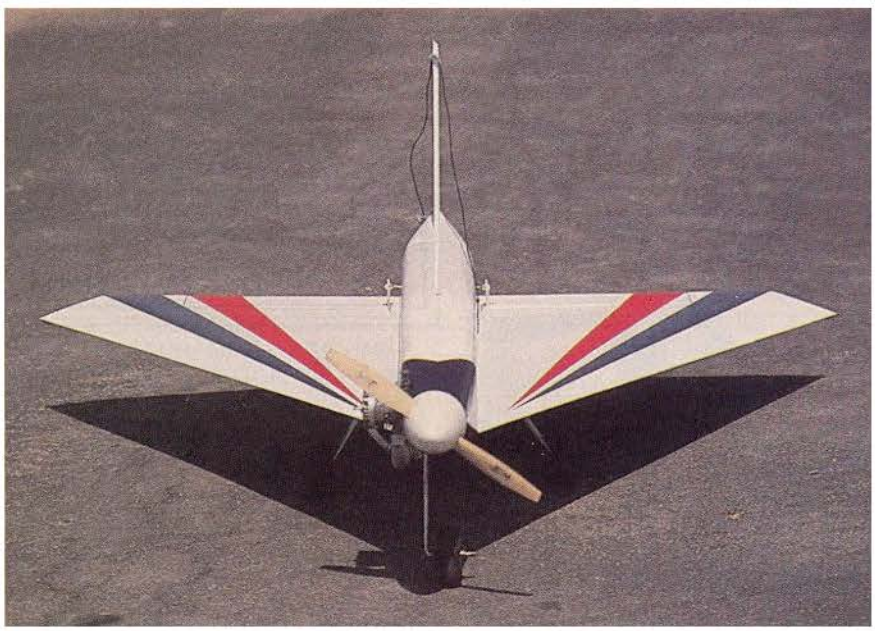


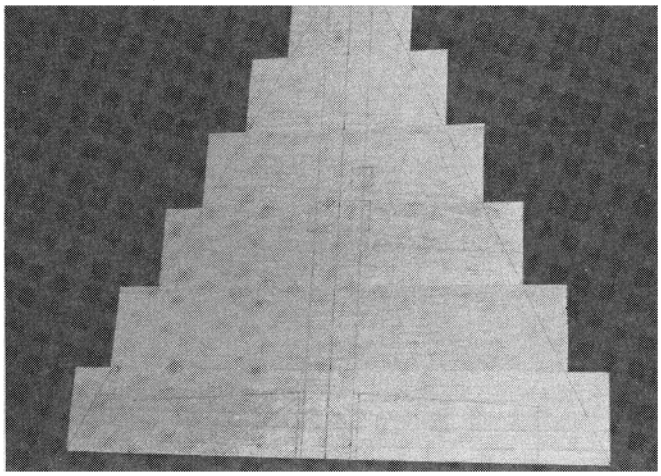
APEX

Tired of the same old thing? Why not put a little excitement in your next R/C project and give this .25 powered sport delta a try!

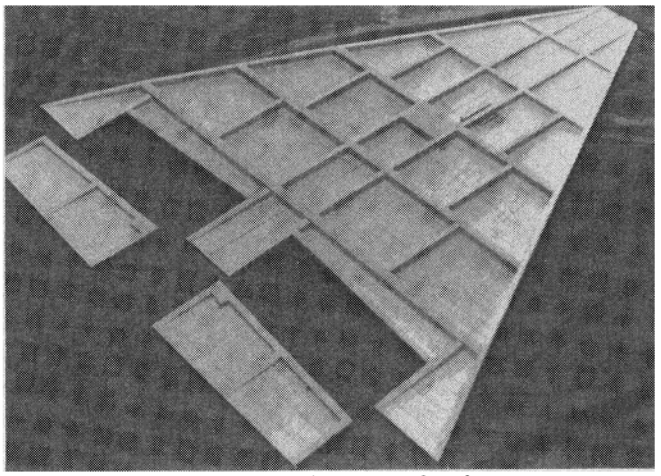
By Steven Ellzey

In the immortal words of C-3PO, "Here we go again," or was that President Reagan? I do seem to have a taste for what many call unusual models. Unfortunately, most unusual models are also somewhat complicated. In an effort to correct this oversight, I decided to come up with a simple, lightweight, and yet unusual model.

A delta wing is one of the simplest configurations available (it has no horizontal tail) and the small wingspan makes for a stronger wing. Putting simple and delta together sent me down the road to what would end up being the Apex. My first pass at this idea was basically a foamboard wing with a box fuselage. While this very simple model flew fairly well, it did have a few problems. It was a bit on the heavy side and it lost quite a bit of speed in a tight turn. I knew the weight problem would be solved by the use of a built-up balsa wing, but preventing the loss of speed in a turn would,



The bottom wing sheeting.



Wing and elevons ready for the upper sheeting.

however, require the use of some slightly more modern technology.

The loss of speed in a turn is due to what we aerodynamic types call induced drag. This problem is not limited to models of course, even delta wing fighters have the same problem. The high induced drag is due to a strong vortex that forms along the leading edge of the wing when it is at a moderate to high angle of attack. This vortex then flows down the leading edge of the wing. The suction it generates creates quite a bit of lift, which is good, and quite a bit of drag, which, needless to say, is bad. Well, some bright chap thought of just bending the leading edge of the wing down and letting the suction help pull the wing along, thereby reducing the induced drag. Armed with this theory, a great many people (myself included) ran off to their wind tunnels to find out if this idea would really work and, to everyone's surprise, it did. At this point the great many people wrote a great many papers discussing the effects of what is now called a vortex flap.

Simplicity dictates the use of a fixed vortex flap, which has a few drawbacks. In straight and level flight, the drag created by the vortex flap reduces the top end speed a bit, plus sustained inverted flight is not very easy or pretty. However, when it comes time to maneuver, the use of the vortex flap increases the capability of the model dramatically.

In the vein of keeping things simple, every piece of wood (with the exception of the hatch sides) can be cut out using a straight-edge, and the wing is built on a flat surface. All of this makes for fairly fast building.

A few words of warning should be passed on at this time. First, this model is for experienced pilots only. This plane is designed to be very responsive and can get into and out of trouble a dozen times in less than twenty feet. Next, I know a few modelers who feel if the plans call for a 25 size engine, then a 40 should be just about right. **Do not try that here!** The model simply cannot handle the added weight and torque of a bigger engine.

If I did not scare you off with the last couple of sentences and you want a plane that is a real kick to fly, let's start cutting wood.

APEX

Designed By:
Steven J. Ellzey
TYPE AIRCRAFT
Sport Delta
WINGSPAN
30 Inches
WING CHORD
Root 26⅛", Tip 0"
TOTAL WING AREA
392 Sq. In.
WING LOCATION
Low Wing
AIRFOIL
Modified Flat Plate
WING PLANFORM
Delta
LEADING EDGE SWEEP
60 Degrees
DIHEDRAL, EACH TIP
0 Inches
OVERALL FUSELAGE LENGTH
36¼ Inches (not incl. rudder)
RADIO COMPARTMENT SIZE
(L)17" x (W)2¼" x (H)2½" (Avg.)
STABILIZER SPAN
NA
STABILIZER CHORD (incl. elev.)
NA
STABILIZER AREA
NA
STAB AIRFOIL SECTION
NA
STABILIZER LOCATION
NA
VERTICAL FIN HEIGHT
6⅜ Inches
VERTICAL FIN WIDTH
5¼ Inches (Avg.)
REC. ENGINE SIZE
.25 Cu. In.
FUEL TANK SIZE
6 Oz.
LANDING GEAR
Tricycle
REC. NO. OF CHANNELS
4
CONTROL FUNCTIONS
Elevons, Rudder, Throttle

BASIC MATERIALS USED IN CONSTRUCTION

Fuselage	Balsa, Ply & Spruce
Wing	Balsa, Ply & Spruce
Empennage	Balsa
Wt. Ready To Fly	60 Ozs. (3 Lbs. 12 Oz.)
Wing Loading	22 Oz./Sq. Ft.

CONSTRUCTION

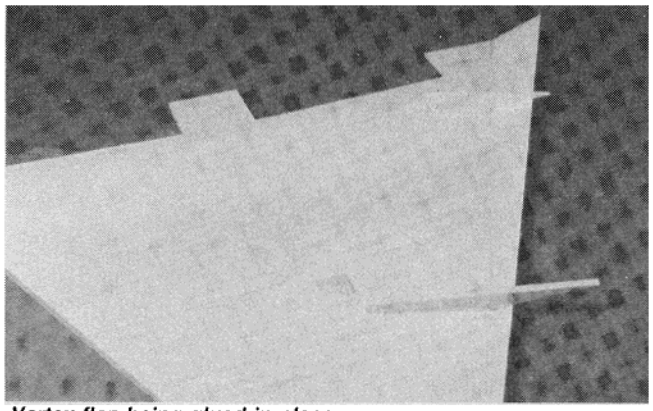
Wing:

Construction of the wing begins by cutting to length the six 1/16" x 4" sheets of balsa that form the bottom of the wing. Notice that they do not go all the way across the wing, but only to the line where the vortex flap starts. These sheets are then butt-glued together so that they resemble a six tier wedding cake or a Picasso Christmas tree. Next, using carbon paper under the plans, draw a line at the inside edge of the vortex flap, two more lines that are each 1⅛" off of each side of the centerline, the outline for the elevons and the outline for the landing gear and pipe mounting plates.

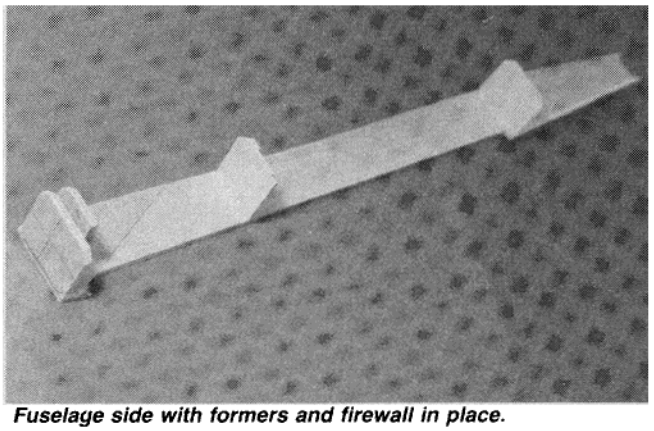
Cut out the elevons and set them aside. Replace the balsa in the landing gear and pipe mount area with 1/16" plywood. Even if you do not plan on using a pipe you should put the mounting plate in place so that you can change your mind at a later date. Now glue 1/4" square balsa to the sheeting at the leading edge; then glue the spars in place, centered on the glue joints of the wing sheeting. Notice that the aft three spars are 3/8" x 1/4" spruce and the forward three are balsa. Now glue in the rest of the 1/4" square balsa and epoxy in the 1/4" plywood landing gear mount.

After all of the glue has dried, trim the sheeting even with the leading edge; then, using a large sanding block, taper everything from the rear spar to the trailing edge. When you are finished, the trailing edge should only be about 1/64" thick. Make sure that you sand the 1/4" square balsa on the elevons also. Next sand a taper from the first spruce spar to the front. In this case, only sand down to the wing sheeting at the front, at which point the front spar (such as it is) will almost disappear. In order to reflex the trailing edge you will need to remove a small amount of the 1/4" square balsa where it touches the back of the rear spar. After doing this it should be possible to hold the wing upside down on a flat surface and push the trailing edge down to the surface.

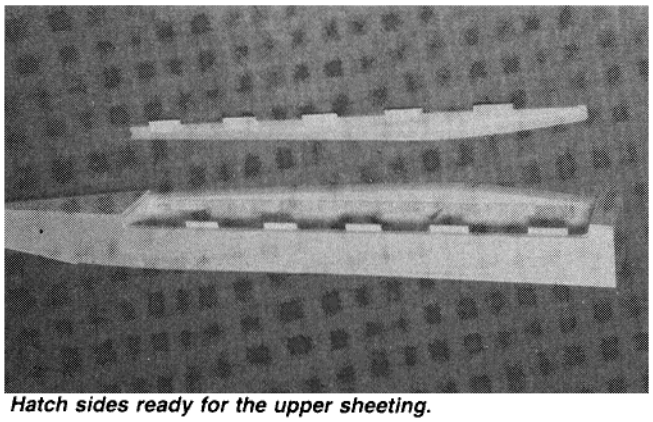
Now we shall sheet the top of the wing.



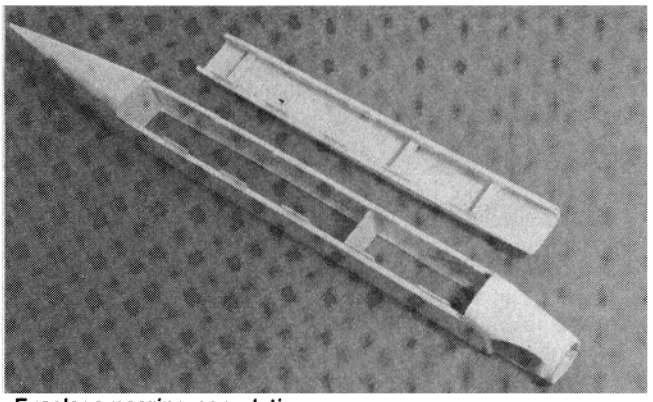
Vortex flap being glued in place.



Fuselage side with formers and firewall in place.



Hatch sides ready for the upper sheeting.

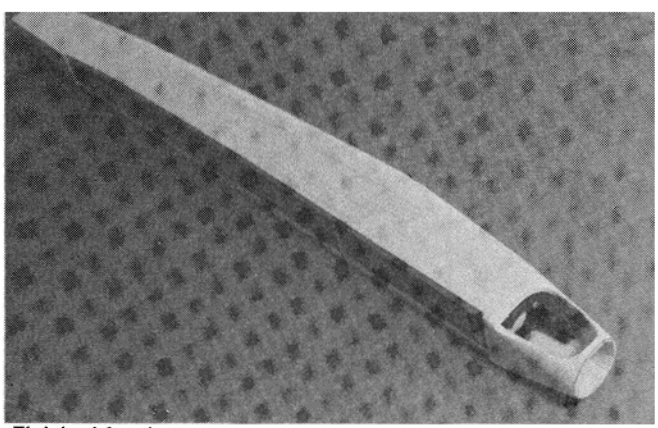


Fuselage nearing completion.

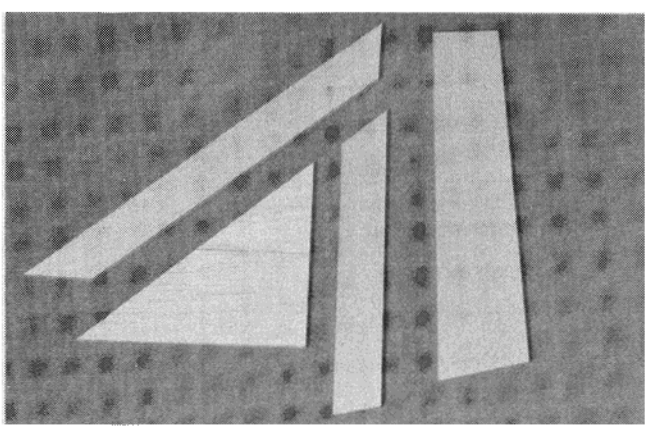
Cut six sheets of 1/16'' balsa sheet to the same length as the ones you made in the first step; however, do not glue them together. Cut out the area for the 1/16'' plywood landing gear plate in the third and fourth sheets. Lay the wing on a flat surface and start gluing the sheeting down starting at the rear spar and going forward (we will add the rear most sheet in a moment). Cover the wing with waxpaper and stack several heavy books, or a few years of model magazines, on top of everything and allow the glue to dry. To glue the rearmost sheet in place, first apply glue to all the areas that this sheet touches, then hold it in place, set the wing upside down, weight down the main part of the wing, and pin the trailing edge down to the building surface. After this is finished, the wing will have the right amount of reflex (more by coincidence than anything else). If the wing is bowed at this point, do not worry, it will straighten out when it is attached to the fuselage. Remove the elevon sheeting from the wing and glue it to the top of the elevons.

To build the vortex flap, cut (from 1/4'' balsa sheet) a piece to the planform shape of the flap. Glue a 1/16'' x 1/4'' plywood strip to the bottom leading edge and then fill in the rest of the bottom with 1/16'' balsa sheet. Cut out two 15 degree jigs from 1/4'' balsa. The best way that I know of to sand the necessary angle on the edge of the flap (where it attaches to the wing) is to pin the jigs to a large piece of wood (like a 2'' x 4'') so that the pointed end is flush with the edge. Next pin the flap, upside down, onto the jigs. By keeping a sanding block parallel to the side of the piece of wood, you will be sanding a 15 degree angle on the edge of the flap. Just as you are finishing you should be sanding the piece of wood at the same time you are sanding the flap.

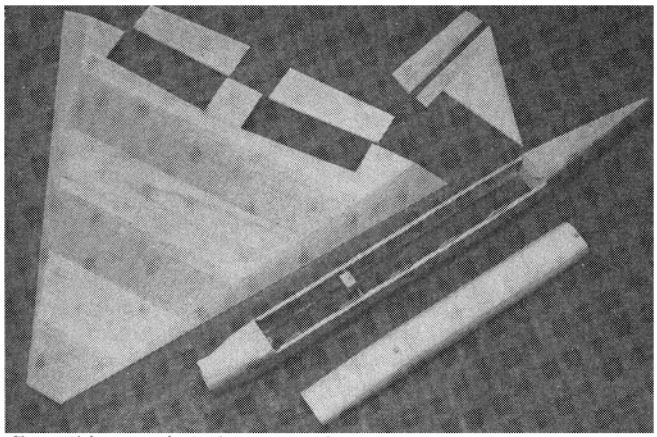
Now pin the jigs to the bottom of the wing so that they will support the flap when it is glued on. Make sure that the jigs are at a 90 degree angle to the current leading edge. When you hold the flap in place you will notice that it does not line up with the bottom of the wing near the trailing edge due to the reflex in the wing. Go ahead and trim the bottom of the flap so that it does line up with the bottom of the wing. When you are happy with this fit, glue the flap in place, making sure that the bottom of the flap and wing line up with each other. Do not worry



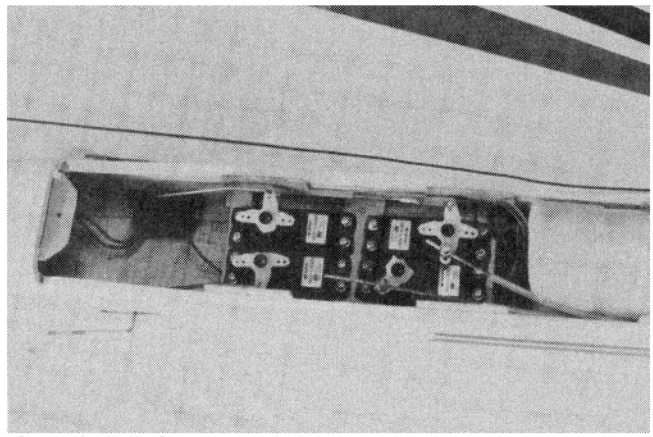
Finished fuselage.



Vertical fin and rudder.



Everything ready to be covered.



Servo installation.

about the top — it will be sanded to shape next. Once the glue on the flaps has dried, use coarse paper to sand a bevel on the top of the 1/4'' balsa leading edge so that the leading edge is 1/16'' thick. Make sure that the left and right sides are the same, then round off the area on the top where the flap and wing meet. To finish the wing, round off the edge of the 1/16'' plywood strip on the leading edge, bevel the leading edge of the elevons, and sand a taper on the trailing edge outward of the fuselage (you might wish to wait until the fuselage has been built to do this).

Fuselage:

The fuselage is a fairly simple box with a hatch that covers a large area of the top. Start by cutting out the sides from 1/8'' balsa. Mark the location of F1 and F2 on the inside of each side. Laminate the 1/16'' plywood doublers to the nose area, then add 1/4'' triangular stock along the entire length of the bottom and to the front and rear of the top. Glue on the 1/8'' x 1/4'' balsa strip that runs the length of the hatch on the top edge. Glue F1 and F2 in place on the left side and add a piece of 1/4'' triangle to the front of F1 where it meets the fuselage.

In order to obtain the required side thrust, the firewall is installed at an angle. This is best done by laying the fuselage on its side and then using a large triangle in front of the fuselage to space the right edge (which is pointing up right now) back 1/8''. Make sure that you have drilled all the necessary holes in the firewall and the nose gear mount for blind nuts, fuel lines, and control cables. Also make sure that you install the blind nuts now. You will need to mount the nose gear off to one side in order for the steering arm to clear the side of the fuselage. Epoxy in the firewall, the 3/8'' x 1/4'' spruce strip, and the nose gear mount at the same time. Use another piece of 3/8'' x 1/4'' spruce to keep the proper spacing between the firewall and the nose gear mount on the right side of the fuselage. When you attach the right side of the fuselage (which you should do now) remember that it will project 1/8'' ahead of the firewall due to the side thrust. Trim the 1/4'' triangular stock at the tail so that you can bring the fuselage sides together, then glue them together.

Glue on the 1/4'' balsa sheet to the top rear of the fuselage and 1/8'' sheets to the bottom rear and top front. Next, cut out the hatch sides and glue the 1/4'' triangle stock to the top edge and a 1/8'' x 1/4'' balsa strip to the bottom edge. The 1/16'' balsa alignment tabs are glued on such that every other one is attached to the fuselage and the rest are on the hatch. Once the alignment tabs are glued on, pin the hatch sides in place and then sheet the top of the hatch with 1/8'' balsa. Glue in the plywood doublers where the hatch hold-down screws go through, then add the plywood pieces that these screws go into on the fuselage.

When you set the wing in place you will notice a small gap just in front of the wing. Fill this gap with 1/8'' balsa, then sand everything flush with the firewall.

The easiest way that I know of to make the nose is to have the engine mounted in place with the spinner on. Now glue the left side in so that the front is slightly wider than the spinner. Then remove the engine, but leave the mount, and glue the right side on so that the nose is just over 2'' wide. Now glue on the top, bottom, and the 3/8'' triangle stock.

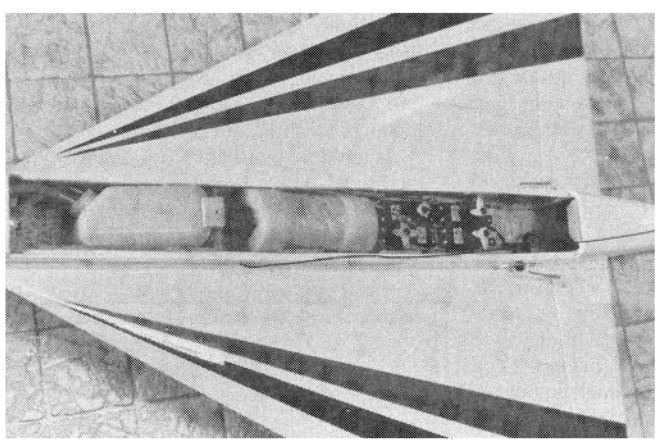
Using your favorite whittling knife and coarse sandpaper, round off the fuselage and open a hole in the nose for the engine. Make sure that you leave the area where the vertical tail attaches flat so that you can get a good glue joint.

Vertical Fin:

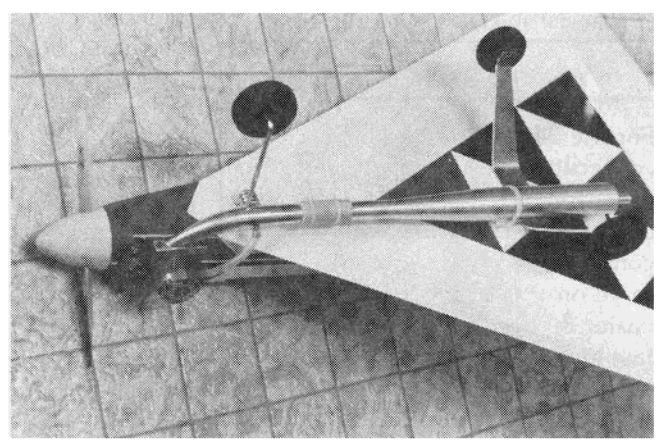
The vertical fin is built from five pieces of 1/4'' balsa. Notice that the grain is oriented so that it is parallel to the free edges. Once you have glued the four pieces together that make up the vertical, taper the rudder from the hinge line back, and then bevel its leading edge.

Landing Gear:

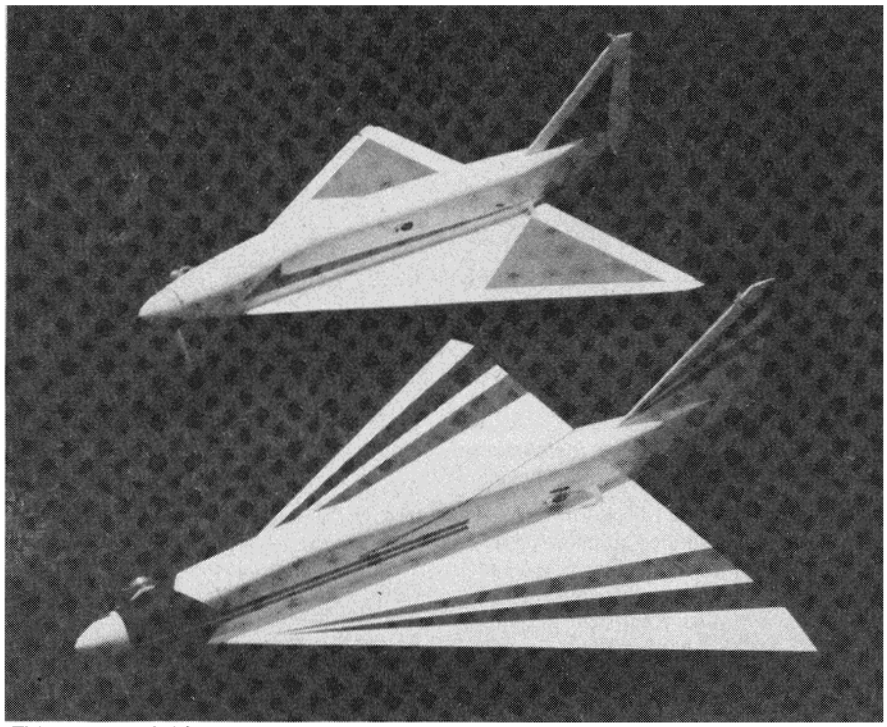
The landing gear is made from a Great Planes L1 landing gear. You will need to rebend it so that it is about 7¾'' wide. Drill



Overall equipment installation.



Landing gear and tuned pipe installation.



Thing one and thing two.

four holes in the gear and in the bottom of the wing for 1/2'' #6 wood screws.

Finishing:

Now you need to clear up all those little details that you take care of before covering --- things like putting hatch screws in, cutting notches for hinges, installing a tube for the rudder cable (exit on the right hand side), and sanding everything smooth, including the bottom of the fuselage where it meets the wing.

I have covered this model both before and after the wing and fuselage are joined. I feel that covering it before worked out a little bit better. Using 15 minute or longer curing epoxy, attach the wing and fuselage together. Then, attach the vertical tail, followed by the control surfaces; finally, add the control horns.

At this time you will need to decide on how to implement the elevon mixing. I have used both mechanical and electronic mixing and I feel that electronic mixing is far better. This is due to what I feel is a lack of a good mechanical mixer suitable for elevons (Airtronics made a good one some years ago, but it would appear that it is no longer made). The model shown here uses electronic mixing in the transmitter which works fairly well. Unfortunately, this method does not mix the trims, so trimming the plane out is a little more work than normal. The best solution is probably something like the Ace Cristy Mixer which electronically mixes after the receiver. If you decide to use a mechanical mixer, install the servos as you see fit (there are too many ways to do this to be covered here). If you use electronic mixing you will probably want to install the servos as shown in the photographs. In this arrangement, the four servos are attached to three 1/8'' plywood rails that go across the fuselage and are glued to two spruce rails that are attached to the fuselage sides.

The elevons are connected to the servos with a threaded rod, while the rudder, nose gear steering, and throttle are all hooked up with flex cables. If you refer to the drawings while setting up the control throws, you will notice that I have called out the use of high exponential rate on the aileron motion and on the rudder. If your radio does not have this feature, start out with only about half the throw shown.

In order to install the battery, you will need to remove most of F2 so that you can push the battery into the tail. The receiver and electronic mixer are installed just ahead of the servos and the switch wherever you like it. At this time install the engine, prop, spinner, fuel tank, pipe or muffler, and all of the landing gear. Check the balance. You will probably need to add a small amount of weight to the tail (behind the battery) to achieve the proper balance.

Flying:

Before your first flight make sure that the plane tracks straight ahead or slightly to the left on the ground. When you begin your take-off roll, hold a small amount of up elevator to soften the nose wheel steering. As you begin to rotate, make sure to apply a small amount of right rudder. Once in the air, trim the elevator and ailerons as you normally would. You will probably notice that the plane turns differently each direction. The side thrust of the engine is there to correct for most of this. However, due to the small wingspan and the difference in torque from engine to engine, it will be necessary to do a little fine tuning with the rudder. To set this up, go into a moderately tight turn. If the model dives, trim the rudder opposite to the direction of the turn. Likewise, if the model climbs, trim the rudder into the turn. Once you have this set up, the model will track very nicely turning either way. Now that you have your plane trimmed out you can start to have some fun. I do not think that the Apex can tip stall, and the angle of attack at which the wing will stall (over 30 degrees) is beyond what I feel the controls can get the plane up to. So you can basically horse the plane around without fear of it falling out of the sky. At high speed the Apex can turn tighter than most any other model I have ever seen, and it is rather interesting to see the angle of attack that can be achieved in a very tight turn. Even with the plane coming out of a turn at a high angle of attack, you can still go into another tight maneuver and have plenty of control power. To get the best axial rolls add opposite rudder. When you get the right amount of rudder, coupled with the ailerons, the rolls are lightning fast. One interesting stunt the plane can do is what I call the tumbling maneuver. At high speed and full power, pull the plane to the vertical and, as you lose speed, add right rudder; the plane will start to roll and then begin to tumble. At the end of the tumble the plane will enter an inverted spin; at this point just cut power and the nose will drop straight down.

The Apex can perform very pretty landings; however, I am the first to admit that this model is not the easiest in the world to land. As the model slows down, the aileron action gets a little sensitive, so it is best to use the rudder after you have turned onto final. Once you get accustomed to using the rudder, you will find that landings are reasonably easy. And since the model can land rather slowly, even the bad landings will not hurt anything.

At the time that I am writing this article, the model shown here has been flying just over one year. On those days that I just want to cut up in the sky, the Apex has been a very dependable friend. □

From RCModeler Aug. 1991