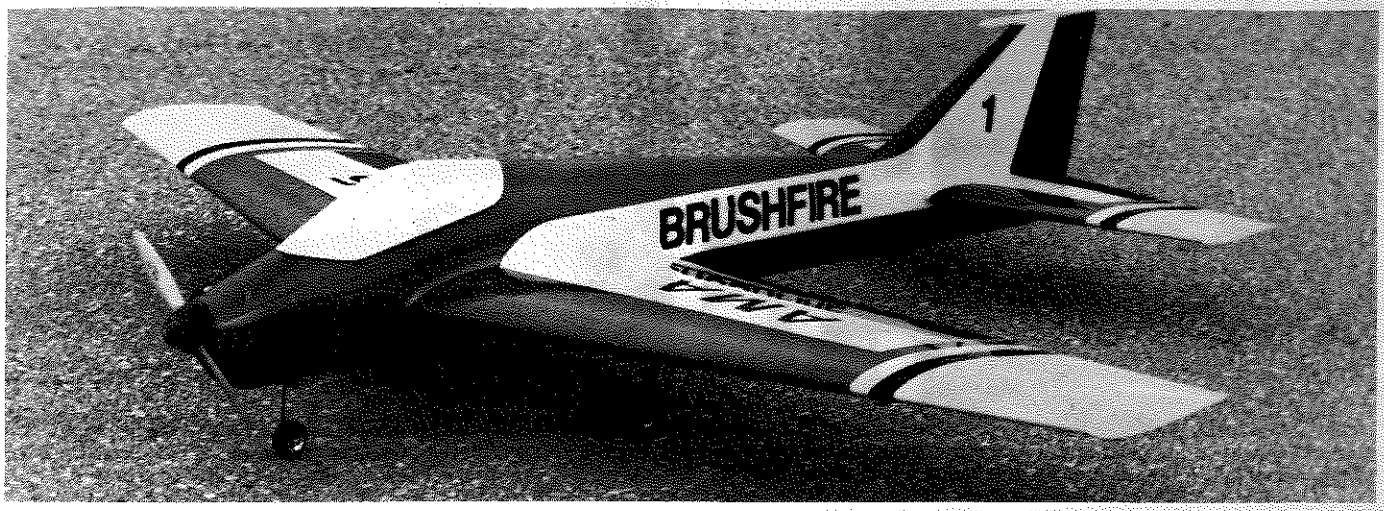


PHOTOS BY AUTHOR UNLESS NOTED

BRUSHFIRE

By KEN BONNEMA . . . Fine contemporary Pattern design being used by several of the top aerobatic contenders. Can be all balsa constructed, or go your own way with foam wing cores and glass fuselage.

CONSTRUCTION

The Brushfire is not a difficult airplane to build, but attention to detail must be maintained if you want yours to be a contest performer. It is a large airplane, and as such, every attempt must be made to keep the weight down. Fuselage blocks must be hollowed as shown or the weight will become excessive. A fully sheeted wing may be easier to build, but it would add weight and its higher mass inertia would definitely degrade the roll performance of the airplane. Some people don't like Mylar covering materials, but their weight saving is a fact, and painting the top and bottom of an 860-square-inch wing can easily add 6 to 10 ounces. Alignments and incidences must be painstakingly measured. A wing or tail incidence error can drastically change an airplane's pitch response to rudder inputs, making point rolls a real nightmare. Simply put, building shortcuts must be avoided if you intend to fly your Brushfire in competition. The 20% construction time you might save by cutting corners will probably degrade your airplane's performance by 50%.

Fiberglass fuselages and/or foam wing cores for the Brushfire may become commercially available in early 1980. Inquiries should be addressed to: Brushfire, c/o S. Rojecki, 1432 Devoe Dr., Xenia, OH 45385.

FUSELAGE

1) Cut out F1, drill holes, countersink blind nuts since motor mount and nose wheel unit overlap vertically.

2) Build up F2 through F8 from 1/8x 3/8 balsa. Use overlap joints.

3) Cut out fuselage sides and splice with ply doubler. Mark wing section on sides, but *do not cut out yet.*

4) Epoxy the basic fuselage box structure together on a flat surface.

5) Epoxy in F1 and F9. Check carefully for alignment.

6) Epoxy 3/4-in. square and 1/4-in. sheet balsa together to form fuselage bottom.

7) Spot glue the bottom to the fuselage.

8) Spot glue the small block in front of the vertical fin to the fuselage.

9) Glue R2 to the fuselage. Spot glue R1 in place.

10) Glue on R4 and 3/8-in. leading edge. Check alignment carefully.

11) Glue R3 in place.

12) Sheet the vertical fin, being careful not to twist or warp it in the process.

13) Trim sheeting, add 5/16 at top rear, and rough sand vertical fin.

14) Spot glue the 3/8-in. rudder leading edge to the back of the vertical fin and sand.

15) Glue rudder ribs and dowel area block to rudder leading edge.

16) Sheet rudder. Do not warp or twist.

17) Trim sheeting. Add 3/8-in. bottom block to rudder.

18) Spot glue the top block, 3/4-in. square, and nose blocks to the fuselage. Do not glue on the canopy block yet.

19) Cut out the wing hole in the fuselage sides.

20) Carve and sand fuselage to shape. Use cross section templates to assure symmetry. Use a spinner to help contour the nose.

21) Fit the canopy block to fuselage. Trace front face and rear face canopy cross sections from fuselage. Shape and sand the canopy. The rear of the canopy should fair smoothly into the fuselage turtledeck. The forward part of the canopy forms a waist in the fuselage cross section. See section B on the plans. Spot glue canopy to fuselage.

22) Smooth sand entire fuselage.

23) Remove all fuselage blocks and hollow to approximately 3/16-in. wall thickness with a gouge or Dremel tool.

24) Epoxy all the top blocks permanently in place.

25) Reinforce the rear of the firewall to the fuselage sides and top with fiberglass tape and epoxy.

26) Epoxy all fuselage bottom blocks and nose blocks permanently in place.

27) Cut engine and pipe clearance holes in nose blocks.

28) Add the plywood ring to the front of the nose.

29) Cut out clearance holes for the nose wheel and strut in the bottom of the fuselage.

30) Use an X-Acto saw to cut the belly pan away from the fuselage.

31) Sand all the belly pan/fuselage interface surfaces and then face with 1/32 ply.

32) Cut nose wheel clearance holes in ply faces at front of belly pan.

33) Epoxy 1/8 balsa oil dam into belly pan just aft of nose wheel cutout.

34) Epoxy 1/4-in. ply wing mounting plates and balsa supports into fuselage. Do not drill wing bolt holes in plates yet.

35) Add fuel and vent tubes, and plywood floor above nose wheel compartment.

36) Add servo rails, and locate gas tank with balsa supports.

37) Remove the rudder, bevel the leading edge, and glue in the 3/8-in. dowel for the rudder horn.

38) Glue the balsa probe on top of the vertical fin.

39) Add a plywood box to the aft fuselage to serve as a bearing mount if you intend to use a flying tail.

WING

1) Hot wire two foam blocks from six-inch, one-pound density beaded styrene foam. Hot wire a half inch off the top and bottom of each block, so that

two five-inch blocks with perfectly flat and perpendicular surfaces are obtained.

2) Locate the root template on the wide end of one block on the centerline. Locate the tip rib on the narrow end of the block on a line 0.52 inches above the root rib centerline. This establishes the proper dihedral. Make sure you shift the tip rib in the opposite direction on the other block.

3) Hot wire the wing cores, including the spar notches.

4) Epoxy the 1/4-in. balsa spars into the wing. Set the cores back in their blocks, and weigh them on a flat surface. Allow time for epoxy to cure thoroughly. Sand spars flush with wing.

5) Make two templates for the wing cutouts from cardboard or thin plywood.

6) Sandwich the two wing blocks between the templates and secure with pins or tape.

7) Poke a piece of 1/16 piano wire through the sandwich in the middle of one of the spaces to be cut out.

8) Slip a piece of dowel over each end of the wire, and connect to hot wire power supply. Adjust the current so the wire will cut foam. Holding the hot wire by the wooden dowels, trace around the template to cut out the area to be removed.

9) Repeat steps 7 and 8 for each cutout area.

10) A loop of 1/16 wire in a soldering gun may also be used to make the wing cutouts.

11) Use the soldering gun method to cut recesses in the underside of the wing for the landing gear mounts.

12) Install blind nuts on the 1/4-in. ply mounts and then epoxy them into the wing. Drill through the large holes in the mounts about 1-1/2 inches into the foam, and then epoxy the four 3/16 dowels through each mount and into the foam.

13) Use the soldering gun method to cut clearance holes for the landing gear unit. Install the unit and then glue enough balsa filler around it to build back up to the wing surface. Remove the landing gear and sand the balsa filler flush with the wing surface.

14) Use the soldering gun method to cut channels into the underside of the wing for the aileron servo wires.

15) Epoxy on all leading and trailing edge sheeting. Use glue sparingly. Put the wings back in their blocks and weigh on a flat surface while epoxy cures.

16) Join the wing halves with epoxy. Keep the wings in their blocks during the joining process to assure proper alignment and dihedral.

17) Cut a channel in the top of the wing and epoxy in the 1/4x3/8 dihedral brace.

18) Epoxy on the top and bottom center section sheeting.

19) Cut out the trailing edge area where the flaps go. Sand a flat on the front of the wing.

20) Epoxy on 1/4-in. leading edges and 3/16-in. trailing edges.

21) Install the flap linkage.

22) Glue trailing edge center section on over the flap linkage.

23) Face edges of flap area with 1/16 sheet.

24) Add cap strips, tip sheet, and fixed aileron ends at tip.

25) Add 1/16 wing tip.

26) Build ailerons and flaps. Make sure 1/32 ply in ailerons is notched for hinges before laminating. Spot glue on wing.

27) Shape and sand the wing. Be sure to sand a fairly sharp leading edge into the last 12 or 14 inches of each panel.

28) Center drill 5/8-in. dowels with 3/16-in. holes. Drill 5/8-in. holes in wing and epoxy in dowels. Sand flush with surface.

29) Fiberglass wing center section top and bottom.

30) Cut out holes for gas tank, retract servo, and flap servo.

31) Install servo rails.

32) Cut wing sheeting away which has covered landing gear mounts.

33) Use hole saws to cut wheel wells and aileron servo wells. Line wells with 1/16 sheet.

34) Cut clearance from L.G. mount to wheel well for L.G. strut.

35) Use sharpened tubing to cut channels from the retract servo compartment to the wheel wells and forward to the wing leading edge below the gas tank cavity.

36) Remove ailerons and flaps. Bevel leading edges. Install 3/8-in. dowels for control horns.

37) An all-balsa built-up wing can be constructed. Make ribs by sanding a stack of balsa between the root and tip templates. Use the same spars, sheeting, and cap strips, but add vertical web sheeting to the front spars. Add plywood dihedral braces, and beef up landing gear mount area with plywood and balsa half ribs. A built-up, fully-sheeted horizontal tail is also possible.

HORIZONTAL TAIL

1) Cut out foam cores.

2) Epoxy on sheeting. Let cure in weighted blocks.

3) Add 1/4-in. leading edge, 1/4 by 3/4 trailing edge, and 1/16 tips.

4) Cut off elevators.

5) Add 1/4-in. leading edge to elevators and 3/16-in. trailing edge to stabilizer.

6) Cap elevator ends and exposed stabilizer edges with 1/16.

7) Spot glue elevators back on.

8) Join stabilizer halves.

9) Shape and sand entire stabilizer.

10) Fiberglass center section top and bottom.

11) Remove elevators, bevel leading edge, and install 3/8-in. dowel for control horns.

ASSEMBLY

1) Level the fuselage on a flat surface.

2) Glue in the horizontal tail at 0° incidence and parallel to the table top.

3) Form fillets around tail with plastic balsa or Sig Epoxolite.

4) Cover the top of the wing with Saran Wrap. Align it on the fuselage at 0° incidence, parallel to the table top, and equidistant from the front of the rudder probe to each wing tip. Lift the fuselage, apply putty or Epoxolite to the wing saddles, and set back down on the wing. Recheck alignment very carefully before putty hardens.

5) After hardening, turn the airplane over, being careful not to move the wing at all.

6) Using a 3/16-in. bit, drill through the 3/16-in. holes in the wing dowels and clear through the plywood wing bolt plates in the fuselage.

7) Remove the wing, enlarge the holes in the fuselage plates, and install the wing bolt blind nuts.

8) Replace the Saran Wrap on the top of the wing with a piece that overhangs the leading and trailing edges at least six inches. Bolt the wing to the fuselage and recheck alignment. Sand or build up the wing saddles to correct any misalignment.

9) Trim the belly pan so that it fits the wing and aligns with the fuselage. Glue it to the wing, using the Saran Wrap overhang as a barrier between the ends of the belly pan and the fuselage.

10) Glue the 1/32 ply fillet keels to the fuselage at the wing trailing edge.

11) Form wing fillets on fuselage and on belly pan from Epoxolite. The Saran Wrap will separate the fuselage and belly pan fillets at the leading and trailing edge of the wing.

12) Remove the wing. Sand fillets. Fine sand entire aircraft.

13) Hinge all surfaces.

14) Remove the lower crossmember of F4 to provide clearance for flap linkage.

FINISH

1) Coat the engine and fuel tank areas with epoxy for fuelproofing.

2) Apply a layer of 3/4-ounce fiberglass to the fuselage and belly pan.

3) Monokote or Solarfilm the wing and horizontal tail.

4) Paint the fuselage and trim on the wing and tail. (Note: Epoxy or polyurethane paints will adhere nicely to Monokote, especially if the area to be painted is very finely sanded first. Two of the Brushfires shown have Monokoted wings with epoxy paint trim. The other has a fully painted wing and weighs 3/4 of a pound more than the other two.)

INSTALLATION

1) Rudder, elevator, and throttle servos sit three across in the aft fuselage compartment. Use cable steering for the nosewheel.

2) The receiver and flap mixer occupy the next compartment forward. (If air retracts are used, the valve servo should go in this compartment with the receiver, and the flap mixer may be moved above the gas tank.)

3) Flight battery may be placed anywhere from the firewall all the way back to the receiver compartment. It should be located as necessary to achieve the proper CG.

4) Use a 180° servo for the retracts, a

9801

standard servo for the flaps, and mini servos for the ailerons.

5) Install the gas tank and connect its tubes to the aluminum tubes in the fuselage with silicon tubing. (Note: The gas tank is located aft so that little CG shift occurs as fuel burns off. If you choose, you can put the tank immediately behind the firewall and eliminate the gas tank cavity in the top of the wing.)

6) Install the engine and pipe. One of the aft wing bolts may be used with a standoff to support the back of the pipe, or a separate standoff and pipe mount may be installed elsewhere in the belly pan.

7) Connect pipe pressure to the vent pipe protruding from the bottom of the fuselage with silicon tubing. Remove tubing during gas tank filling operation so overflow doesn't run into the pipe.

TRIMMING AND FLYING

(Comments by Steve Rojecki)

Ken has already discussed the design philosophy of the Brushfire, so I'll limit my comments to setting it up and trimming it for contest flight. Trimming any airplane actually starts during construction, when you are aligning the thrust and wing and tail incidence. Errors in alignment may result in flight problems that cannot be corrected by trimming. One of the fiberglass Brushfires was accidentally built with a one-degree offset in the horizontal tail incidence. This caused a very pronounced pitching in the knife-edge portion of point rolls. Nothing we tried corrected the problem until we cut the tail completely out of the fuselage and glued it back in at the correct incidence.

The original Brushfire was balanced at the point shown on the plans. This is a good location for test flying and reasonable maneuverability, but you may want to move the CG another half-inch back later on for maximum performance in spins, knife-edge, and snap rolls.

The first airplane had a flying stab set up using a Giezendanner mechanism. About eight degrees of stabilator travel in each direction provided enough pitch authority for the full maneuver range. The other two Brushfires built so far have had conventional elevators. The deflections for all the control surfaces are noted on the plans. It should be pointed out that the aileron throw shown represents high rate if a dual roll rate system is used. As always, you'll have to adjust your throws to suit your own style of flying, but the values shown are adequate for all the maneuvers if the CG is at or near the specified point.

Before your first flight you'll have to balance the airplane fore and aft. This is pretty straightforward and most modelers should be used to it. Equally as important, but not as well known, is lateral balancing. A quick method for lateral balancing is to hold the airplane by the prop shaft and the top of the vertical fin. Pick up the airplane in this manner and note which wing drops. Be sure to do this with the landing gear retracted, as the balance may change with the gear down. Add weight to the high wing tip (at the CG, if possible) until the airplane hangs level.

Another preflight trick which improves performance in all maneuvers is sealing hinge gaps. This can be done with Monokote or clear vinyl tape. As a minimum, aileron and elevator hinges should be sealed. Flaps and rudder are not as essential, but sealing their hinges can only help. Sealed hinges prevent asymmetric hinge gap leakage during maneuvering, which creates unwanted roll or pitch inputs.

During the first few flights you should concentrate on trimming the airplane for straight inside and outside loops. Several good articles on trimming have been published, so I don't plan to go into much detail here, but briefly, if the same wing panel keeps dropping in both insides and outsides, either remove tip weight from that panel or add weight to the other. If insides and outsides corkscrew in opposite directions, check the aileron trim. Finally, if the loops are pretty much wings level, but heading changes occur, retrim the rudder or check for engine side thrust offset. Loop trimming can be frustrating, since changing one thing always seems to foul up something else, but if you keep at it and you built your airplane straight, loops on a rail should be obtainable.

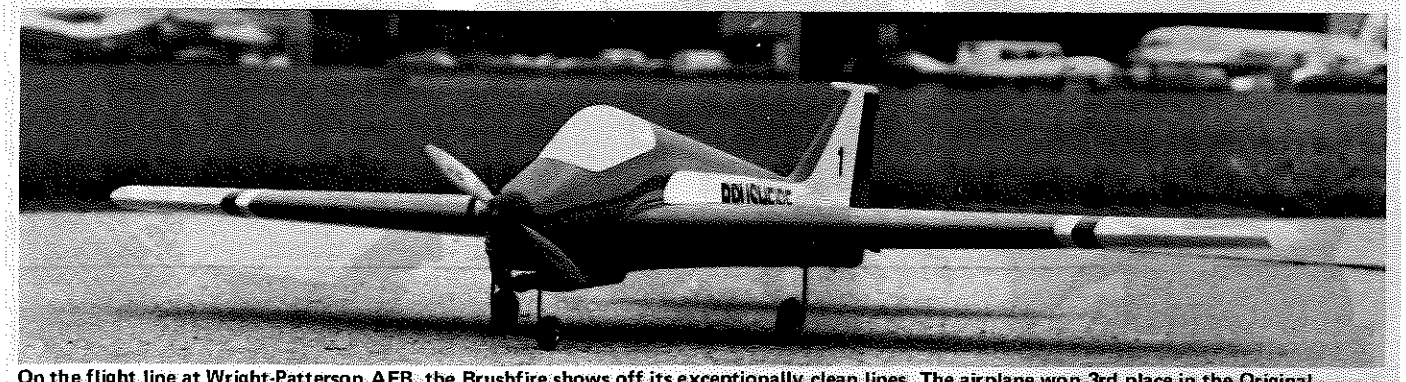
Roll tailoring is not often considered by many fliers, but the nature of your airplane's roll can be varied by playing with differential aileron throw. Start out with equal aileron throw up and down. Fly straight away from yourself and do a half roll to the right with no rudder or elevator inputs. If the nose of the airplane is pointing off to the left after the half roll, adjust your ailerons so they travel more up than down. If the nose winds up off to the right, set it up for more down aileron than up. None of the Brushfires to date have required any differential, but it never hurts to do this test on a new airplane.

To trim the airplane for knife-edge, roll it up on either side and apply only rudder to hold the nose up. If it rolls in the direction of the rudder input, it has too much dihedral. If it rolls opposite to the rudder direction it needs more dihedral. This should not be a problem on the Brushfire, since we adjusted the dihedral after the first airplane. If the airplane pitches up in knife-edge, roll it over to the other knife-edge position and try again. If it still pitches up, add incidence to the wing by shimming above the trailing edge. If it pitches down in both knife-edge attitudes, decrease the wing incidence by shimming above the leading edge. If it pitches up in one knife-edge direction and down in the other, check engine thrust alignment.

Flight trimming is a very painstaking process, but the rewards are well worth the effort. A well-trimmed aircraft requires only maneuver inputs from the pilot. A poorly trimmed airplane requires maneuver inputs plus corrective inputs to straighten out what it's doing wrong. All the Brushfires flown so far have required very little trimming and have exhibited no nasty habits. The Brushfire is fully capable of all AMA and FAI maneuvers, and it is truly a pleasure to fly.

ONE LAST THOUGHT

A brush fire is something that starts from a small spark, gathers momentum slowly, and eventually lays waste to everything in its path. That may be a rather optimistic definition for the "Brushfire" namesake, but a fourth, a second, and a first in its initial Masters pattern competition season would seem to indicate that the design is already a legitimate contender, and that its appearance in the winners circle will likely increase as more Brushfires begin to appear on the contest scene. •



On the flight line at Wright-Patterson AFB, the Brushfire shows off its exceptionally clean lines. The airplane won 3rd place in the Original Design competition at the last Toledo R/C Exposition, was the highest placing Pattern ship.

#7801