Push-To-Test

By Tom Prescott

I have designed a number of pusher configured model aircraft. The Push-To-Test model was conceived to accomplish several goals. First, all of the pusher designs that I have modeled have been scaled full-scale designs or for competition. I just wanted to design a pusher model aircraft to fly for fun and demonstration. Second, I am conducting a pusher propeller development program and wanted an aircraft to use for these tests. To accomplish a realistic propeller development program, there needs to be a platform that can provide feedback on how well the new propeller's configuration's performance compares to baseline performance. To supply this platform, I designed a .90-1.08 2-stroke/1.20 4-stroke model that can incorporate a data downlink system which provides the needed feedback. The data downlink system is the subject of a previous article (RCM March 1997).

Finished Push-To-Test.

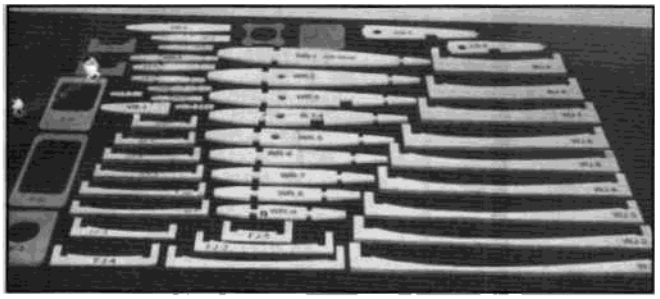
The design of the Push-To-Test is based somewhat on the Pattern Pusher, the subject of a previous article (Plan No. 1043), with increased wing area and an uncowled engine. It incorporates, like my other pusher designs, the use of a propeller extension which moves the engine's C.G. as far forward as possible. To keep it simple and light, a fixed landing gear was chosen. However, it can be built with retracts. As with any of these pusher/rear engine configurations, the builder must understand the requirement for lead ballast to obtain a proper C.G. location.

CONSTRUCTION

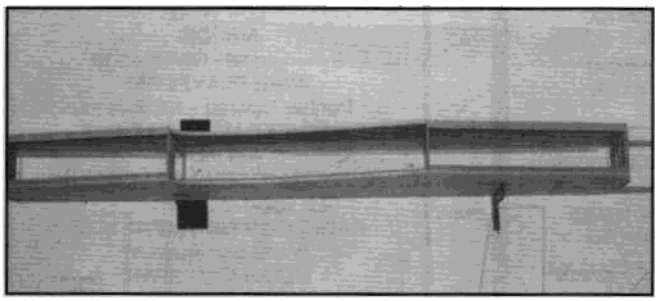
Fuselage:

Glue F-1A to F-1. Temporarily install the engine mount and secure T-nuts for mounting the engine. Mount the nose wheel steering bracket F-4. Temporarily mount the ballast boom and install T-nuts for later installation.

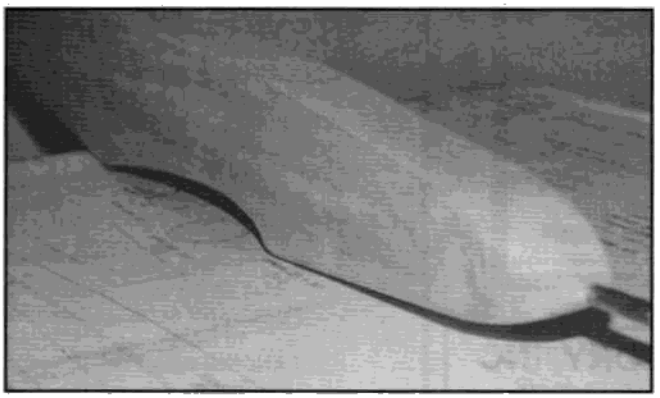
Make two each fuselage sides. The blank can be made from 1/4" x 4" x 48" balsa sheet and a 1/4" x 3" x 48" balsa sheet glued together. The top rear straight section should be used as the reference. Cut the sides from these blanks. Mark the locations for the bulkheads and glue in place the 1/4" triangle balsa stock and 1/16" plywood doubler. When dry, glue to the right side F-1, F-2, F-3, and F-4. Make sure the bulkheads are square with the side. After the bulkheads dry, glue in place the left-hand fuselage side. Next, glue to the bottom of the fuselage the aft lower 1/4" balsa sheeting. Glue in place the 3/32" balsa cross-grain above and aft of the fire wall F-1. When dry, use thinned epoxy to coat the area of the inside of the fuselage forward of F-1. Mix epoxy and cut fiberglass fibers to make a paste to secure the corners of the fire wall F-1. Glue on the fuselage the 1/4" top sheeting and the 3/8" balsa forward bottom sheeting. Next, rough



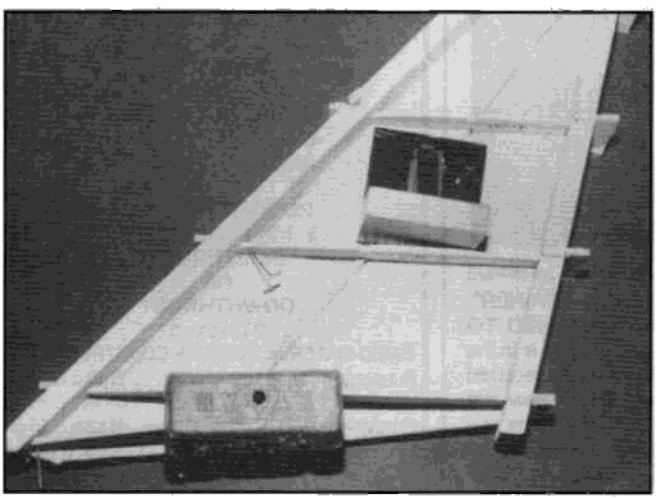
Parts and jigs.



Joined fuselage sides.



Completed fuselage.

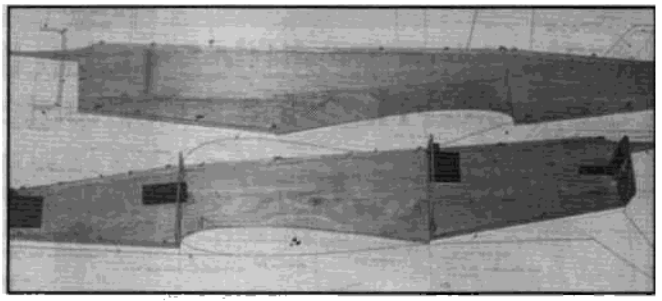


Vertical fin initial lay-up.

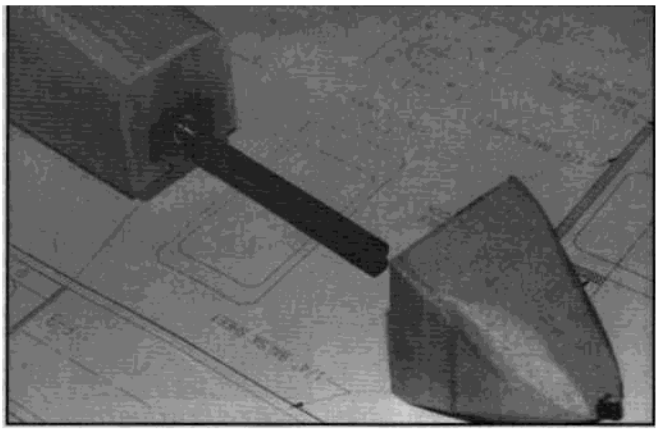
shape the balsa nose block and drill a 5/8" hole to accept the ballast boom. Tack-glue the nose block in place while final sanding the fuselage. Glue in place the hardwood wing mounting blocks and the 1/8" plywood support. Set the fuselage assembly aside until later.

Vertical Fin:

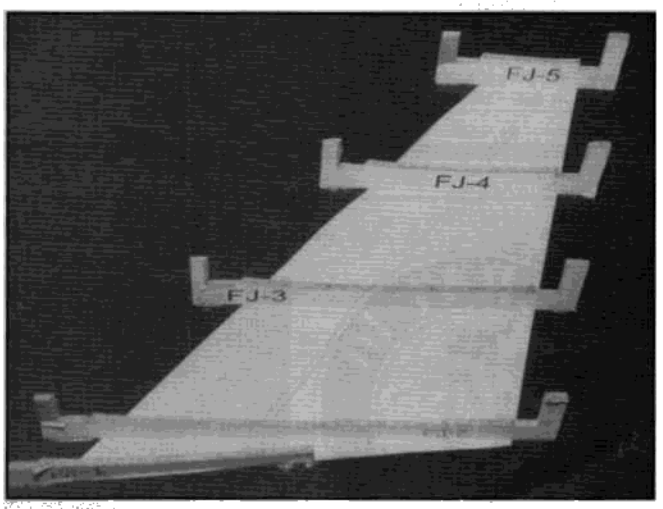
Cut out the vertical fin planform from the plans. Use this to cut the 1/16" balsa fin sheeting to shape and lay over a flat building surface to properly align the jig. Glue into place the vertical fin jigs on the building board. Trial-fit the leading and trailing edge pieces



Fuselage sides and bulkhead installation.



Nose block and ballast boom.



Vertical fin jigs.

and the right-hand skin in the jigs. The ribs need to be beveled at the leading edge and trailing edge to properly fit in the jig. Trial-fit all ribs. Note: The following steps are continuous and must be completed before the glue has time to dry. Place glue on the leading and trailing edge of the right-hand skin. Install in jig. Next glue in place the bottom 1/8" square spar. Glue in place VR-2 and VR-5. Glue in place VR-1, VR-3, and VR-4. Weight and pin the assembly as required to secure the components in the jig. When the assembly is dry, glue in place the top 1/8" spar and the left skin. When dry, remove the assembly from the jig and install the balsa tip. The vertical fin can now be sanded to its final shape. Set the assembly aside for now.

Horizontal Stabilizer:

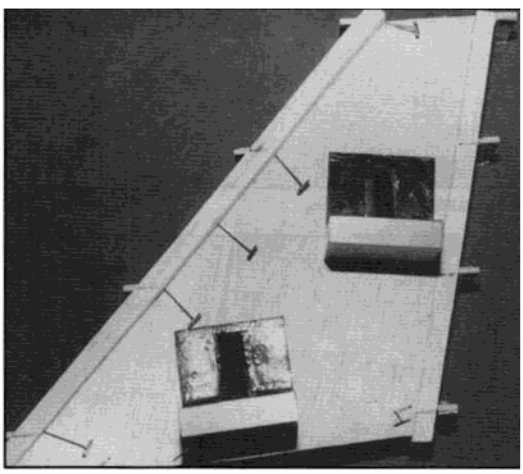
Cut out the horizontal stabilizer planform from the plans. Use this to cut the 1/16" balsa horizontal stabilizer sheeting to shape and lay over a flat building surface to properly align the jigs. Glue into place the jigs on the building board. Trial-fit the leading and trailing edge pieces and the bottom skins in the jig. The ribs need to be beveled at the leading edge and trailing edge to properly fit in the jig. Trial fit all ribs. Note: The following steps are continuous and must be completed before the glue has time to dry. Place glue on the

leading and trailing edge of the bottom skins. Install in jig. Next, glue in place the bottom 1/8" x 1/4" balsa forward spars and the 1/8" square rear spars. Glue in place HR-1 and HR-6. Glue in place HR-2, HR-3, HR-4, and HR-5. Weight and pin the assembly as required to secure the components in the jig. When the assembly is dry, glue in place the top spars and the top skins. When dry, remove the assembly from the jig and install the balsa tips. Epoxy the 1" fiberglass cloth on the top and bottom of the center section. The horizontal stabilizer can now be sanded to its final shape. Set the assembly aside for now.

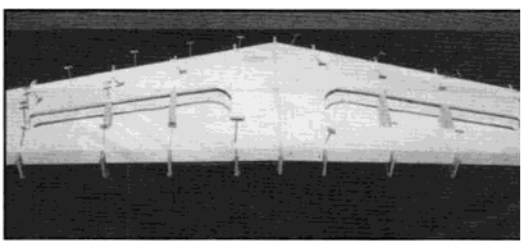
Wing:

Glue LG-1 and LG-2 to their appropriate ribs. Remember to make a right and left-hand set.

Cut out the wing planform from the plans. Use this to cut the 3/32" balsa wing sheeting to shape and lay over a flat building surface to properly align the jigs. Glue into place the wing jigs on the building board. Trial-fit the leading and trailing edge pieces, the bottom skins, the landing gear blocks, WR-2, WR-3, WR-4, and the balsa filler blocks in the jig. The ribs need to be beveled at the leading edge and trailing edge to properly fit in the jig. Trial-fit all ribs. Note: The following steps are continuous and must be completed before the glue has time to dry. Place glue on the leading and trailing edges of the bottom skins. Install in jig. Next, glue in place the bottom 3/8" square front spars, the bottom 1/4" square aft spars, and the landing gear blocks. Glue in place WR-1 and WR-9. Glue in place WR-2 through WR-8 and the balsa fillers. Weight and pin the assembly as required to secure the components in the jig. Glue in place the landing gear vertical support block. Glue in place the 3/32" balsa vertical sheer webs from WR-1 to WR-5. When the assembly is dry, glue in place the top spars and the top skins. Glue the 3/32" x 1/4" top rib caps on WR-4 through WR-7. When the assembly is dry, remove from the jig and install the balsa tip. Note: The balsa tips should be hollowed as much as practical. Glue in position the center section balsa trailing edges. Glue



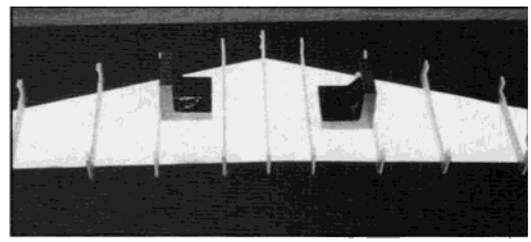
Vertical fin left side installed.



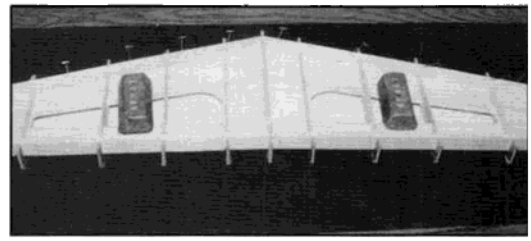
Finished horizontal in jig.

PUSH-TO-TEST

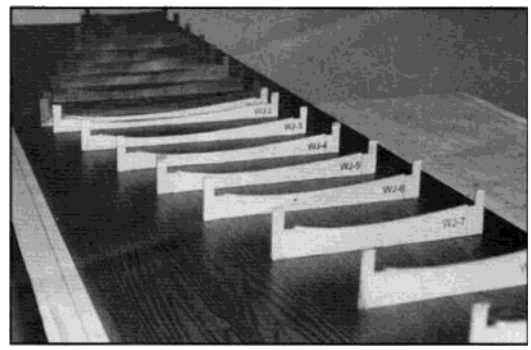
Designed by:
Tom Prescott
TYPE AIRCRAFT
Sport Pusher
WINGSPAN
74 Inches
WING CHORD
12-3/4 Inches (Avg.)
TOTAL WING AREA
947 Sq. In.
WING LOCATION
Low Wing
AIRFOIL
Symmetrical - Own Design
WING PLANFORM
Double Tapered - 10° Sweep
DIHEDRAL, EACH TIP
1-1/4 Inches
OVERALL FUSELAGE LENGTH
55-1/2 Inches
RADIO COMPARTMENT SIZE
Ample and Forward
STABILIZER SPAN
28 Inches
STABILIZER CHORD (inc. elev.)
7 Inches (Avg.)
STABILIZER AREA
196 Sq. In.
STAB AIRFOIL SECTION
Symmetrical
STABILIZER LOCATION
Top of Fuselage (1-1/2° Incidence)
VERTICAL FIN HEIGHT
8-1/2 Inches
VERTICAL FIN WIDTH (inc. rud.)
8 Inches (Avg.)
REC. ENGINE SIZE
.91-1.08 Cu. In.
FUEL TANK SIZE
16 Oz.
LANDING GEAR
Tricycle
REC. NO. OF CHANNELS
5
CONTROL FUNCTIONS
Ail., Elev., Rud., Throt., Mix
C.G. (from L.E.)
5-5/8" to 6-1/2" (at Fuselage)
ELEVATOR THROWS
1/2" Up — 1/2" Down
AILERON THROWS
5/8" Up — 1/2" Down
RUDDER THROWS
1-1/2" Right and Left
SIDETHRUST
NA
DOWNTHRUST
2 Degrees
BASIC MATERIALS USED IN CONSTRUCTION
Fuselage ..... Balsa & Ply
Wing ..... Balsa & Ply
Empennage ..... Balsa & Ply
Wt. Ready To Fly .184 Oz. (11 Lbs. 8 Oz.)
Wing Loading ..... 28 Oz./Sq. Ft.



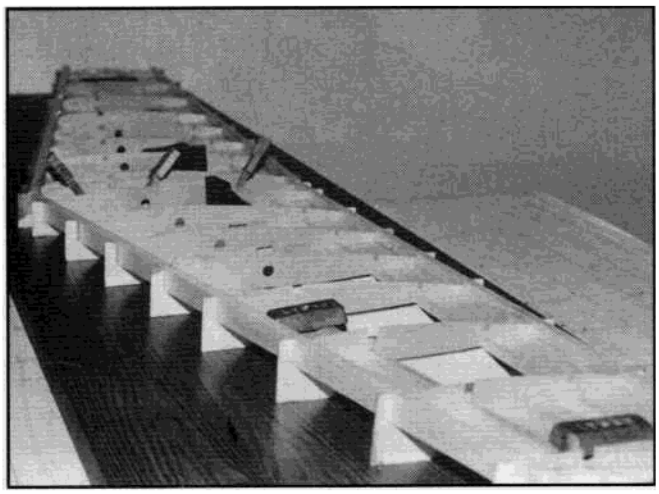
Horizontal jigs.



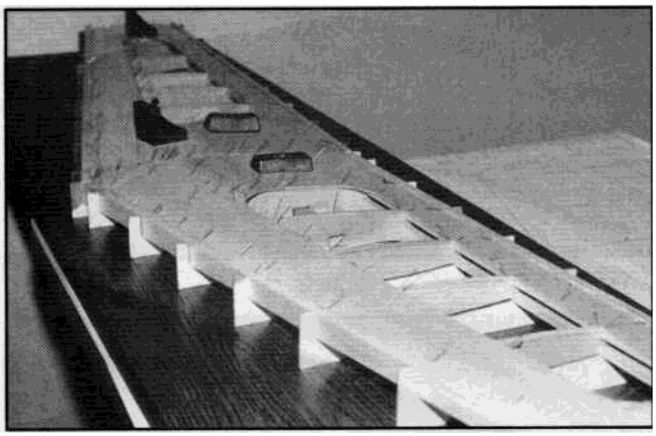
Horizontal initial lay-up.



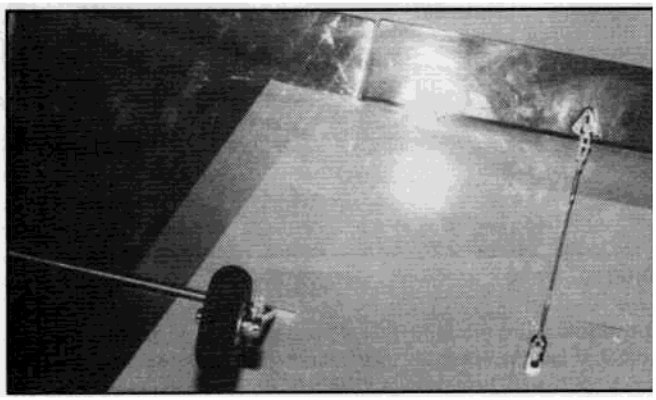
Wing jig layout.



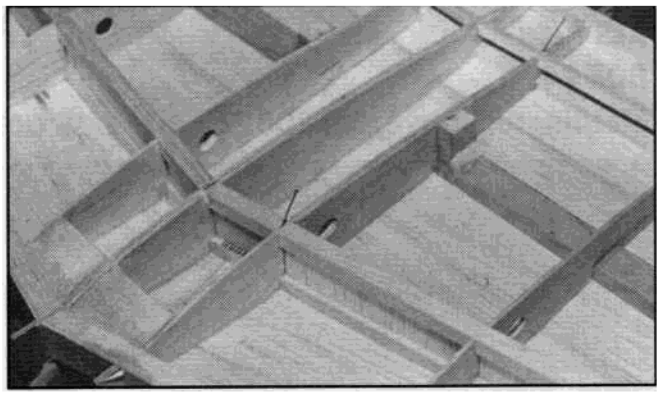
Wing initial lay-up.



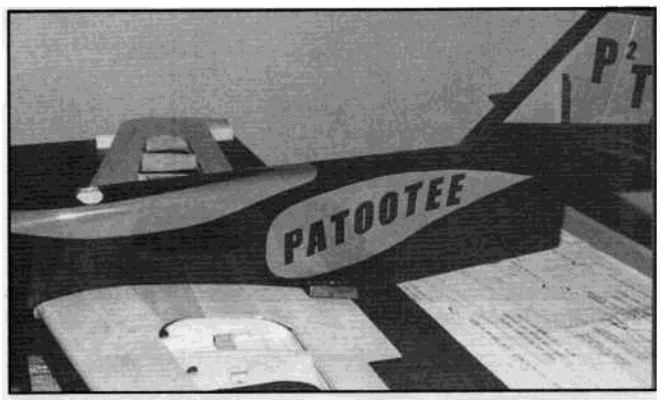
Finished wing in jig.



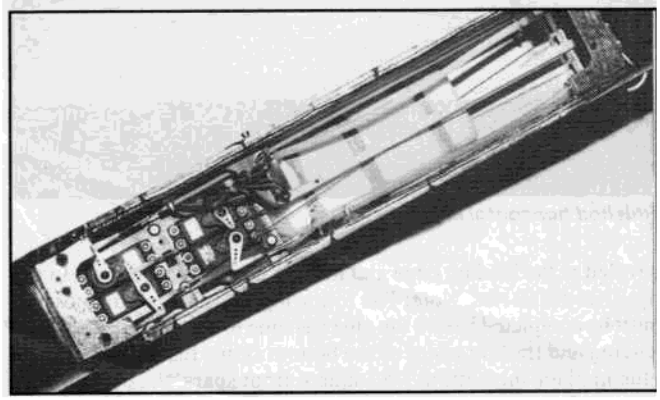
Aileron servo/landing gear detail.



Landing gear blocks detail.

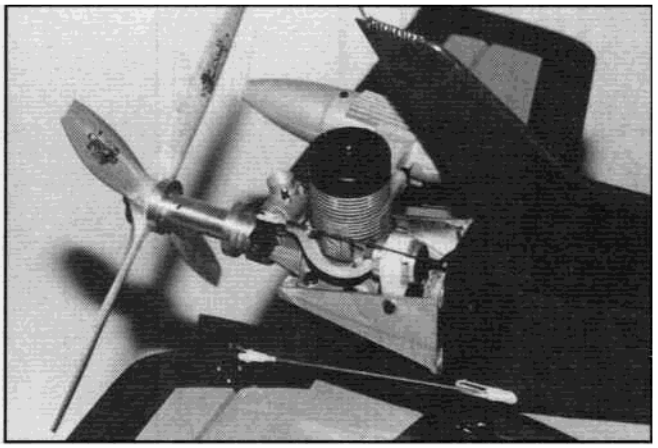


Empennage installation.

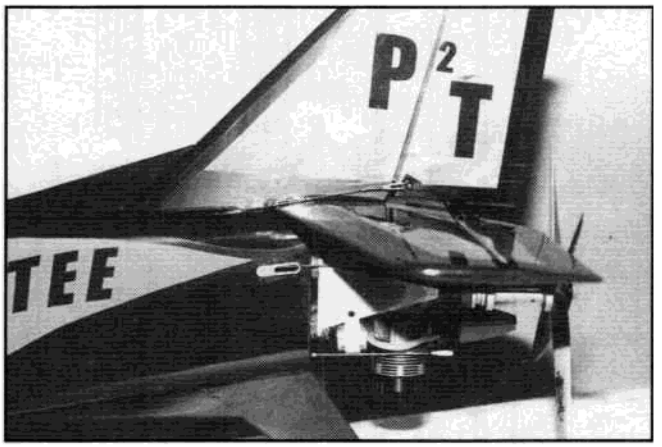


Radio and tank installation.

into position the 3/32" balsa sheeting between WR-5 and WR-6 on the bottom. Glue a 3/32" x 1/4" bottom capstrip on WR-7. Glue in place the 1/8" plywood servo mounting plate and spruce support between ribs WR-5 and WR-6. Cut out a rectangular hatch in the



ASP 1.08 installation with propeller extension.



Empennage of finished Push-To-Test.

3/32" balsa skin between these ribs and install a 3/32" lite plywood hatch support which allows the hatch to be secured with No. 2 machine screws. Trial-fit the wing to the fuselage and face off the center section between ribs WR-2. Sand the wing structure to final shape. Epoxy the top and bottom center section with 3" fiberglass tape.

To mount the wing to the fuselage, check to make sure it is square and centered and drill in place the leading edge and trailing edge vertical 1/8" locating dowels. These dowels ensure that the wing is properly located each time the wing is installed. Glue in place the balsa filler at the leading edge of the wing where it mates with the fuselage. Next, mark and locate the four wing mounting screw locations and drill undersize. Remove the wing and tap the hardwood mounts with 1/4"-20 threads. Harden the threads with a coating of cyanoacrylate glue. Drill the wing holes to size.

Fuselage Final Assembly:

Mark the center section of the horizontal stabilizer where it will glue to the fuselage and repeat the same where the vertical fin will attach and then Super MonoKote these two components as desired.

With the wing mounted in place, trial-fit the horizontal stabilizer on the fuselage. When you are satisfied that the horizontal stabilizer is properly aligned, epoxy in place. Install the Super MonoKoted elevators with hinges and seal the gaps with a 1/4" strip of Super MonoKote. To secure the seal, run a bead of cyanoacrylate along both sides where attached.

Super MonoKote the vertical fin as desired. Trial-fit the vertical fin to the fuselage and, when satisfied with its proper alignment, epoxy in place. Glue in place the Super MonoKoted 1/4" balsa dorsal fin. Install the Super MonoKoted rudder with hinges. Note: Cut lightening holes in the rudder to reduce its weight.

Properly align and glue into position the Super MonoKoted ventral and sub fins. Insert the 3/32" music wire skid and sew permanently in place with nylon thread.

Super MonoKote the nose block. Install the ballast boom and epoxy the nose block in place (remember to hollow the nose block as much as possible. Lead shot can be inserted as ballast when the model is finished.) This completes the assembly of the model. Finish the remainder of the model as desired. Note: Do not forget to seal the gap on the ailerons using the same procedures as described for the elevators. Install a canopy to suite. Install the radio, making sure the battery and receiver are located as far forward as possible. Install the landing gear. Mount the engine and locate the fuel tank at the C.G. When the model is completely finished, check the Center of Gravity to make sure it is forward of the location shown on the plans.

The prototype completely finished with an ASP 1.08 engine installed weighed in at just 8-3/4 pounds. As previously mentioned, you cannot be afraid of lead ballast. It took almost 3 pounds to bring the C.G. within proper limits. All in all, at just under 13 pounds, a model with 945 square inches of wing area is not that bad.

Flying:

One of the goals when the Push-To-Test was conceived was to explore the flight envelope of the pusher configuration. Some common characteristics have become apparent with similar pusher designs that the Push-To-Test represents. Because of the pitch down moment developed by the engine thrust line location, they tend to stick to the runway until both flying speed and adequate elevator control force is present. An early attempt to lift off will result in a noticeable leap into the air that will startle the first time it occurs. Smooth lift-offs are easily obtainable with adequate airspeed and control. If you think about it, this is also true of many other aircraft configurations as well. Once flying, the configuration is very stable, particularly with the addition of power. There is some noticeable pitch change with power but not excessive and certainly controllable.

The Push-To-Test rolls nicely and requires very little down elevator for inverted flight. The rudder, which is quite effective, is offset considerably from the aircraft centerline and provides more than desirable roll-yaw coupling. Good knife-edge flight characteristics could only be achieved with the addition of a second rudder under the fuselage centerline. Not a design goal for this aircraft. Stall spin characteristics are normal with a slight pitch down at the stall. Recovery is hands-off.

Landings are a breeze where a little power on final keeps things very smooth. A bounced landing is best followed by a full-power go-around. Remember power makes this airplane groove.

I have flown with 14 x 6, 14 x 8, and 12 x 6 four-bladed propellers. The 14 x 8 is best all around for the 1.08 engine. The four-bladed prop really sounds different, offers better ground clearance (ground clearance is not a problem with the 14" props), and provides reasonable performance.

Conclusions:

The Push-To-Test is a fun aircraft to build and fly if you are the least bit curious about pushers. It attracts a lot of attention on the ground, makes a most unusual sound in the air, and is a show stopper just because it is so unique. As an afterthought, I wished I had installed retracts. But, the goal of the design was to keep it simple.

I should have known better, but did not design in negative incidence in the stab. Consequently, the prototype requires up elevator. I have modified the plans to reflect 1-1/2° of horizontal stabilizer incidence. No other changes to the design are required. Hope to see you pushin'!