BOX BIPE II

By James Kerchum

The concept of a box-tail was not conceived for the purpose of being unique. It was contrived to be used with other factors to create a more efficient aircraft.

Let me explain what a box-tail is and how it works.

The concept of two channel directional control of an aircraft consists of more than just a rudder and elevator yawing and pitching a plane. There are many other factors involved that can be used to one's advantage. Let's begin with the simpler of the two; the horizontal stab.

As an aircraft travels through the air, equal air pressure on the top and bottom of a stabilizer prevents the craft from pivoting on its balance point. By moving the elevator, air pressure is increased on one side, thus pushing the tail of the aircraft and pivoting it on its balance point, which in turn changes the direction of the aircraft.

This is simple and works well. Therefore, all that is left for us to do is to locate the horizontal stabilizer in an area where it can perform its function with the least amount of adverse effect.

ABOUT THE AUTHOR

Jim Kerchum, age 27, resides in the small town of Newton Falls, Ohio, with wife Cheryl and their three children.

As an ex-policeman and now a private investigator, he finds R/C modeling a welcome vacation from the everyday pressures of the job.

His first endeavor in this hobby was in the spring of 1982 with a rubber powered stick and tissue kit. After building several of these, Jim purchased a 4 channel R/C system and designed his own trainer. The plane flew well, but was demolished by pilot error. He designed and built another slower, more docile craft on which he trained himself and which he still has. Becoming bored with this plane after a few short weeks, he designed and built another more aerobatic craft. It was at this point that Jim realized that he enjoyed designing R/C aircraft as much as flying them. He has designed and successfully flown eight R/C aircraft to date. Some of these may be featured in RCM in the future. Jim looks forward to designing and building many more as the years pass.

By locating a horizontal stabilizer directly on the fuselage of an aircraft, we gain structural strength, but lose effectiveness because of turbulent air coming off the fuselage and wing. By locating the horizontal stabilizer up high at the top of the vertical stabilizer, we virtually eliminate this problem but reduce the structural strength.

This problem can be overcome by using two vertical stabs. By keeping the width of the fuselage the same throughout its length we can locate a vertical stab on each side of the fuselage with enough distance between them to allow for a solid support for the horizontal stab. This produces an extremely strong tail system and solves yet another problem.

By using two vertical stabs we can maintain enough stab area and still keep it low enough on the aircraft to eliminate adverse roll effect from the rudders. Let me explain.

When a rudder is moved on an aircraft, air pressure pushes the tail section the opposite direction yawing the whole craft. Air pressure under the wing on that side is increased (provided there is dihedral in the wing), thus rolling the aircraft in the direction of the turn. If the rudder is above the roll point of the aircraft, air pressure on the rudder rolls the aircraft in the opposite direction. Pressure under the wing is much greater, therefore, still allowing the aircraft to roll in the proper direction, but inefficiently. On the other hand, if the rudder (or rudders) is below the roll point of the aircraft, the effect is the opposite aiding the aircraft in its roll, and this lends itself to another idea.

Since the fuselage is the same width through its length, it can be used as an airfoil, thereby further increasing efficiency of the overall aircraft.

If the fuselage is used as an airfoil we must first look at it as a section of wing. Then we must find its balance point and place the conventional wing (or wings) on the aircraft so that both the balance points of the wing and fuselage are the same. We then end up with an aircraft that is actually a wing or set of wings with a tail attached.

This eliminates all the adverse effects of a fuselage, but still allows us a place to put our engine, radio equipment, etc.

Because of the efficiency of this design and a large wing area, a small engine can be used while still maintaining high speed capabilities. The aircraft can also be built heavy (strong) and still maintain its capability of very slow flying without altitude loss.

A high wing monoplane constructed using these concepts is extremely stable in flight and makes an ideal beginner's aircraft. A biplane, on the other hand, is extremely maneuverable while still retaining a degree of stability not usually found in this type of aircraft.

CONSTRUCTION

Fuselage:

Cut the fuselage sides from 3/32" balsa. Cut out 1/32" ply doublers. Be sure to make cutouts for spruce stringers on the rear half. Glue the doublers to the fuselage sides.

The vertical stabilizers are countersunk flush with the fuselage, therefore, the verticai stab backing plates must be 3/16" in from the fuselage sides. This is achieved in the following manner. Cut two strips (for each side) of 3/32" balsa to the specifications on the plans. Glue these to the inside of the fuselage sides on the edges of the vertical stab cutouts.

This neat little .09-.15 powered bipe is not only unique, but the performance is outstanding.

BOX BIPE II
Designed By:
James Kerchum
TYPE AIRCRAFT
Sport Biplane
WINGSPAN
35½ Inches
WING CHORD
6½ Inches
TOTAL WING AREA
461 Sq. In.
WING LOCATION
Biplane
AIRFOIL
Flat Bottom
WING PLANFORM
Constant Chord
DIHEDRAL EACH TIP
1½ Inches
O.A. FUSELAGE LENGTH
25 Inches
RADIO COMPARTMENT SIZE
(L) 10" x (W) 3¼" x (H) 3"
STABILIZER SPAN
15 Inches
STABILIZER CHORD (incl. elev.)
5¼ Inches
STABILIZER AREA
78¾ Sq. In.
STAB AIRFOIL SECTION
Flat
STABILIZER LOCATION
Top of Vertical Fins
VERTICAL FIN HEIGHT
3¼ Inches (Avg.)
VERTICAL FIN WIDTH (incl. rud.)
4¾ Inches (Avg.)
REC. ENGINE SIZE
.09-.15 Cu. In.
FUEL TANK SIZE
2 Oz.
LANDING GEAR
Tricycle
REC. NO. OF CHANNELS
4
CONTROL FUNCTIONS
Rud., Elev., Throt.
BASIC MATERIALS USED IN CONSTRUCTION
Fuselage ..... Balsa, Ply & Spruce
Wing ..... Balsa, Ply & Spruce
Empennage ..... Balsa
Wt. Ready To Fly ..... 40-48 Oz.
(2 Lbs. 8 Oz. - 3 Lbs.)
Wing Loading ..... 12.5-15 Oz./Sq. Ft.

Cut out the backing plates, also of 3/32" balsa and glue these on. Finally glue a strip (scrap) along the top of each backing plate. This will provide a larger edge for gluing the top of the fuselage.

Now glue all 1/8" square stringers to the fuselage. The vertical ones will later adhere to the firewall.

Cut the wing saddles (two per side) from 1/4" balsa and glue in place. These should now be capped with 1/64" ply for hardness. Cut eight (four per side) servo rail braces to length. These should be 1/8" by 3/8" spruce or ply. Glue these in place. Cut out and glue balsa strips (from scrap) in position forward of the servo rails. These will later hold a shelf for the battery pack and fuel tank.

Now cut two strips (one per side) of scrap balsa and glue in place behind servo rail braces. These will later adhere the pushrod holding plate. Now glue in the balsa braces toward the rear of the fuselage.

Cut out the rear top and bottom fuselage sections from 3/32" balsa. Cut out and glue on all spruce and balsa cross braces. The top section must also have a balsa plate installed toward the rear, where the pushrods will exit.

Now cut out the lower front fuselage section from 3/32" balsa. Cut out and glue a 1/32" ply doubler to this section. The top hatch is made the same way but will later be cut to fit around the engine. This piece does not have to be doubled with ply, but if you choose to use only balsa, use 1/8" hard stuff.

Cut the engine plate mounting rails to length from 1/2" by 3/8" maple. If you are using a .15 engine, bevel the rails to provide a couple of degrees downthrust. A slight amount of downthrust may be used with an .09

Top wing and hatch removed to show radio installation, fuel tank, and engine.

Materials Needed

3 — 1/32" x 2" x 36" balsa — wing sheeting
2 — 1/16" x 4" x 36" balsa — wing formers (2 from scrap)
3 — 1/8" x 36" hardwood dowels — wing leading edge and wing hold-downs
2 — 3/32" x 36" balsa — fuselage
6 — 36" x 1/8" sq. spruce — wing spars and fuselage stringers
1 — 1/8" x 3/8" x 12" spruce — servo rail braces
1 — 1/32" x 6" x 48" spruce ply — fuselage doublers and dihedral brace
1 — 3/16" x 3" x 36" balsa — tail surfaces
1 — 1/8" x 6" x 12" spruce ply — firewall engine plate and servo rails
1 — 1/2" x 3/8" x 12" maple — engine plate rails
1 — 1/8" x 36" music wire — main landing gear

Hardware Needed

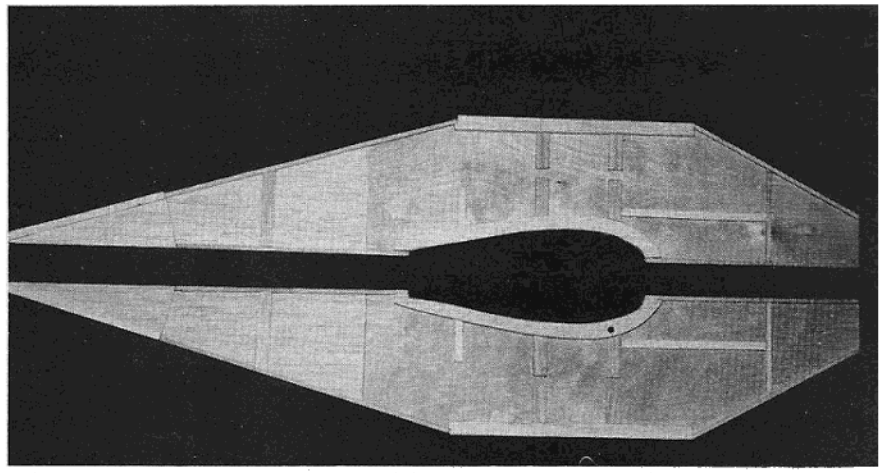
1 — pack NyRod
1 — 1/8" or 3/32" nose gear assembly
2 — 2¼" wheels
1 — 2" wheel
1 — 2 meter roll covering material (if only one color desired)
1 — 2 oz. bottle dope — engine compartment
1 — 36" roll of 3/8" wing cushion tape
2 — angle hold-downs — hatch
10 — mini snaps
4 — 1/8" wheel collars
2 — 3/32" wheel collars
7 — small pin hinges
3 — 1/2A control horns
4 — landing gear straps
1 — 2 oz. fuel tank
4 — wood screws — engine plate rails
4 — 4-40 3/4" socket head screws and blind nuts — engine plate
1 — box #64 rubber bands — wing hold-down

but is not absolutely necessary. Cut the proper lengths of 1/8" by 1/4" maple or ply and glue these to the bottom of the engine plate rails, leaving room for the 1/8" fuselage stringers. Now glue these units to the fuselage sides.

Cut out the firewall from 1/8" ply and drill holes for the pushrod and fuel lines. Also drill the holes for the nose gear mounting plate screws. If you are using blind nuts, install them at this time. The fuselage is now ready to be assembled.

Glue the firewall to one side of the fuselage with epoxy. Before this sets, glue the other fuselage side to the firewall. Now glue on the front bottom panel and the top and bottom rear panels. Trim the trailing edge of the rear fuselage panels as necessary. The trailing edge of the fuselage is angled in on both sides to allow for rudder movement. Trim these as necessary and cover the triangular holes in the fuselage sides with 1/32" scrap balsa. Trim to fit.

Now apply wing cushion tape to the top and bottom wing saddles (must be removed for covering). Set the wings in place and check for proper fit. Glue in scrap cross pieces to fill any gaps between the wings and the fuselage.



Inside view of fuselage sides showing braces, stringers, doublers, and wing saddles.

Cut the servo rails to length from 1/2" by 3/8" spruce or ply and glue in place.

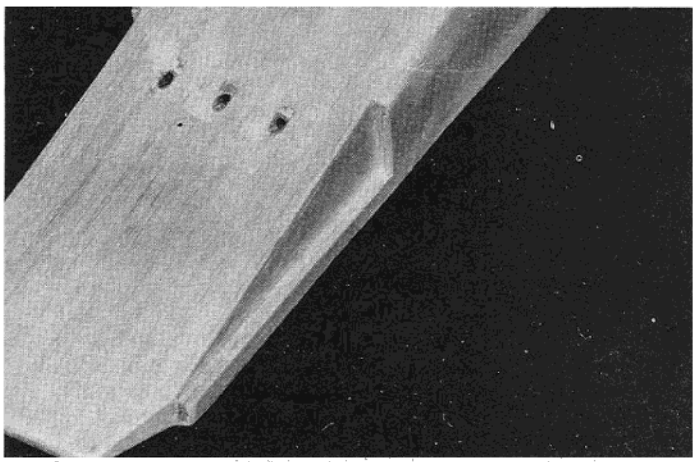
Cut out the engine mounting plate to fit your engine. The engine cut-out should be one or two degrees to the right, depending on the engine size. This is not absolutely necessary with an .09 but is a **must** with a good .15.

Set the engine and engine plate in position in the fuselage. Make a cut-out in the hatch to clear the engine. Make a cut-out in the fuselage side to allow the muffler to exit.

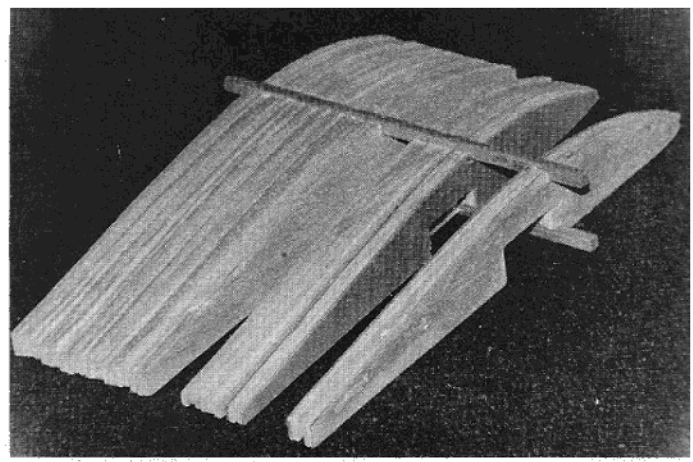
Now glue on a balsa nose plate. This must be cut to clear the prop shaft.

Cut the 3/16" hardwood wing hold-down dowels to length, and drill the fuselage to accept them. (Do not glue in until after covering fuselage.)

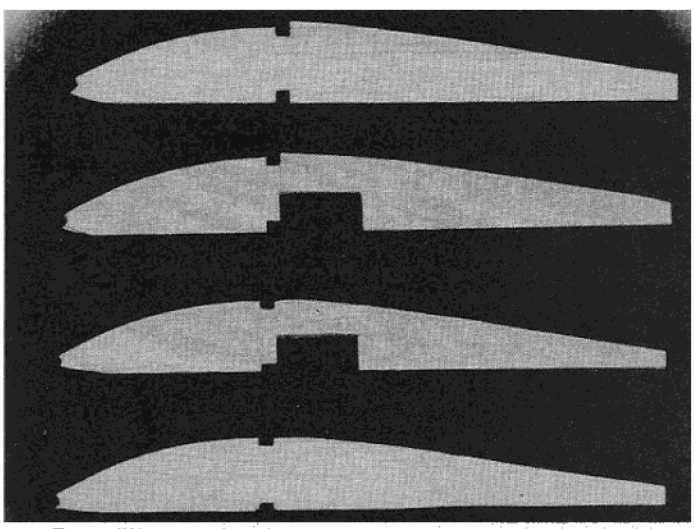
Cut the pushrod plate from 3/32" balsa and glue in place. Use scrap piece to secure the throttle pushrod.



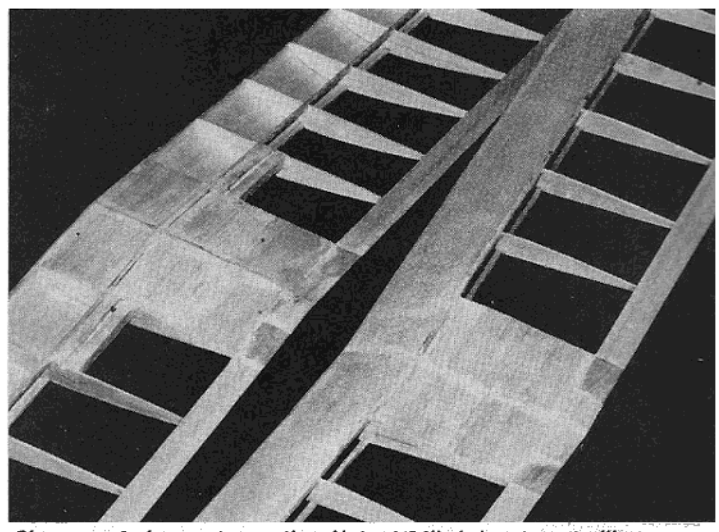
Trailing edge of fuselage showing NyRod exits and area countersunk to accept vertical stab.



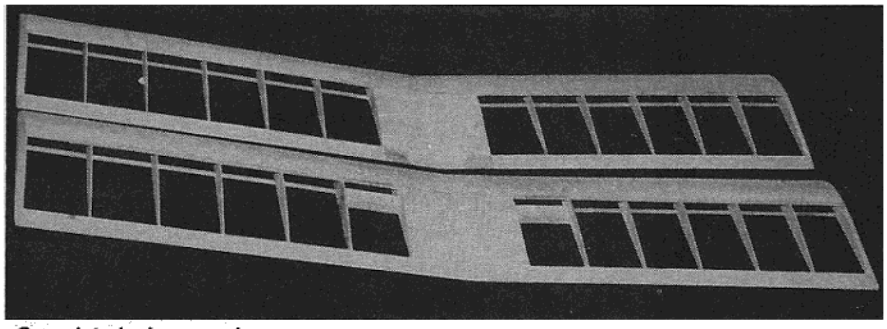
Wing ribs stacked together for final sanding.



Four different wing formers. Note: Ply doublers on formers notched to hold landing gear blocks.



Close-up of wing center section. Note: 1/64" ply insets on trailing edge to prevent rubber band damage to balsa.



Completed wing panels.

Glue in the outer NyRods and sand flush with the fuselage.

Round all edges on the fuselage (except for hatch area and countersunk vertical stab area) and sand smooth.

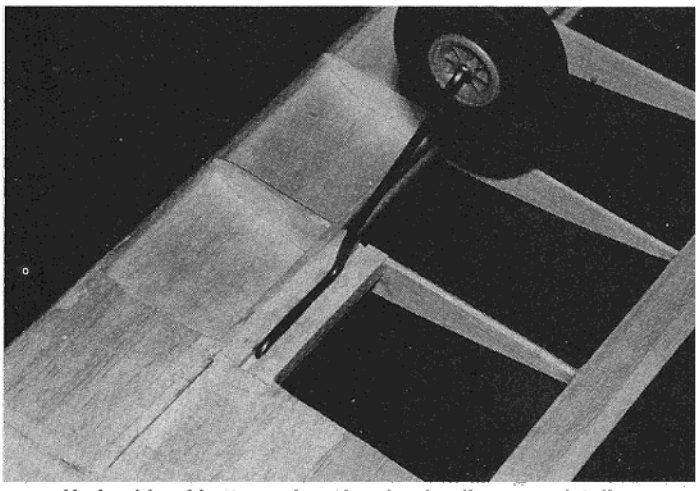
on the top and bottom in the notches. This will ensure perfect alignment while sanding.

Make sure to have the forward top portion in front of the spar of the formers cut down to accept the 1/32"

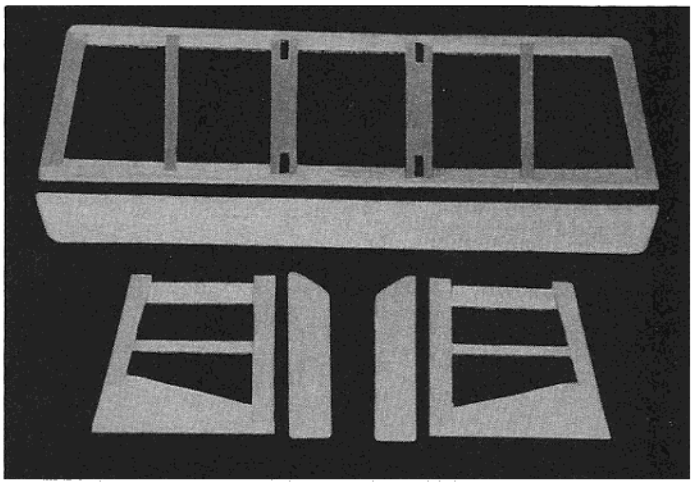
the landing gear blocks. Now double two regular formers (on opposite sides) with 1/32" ply and cut insets for the landing gear blocks. Sand smooth.

Next, cut four 1/8" dowels to 17½" length, four 1/8" square spruce spars to 17½" length, four 1/8" spruce spars to 17-7/16" length and four 3/16" by 3/4" trailing edge stock to 17½" length.

You can either build over the plans or in the air, so to speak. I prefer the air method (it saves the plans). Mark 2½" increments on four longer wing spars. Place one of these on a flat surface and glue the formers in their appropriate places over the marks. Make sure the inside end former is canted in slightly for dihedral. Now glue in the top spar and adjust the inside end former to match up with the



Underside of bottom wing showing landing gear detail.



Tail surfaces.

Wings:

Begin by making a plywood template of the wing formers (32). Place the template down on 1/16" balsa and trace around it with a modeler's knife. Then finish cutting them out. Place all formers together and sand evenly. A nice way to do this is by placing 1/8" square spruce strips

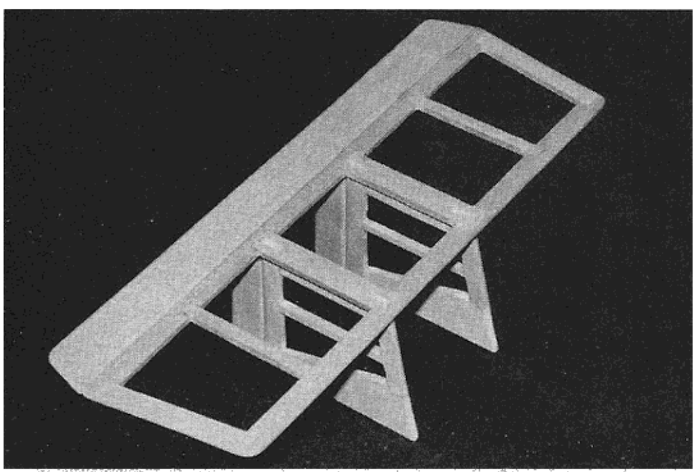
sheeting. Check this by placing the sheeting you're using (thickness may vary) on top of the formers. Make sure the sheeting and spar are flush.

Cut eight of the formers to specifications to accept the center sheeting. Two of these must be doubled with 1/32" ply (on opposite sides) and insets cut in them to accept

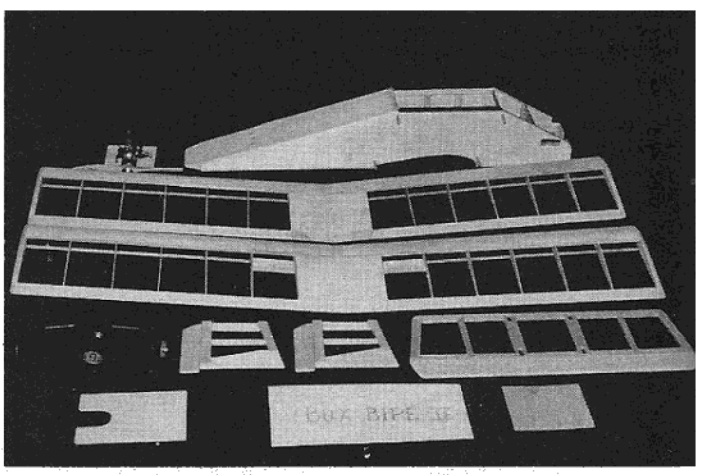
top spar. This will give you the correct dihedral angle.

Now glue on the leading edge dowel and trailing edge, being sure to keep the wing panel square. Make sure that the two inside end formers are glued to the trailing edge leaving room on the top and bottom for sheeting.

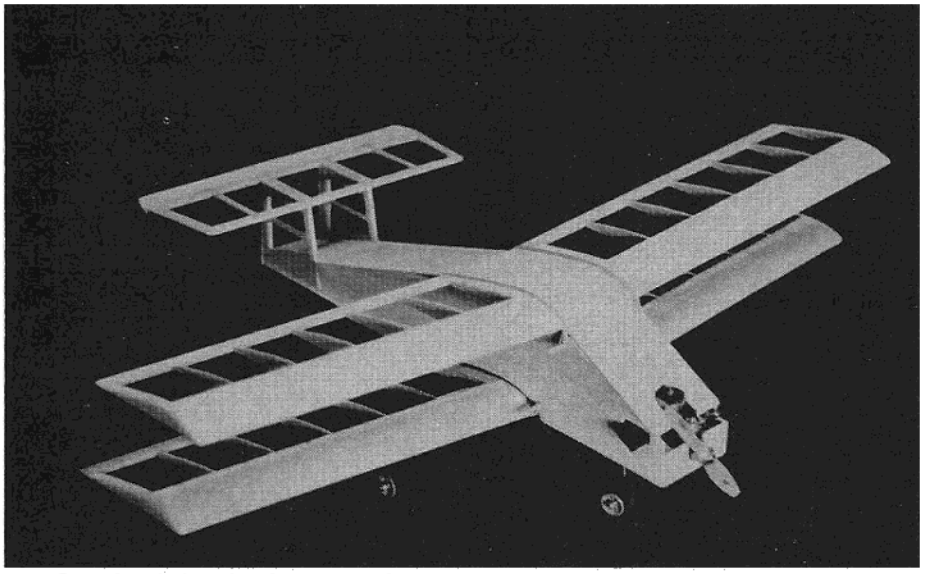
The only difference between the top



Tail surfaces placed together for trial fit. Do not glue together until after covering.



Completed aircraft parts.



Completed aircraft prior to covering.

and bottom wings is the landing gear blocks and the ply doubled formers that hold them. Cut the landing gear blocks to the proper length and glue them in. Cut the dihedral braces from 1/32" ply. The wing halves can now be joined.

First, make a cut on each inside end former to accept the 1/32" ply dihedral brace. Place the wing halves together on a flat surface with each tip raised 1½". Now put in the dihedral brace by first gluing one side to the spruce spars. Now spread glue on all surfaces that will meet (slow setting glue will give you time to make adjustments). Push the halves together and clamp. Fill all gaps with scrap balsa and glue.

When dry, sheet the top and bottom center sections and outside top forward sections with 1/32" balsa and glue on the wing tips. Apply wood filler to all rough areas, dings, imperfect joints, etc. Now sand the wings to a smooth finish, leaving no sharp edges.

Tail Section:

Cut out all parts of horizontal stabilizer from 3/16" balsa and assemble. Be sure the trailing edge is straight so the elevator will match up well. Shave it if necessary. Fill all gaps with wood filler and sand smooth. Round all outside edges with the exception of the trailing edge.

Cut out the vertical stabilizer parts from 3/16" balsa and assemble. Place both vertical stabilizers together and make sure they are identical. Fill all gaps with wood filler and sand smooth. Round the leading edge and top.

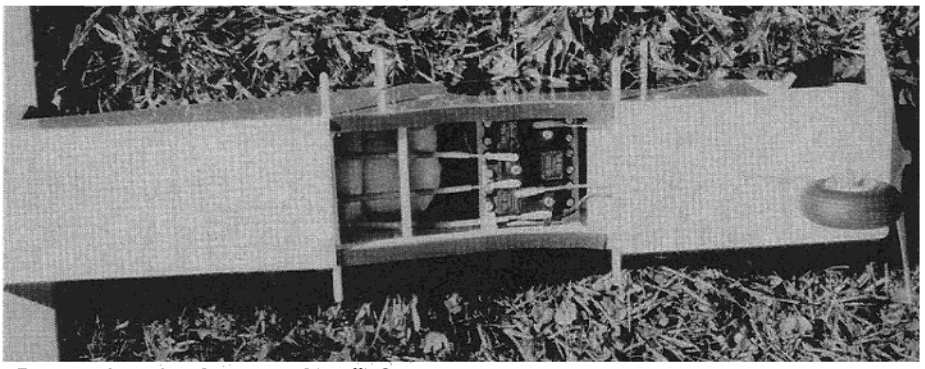
Now, cut out the elevator and rudders (2) from 3/16" balsa. Round all edges again with the exception of the hinged edge. Make sure they match nicely with their respective counterparts. If necessary, shave to fit.

Covering:

Any of the conventional covering materials may be used. On both of my prototypes I used an "economy" mylar and was very pleased with the results.

Cover the wings, fuselage, and hatch as you ordinarily would. I prefer to dope the nose area (ahead of the firewall) to prevent fuel seepage from softening the balsa. All of the engine and radio compartments must be fuelproofed. I also used dope on these areas as well as the wing hold-down dowels.

Cover the horizontal and vertical stabilizers except for surfaces that will later be glued. Cover the elevator and rudders. Fasten the elevator and rudders to their counterparts with small pin hinges and install the control horns.



Bottom view showing servo installation.

Final Assembly:

Glue the horizontal stabilizer to the vertical stabs. The tabs and notches should assure alignment but double check to be safe. Now place this unit on the fuselage. Check for alignment and then glue in place. Cover all seams with strips of covering material for a nice smooth finish.

Install the fastening system to the hatch and glue in the wing hold-down dowels. Mount the nose and main landing gear and adjust for alignment.

Fasten down the engine and engine plate. Position the battery pack and fuel tank on the removable shelf and hook up the fuel lines. Mount the servos in the fuselage (inverted) and connect the pushrods. Note that the rudder servo operates two pushrods (refer to plans). Place the receiver behind the servos. Use six #64 rubber bands to secure each wing.

Check the aircraft for balance and adjust by moving the battery pack and/or receiver.

Double check everything and you're ready to fly.

Flying:

Be sure to test glide and trim your aircraft before flying it. This will help ensure a successful first flight. I have a method of testing aircraft that I have used for years. This consists of three steps. Use this procedure in high weeds if possible.

First, hand launch the aircraft by giving it a good, hard, straight, forward thrust. The aircraft should travel out and gradually down. If it glides out and stalls or noses up, it is tail heavy. If it noses down too quickly, it is nose heavy. Change the balance if necessary and repeat the procedure. Now go to Step 2.

If possible, have a friend hand launch the craft as before, but this time have your radio turned on and watch the plane as you gently move the controls up, down, left and right. Try this several times until you are sure the plane is responding properly. Proceed with Step 3.

Start the engine and throttle it just a little above idle (be sure to have your radio turned on). Have your friend hand launch the plane just like in Step 2. By having the engine idling, your plane will stay airborne a little longer. This will allow more time to check responsiveness and get a feel for the plane. With this particular plane be sure not to use too much throttle at this point. I did and my plane went soaring to the heavens. It doesn't take much power to pull this little craft.

If all has gone well up to this point then proceed with a normal powered flight. If using a .15 engine be sure not to use more than about 3/4 throttle until well in the sky. At full throttle this little ship tends to torque over. This can easily be controlled once you

are familiar with the aircraft. If you are using a .09 this problem should not be significant enough to worry about.

A strong .15 engine is a lot for this plane but once you have mastered it, it is also a lot of fun.

This plane will rise and fall slightly with variations in throttle. This is due primarily to the flat bottom airfoils and a high lift potential. Unless you are using a .15 with a lot of throttle, compensation can be made with minor elevator travel. With a hot .15 and a lot of throttle you will need to compensate a little more but still not nearly enough to cause you to add more elevator travel.

Please do not add any more elevator or rudder travel than indicated on the plans until you are thoroughly familiar with the plane. Believe me, there is plenty already. This aircraft is inherently very aerobatic and too much control surface movement could result in disaster.

Follow the procedure and keep the throttle down on the first few flights and you shouldn't have any major problems.

On a calm day or when flying into a headwind, I like to throttle back and feed in a lot of up elevator. The tail will drop and the plane will darn near hover. By gradually adding throttle and elevator you can slow it down even more. I have flown mine backwards in a 10 mph headwind. Don't be afraid to try this. Just make sure you have enough altitude to be safe.

You will be amazed at how stable this plane really is. Flying at very slow speed does not present any problem. But do be careful on windy days. This one gets a little tricky in winds much beyond 15 mph.

Loops, rolls and inverted flying present no problems either and controllability is amazing for a 3 channel aircraft.

Keep in mind that at low throttle settings this is a fairly docile ship, but at 3/4 to full throttle it is a whole different ball game. It can really be a handful.

When thoroughly familiar with the aircraft, the balance point may be moved rearward approximately 1/4". This will add to maneuverability but reduce stability. The reduction in stability can be partially offset by "warping" each wing tip slightly down. This will help prevent tip stalling and can be accomplished with a covering iron. Lay each wing section flat on a table leaving 4"-6" of the wing sticking over the edge. Have a friend hold the wing half flush on the table. Twist the wing near the tip so the leading edge is slightly down. Take out the wrinkles in the covering material with an iron. This will "lock in" the warp (wash out).

Hand launching this plane is not absolutely necessary. For a small plane, this one takes off from rough fields easily. This is due partly because of the wide spread on the landing gear but mostly because it lifts so quickly (less time on the ground).

When landing be sure to keep some power on and keep the nose high. This will keep the plane from nosing over on the runway.

Larger wheels can be used for rougher fields but be sure this change does not throw the craft out of balance.

Well, I hope you enjoy this little wonder as much as I have. Happy flying!

□

From RCModeler May 1987