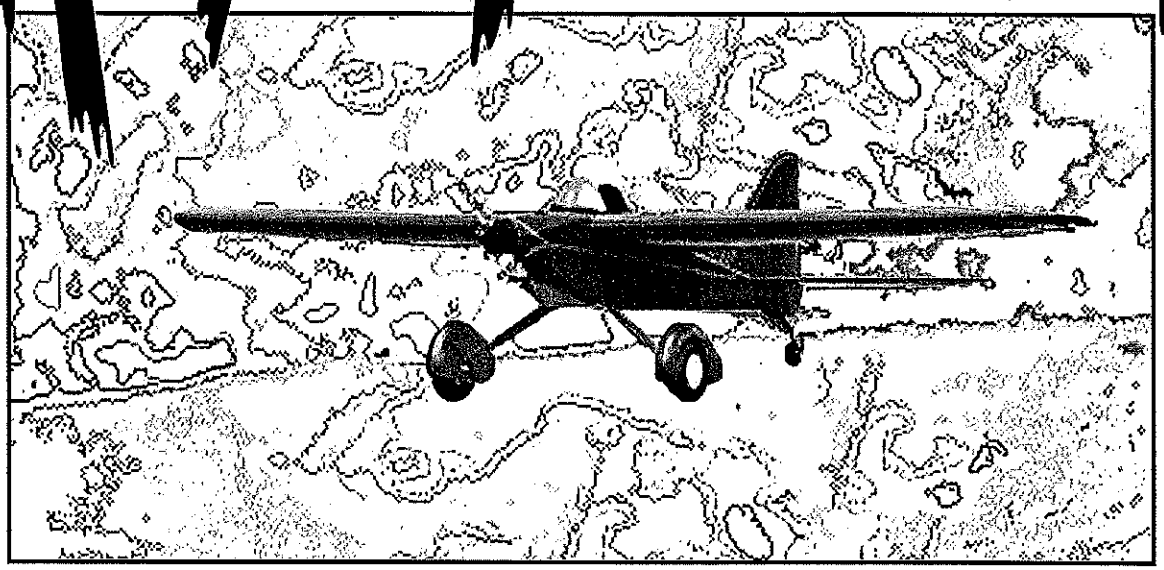
#756

RAPTOR



■ Bill Winter & John Hunton

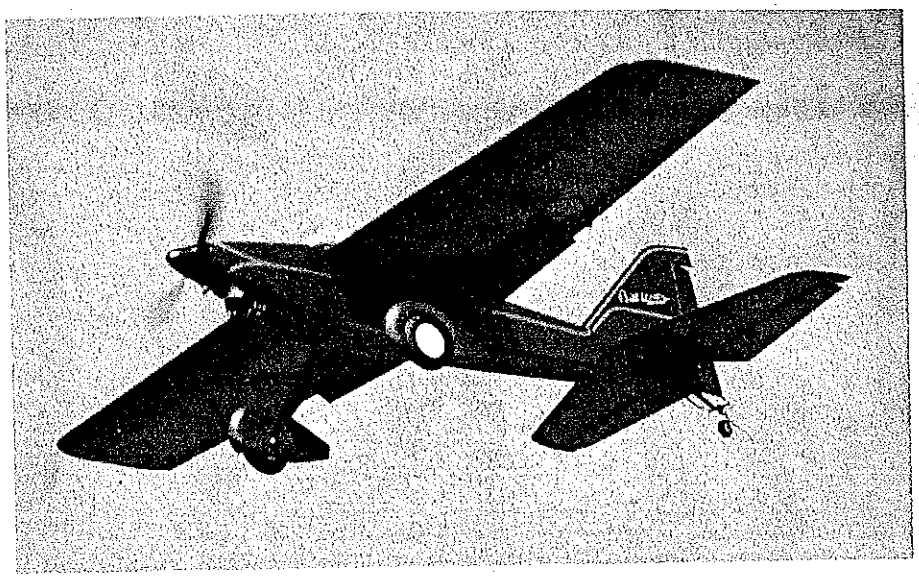
Akro Bat-based design extends the performance envelope for RC sport models.

Raptor has the exceptional low-end performance of Cloud Niner and the RC Special, and was designed to extend the top end of the performance envelope.

Raptor is different in appearance and performance from the usual airplanes that I have designed and published. Raptor moved a couple of notches up the performance ladder, although I can still fly it sedately with partial flaps.

I wished to maintain a smoothly flowing blend of responses: adequate stability (without visual dihedral) with bank-and-turn characteristics to please any lightplane pilot. Raptor has a very wide speed range. It is fast enough to please a sport pilot who wants to bore holes, yet has landed (with flaps) with a two-foot roll in near calm conditions after a prolonged STOL approach (you would have to see it to believe it).

This design is aerodynamically compact, with minimized moments around all axes. This is achieved through its double-tapered shoulder wing, high thrustline, and large, short-coupled empennage.



Short-coupled model has large, effective tail surfaces. Design is based on the Akro Bat (April 1991 *MA*) CL model.

Its NACA 00-series airfoil varies in thickness from root to tip; incidence and decalage are set up to minimize drag and tail-dragging, and washout for good stall stability. Even though Raptor was designed to fly just this side of neutral stability, it will fly hands-off.

The Raptor provides for a perfect transition from the typical trainer. If flown with moderate throttle and no flaps, Raptor flies just like a typical trainer, yet is easier to fly with the stall-safe wing design. But the guts are there for you to advance to steeper climb, higher velocities, inverted flight, and more verticality in maneuvers.

With the flaps, however, other windows open up with Raptor. The world of close-in flight opens up...tight maneuvers, quick turns, unbelievably quick takeoffs and tippy-toe landings. This also means the capability to climb to altitude, idle, and then slow down and sniff for thermals. Raptor provides the widest range that I have ever seen in a sport model.

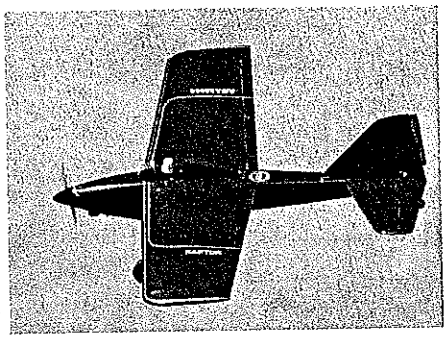
CONSTRUCTION

Wing: Each panel has aerodynamic twist or washout, which greatly improves stall characteristics. This feature makes the panels and flaps non-interchangeable.

Duplicate the rib sections on a copier. Spray the backs of the copies with 3M adhesive and apply to the selected rib balsa. Partially precut ribs at stations 0 and 1 facilitate later removal of the area between the main spars.

Tape a wing plan down over a building board and cover it with waxed paper. Fasten the "top up" trailing edge jacks in place at wing stations 1, 4, 7, and 10. Pin the bottom spar down from the sides in the spar doubler area, then glue on the bottom spar doubler. Mount the trailing edge onto the jacks.

Slip the ribs into place, centering them on the trailing edge. Tilt the root rib as shown for dihedral. Glue sub assembly. Pin the leading edge in place. Check the ribs for proper fit, trim if necessary, then



Raptor's wing, nose, and tail cone have straight tapers that focus toward the model's center of gravity.

glue the LE on. Install the top stub spar, top spar, rear spar, and trailing edge sheet.

Fit the top D-tube sheet to the leading edge. Mark and trim the rear of the sheet ⅛ short of the rear of the spar to provide a shelf for the cap strips to land on. Wet the outer surface of the LE sheet, then glue it on by applying Titebond to the ribs and cyanoacrylate glue (CyA) to the leading edge joint.

Remove the "top up" trailing edge jacks and install the "bottom up" jacks to accommodate the aforementioned washout. Pin the wing panel back down to the board, bottom up.

Install all spar webbing, the trailing edge sheet, and the bottom leading edge sheet. These steps complete the D-tube and gives the wing panel its torsional rigidity. Install the rear stub spar and flap well sheeting, then the center section sheeting. Add the hold-down screw reinforcing and the stub ribs that form the front wing cutout.

After the wing panels are complete, cut out the center sections of the ribs at stations 0 and 1. The wing joiner is laminated from ⅛ plywood (do not use Lite Ply) and is trimmed to shape on a bandsaw. Use a generous amount of epoxy to mate the panels and joiner. Run medium-weight glass cloth over the center section. Wick it down with CyA, then coat with epoxy.

Sand the wing panels to final shape with a long sanding block. Cut out the aileron and sand it to shape. Cut and fit flap panels to the flap wells. Use firm sheeting for the flap.

Fuselage: Select matched wood to facilitate equal bending of the sides. Underlay the plan with your selected side sheet. Go over the salient features with a serrated dressmaker's wheel. Use a straightedge to run the wheel along to insure trueness where you can. Prepare ¼ sheet doublers the same way.

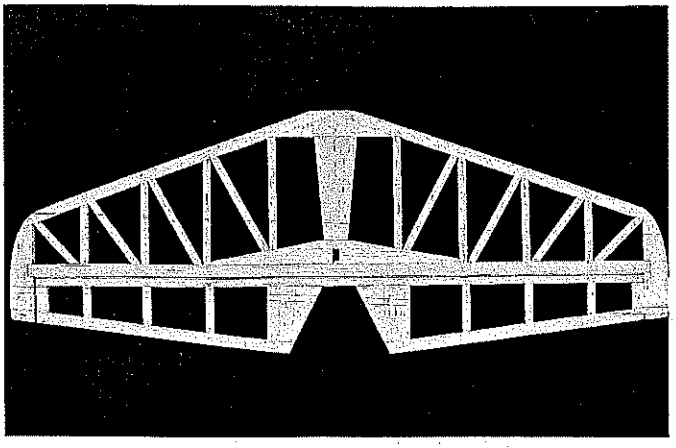
Unless you have ordered 48-inch sheets for the sides, you will have to make side sheet extensions with tapered joints at the rear of the fuselage. Glue the nose doublers to each side sheet. Use cooled CyA to retard the setting of the glue, or use aliphatic resin (Titebond) with dots of CyA in it for quick adhesion. Select the strongest ¼ square wood that you have for the longerons. The verticals can be softer wood, particularly in the aft areas. Use hardwood for the RC tray supports.

Position the plywood formers onto one fuselage side at each end of the wing mounting area. Use a small drafting triangle to align the parts vertically, then glue the parts in place. Attach the other side to this subassembly, being careful to accurately align the sides. Add the triangular parts behind the front former, then the balsa gussets behind the rear former.

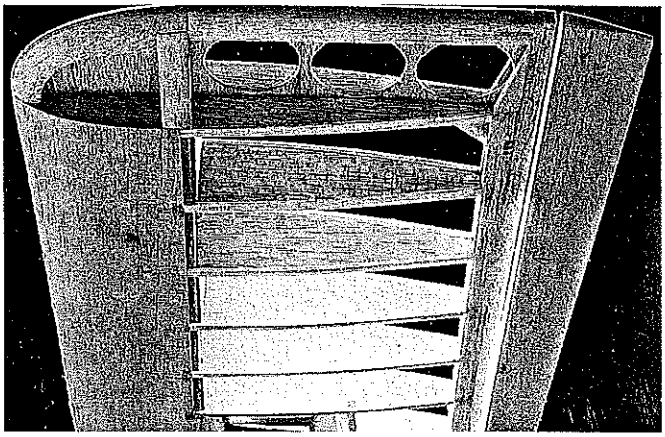
The fuel tank compartment is only accessible through the hole in the front wing box former, so the fuel tank must be no more than two inches wide. The Hayes eight-ounce tank meets this specification.

Drill the landing gear mounting plate for 6-32 blind nuts. Recheck fuselage squareness and install the plate. Install lateral spreaders top and bottom in the wing box area.

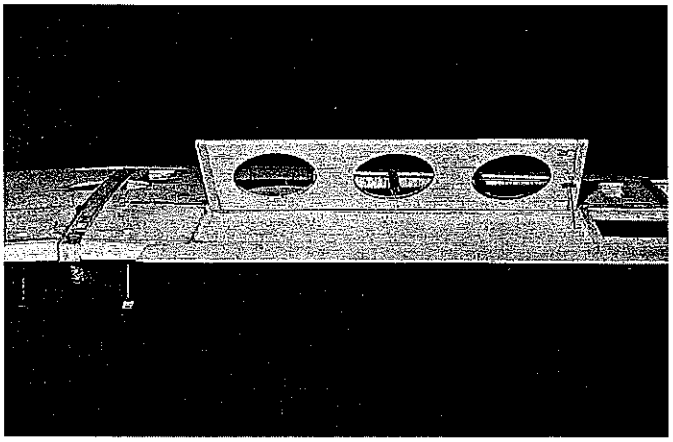
Lay the partially assembled fuselage over the top view. Pull the fuselage sides together at the tail, match the up, then pin then or clamp with clothespins. Check the



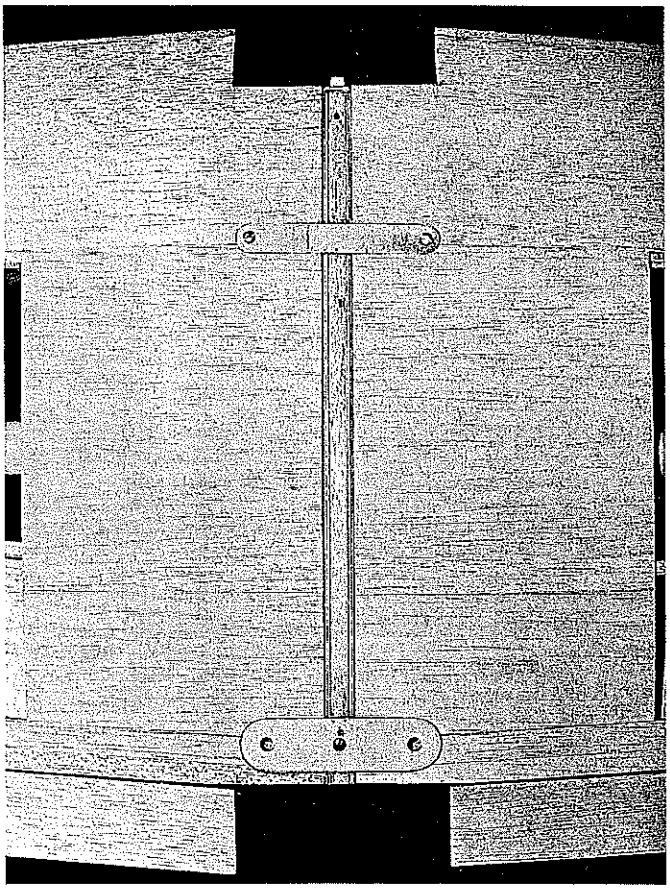
Tail surfaces are squared up with a sanding block at the end of the work surface. Tight joints are a must.



Wing is built with trailing edge above the work surface. Built-in washout improves Raptor's stall charcteristics.



Above: Split flap shown partially deployed. Flaps shorten landing profile and allow flying from small fields.



Right: Prototype wing had individual panels to allow for dihedral adjustments, but initial setting was fine.

vertical alignment of the tail, and glue the sides together. Install all lateral spreaders. Lay a block across the horizontal stabilizer seat to check that the seat is true and level with the fuselage bottom at the landing gear support plate (and thereby the wing mount area).

Install the doubler, which provides lateral support for the fin leading edge. Sand the fuselage top and bottom with a block to provide level surfaces. Cover the top with the grain running across the fuselage and the bottom with the grain running fore and aft. Add the plywood tail wheel mounting plate and the balsa tail fairing.

The prototype was designed around the YS .45 with a concealed muffler. The concealed muffler setup is more difficult to build; you may not wish to bother with this drag-reducing feature, although it looks clean. Any .40 to .50 two-stroke can be used with the normal side muffler.

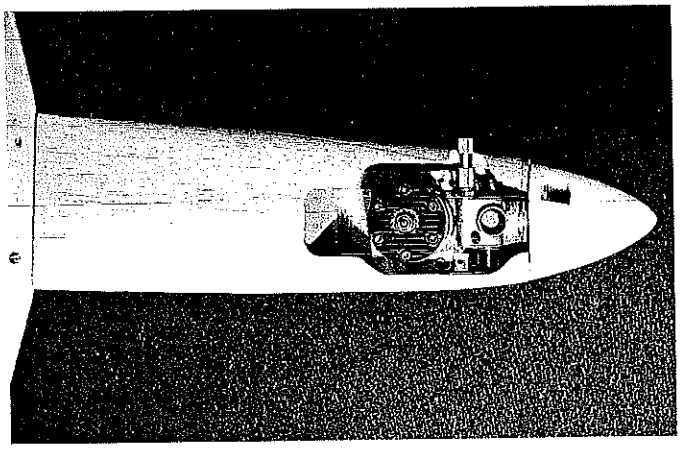
The nose is designed for the spinner to be centered, even though the engine is provided with two degrees of right thrust. This results in the engine mounts being offset from the firewall centerline.

Determine the geometry of your particular engine/muffler combination—in particular, the distance from your spinner backplate to the firewall (or rear of the engine mount). The amount of offset in the mounts will vary, and can be interpolated from the following relationships: 1/8 offset at 4 inches, 5/32 offset at 5 inches, and 3/16 offset at 6 inches.

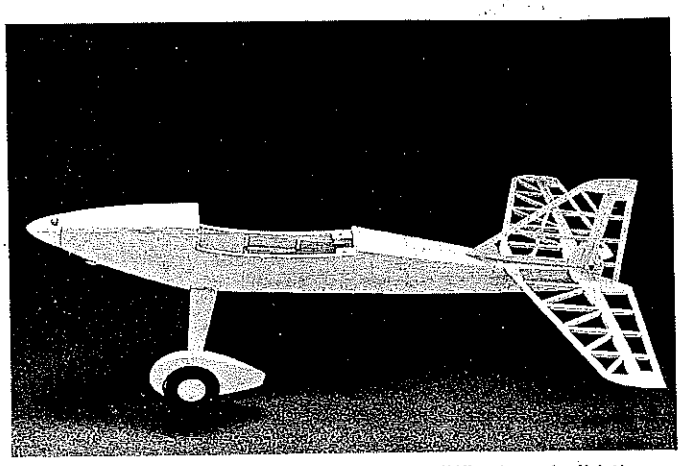
Depth of firewall placement will also depend on your engine's geometry. When laying out the firewall, mark it with the reference centerline. Cut the firewall to proper depth and width. Drill for the engine mounts, fuel lines, and the throttle linkage, then assemble the engine/engine mount combination, and fasten this subassembly to the firewall with 6-32 blind nuts. Tack-glue the firewall in place, using centerline references and the sides at the nose for proper centering information. Trim the sides to final length at the nose and install the nose ring former. Use the spinner backplate as a reference to center it accurately on the shaft.

Use hard triangular balsa for the firewall backing and the top and bottom triangular fuel tank compartment parts. Use soft balsa for installation of the triangular parts around the engine compartment. Trim the parts to facilitate engine removal. You may also want to remove the part of the nose ring for this same purpose. Smooth the interior of the engine compartment, and add the fuel tank floor and the buffers at the front and rear of the wing mount area.

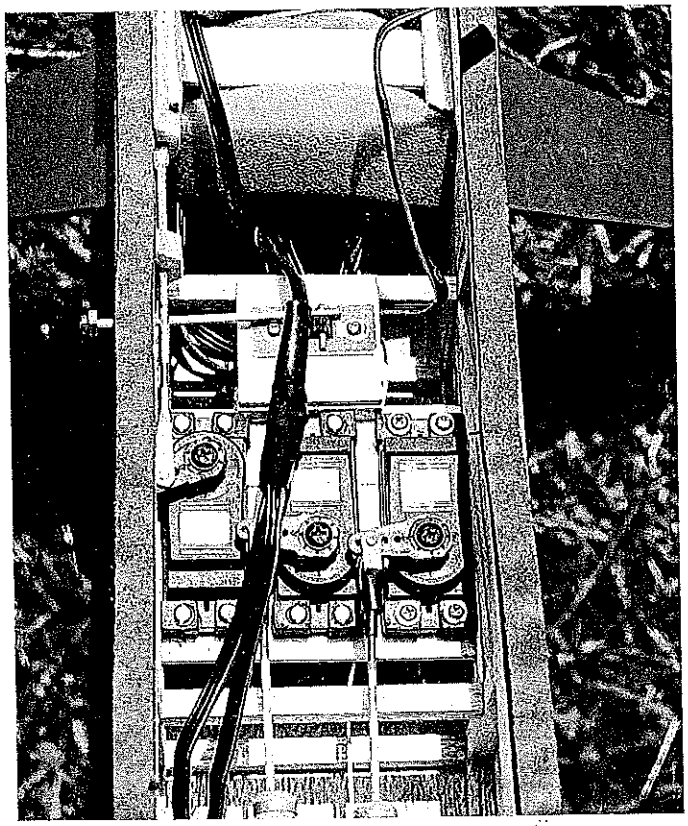
Tack-glue the top and bottom nose blocks in place. When shaping the nose and tail surfaces, all rounding is generated from the areas that are to remain perfectly



YS 45 is a reliable power source. Note provision made for optional vertical rear silencer—helps streamline nose.



Fuselage and empennage are no more difficult to build than a typical trainer. Round nose and aft fuselage.



Airtronics radio equipment was used on the prototype. Note remote switch setup. Raptor photos by Bernie Stuecker.

square: the front wing mount and the landing gear mount areas.

Shape the nose to a temporarily installed spinner. When shaping the top block, leave it high at the wing juncture. After final mounting of the wing, sand this area to mate to the wing. Do not round too heavily in the engine area, to avoid exposing the left top engine mount. Remove the nose blocks and hollow them to remove excess weight. Fuelproof the engine compartment. Permanently install the nose blocks.

Empennage: Two important considerations are lightness and accurate fit of the parts. The tail has very large lever arm advantage over the nose; if there is excess weight in the tail, approximately three times that excess weight will be required in the nose to achieve proper balance.

The way to keep the tail light, yet strong, is to select wood properly. Maximum strength is required at the root of the surfaces, and good strength is also required for the leading edges. Crossmembers and control surfaces can be of softer (lighter) wood. Light control surfaces will also reduce the possibility of flutter.

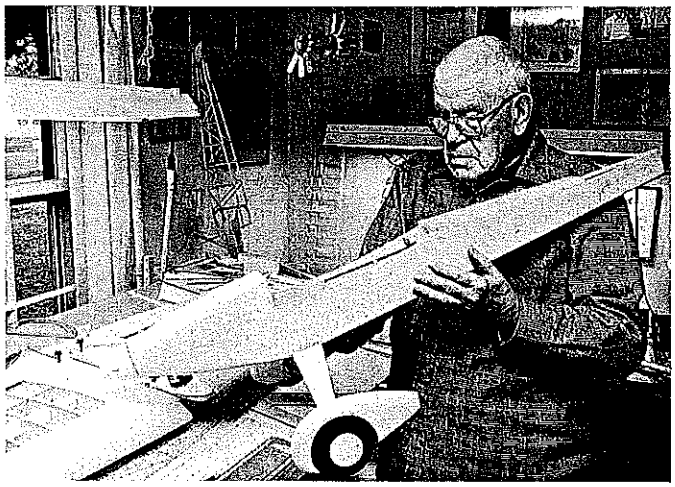
Cut all parts 1/16 longer than the marks. Use the end of the building board as a guide for your sanding block, hang the parts slightly over the edge, and sand them to final length and angle. This method ensures an accurate vertical angle. Do not hesitate to throw a part away and make another if it is inaccurate or too short.

Cut and pin all parts in place, being sure to have a good tight fit at all connections. Most shaping and sanding should be done with a sanding block for best accuracy. Don't make the trailing edge too sharp; keep sufficient material to maintain good trailing edge strength.

It is best to have the wing mounted to the fuselage first, so it can be used as reference to align the horizontal stabilizer. Bare the mating surfaces to the wood, apply epoxy to the both surfaces, and mount the stab. Sight the stab tips to the wing and adjust to make level.

After the stab bedding has cured, epoxy the fin in place using a triangle to reference verticality to the stabilizer. Drill the elevator and rudder for horns.

Miscellaneous parts: Wheel pants are made with a plywood backbone and soft balsa fairings. Cut the parts to outline with a bandsaw or jigsaw, then sand out the inside wheel well surface with a drum



Bill Winter with Raptor under construction. Design pushes sport performance toward its limit.

sander before assembly. Coat all joining parts with aliphatic resin glue, and clamp them together tightly. Use scrap plywood for pressure plates on each side of the buildup. Sand to shape.

Smooth and clean the Klett landing gear with Scotchbrite before painting.

The canopy parts are assembled to a removable balsa base. Build up the base and mate it to the wing seat for a good match.

Sig "Easy Hinges" were used throughout. Prebend the hinges to insure sufficient flexibility. Slit the balsa with an X-Acto and install the hinges with CyA. Align hinge axes accurately for smooth operation.

Finish: During construction the occurrence of CyA or aliphatic glues on the outside balsa surfaces should be minimized for smooth, evenly sandable surfaces. Use aluminum oxide paper: coarse for shaping, medium for smoothing and fine for finishing. Use Elmer's carpenter's wood filler on small imperfections. Vacuum or blow-off the entire model thoroughly before covering.

Coverite's 21st Century spray paints were used for difficult surfaces such as the wheel pants, landing gear, gear mount plate, cockpit parts, and inside the engine compartment. Prime the areas well, but use masking tape to keep any paint off surfaces to be covered with film.

Coverite has an excellent videotape available that shows many good tips on covering with the 21st Century films. The gist is to closely follow temperature directions on the covering information sheet, and be sure to apply the film under tension in all directions. Be generous with excess material to grab and pull across surfaces—pull it tight and it will stay tight.

Seal film edges subject to fuel and oil with Balsarite, and wipe off the excess with thinner. Be sure to use contrasting colors or trim on top and bottom for quick identification during flight.

The first test flight series went perfectly, with no pitch trim required. Raptor has balanced feel in all axes. During first flights the model has a jointed wing with a removable stub spar for dihedral refinements, but the very slightly positive stability produced as designed seemed to satisfy us.

With the YS .45 and no pipe, smooth, reliable power is yours for the asking. The custom concealed exhaust silencer is very effective and does not rob power. Climb can be made at over 45 degrees. Of course, any good .40 to .50 can be used with the side muffler.

With generous washout and the flaps extended, adding to improvement of stall propagation characteristics, the model can be flown right down to stall. If a burble or porpoise occurs, just add a tad of power. Raptor will not drop a wing.

You will have to understand how to use flaps before you will be fully satisfied with them on the Raptor. These flaps are large and very effective. Never pop them on at speed—the model might loop.

(The most frequent complaint about flaps is that there are trim changes when they are applied. This is not necessarily true, if you factor in velocity. As velocity is reduced, more and more up elevator is required to maintain level flight. The addition of proportional flaps will eliminate the need for up elevator when slowing down.)

During the flight test series I was experimenting with the flaps, got into very slow level flight, and reduced power to idle. The model began a slow, steep descent that I could not resist continuing right down to the runway, where the Raptor still had enough lift to flare. The model sat down with a two-foot roll.

Later tests included high-speed runs, which happened to occur on a very gusty day. A surprising benefit of near-neutral stability was Raptor's ability to fly in wind. Of course it can penetrate, but the interesting thing was that it was not affected by gusts like other models that were flying with considerable trouble that day. ✈

RAPTOR

Type: RC sport

Wingspan: 59½ inches

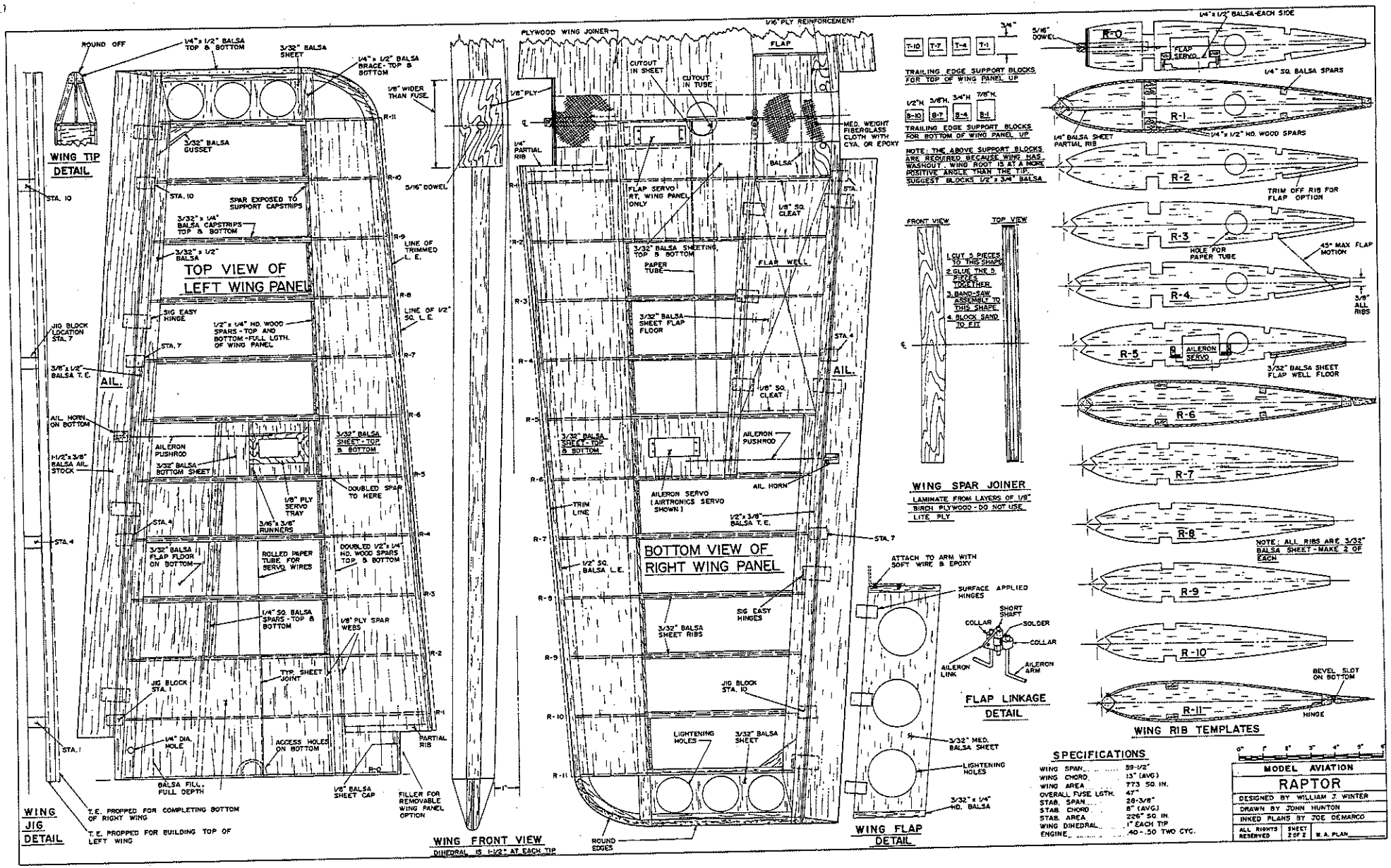
Engine: .40-.50

Number of RC chanels: 4 (5 with flaps)

Flying weight: 7 pounds

Construction: Built-up

Covering/finish: Coverite 21st Century paint/film


TOP VIEW OF LEFT WING PANEL
BOTTOM VIEW OF RIGHT WING PANEL
WING FRONT VIEW
DIHEDRAL IS 1-1/2" AT EACH TIP
WING TIP DETAIL
WING JIG DETAIL
WING FLAP DETAIL
WING SPAR JOINER
LAMINATE FROM LAYERS OF 1/8" BIRCH PLYWOOD - DO NOT USE LITE PLY
TRAILING EDGE SUPPORT BLOCKS FOR TOP OF WING PANEL UP
TRAILING EDGE SUPPORT BLOCKS FOR BOTTOM OF WING PANEL UP
NOTE: THE ABOVE SUPPORT BLOCKS ARE REQUIRED BECAUSE WING HAS WASHOUT. WING ROOT IS AT A MORE POSITIVE ANGLE THAN THE TIP. SUGGEST BLOCKS 1/2" x 3/4" BALSA
FLAP LINKAGE DETAIL
WING RIB TEMPLATES
NOTE: ALL RIBS ARE 3/32" BALSA SHEET - MAKE 2 OF EACH
SPECIFICATIONS
WING SPAN 59-1/2"
WING CHORD 13" (AVG.)
WING AREA 773 SQ. IN.
OVERALL FUSE LGTH. 47"
STAB. SPAN 28-3/8"
STAB. CHORD 8" (AVG.)
STAB. AREA 226" SQ. IN.
WING DIHEDRAL 1" EACH TIP
ENGINE .40 - .50 TWO CYC.
MODEL AVIATION
RAPTOR
DESIGNED BY WILLIAM J. WINTER
DRAWN BY JOHN HUNTON
INKED PLANS BY JOE DEMARCO
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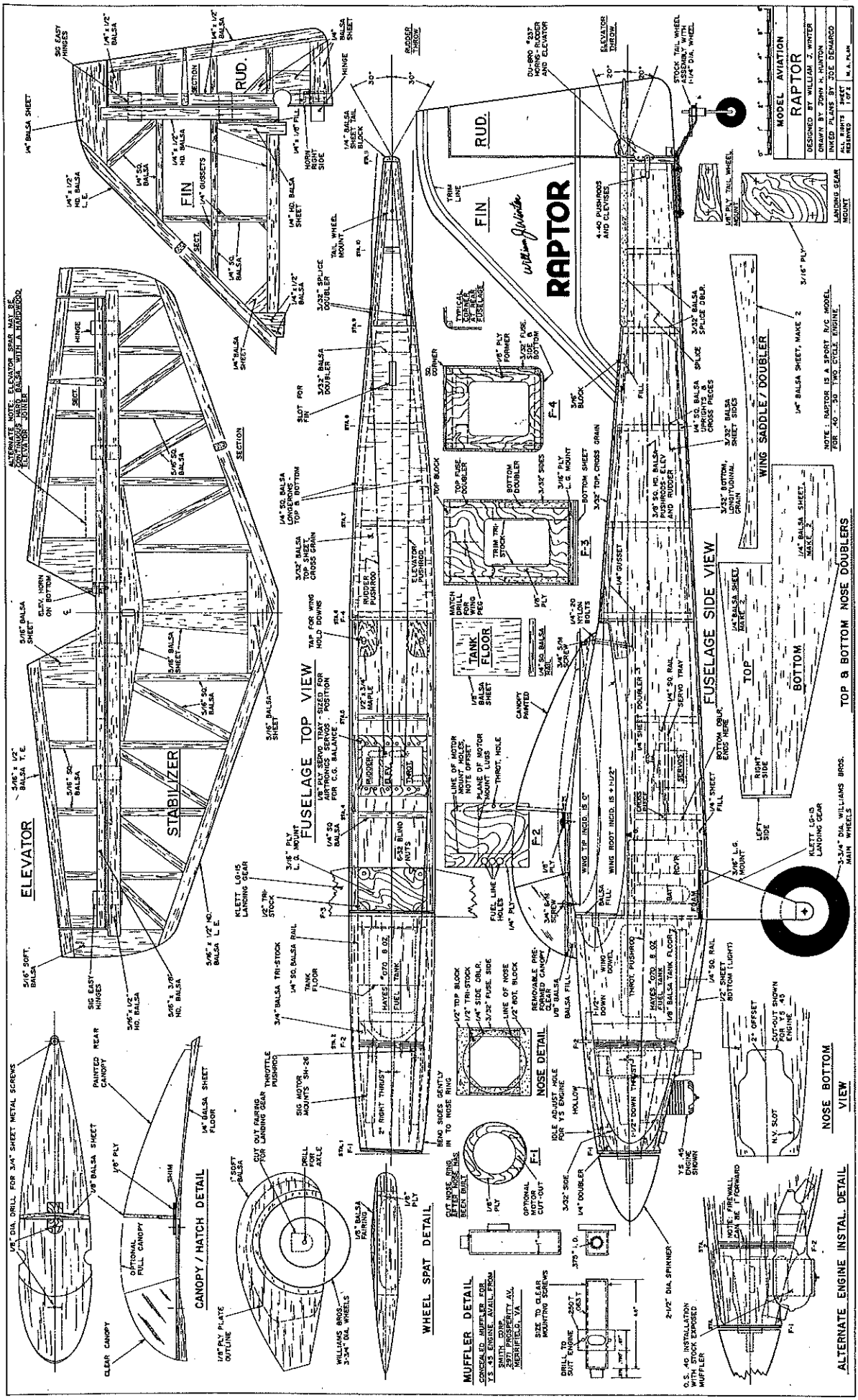
SHEET 2 OF 2
M.A. PLAN

Full Size Plans Available—See Page 160



RAPTOR

BILL WINTER