small screw eyes to form hooks and screw them into the wing roots midway between holes. The wings are held on by a rubber band between the screw eyes. Feed the rubber band through the hole in the fuselage with a wire hook. The interior of the nose section may be fiberglassed or covered with Celastic for additional radio protection. A nose skid may be made from a six-in. length of servo tape covered with a 6 x 1/2" piece of shim brass of living hinge material. A small round-head screw works well as a tail skid. A towhook may be formed from coat hanger wire and fastened with sheet metal screws as per plans. With radio installed, add lead weight as necessary to make assembled plane balance between 3½-4 in. from leading edge measured next to fuselage. The lead may then be epoxied into a hole cut in bottom of nose block. Neutral position of stab may be roughly set by placing fuselage on flat surface before adding skids, and setting stab parallel with surface.

Flying

Flying the Nebula is where the fun starts. Our testing was done using one of Ray Smith's hi-starts—we used 80 ft. of the heavy shock cord and about 500 ft. of 125-lb. test line. A longer setup would be better, but we have gotten good flights with this one.

Start with the balance point as shown on the plans—the balance point may be changed to suit your own flying style. We want it as far back as possible without making the flying unstable. The flying stabilizer seems to be much better than the separate stab/elevator for trimming the plane; up trim can slow the plane down for thermal hunting, and down trim will really speed it up for penetrating on a windy day. Hand launching is no problem for initial tests; just be sure to throw it level or slightly down.

The towhook location can be varied to suit your preference; be careful not to get it too far to the rear—a stall when launching can be a very bad occurrence.

As with any large plane, be careful with landings. Don't turn too close to the ground—that big wing can go down a long way.

All our flying has been done with the latest Royal Classic radio equipment, which has worked perfectly. Flying a nine-ft. sailplane to an altitude where it appears as a mere speck in the sky is a real test for the RC system—our Royal equipment obviously has plenty of range.

We would like to recommend to all sailplane enthusiasts that you join the East Coast Soaring Society, no matter where you live. The monthly newsletter is well worth the cost of membership.

For anyone who would like to purchase a vacuum formed canopy for the Nebula, or a set of foam cores for the wing and stab, you can write us at 32 Alameda Ct., Shrewsbury, N.J. 07701.