Zenith 40

By Neil Allen

A .40 Size Model With True Pattern Performance

The design requirements for this plane are easy to sum up:

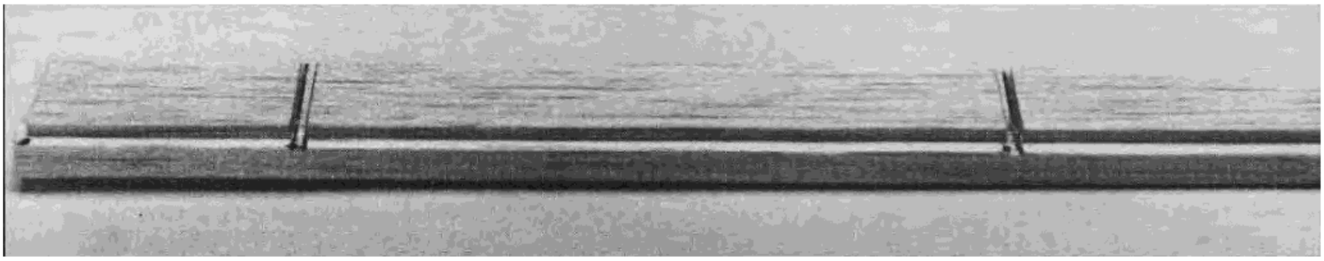
(1) It must be an ideal low wing trainer. That is; it must be suitable for a novice's second or third plane, being easy to fly and, particularly, easy to land, and it must be very rugged. It must be quick and easy to build, with a low "parts count."

(2) It must have pattern aerobatic performance so good that it can flawlessly go through the most demanding of Pattern schedules, such as the FAI or Masters.

Do these sound like opposite requirements? Well, they really are not.

Look at the modern generation of Turnaround Pattern craft. Nowadays, planes have much larger wings, coupled with lower weight, making them pleasant to land and take off. They have a modest top speed, and the light weight plus fairly high drag mean that they do not build up speed quickly in a dive. This also means that they are easier for a novice to handle, and so our design goals are possible.

Zenith was designed to fulfill our goals as stated above, and it has succeeded. How have these objectives been achieved?



Leading edge parts, glued and slotted for ribs.

(1) Zenith has a .40 size engine. This size plane is much more rugged than a .60 size. A smaller craft will never really fly quite as well as a bigger plane, but we can come close.

Note that a .40 size plane which is directly scaled down from a .60 size, will use 66% of the runway length to do a similar take-off or landing roll, given similar flight performance. This gets by perhaps the biggest problem for a novice flying a pattern ship, and that is putting it down easily on the runway.

A nice result of the smaller engine is the ability of all the parts to fit in the trunk of a car, even a compact, plus lower running costs.

The Zenith 40 is lighter than normal for a plane of this size due to its innovative construction methods. This light weight, together with the generous wing area of 625 sq. in., makes an easier to fly, more aerobatic aircraft.

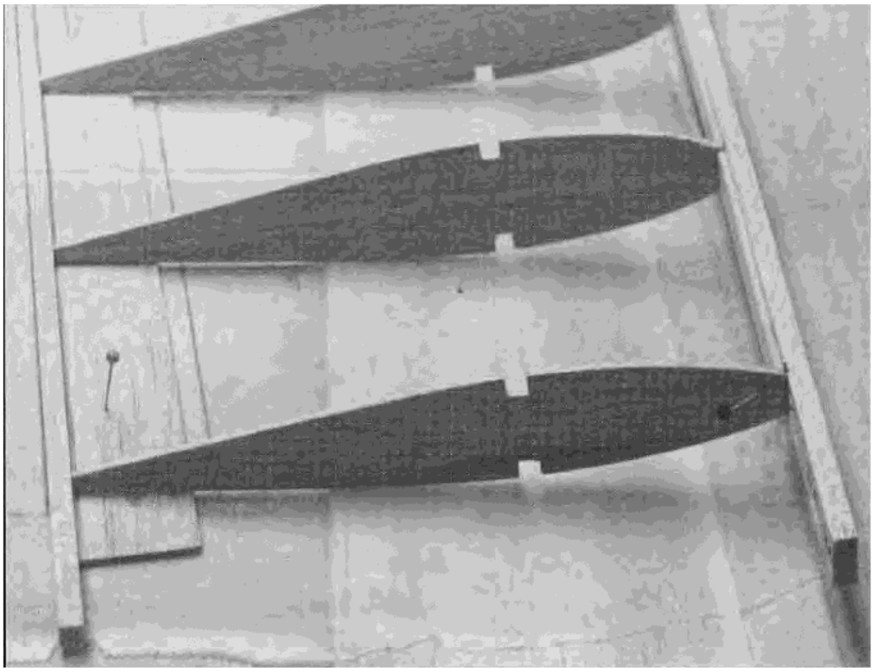
(2) Fuselage mounted landing gear is essential for a "bounce and go," and is used in Zenith. In a bad arrival, a wing mounted gear will get torn out of the wing, doing severe damage to the structure.

With a fuselage mounted gear, damage is minor, and easy to repair. The gear on Zenith is held on the rear of a former by self-tapping screws, and could be knocked off in a crash without destroying the structure. Most other pattern trainers fail in this important requirement.

(3) Probably the most important feature of a top pattern design is the lack of unwanted effects when you move the rudder. When you apply rudder in flight, the plane must yaw (swing sideways) without either rolling left or right, and without pitching nose up or nose down. Not only is this important for learning aerobatics, but it makes the plane more pleasant to fly in normal flight.

ABOUT THE AUTHOR

Neil Allen is 51 years old with 40 years modeling experience; 20 years in R/C. He did serious competition pattern flying for about five years, and still keeps it up at a relaxed level. Neil is mostly into scale modeling. He competed for the South African team in the World Scale Championships in Muncie, IN, in 1992, and came 17th with a Nieuport 28 based on the Proctor design. Neil has done many facets of R/C modeling, including designing what was the world's biggest R/C model in 1980 — a 20' wingspan, four engined Lancaster, weighing 130 pounds! Neil is a pharmacy owner and is married with one son.

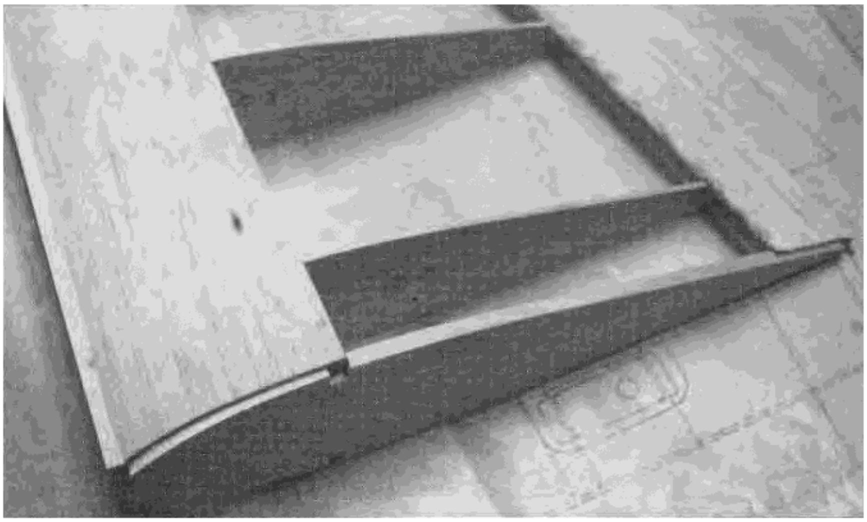


Trailing edge pinned to building board, ribs and leading edge attached.

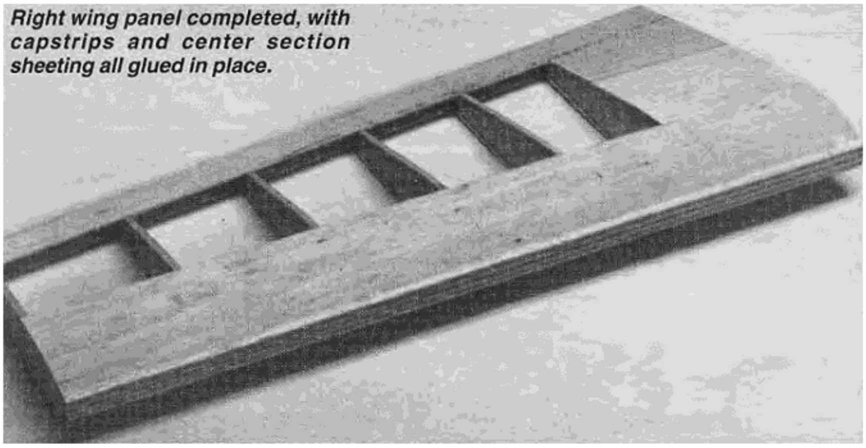
Learning techniques like crosswind landing and take-off are much easier without unwanted control interactions. The worst, common to almost all sport planes is "roll couple," which means nasty roll effects when you use rudder. This makes a novice reluctant to feed in rudder when needed, resulting in a pilot becoming a "left hand cripple" who does not know how to make proper use of the left hand on the rudder stick.

In contrast to most sport planes, you will find the Zenith a delight to fly, and in a short time you will be using rudder corrections like the pros do. This performance is not easy to achieve. It took five different design changes to eliminate this "roll couple." In addition, different wing airfoils were tried until the spin characteristics were optimum.

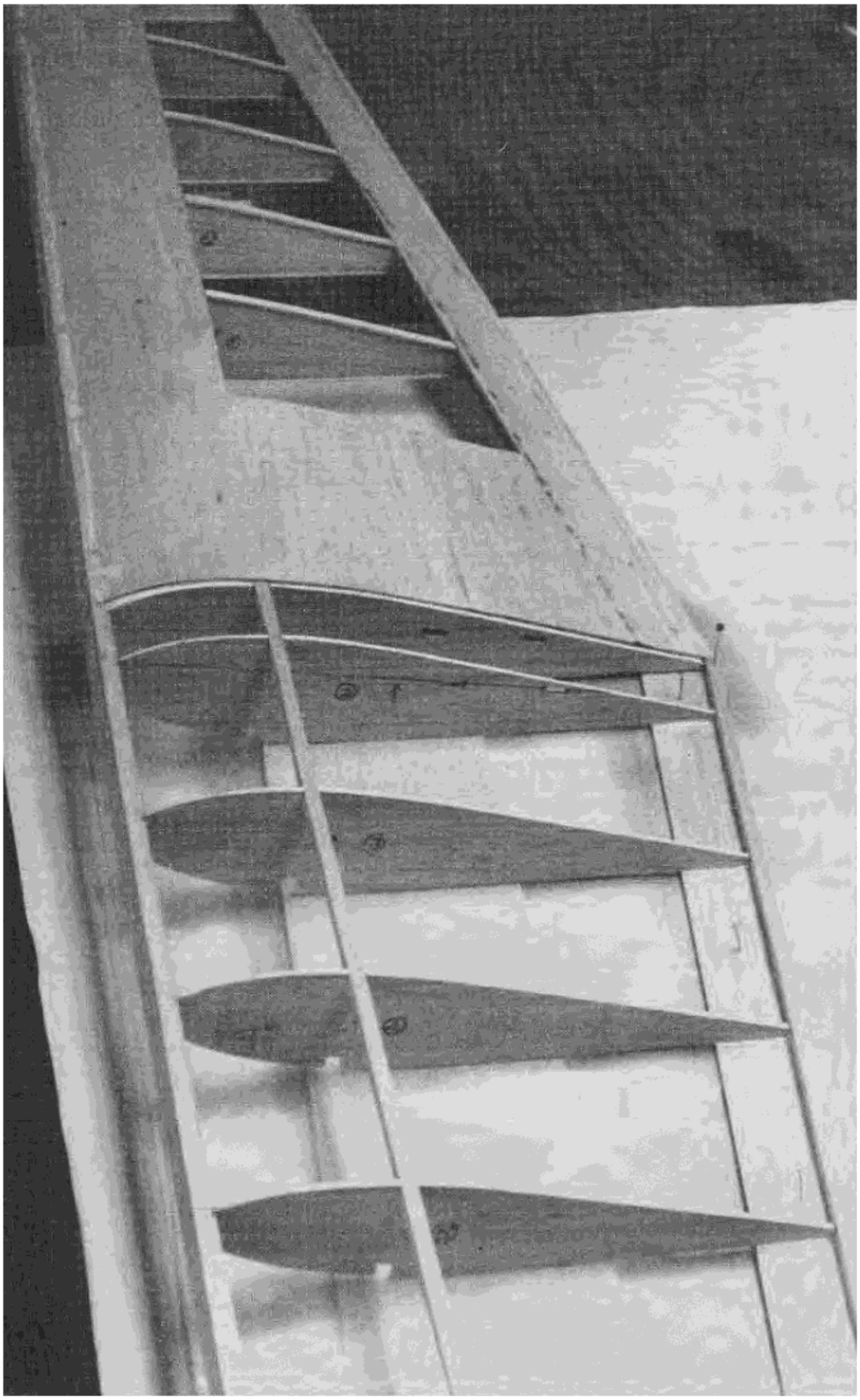
(4) Many features of sophisticated pattern planes are really there because the pilots love sophistication. The graceful, rounded, fish-like fuselage shapes add nothing to performance and do not belong in a trainer. Retractable landing gear is mostly there for good looks and should be



Top leading edge and trailing edge sheeting glued in place.



Right wing panel completed, with capstrips and center section sheeting all glued in place.



Left wing panel is built onto the completed right panel.

ZENITH 40
Designed by:
Neil Allen
TYPE AIRCRAFT
Pattern Trainer
WINGSPAN
55-1/2 Inches
WING CHORD
11-1/4 Inches (Avg.)
TOTAL WING AREA
625 Sq. In.
WING LOCATION
Mid-Wing
AIRFOIL
Symmetrical
WING PLANFORM
Double Taper
DIHEDRAL, EACH TIP
1 Inch
OVERALL FUSELAGE LENGTH
48 Inches
RADIO COMPARTMENT SIZE
(L) 12" (W) 2-3/4" (H) 4"
STABILIZER SPAN
22-1/2 Inches
STABILIZER CHORD (inc. elev.)
6 Inches (Avg.)
STABILIZER AREA
135 Sq. In.
STAB AIRFOIL SECTION
Flat
STABILIZER LOCATION
Mid-Fuselage
VERTICAL FIN HEIGHT
4-3/4 Inches
VERTICAL FIN WIDTH (inc. rud.)
8-1/2 Inches (Avg.)
REC. ENGINE SIZE
.40-.45 2-Stroke/.45-.80 4-Stroke
FUEL TANK SIZE
10 Oz.
LANDING GEAR
Conventional
REC. NO. OF CHANNELS
4
CONTROL FUNCTIONS
Rud., Elev., Throt., Ail.
C.G. (from L.E.)
3-1/2 to 4-5/16 Inches (At Fuselage)
ELEVATOR THROWS
1/2" Up — 1/2" Down
AILERON THROWS
1/4" Up — 1/4" Down
RUDDER THROWS
1-3/4" Left — 1-3/4" Right
SIDETHRUST
1° Rt.
DOWNTHRUST/UPTHRUST
NA
BASIC MATERIALS USED IN CONSTRUCTION
Fuselage .... Balsa & Ply
Wing ... Balsa, Carbon Fiber, Glass Cloth
Empennage .... Balsa
Wt. Ready To Fly .... 72-88 Oz.
(4 Lbs. 8 Oz. to 5 Lbs. 8 Oz.)
Wing Loading .... 16-1/2 to 20-1/2 Oz./Sq. Ft.

avoided until you get into the Masters class. This will save a lot of money and hassle.

FAI class pilots have noise rules to worry about, which trainers do not. This forces them to use quiet pipes buried in the fuselage, soft mounts, and other complications. If we choose, we can make our plane very quiet by using a long, silenced tuned pipe and a large high pitch prop, as the experts do. This could then pass the FAI noise regulations, but we could not quite get down to their levels of quietness.

(5) Zenith has a large fuselage side area. This ensures good "knife-edge flight." In other words, when doing a four-point roll, you first roll 90°, and hold it there with rudder. The more fuselage area you have, the less "top rudder" you will need, and the less the wobble will be when you put it in and take it out.

(6) The design is very simple and rugged. For example, there are no conventional fuselage doublers, yet the 1/2" balsa top and ply bottom, together with the ply formers, make a very tough "box," which results in a strong, light fuselage.

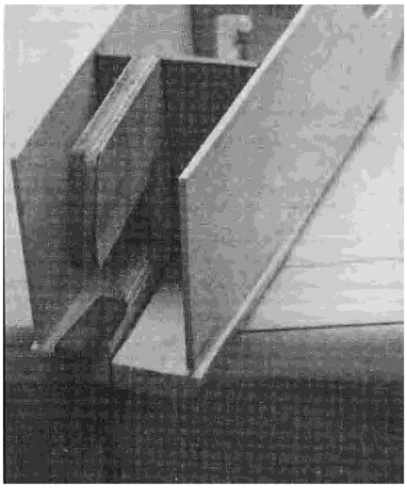
Many "tricks" are used in the design. I recall building a Japanese kit that used five separate plywood dihedral braces at the center section! All were the same length, meaning that when it hits the ground, the wing must shear off where all those braces stop.

This design has no dihedral braces at all, only glass cloth to reinforce the center joint. What is not so obvious is that the wing section is very thick at the center, tapering to the tips. In addition, the wing chord also tapers considerably. The result is a massive center section, and the ordinary spars and sheet do all the reinforcing needed here, with a great saving in building time and weight.

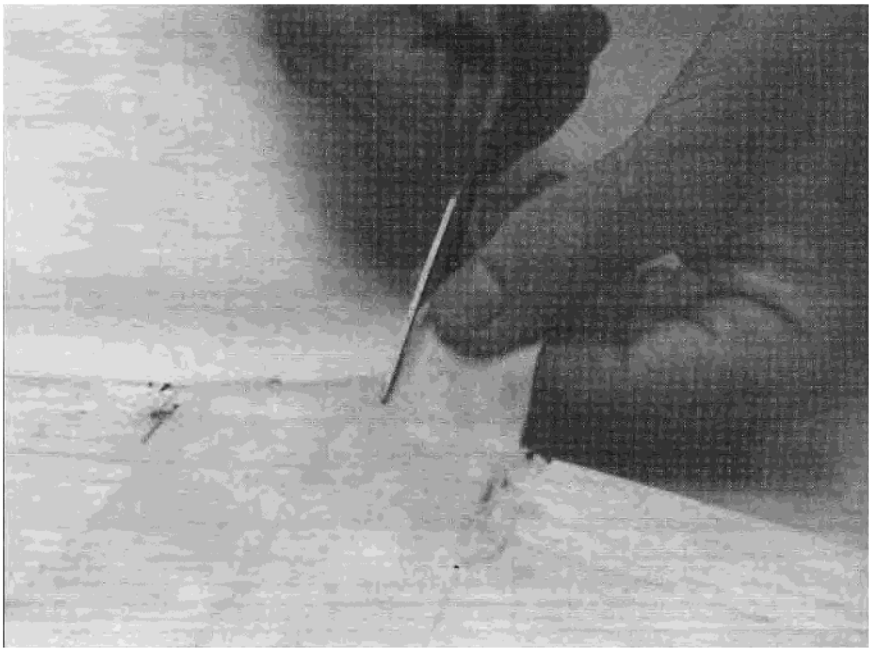
The vertical webs between the spars on all other designs I have seen, require you to painstakingly trim the webs to fit neatly between a pair of ribs. This loses sight of the reason for those webs being there in the first place. If you twist a wing in your hands that has no webs, it can only flex by the spars moving in opposite directions to each other. Adding webs prevents this motion and adds great resistance to twist, so warps will not happen when covering. However, placing webs along the whole length of the spar is a waste of material and effort.

(7) Some other points worth noting:

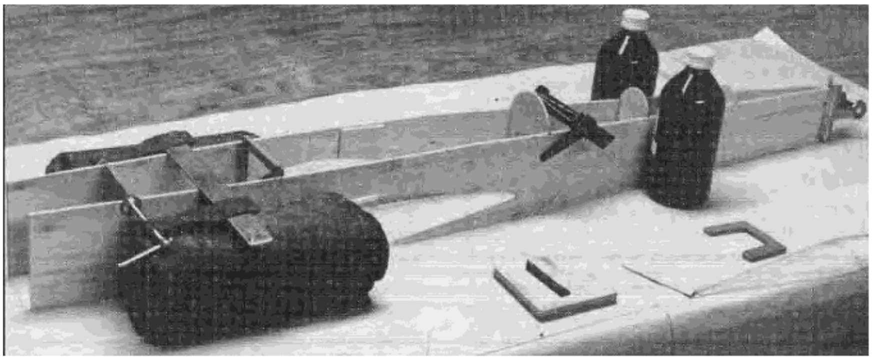
(a) Zenith was designed to be used with the simplest 4-channel radios. If you have a more advanced computer set, you can try selecting about 30% exponential control for the ailerons. This makes faster rolls possible without making it more sensitive about neutral.



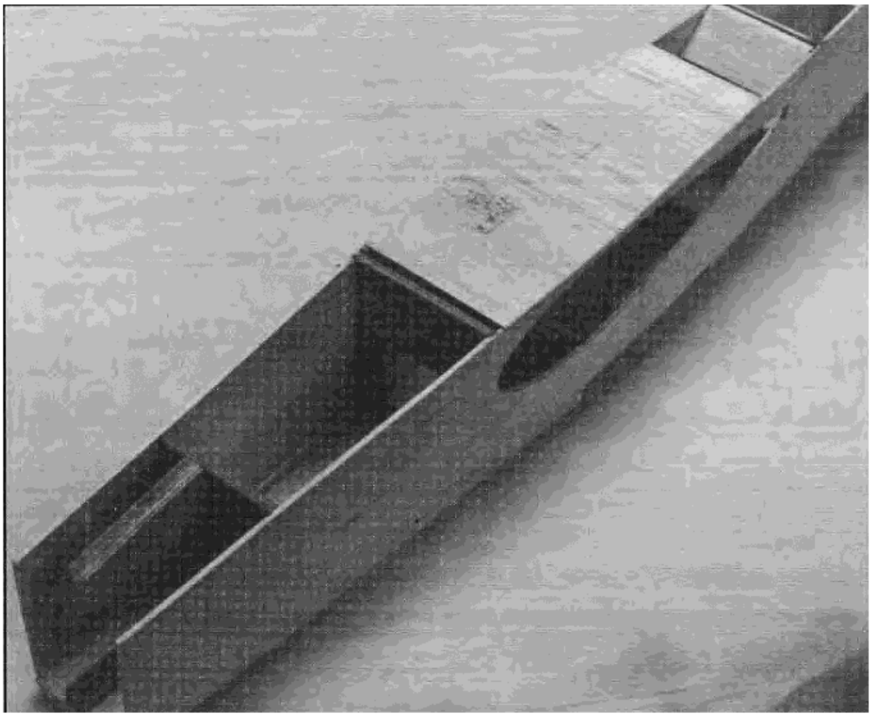
Engine mount plate is glued in place. Be sure to install at the correct thrust angle.



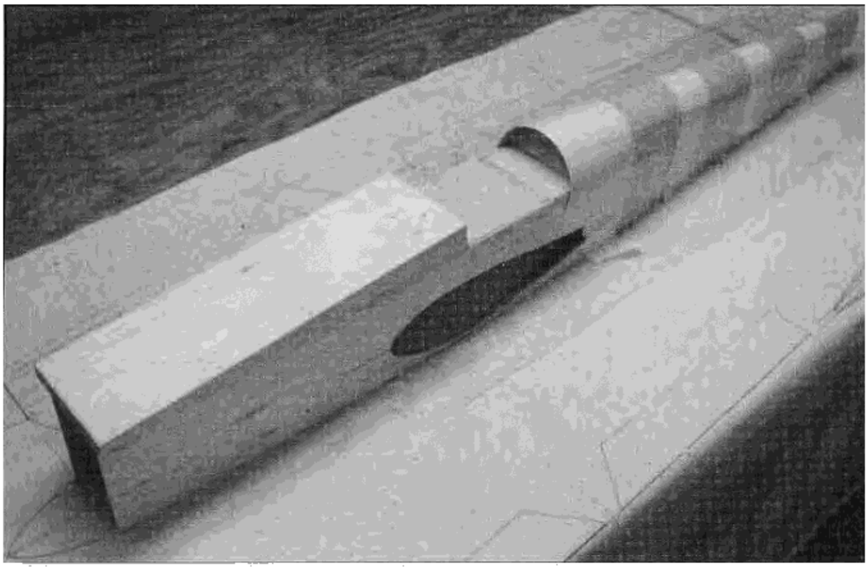
Lightweight glass cloth is used on center section joint.



Fuselage sides are glued to formers using heavy weights and clamps to hold everything in place.



Sheeting is glued to under-wing section. Leave the aft section open for the wing bolt installation later.



Top front block and turtledeck sheeting is installed at this time.

(b) Building this design will probably introduce you to several novel ideas, which are the norm in advanced pattern planes. Sealing the aileron gap is one, which gives much more accurate rolls, with less drag.

Two ideas from the pattern world are used in the controls: The rudder is controlled by a "closed loop" system of wires instead of pushrods. The elevator halves are not joined by a rod, but are operated separately by a pushrod with two ends. Somewhat surprisingly perhaps, I find both of these methods easier to make than the conventional systems, apart from being more precise.

(c) The engine is side mounted to ensure that the tank is dead level with the engine. This prevents the engine going rich or lean when inverted. Side mounting also makes adding right or left thrust adjustment a matter of only adding a washer or two. An upright engine cannot have the tank at the correct level, and an inverted engine is difficult to get to.

(d) Some taildragger aircraft are a bit twitchy, with a tendency to chase their tails on the runway. Zenith has completely tamed these problems by using a very wide track landing gear, and using a simple throw reduction on the steerable tail wheel. The reason why it is a "taildragger" type aircraft is the reduced drag and weight from using two wheels and legs instead of three. This makes a retractable gear not necessary. When you build yourself a Zenith, you are in for a delightful surprise. You may have thought that pattern-type craft were only for the experts. Well, even novice fliers will be surprised at how easy this plane is to handle in the air. Take-off and landing are a dream, and there is nothing to beat the pleasure of flying a precision craft that goes exactly where you point it.

It won't be long before you wonder how you ever put up with flying trainers or sport planes — you will be hooked!

CONSTRUCTION

General

Cut out all parts first. For cutting out wing ribs and formers, photocopy the parts of the plans to be used and stick these on the wood using rubber cement or 3M Spray Adhesive. Alternatively, use carbon paper, or prick the outlines on the balsa through the plan with a pin.

Drill all marked holes in formers, etc., except for engine mounting bolts and wing hold-down bolt holes.

For gluing, either CA or white PVA modeling glues are recommended for balsa to balsa joints. For ply to balsa, PVA or epoxy is best; and for ply to ply, slow epoxy is recommended.

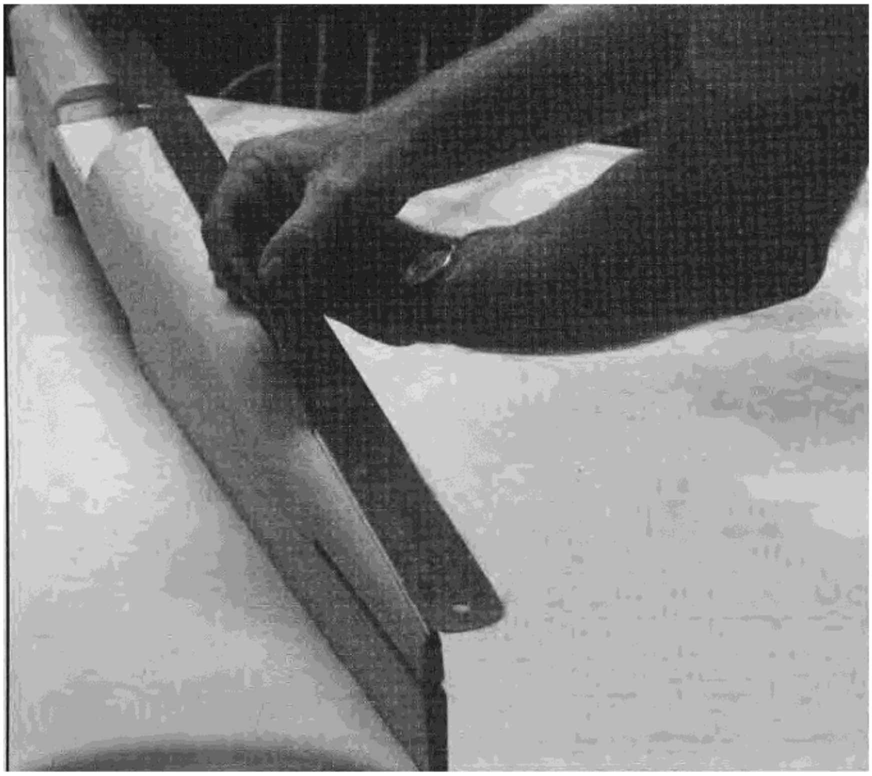
Note: TE means trailing edge (rear), and LE means leading edge (front).

Wing:

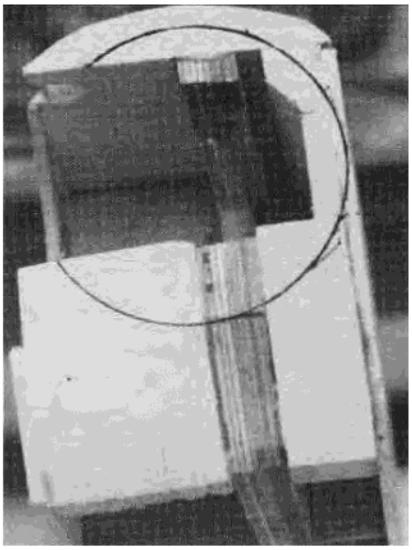
The right-hand wing half is built first. The left half will be built onto it. This eliminates the tricky job of making a good match between the two wing halves at the root, and results in a stronger wing center section joint. This method does mean that when you come to the final part of building, which is adding leading edge sheeting, etc., to the lower left side, the wing must be pinned flat on the board with the right half jutting out over the edge of your building board.

Note: Although the wing tapers, the rear part can be placed flat on a building board either way up, without warping it. This feature is unique to this design — it will not work with most other planes.

If there is a noticeable weight difference between the balsa parts for the two wing



Locate and cut out the slot for the vertical fin.



Nose blocks glued in place and the spinner backplate shape has been traced on the wood before rounding off the nose.

halves, use the heavier wood for the left-hand wing. This is because this side needs weight added anyway to counterbalance the engine cylinder mounted on the right side.

(1) Sand dihedral angle at root of LE parts (see front view of wing). Mark all rib positions on the back of the LE with accurate double lines. Add a center line on the front for use when shaping the LE later. Be careful to make a mirror image of left and right LE parts!

Glue the 3/32" sheet sub LE support on the back of the 1/4" sheet LE, using glue only between the rib positions. A couple of drops of CA glue between each rib position is fine. Cut the notches for the ribs in the 3/32" sheet sub LE only, using a razor saw or knife.

All spars, TE, LE, etc., should have about 1" excess length, which is cut off later after completing the wing.

(2) Cut the angle of the lower TE (3/32" x 1-3/4" sheet balsa) for the sweep forward, and pin it on the plan on your building board, using wax paper to protect the plans. Glue on it the 3/8" sq. TE strip.

(3) Put a spare 3/32" sheet in place under the wax paper to support the ribs (see plan). Glue ribs W1 and W3 to W8 in place. Rib W1 overhangs the center slightly, and is angled approximately as per front view. Glue in 1/8" ply wing hold-down bolt plate, and glue rib W2 up against it. Add balsa hold-down plate packing on top of 1/8" plywood plate. Sand this down if it is higher than the ribs.

(4) Glue on LE assembly. Check its alignment by looking along the wing from the tip or root to ensure that it is straight, and the ribs are aligned.

(5) Reinforce 1/4" sq. mainspars by sticking on a 1/4" wide strip of .007" carbon fiber. This will go on the inside of the spar when fitted to the wing. These are glued in place with CA or epoxy. Glue top mainspar in place, stopping in the center of root rib W1.

(6) Attach upper TE part (3/32" x 1-3/8" wide sheet).

(7) Add the LE sheeting. If the front edge does not match the LE well, try the other side, and cut or sand to fit if needed.

Soak with water first to make it flexible. The sheet will extend behind the spar slightly, but this does not matter.

(8) Add capstrips on top, and center section sheeting.

(9) When the glue and the leading edge sheet is dry, remove the wing from the plan. Plane or sand the TE strip level with the TE sheet.

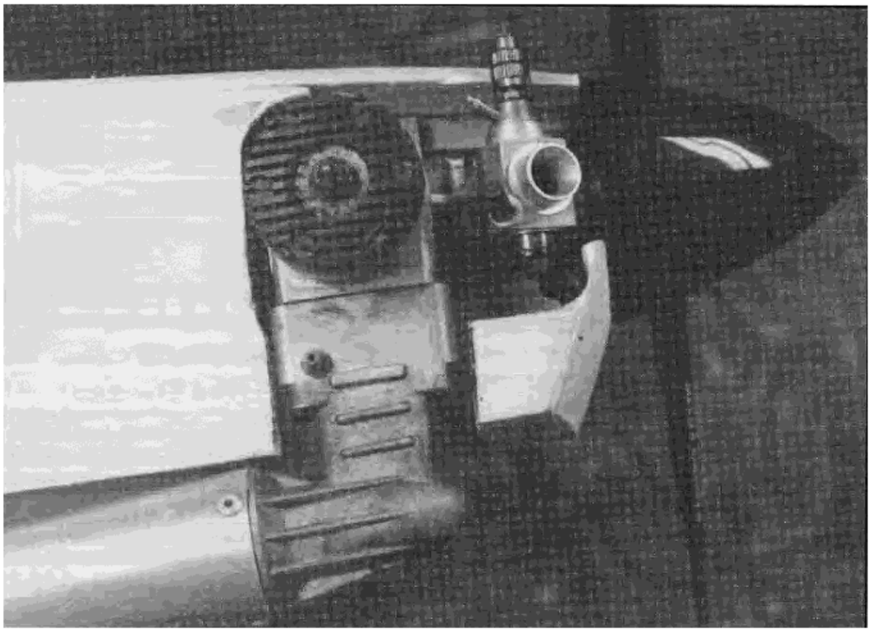
(10) Turn the panel over and complete the bottom, pinned down or weighted down at the trailing edge again. The 3/32" sheet support is not needed now.

(11) After removing from plan, add the 1/16" sheet spar webs. These are glued on the face of the wing mainspars, butting up against one rib, not two. These stop level with the top of the mainspars — see section W8.

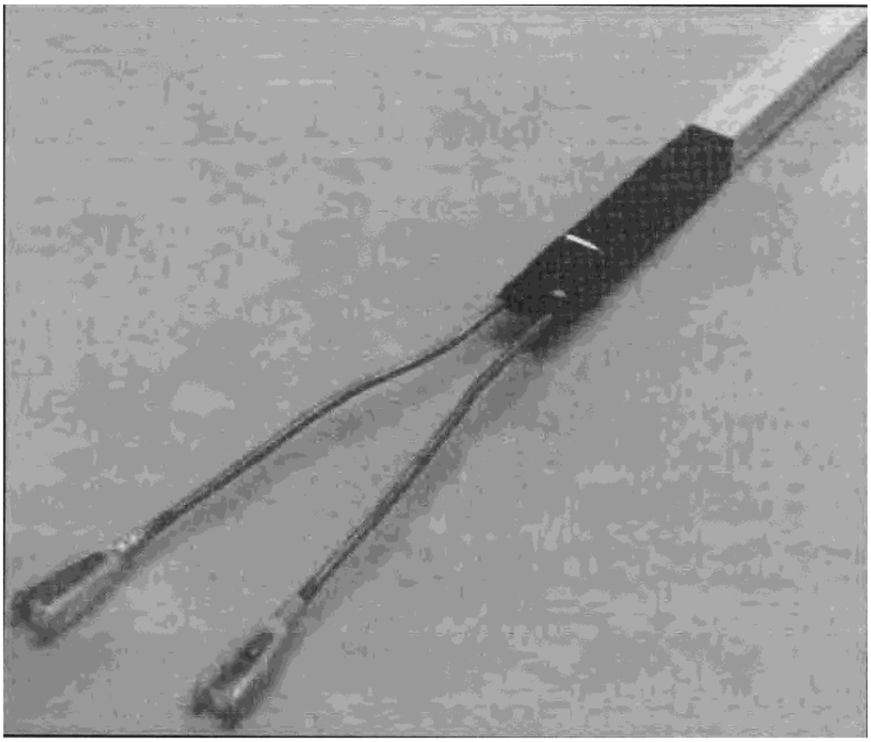
Left Wing:

(12) Pin down the TE part on the building board as before. Position 3/32" sheet support for ribs.

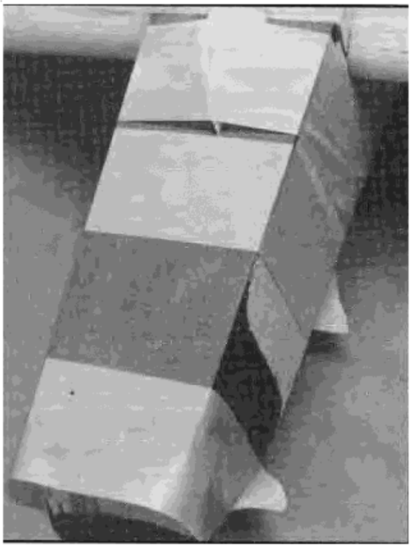
(13) Glue the completed right wing in position on the TE, using a block 2" high to support the wingtip to the correct dihedral angle. The overlapping root rib should support the center of the wing securely on the 3/32" spar sheet support. This must be



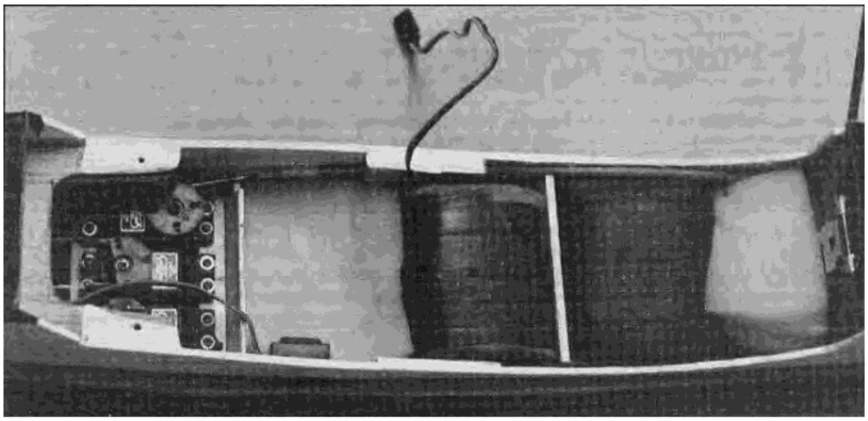
Cut away the nose section to clear the engine, muffler, and throttle arm.



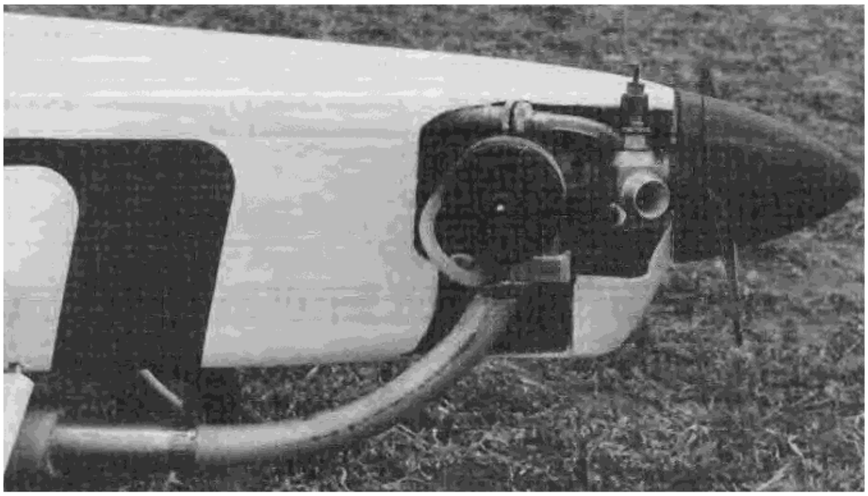
Elevator pushrod is made up with two wire ends for the two separate elevator halves.



1/16" plywood sheet is glued to bottom of nose. Use tape, etc., to hold in place while glue sets. Note scrap wood used to apply pressure to help hold center section down.



Servos and receiver are installed.



Tuned pipe header on second prototype plane.

done accurately so that there is no twist between the two wing halves. Look along the leading edge to ensure that you have no sweepback or forward.

(14) Add the TE strip, wing ribs, hold-down plates, leading edge, and wing spars as was done for the right wing.

All spar joints at the center section should be well fitted by sanding the parts to the required dihedral angle before gluing.

(15) Add the servo mounting rails, making the spacing between them correct to fit the servo you will use.

(16) Complete the left wing top in the same manner as the right by adding LE sheeting, TE top, and capstrips.

(17) Remove from board and complete the underside of the left wing flat on the board, as described before, with the right wing jutting out.

(18) Remove completed wing assembly from board when dry. Add the 1/16" sheet spar webs.

Complete Wing:

(19) Shape the leading edge. This must be done accurately or else flight performance will be affected. It is important to get the left and right halves identical. If in doubt, cut cardboard templates using the plan sections, and use these to check your work.

The leading edge shape is fairly sharp. This is to ensure good spins and snap rolls. First sand or balsa plane the LE at an angle to extend the shape of the LE sheeting. Then round the remaining corner carefully, without sanding off the previously marked centerline. Only when using the final fine sandpaper should that centerline mark be touched.

(20) Attach the tips, and round these off. Sand the remainder of the wing lightly.

(21) Make up the aileron torque rods from a Du-Bro 3/32" wire set.

Cut the plastic guide tubes to length as per plan, insert the wire, and bend and cut these. Note how the threaded part of the torque rods are bent to the left to line up better with the offset aileron servo.

Glue the torque rod plastic tubes to the wing TE in the correct positions. One way to do this is to glue with thick CA glue, sprayed with quick-set accelerator. Epoxy can also be used, using pins to locate them until dry.

(22) Cover the center section with a single piece of 2-3/4" wide 4 oz. fiberglass cloth reinforcing. It must not be so wide that it reaches the wing where the fuselage sides will fit. It must, however, extend past the aileron servo cut-out hole by at least 1/4".

The cloth also wraps around the aileron torque tubes. Avoid getting excess glue in these tubes, or grease these parts with petroleum jelly first.

Start gluing at the TE at the bottom. Go around the LE. When you get to the TE at the top, make two cuts along the length of the cloth with scissors at the point where the torque tubes stop (inboard ends), so that it can wrap around the aileron torque tubes and overlap about 1/4" along the bottom.

(23) Cut the ailerons to shape as per plan. Sand or plane to section. Drill the holes for the aileron torque rod wires, and cut a groove to fit these wires at the root.

(24) Glue the small weight to the left-hand wingtip as per plan. Do not bother to get this balancing exact, as this is better done by flight tests later.

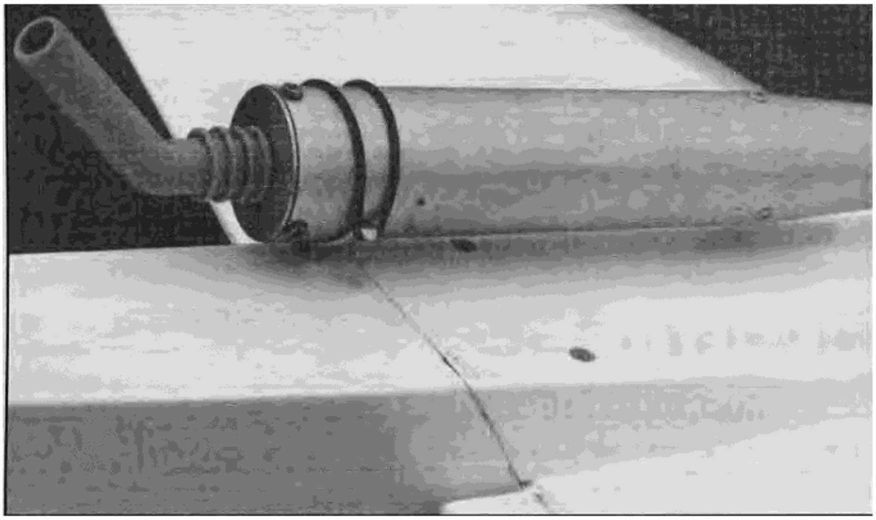
Fuselage:

(1) Join fuselage side parts F1, F1A, and F2, adding the doublers F3 at the rear. To join neatly, first cut the vee shape on the long fuselage side F1, then use this as a cutting guide to cut the rear part F2. When doing this, keep a straightedge lying along the bottom line of the sheet to keep it straight.

Do not attach doublers F4 yet. Make sure you make a left and a right side. Mark the positions of the formers F6, F7, F8, and F10 on the insides of the fuselage sides. Sand the joined sections smooth on the outside. Add F11A.

Glue former F7A to F7.

(2) Build the fuselage flat on the top view plan. Protect the plan with wax paper, then pin down the rear cross braces cut from 1/8" by 1/2" balsa. Join the fuselage at the rear, preferably using white glue (PVA) to



Tuned pipe is held in place with an "O" ring on the aluminum bracket.

allow repositioning if required, and use a clamp to hold it together. The sternpost is made of one piece of balsa, and only cut apart later to fit the tail plane. This keeps the rear fuselage straight.

Place the sides over the plan and use weights such as bricks, etc., to hold the sides together. Make sure the sides follow the plan shape. Glue formers F10, F7, and F6 in place. Note that F6 is raised above the building board.

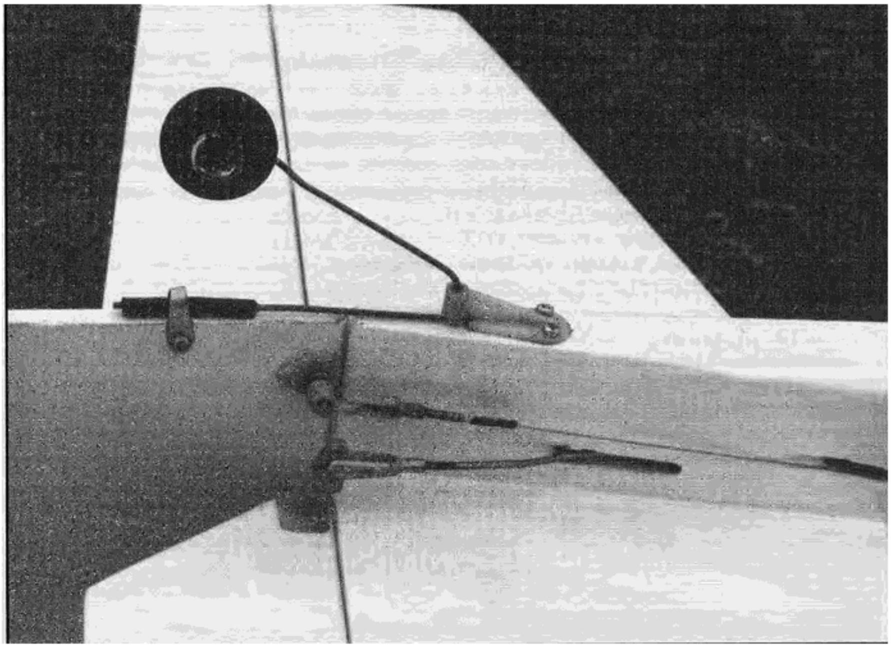
Remove the pins from the cross braces when these are glued, and add pins from the outside if needed to hold the sides in position.

(3) Add the doublers F4 and clamp these to follow the curvature of the fuselage sides. Add formers F8, F8A, F9, and attach the cockpit floor. Attach the front servo mounting rail to F9 and the sides. Glue the rear servo rail in place, the correct distance apart from the front rail to suit the mounting lugs on the servos you will use.

(4) Attach formers F11, F12, and the 1/2" balsa top.

(5) Look along the rear turtledeck formers and sand off any high spots to get a smooth curve. Make up the rear turtledeck sheeting from its two parts, using a waterproof glue such as CA. When dry, sand the outside smooth. Soak in boiling water or ammonia solution for a while until it is very flexible, curving and folding it over gradually. Curve it over the formers, without glue. Hold it down with masking tape. Use a clamp at the rear of the fuselage. Do not pull it down too hard or it will sag between the formers. Let it dry completely. Mark where to cut off excess material on one side only before removing the tape.

Remove the tape and sheet, then cut this first edge to fit against the fuselage side. Place sheet in position, and cut the other side to fit. Make it a little larger at first, and cut or sand carefully until it fits. Glue in position. If you overdo the trimming, just glue a thin strip on the edge.



Note how the tail wheel is steered from the rudder. This gives a 2:1 reduction in travel.

(6) When dry, remove the fuselage from the plan and cut off the jig portions of the lower front sides.

(7) Fit the engine to the mount plate. First fit a propeller and a spinner of the same type you will use for flight. The engine is positioned so there is a gap of 1/16" between the back of the spinner and the front of the engine mount, then the mounting holes are marked. The reason for this is that the back of some spinners is flush with the engine thrust washer, and some, such as CG, are recessed.

Remove the engine and drill holes. I use self-tapping screws to hold the engine in place, which works well in the plywood plate. If you prefer, you can use blind mounting nuts and bolts instead.

Check the fit of the engine. Glue in the mount plate with slow set epoxy, ensuring the 1° right thrust is as per plan.

(8) Add the front and rear 3/32" sheet to the undertray that will later be attached to the wing. Plank this portion of the bottom only with 1/16" sheet, with the grain going across. Leave out the rear portion of planking at this stage, from 1/2" in front of the wing mounting bolt position all the way to the tail, to simplify connecting up the controls and drilling the wing mount bolts.

Cut the completed undertray off.

(9) Add the blocks around the nose, and the 3/8" tri-stock between F6 and F7. Rough shape the 1/2" top block.

(10) Mount the servos in place.

(11) Add the plywood wing hold-down plate and the 1/4" sq. reinforcements.

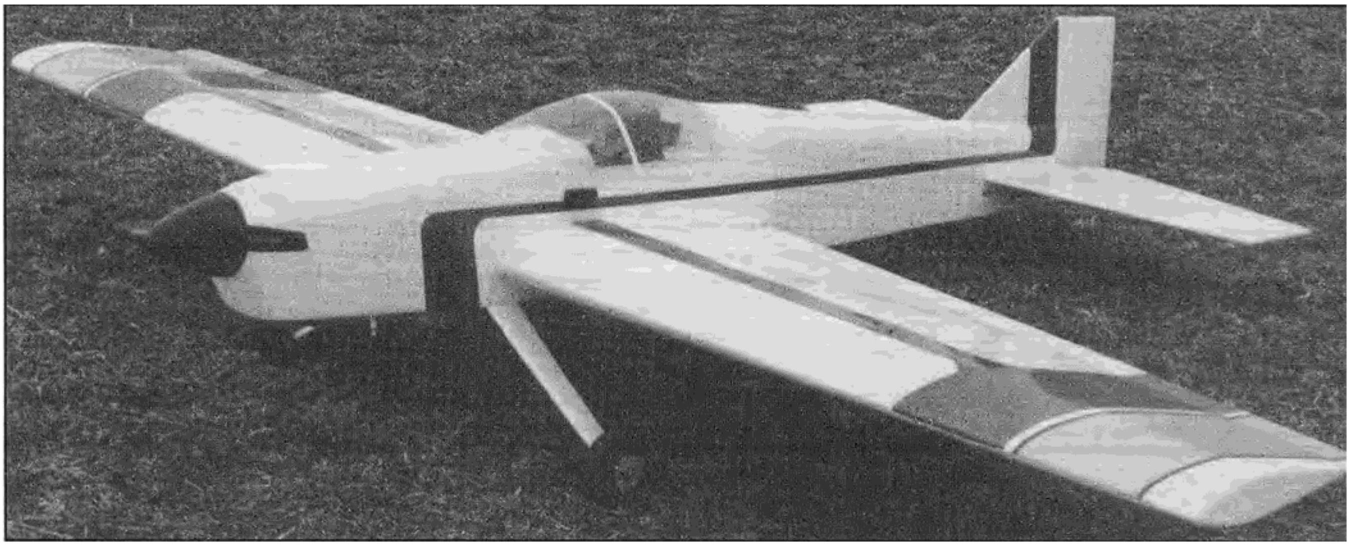
(12) Cut out the fuselage sides and nose blocks to allow the engine to be fitted. Make these cut-outs quite generous to allow easy access to the engine. The 1/2" balsa nose block must be hollowed as needed for the carburetor control arm.

(13) Fit the spinner to the engine. Sand the nose blocks if needed to get at least 1/16" clearance between the back of the spinner and the fuselage. Draw a line around

Materials List

Wood
1 — sheet 1/2" x 4" x 18" soft balsa — fuselage top block and nose blocks
3 — sheets 1/4" x 4" x 36" medium balsa — tail surfaces, ailerons, root rib, tips, wing LE
3 — sheets 3/16" x 4" x 36" medium to light balsa — fuselage sides, muffler box
10 — sheets 3/32" x 4" x 36" medium to light balsa — wing ribs, sheeting, TE, fuselage formers, turtledeck
2 — sheets 1/16" x 4" x 36" medium balsa — fuselage underside, rear doubler, cockpit floor, wing webs
4 — strips 1/4" square x 36" medium to hard balsa — wing spars
2 — strips 3/8" x 5/16" or 3/8" square light balsa —TE
1 — strip 1/8" x 3/8" x 36" balsa — sternpost, F11A
4" x 20" of 1/4" ply (marine, or aircraft-type birch) — engine mount (using two laminations of 1/4"), fuselage formers, wing mount plate
4" x 9" of 1/16" ply (aircraft-type birch) — fuselage front underside
4" x 7" of 1/8" ply (aircraft-type birch) — fuselage formers, servo mounts, wing screw plates
1 — hardwood dowel 1/4" x 18" — elevator pushrod, wing locating dowel

Hardware
1 — Sullivan NyRod (red) or equivalent — throttle
6" of 1/16" music wire — tail wheel
21" of 5/32" music wire — landing gear
2 — wheels 2-1/2" diameter and 5/32" wheel collars
1 — wheel 1" diameter and 1/16" wheel collar — tail wheel
4 — landing gear clamps, metal or nylon
10" x 6" x 1/16" thick ABS or other plastic — landing gear fairings.
6 — Nylinks
4 — threaded end wire pushrods — aileron and elevator
2 — threaded rods with drilled ends, or custom set for closed loop (pull-pull) rudder linkage — rudder
Canopy — many suitable canopies from other pattern-type designs may be cut down for use (.60 size or .40 size planes). They should be shaped for a round turtledeck at the rear, and a flatter nose section. This is very common, e.g., Sig Kougar, Goldberg Tiger II.
4 Pieces — 36" x 1/4" wide carbon fiber .007" thick
36" of 1/8" plastic tubing — antenna guide
17 — hinges for control surfaces
4 — self-tapping screws No. 6 x 3/4" — engine mount
2 — self-tapping screws No. 8 x 1-1/4" (Phillips head preferred) — wing mount
8 — self-tapping screws No. 8 x 1/2" — landing gear clamps
1 — screw and nut 4-40 x 1/2" — tail wheel to rudder connector
1/3 ounce lead weight — for left wingtip
Covering materials and paint



the spinner backplate, then remove the engine and spinner.

(14) The standard muffler on the engine may interfere with the fuselage. The plans show a simple balsa "box" of 3/16" sheet that will solve the problem simply, and provide a neat installation, with the muffler streamlined into the fuselage.

There are two other alternate choices:

(a) Extend the muffler with a spacer. Either use the Du-Bro aluminum extension or spacers, such as a couple of pieces of flat 1/8" aluminum sheet, drilled out with holes for the bolts and the exhaust. Note that getting suitable extra length muffler mounting bolts may be a problem. Seal the spacer during final assembly using RTV silicone compound, as is used for bathroom sealing jobs.

(b) Use an exhaust manifold leading to a tuned pipe, "Magic Muffler," or other muffler. A tuned pipe exhaust system is a good choice, as these produce more power than the standard system, yet are quieter. This type of muffler attaches to the exhaust manifold with a length of silicone tubing. It sits in a block of wood or aluminum support at the rear. This is screwed onto a short length of 1/2" dowel, glued into the fuselage near the wing mount bolts.

The pipe is strapped onto the mount with a suitable size "O" ring or rubber band stretched over hooks. This must be detachable to allow the wing to be removed from the fuselage. Tuned pipes and manifolds are easily available commercially.

(c) Use your standard muffler system, and build into your fuselage the optional muffler space as per plan.

(15) Shape the nose blocks and top decking to the marked spinner outline. Be careful not to round the fuselage too much at the corners or it will be weak.

(16) Fit the throttle pushrod outer NyRod. Check that when the engine and muffler are in place, the NyRod inner will not interfere, as it will melt if it gets hot.

(17) Glue in the antenna tube. Running the antenna inside the fuselage does not affect the range, and is much neater looking and safer — less likely to be accidentally snagged or tripped over, and it will not be ripped off the receiver in a crash.

If you do not believe that the signal is unaffected, do a ground range check with the antenna inside, then outside, and convince yourself.

(18) Fit the fuel tank. It must have a loop of tape, such as fiber parcel strapping tape, around it, with a "tail" at the rear to pull the tank out if needed.

The tank is fitted upside down to make it easier to install the tank pipes through the holes in the fire wall without kinking. Even if the tank has a "bubble" on the top, such as the Sullivan brand, you don't need to use this. One reason for this is that a "taildragger" sits tail-down on the ground, so the tank fills almost full anyway.

Line the tank compartment with foam plastic to locate the tank. Use a block of firm, closed cell type foam about 1/2" thick in front of the tank to space it slightly back from the fire wall to allow space for the pipes, and also to prevent crash damage. This block is cut away and offset to the left to allow for the filler and vent pipes. The foam should be fixed in position on the sides and top. Thin double-sided tape, as used for joining carpets, does a good job here, or use PVA glue, which will not melt the foam.

Remove tank again.

(19) Paint the inside of the engine compartment (usually black) with a fuelproof paint. You can also paint the inside of the tank area to protect the fuselage in the event of fuel leakage from problems such as a split tank pipe.

The lower fuselage decking is left off at this stage to gain access for fitting pushrods, fuel tank, etc.

(20) Fill any dents, preferably using CG Model Magic lightweight filler, and sand fuselage smooth.

All Tail Parts:

(1) Cut out parts, join where necessary, and sand to shape.

(2) Mark centerlines at front and rear of surfaces, and sand or balsa plane to rounded or pointed sections as per plan. The rounded surfaces are only for appearance — you can leave the corners square without affecting flight performance.

(3) Cover the tail plane and elevators with plastic covering film, and the fin and rudder also if the fuselage is not being painted.

Cut the hinge slots for the rudder and elevators, but do not attach these yet.

Assembly:

(1) Mark a centerline accurately on the bottom of the wing by measuring equal distances from each tip along the front and rear of the wing.

(2) Fit the wing to the fuselage, ensuring that the fuselage is vertical to the wing. The angle between the top of the wing and fuselage must be the same on both sides. It is almost a right angle (90°).

(3) Strap the wing in place, carefully centered on the fuselage, using tape, rubber bands, etc.

Make the hole in the LE for the wing dowel by either:

(a) Pushing a dowel with a pointed end through F7 from the front to mark the LE, and then drilling at this mark.

(b) Using a piece of brass tubing the same diameter as the dowel, with an end sharpened with a file to act as a drill. Push this through F7 from the front, and rotate it to cut the hole.

Glue dowel into wing, with the wing fitted to the fuselage while it dries in position.

(4) Strap the wing TE to the fuselage, and measure equal distances from each tip back to a point on the fuselage centerline to ensure that the wing is at right angles to the fuselage centerline.

(5) Drill the wing hold-down bolt holes, starting from the marked positions on the wing first. Drill a pilot hole of about 1/16" diameter, angling the drill bit as per plan. Remove the wing and check that it came out in a suitable place in ply plate. Replace the wing, and drill through using a 7/64" diameter bit for the self-tapping screw threads. Remove the wing, and drill a 11/64" diameter hole in the wing to clear the screw threads.

(6) Attach the wing to the fuselage, having first protected the joint with cling wrap.

(7) Glue wing undertray in place, lined up with the fuselage.

Make up a paper tube by gluing about three turns of paper rolled around a suitable dowel, pencil, etc., of a diameter just larger than the head of the wing hold-down screws. Protect the dowel with wax paper first. Cut the tube into two portions, leaving excess length at this stage.

Unscrew each wing mount screw in turn about six turns. This makes the head project above the surface to locate the tube properly, then attach the tubes.

Complete the sheeting of the undertray only, making holes for the tubes. Cut off excess tube sticking out.

(8) Attach the ply underside to the front of the fuselage, checking its fit against the wing undertray.

Drill the two oil drain holes, then paint the unpainted inside ply part of the engine bay.

(9) Slide tail plane into slots. Center it, then align it accurately, both for tilt (visible in front and rear view), and square (checked by measuring diagonals from tail plane tips to fuselage centerline as was done for the wing).

When accurately aligned, draw lines to mark the places where the tail plane will be inside the fuselage. The plastic film covering must be cut out just inside these lines. When the tail is glued in place, the plastic covering will be neatly sealed in place, but enough wood of the tail must be exposed to make a strong glue joint.

When cutting the covering away, first cut the film at the LE and TE, and run a very sharp blade gently along the cutting line. Lift the film away from the tail and tear along this line, or peel the film up against a blade to cut the remainder to avoid nicking the tail plane. I have seen the results of people not following this procedure, and it is not pretty!

Glue tail plane in place.

(10) Cut a slot in the turtledecking for the fin. Glue the fin in place. This must be vertical to the tail plane, and the hinge line on fuselage and rudder must match.

(11) Hinge the rudder and elevators, and glue the hinges in place on one surface only. The rudder and elevators should be hinged without glue at this stage, as the fuselage rear must be covered before attaching these.

(12) Mount rudder and elevator horns. Make up the elevator pushrod and connect it up. Bend the pushrod wires slightly apart to make it easy to feed through the fuselage holes. Leave the Nylinks off whenever you remove and replace these pushrods.

It is recommended that you connect to similar spaced holes on the servo arms and horns as shown on the plan, to give about the correct amount of control movements.

Connect the rudder cables first to the servo arm. Crimp the sleeves to secure them. Connect the rudder ends next, with the rudder pegged in position, and the Nylinks screwed on a central position on the adjuster rods. The cables must not be very tight, as this would cause wear to the servo bearing. When the cables are plucked, they should give a dull clunk sound, not a musical twang!

(13) Operate the servos, and check that the controls move freely.

(14) Fit plywood tail wheel mount plate. The tail wheel design shown reduces the movement of the tail wheel by a 2 to 1 reduction. This is used because pattern planes have a large rudder movement, and this would make a normal steerable tail wheel design too sensitive on take-off.

(15) Complete the sheet covering of the underside with the wing in place to get a good fit. Note that the fuselage can be easily twisted before the sheeting is attached, so do not put pressure on one side of the tail plane while doing the sheeting.

(16) Cut out the ABS plastic landing gear fairings. Thin ABS sheet is often used for display signs in shops and can usually be obtained free when discarded. Note that ABS is a flexible, slightly rubbery plastic which does not crack easily.

Clamp the fairing material in a vise along the fold line between two strips of wood or metal. Heat the fold with a heat gun and pull the material back at right angles. When cool, it can be squeezed further in the vise, and heated again, with the wire leg in place, until it folds neatly in half around the leg.

Clamp the wire gear in a vise so that it is horizontal, and the fairings can hang down in position. Now coat the wire with silicone rubber (bath sealing material), place the fairing over the wire, and fill the gap with more silicone rubber. Clamp in place with clothespins until set. The result is very tough and flexible.

If you use white plastic and white silicone rubber, it need not be painted. If you need a different color, ABS takes paint well, but the silicone does not. You could use black or clear silicone in this case.

(17) Fit the landing gear in place. Cut slots in the ply lower front sheet to clear the wire legs. Remove landing gear again before covering.

(18) Make a hole for mounting the receiver switch.

Covering And Finishing:

(1) Remove the pushrods and wing servo before covering.

(2) To keep the weight low for good flight performance, the wing and tail should be plastic film covered. The fuselage can be film covered also, or painted, as long as this is done lightly. A painted fuselage usually holds up better to the oil soaking of many flights, but takes more time and adds weight.

All joints in the film covering should be sealed with a thin line of CA adhesive (excess can be wiped off) to seal against oil. Painting the fuselage, particularly the nose and other areas where oil is deposited, with Balsarite by Coverite before covering, will considerably extend the life of film covering.

Choose bright, clearly visible colors. Most pattern planes end up being combinations of white and bright colors for this reason. Put a different color scheme on the bottom to help you see which way is up.

(3) Fit the ailerons, rudder, elevator pushrod, rudder cables, and throttle pushrod. To replace the rudder cables, first push a long wire or plastic tube (such as a NyRod) through from the tail end. Attach the threaded rod links to this with tape or by threading onto the NyRod, and pull them back into place.

Crossing the rudder cables gives a slightly better exit angle for the wires leaving the fuselage sides, but will of course reverse the rudder direction. Friction of the cables rubbing is not actually a problem.

Check the controls for free movement and see that they move in the correct direction.

(4) Add remaining items such as landing gear, tail wheel, receiver, switch, etc. Protect the receiver and battery with dense foam rubber or plastic, and use blocks of foam plastic to hold in place.

(5) Carefully check all items before test flying.

(6) The balance point (C.G.) should be checked. Do not use weight to get it to plan position yet, as long as it's not further back than 1/2" behind the rearmost plan position.

Flying:

The plane is very easy to fly and should present no problems. If this is your first "taildragger," you will not find it much different to trike geared craft. When flying off grass, it is advisable to hold full up elevator when you first open the throttle to prevent a nose-over.

After getting used to the flight performance and the engine, the plane must be trimmed for proper flight performance. Long articles have been written on the topic, which are worth studying, but I will give an outline. Contact your local pattern fliers or ask the AMA to give you the address of the pattern organizations that can help if you want more information.

(1) The control movements are adjusted to make the sensitivity to the controls the way you like it. The elevator movement should be just enough to do a tight loop. The aileron movement can be set for your own requirement — for example, I find that three rolls in five seconds is a pleasant rate to fly with.

(2) The C.G. is adjusted with lead weight in the nose or the tail. These weights can be attached with self-tapping screws to the engine mount plate in front, or ahead of the tail wheel on the tail wheel mount plate at the rear.

If you move the C.G. back, these things happen:

(a) Less down elevator is needed for inverted. This makes good rolls much easier to do, and inverted flight simpler.

(b) The plane spins and snap rolls more easily.

(c) It becomes more pitch sensitive. Compensate for this by reducing elevator movement. When it becomes difficult to fly straight and level, you have gone too far back.

(3) The aileron level position is trimmed by getting equal roll drift off from level flight upright and inverted.

(4) The rudder is trimmed to get successive inside loops on top of each other, assuming you are flying dead into wind.

(5) The final step is wingtip weight. Small amounts of weight, such as a nail pushed into the tip (covered later with film), are used to get inside and outside loops on top of each other. Simply explained, left rudder will make both inside and outside loops go left. Weight on the left wingtip will make an inside loop go left, and an outside loop go right. This is due to the centrifugal force in the loops. Think out how this works, and you will understand what to do fully. Adding tip weight will also change the rudder trim, which must be reset.

This may seem like a lot of hassle, but the pleasure of flying a properly trimmed pattern plane is incredible. You will certainly not enjoy flying ordinary old sport planes anywhere near as much after being spoiled by a plane that flies **for** you instead of **against** you.

From RCModeler Apr. 1996