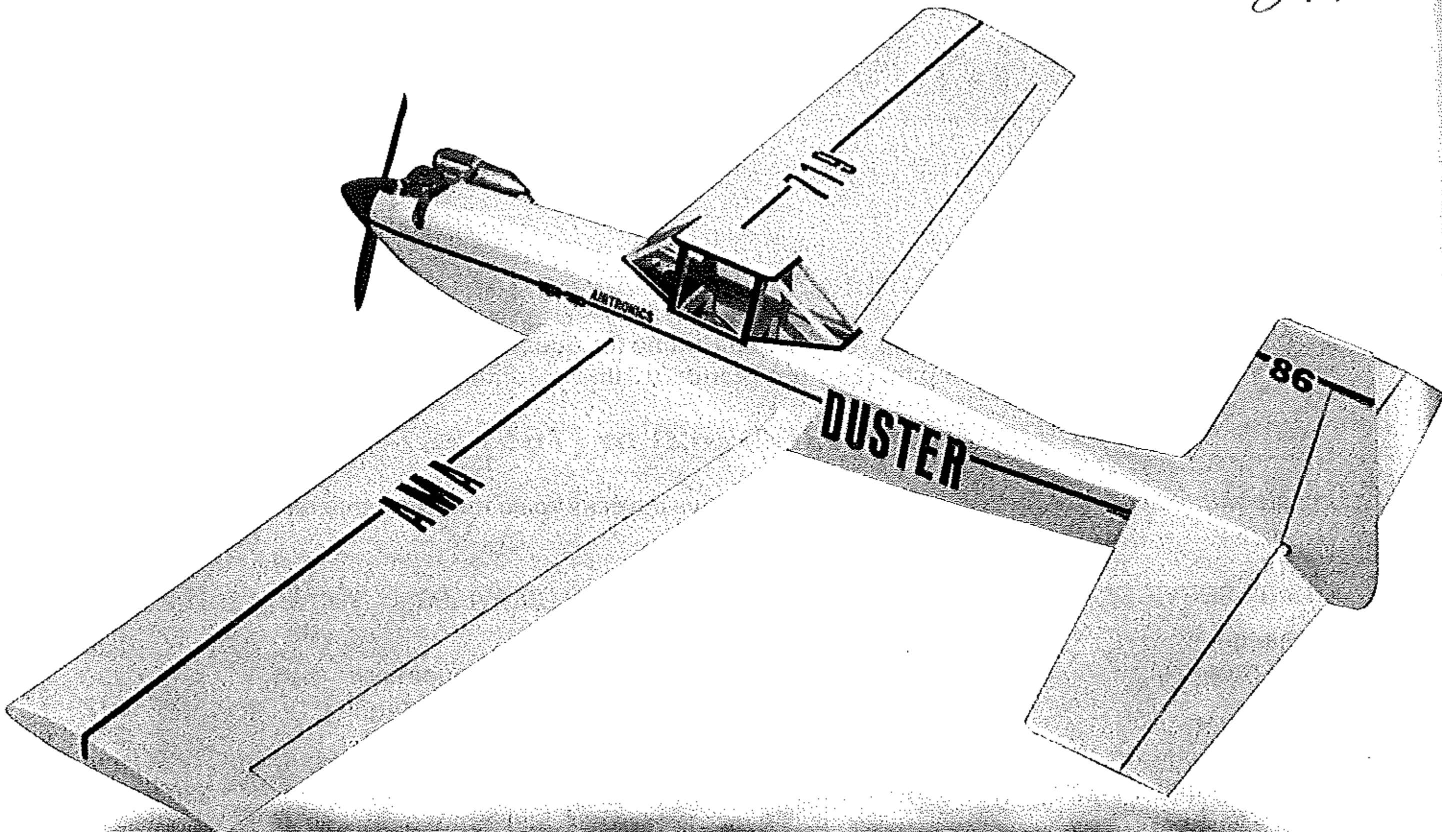
871

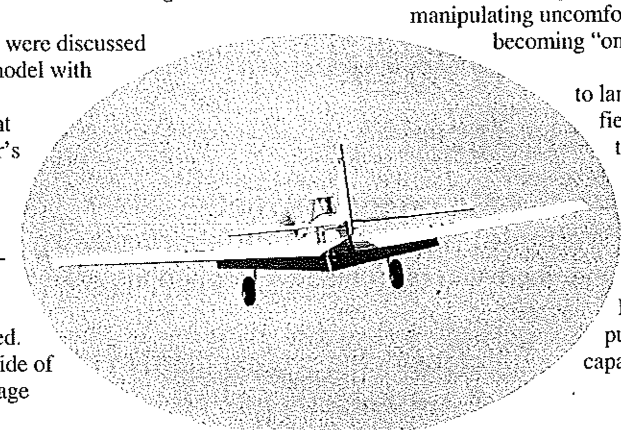


DUSTER

■ Bill Winter & John Hunton

Editor's note: As this article was being prepared, we learned of the passing of Bill Winter on December 11, 1998. Our sympathies to his family and his many friends and associates in modeling.

Preliminary specifications were discussed for a new .40-powered model with outstanding low-speed characteristics, with flight characteristics similar to the designer's classic Rookie of the early 1960s. It seemed logical to couple the design parameters of the Rookie with the long-nosed styling of a crop duster—thus the Duster.



This model does not "push the envelope" with brute power and speed. Duster combines the more-realistic side of model performance with above-average aerobatic capability.

The flight-test series showed that the Duster met or exceeded the design expectations, with solid performance in the moderate-to-low velocity areas, while not compromising the top end.

As RC pilots, we do not have the benefit of flying with the horizon over the dash or varying air pressure over the controls to provide feedback directly through the sticks. But some models—and the Duster is one—provide ample visual clues to give us that feedback. This allows us to change from being a person on the ground, manipulating uncomfortably small sticks on a black box, to becoming "one" with the model.

In a recent fun-fly event, the object was to land on a "playing card" marked on the field; Duster got five-of-a-kind and won the event. This is a testament to just how predictable and controllable the model is compared to other standard designs, some of which folded their cards early.

With its great contrast between high-end performance and the low capability, Duster is now my favorite model. It is a pure pleasure to fly Duster and explore its capabilities, as well as to expand my own.

John Hunton

CONSTRUCTION

In order to build an airframe that is as efficient as possible, yet structurally sound, several different sizes of wood of various weights are required for specific applications. It is normally expected of you, the builder, to review the plans carefully and obtain the required wood in the proper amounts before building, and there are some good balsa suppliers out there.

Some of us, however, are anxious to begin building when getting into a new project, so you can stock up on cheaper bulk balsa in various sizes in advance, including large (2 x 4) blocks, and use a table saw with a planer blade to cut most of the necessary final sizes of wood for the specific applications. This also makes it possible to cut the difficult-to-obtain aileron stock to the proper size and from the desired density of wood. In addition, this home-custom cutting method saves considerable money.

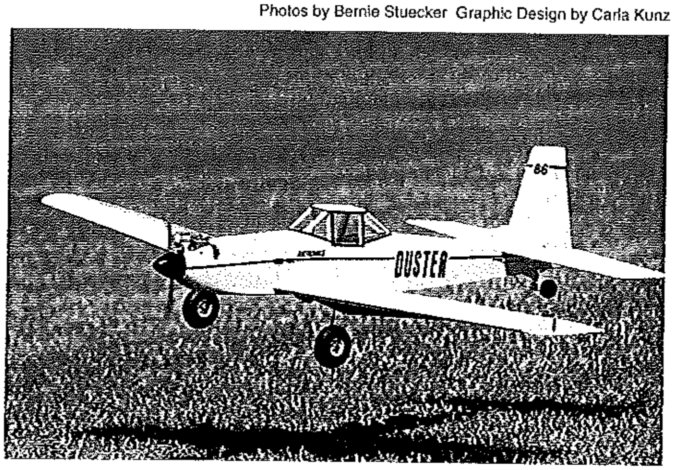
There are many glues and adhesives available, but Bill and I have developed allergic reactions to cyanoacrylates (CyAs) through the years. When using CyA, do it in front of a fan and provide good ventilation, with air changes. I have reverted to Duco cement (available in hardware stores) where possible for most building, and use CyA only when necessary. We use waterproof aliphatics (like Titebond) when slow curing is required.

Fuselage: Select medium-light balsa for sheeting and doublers, firm for longerons, medium for verticals and diagonals. Trace balsa and plywood parts and cut out, marking left and right inner side panels (note that the right-side inner panel is shorter than the left, to account for the required side thrust).

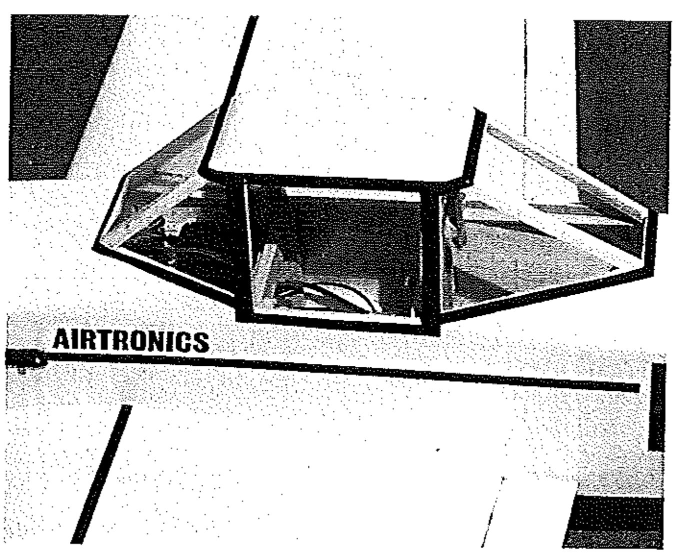
If you do not have sheet balsa wide enough, you may have to butt-join halves of outer and inner nose side panels over the plan and CyA the joint.

To assure equal wood strength, cut all longerons from the same

Photos by Bernie Stuecker Graphic Design by Carla Kunz



Duster ready to land. Good landings are normal with this model. With flap deployed, it will take off by itself.



Raised cockpit is reminiscent of crop dusters, as is the yellow color. Pilot sits up high for good visibility.

The design of the Duster fulfilled a spectrum of essential and special objectives. It is a 71.5-inch tapered low-wing, with effective-but-docile split flaps, powered by an O.S. .40 FX. With 910.65 square inches of wing area, weight is 7.25 pounds for a bit light wing loading of 18.354 ounces per square foot. The split flaps lie forward of the standard strip ailerons, and being close to the Aerodynamic Center and Center of Gravity, reduce trim changes with activation.

Duster has a full-scale feel, with its straight leading edge and P-40 type trailing edge. Aerodynamically the wing has "invisible forward sweep" (*a la* Mooney). Because of powerful flaps and for slow-flight STOL-type capabilities, the vertical and horizontal tail surfaces have substantial area. The 2415 airfoil, set at three degrees incidence, is stable enough to be flown as a true wing (with appropriate Center of Gravity).

Duster is not neutrally stable; it has just enough stability to produce eventual recovery from moderately disturbed attitudes. It is aerobatic without a sense of stability restriction. At cruise speed, if nosed down slightly, it will be back to straight-and-level by the time it crosses the field. When about "two mistakes high" if put into a mild turn at full bore, it recovers by "one mistake high," resuming straight flight with a slight nose-up attitude, within 360-720°. At comfortable cruise it will maintain altitude for a 360° recovery if mildly banked.

Above all, Duster flies on the wing, not on brute power. But it is faster and cleaner than a .40 trainer. Trimmed out, it flies "on the step." I would reject any sport airplane that does not do these things.

Because of its loading and inherent trim, Duster has a wide speed range, with hovering power approaching that of the feisty Ugly Stick, but without that inherent tail-down attitude. With flaps fully deployed, Duster almost hangs in the sky; it can be landed settling almost vertically in a STOL-like descent (on the wrong side of the power curve) with little roll-out.

Airliner flapped approaches, while holding some down, are arrow-true. Rule of thumb: On downwind, use ⅓ flap, power reduced to maintain altitude, then ⅔ on crosswind, and full flaps on final. Flaps are never dumped at high speeds or raised at very low altitudes or speeds.

Trim differences between normal and flapped flight are well into the comfort zone (at power to maintain altitude). Sudden power changes do not upset trim.

After two test hops, Duster did much more than just "fly off the board." No aspect of flight required the slightest adjustment or correction. The initial test flights were as if the airplane had been flown hundreds of times and been fine-tuned to death. I may have "Merlined" the appropriate phugoid, the proper interrelation of stability in three axes, the dynamic relationship of decalage and CG and bla-bla-bla.

After the initial test flights we had the feeling that the Duster knew more than we did. Lady luck is for real.

Bill Winter

sheet, or select and match carefully. Pin the longerons down and seat in glue to the outer side panels. Cut the crosspieces long, then block-sand to final length to assure an accurate fit. Install crosspieces and diagonals.

After the side subassembly is dry, remove all pins and block-sand both sides smooth. Mask off the fuselage side subassembly and apply 3M Super 77® spray adhesive (or equivalent) to the nose area in a light-but-even coat. Remove the mask and spray the inner panel, then join the panels after the adhesive becomes tacky, being careful to match the panels accurately. Apply even pressure all over to ensure good adhesion.

Mark the location of all elements that are to be attached to the side-plate. Cut out left and right triangular side corner reinforcement and install. Install 1/4 sq. tank floor rails, cockpit side rails, and cabin reinforcement.

Build the opposite side similarly, but be sure to build a left side and a right side.

Cut out all balsa and plywood formers using aircraft type plywood for firewall and former C, not Lite Ply. Glue counter-grain reinforcing on formers E and F. Cut out tank floor and servo mounting plate. Install blind nuts in the firewall for the motor mount. Cut cockpit formers from Lite Ply. Begin fuselage assembly by dry-fitting all formers into both sides to insure a good fit. Install formers C through F and the bottom plate at station F in one side of the fuselage. Use a small triangle to check formers for verticality.

Add the opposite side, using slow-curing glue, being certain that all formers bottom in their slots. Install tank floor to make assembly rigid. Lay this assembly top down over the plan (block up rear 3/4 in.) to check alignment and let dry. Install all fuselage crosspieces. Check the tailpost carefully for verticality during this operation. Install the firewall and its balsa cross-supports noting that down-thrust and right-offset are designed-in. Install the side plates at pushrod exits.

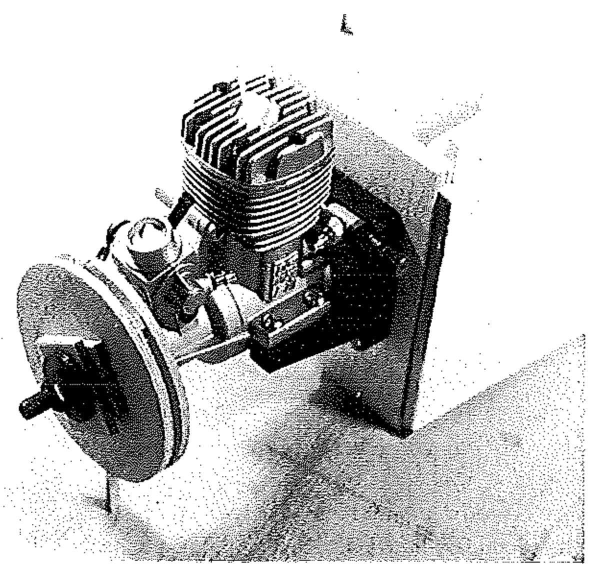
At this point seal all openings in the motor with tissue/tape and install it with the engine mount to the firewall.

Install all servos and linkages while you have good access to the fuselage. Install the rear turtledeck, top nose sheeting and cabin parts. Install the top and bottom nose plates, but check-fit your tank first. The top may have to be hollowed slightly for the tank to be located near the centerline of the needle valve.

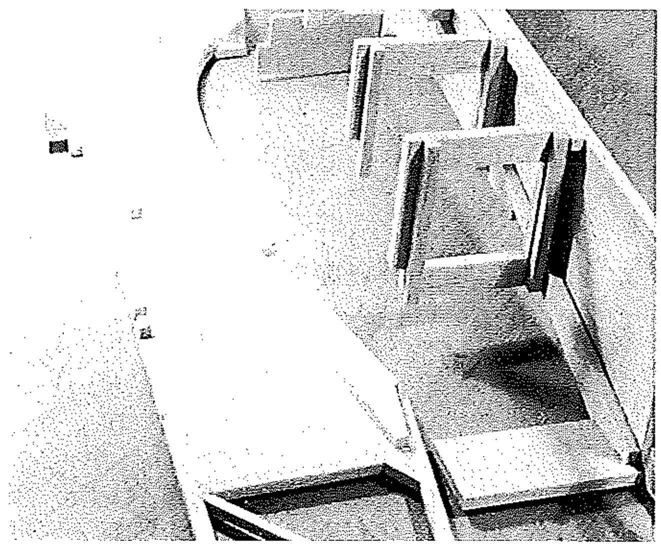
Make a temporary nose ring, drilled for the prop shaft. Install 3/32 balsa spacers (or space as required for your spinner assembly) to the rear of this ring and attach the permanent nose ring to the spacers. The purpose of spacing the nose ring from the temporary nose ring is to provide clearance between the spinner and the engine cowling.

Attach the nose ring assembly to the engine and build up the forward cowling to it. After assembling the forward nose section, remove the prop nut and cut the temporary ring off. Remove the engine and shape the nose to the nose ring.

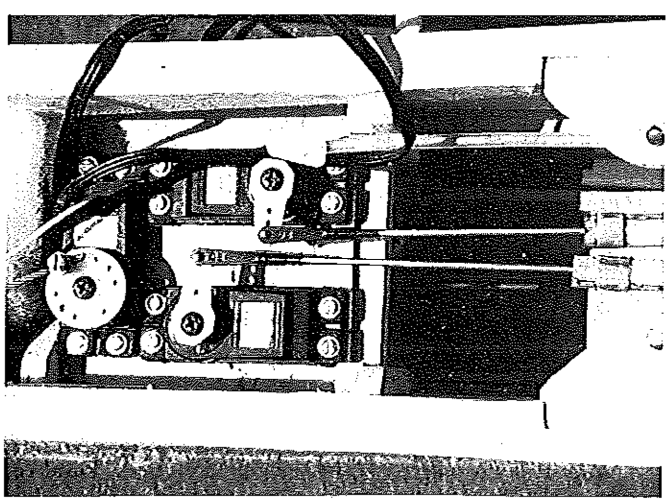
(For a better finish inside the cowling for longer model life, when



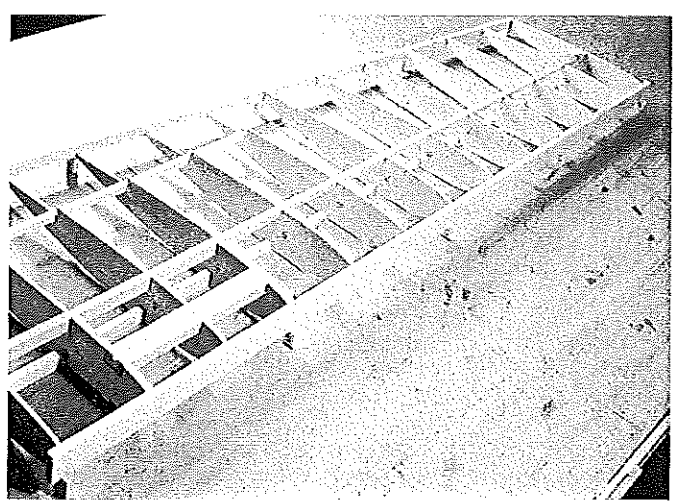
Cowling is built up between nose ring and firewall, taken off for interior shaping and finishing, then mounted permanently.



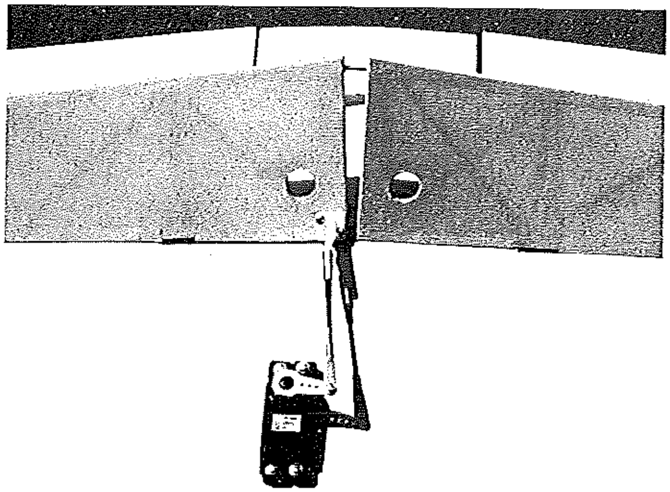
Built-up formers slip into various notches to provide good alignment and accurate fuselage assembly.



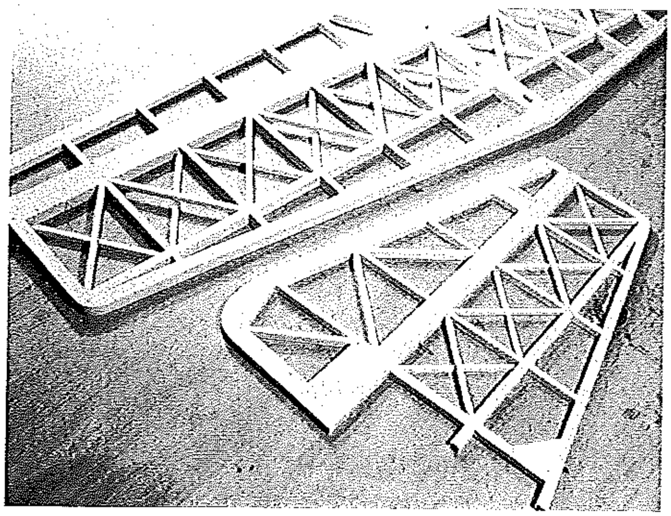
Note split hold-down plate to provide for aileron pushrods. Antenna tunnel makes receiver installation easy.



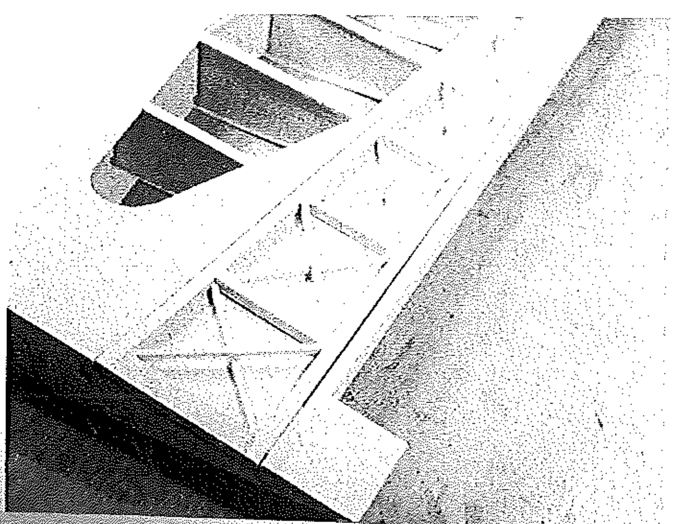
The bottom side of the wing is completed first, with the wing on jack blocks. Large D-tube provides rigid structure.



The secondary flap is actuated by a rigid connecting wire, which must be free to slide in and out of the flap.



Horizontal and vertical stabilizers complete. Diagonal bracing also helps to provide rigidity required for block-sanding.



Wing structure with flap frame dropped into well. Diagonal bracing required because of large torsional loading on flaps.

building the nose up, apply waxed paper to the firewall area, remove the cowling to finish the interior, then reattach it after hooking up fuel lines, linkages, etc.)

Wing: Select medium/light wood for the ailerons, medium wood for ribs and leading edges, and firm, straight-grained wood for the aileron spars. Sheeting for the leading edge D-tube should be pliable balsa. Use spruce or similar hardwood for the wing spars. Select straight-grained wood—the straightest pieces you can find—for the spars. If the spars have any bow at all, place the bows in opposition at the top and bottom.

Cut the spars and subspars to length. Taper the subspars and glue to the full-length spars. Note that the wing panels are built top-side-down to provide access to the flap wells and the landing gear blocks.

Trace the rib outlines and cut out all ribs, including the aircraft-grade plywood half-ribs (two each side). We used the following method to cut the ribs:

Spray a light coat of adhesive onto the traced rib outlines, apply them to a sheet of medium 3/32 balsa, lightly spray the back of the balsa sheet, and apply that sheet to another matched sheet. Cut out the ribs, peel off the outline, block-sand the paired ribs lightly, then separate the matched ribs before the adhesive sets and identify them. Stack the ribs in proper order on a stub spar. Sand the leading edge of the stack smooth.

Pin an assembled spar over the plan and install the ribs onto it top-down (no glue yet), noting that the wing is upside-down. Slip the other spar into its notches. Glue in the 1/16 balsa tip web member to ensure that spars will remain parallel during wing assembly. Pin the top side leading and trailing edge support blocks over the plan at every fourth rib station. Pin the aileron spar onto its support blocks. Pin the inner leading edge on its support blocks. Pin each rib to the aileron spar and the leading edge.

Using the gauge provided, align each rib vertically, except for the root rib, which is aligned and tilted with the dihedral gauge. Pin the ribs to the main spar as necessary and anchor all rib joints with CyA. Install the plywood half-ribs and the landing gear mounting blocks. Add the wing hold-down bolt reinforcement block, flap well sheeting, 1/4 balsa cap, and end cap. Install the flap leading edge outer spar. Trim/sand the leading edge and aileron spar to rough shape.

Use a block to lightly sand over several ribs until the wing surface is smooth rib-to-rib. Do not oversand and lose the accurate airfoil shape. Install the top leading edge sheeting, using slow-drying glue on the ribs. Add the trailing edge sheet, flap well trim, center-section sheeting, and capstrips. When dry, pull up the wing panel and invert it.

Working on the top surface now, pin down the bottom spar. Block up the trailing edge with the proper supports (different supports for top side and bottom side). Install the joiner guides, servo mounting

DUSTER

Type: RC Sport

Wingspan: 71½ inches

Engine: .40 two-stroke

Functions: Rudder, elevator, aileron, throttle, flap

Flying weight: 7¼ pounds

Construction: Built-up

Covering/finish: Coverite® film and paint rails, and hinge reinforcement blocks. Drill 5/32 through the vertical landing gear block to receive the torque rod of the landing gear (installed after completion of the wing). Mark the ribs with a pen and block-sand as before. Complete the D-tube, trailing edge, and capstrips. Install all spar webs.

Sand the front of the wing panel flush and install the outer leading edge. Glue on the wingtip blocks; shape and sand to profile.

Mark a line on the leading edge to represent the chord line (farthest-forward point on the airfoil). Trim and sand the leading edge to accurate profile, using a template if necessary, and leave the chord line mark as intact as possible. Fine-sand the entire wing panel.

Build the second wing panel similarly, but opposite-hand.

Cut rib #1 away for the plywood joiners. Block-sand the wing butts until the joint is accurate at the proper dihedral angle, minimizing gaps. Drill the spar joiners for the wing dowel. Cut the root ribs from the leading edge to the spar group on both sides for the wing dowel. Epoxy plywood joiners and the wing dowel in one side. Trial-fit the opposite-side wing panel. Mate the other side, apply epoxy, push together, and block up for proper dihedral angle.

Locate the landing gear slot by applying the outside portion of the rib template and marking it. Cut the slot to the required length. Trace around the landing gear hold-down brackets and cut to inset them into the sheeting to the pine block. Cut away the trailing edge to clear the aileron actuation system and install.

Cover the center section with a two-inch-wide strip of fine glass cloth and soak in CyA. Mate the wing to the fuselage by running strips of masking tape along the wing at the contact area. Coat the tape with lipstick and fit it to the fuselage. Remove the wing and cut away areas of the fuselage that show lipstick. Repeat this process until the fit is clean and snug. Build up the bottom wing fairing.

Mate the wing to the fuselage again, check alignment, mark the location of the hold-down bolts, and drill and tap for them. Open the hole through wing to ¼ inch. With a wing dowel hole already in the leading edge (you may want to clean this hole out with a drill), place a small piece of modeling clay on the fuselage former at the leading edge of the wing cutout. Install the wing, then remove it. You can read where to drill for the wing dowel. Install the dowel in the wing, then recheck the fit.

Cut aileron strips to length, taper the inner edge as shown to allow proper deflection, then smooth them up with a sanding block. Cut out and drill for the aileron links.

The wing and ailerons are ready to cover.

Empennage: The end-to-end triangulation normally used in lightweight built-up tail surfaces does little to enhance torsional strength. The truss system used on this model provides good resistance to torsional forces because it consists of bilateral triangulation.

Vertical stabilizer: Use very stiff wood for the major fin spar; all other wood can be medium/light. Pin down the main spar and the forward spar, which are equidistant. Note that the forward spar and the leading edge extend through the horizontal stabilizer.

Install the horizontal members and all of the lower truss diagonals, being certain to alternate direction. Install the upper truss diagonals, the leading edge, and all ribs. Build the rudder abutting the fin.

Horizontal stabilizer: This member can be built one side at a time, but the two main spars must be continuous. Select very firm wood for the rear stabilizer spar and its joiner.

Cut both spars to full tip-to-tip length and pin down. Add the fore and aft members. Notch the center members to receive the fin spars before pinning down. Add the lower level of truss diagonals, being certain to alternate direction, then install the upper level. Add the leading edge and all ribs.

Build the elevator, including the pine joiner, against the stabilizer. Epoxy the joiner in place. Raise the trailing edge 1/16 inch with shims to match the main spar during assembly.

After the major empennage assemblies have dried/cured, pull them up and block-sand each side smooth. Sand the leading edges and tips round. Taper the rudder and elevator to proper profiles.

Preassembly: With the wing mounted and the fuselage sitting on the bench with the tail propped up so that the bottom nose sheeting is in full contact with the bench, fit the horizontal stabilizer to the fuselage and trim/block-sand the seat until the stab sits parallel to the bench. Prefit the fin, using a triangle to check verticality.

We used Coverite's 21st Century films with BalsaRite for good adhesion of the film. Coverite spray paints were used for inside the cowling, etc. Follow directions for application closely.

The main ingredient for success and long-lasting film application is to install the film under tension by pulling it and tacking it at many places around a panel. After a panel has been covered, do not soften the edges—this will relax the built-in tension.

Install all hinges and horns. For a model of this size, we recommend Klett-type hinges, installed with epoxy. We used a Great Planes 10-ounce tank and an Ernst Super Mount 40 (#118) engine mount. We used standard Airtronics servos #94102 and their Module transmitter, which is configured ideally for flap actuation.

Check the balance point carefully, moving the battery or adding ballast if necessary. Check for free-and-proper movement of all control surfaces.

Flying: The basic flight regime of the Duster is comparable to any .40 trainer, from which there will be no problem at all in transition.

There is only one unusual flight area that Duster is capable of: the very low-speed area, where most trainers cannot go. As the flight speed of any model diminishes, the less authority ailerons will have in turning, and the more important rudder becomes. In fact, overuse of ailerons in turns can lead to undesirable tip-stall. The slower you fly, the more you should use rudder to keep the wings level. A good compromise, if you are not used to using the left stick, is to use Coupled Aileron and Rudder for low-speed flight.

Duster has the capability to do standard maneuvers well, and it flies inverted. With the flaps fully deployed, the Duster will fly very slowly. In a light breeze, the model will seem to hover. With the flaps positioned ahead of the strip ailerons and close to the Aerodynamic Center and CG, there is little ballooning with application of flaps. While the flaps add desirable drag to steepen the landing approach and a little extra lift for slower flight, there is no drastic trim change to worry about, and stall stability is improved.

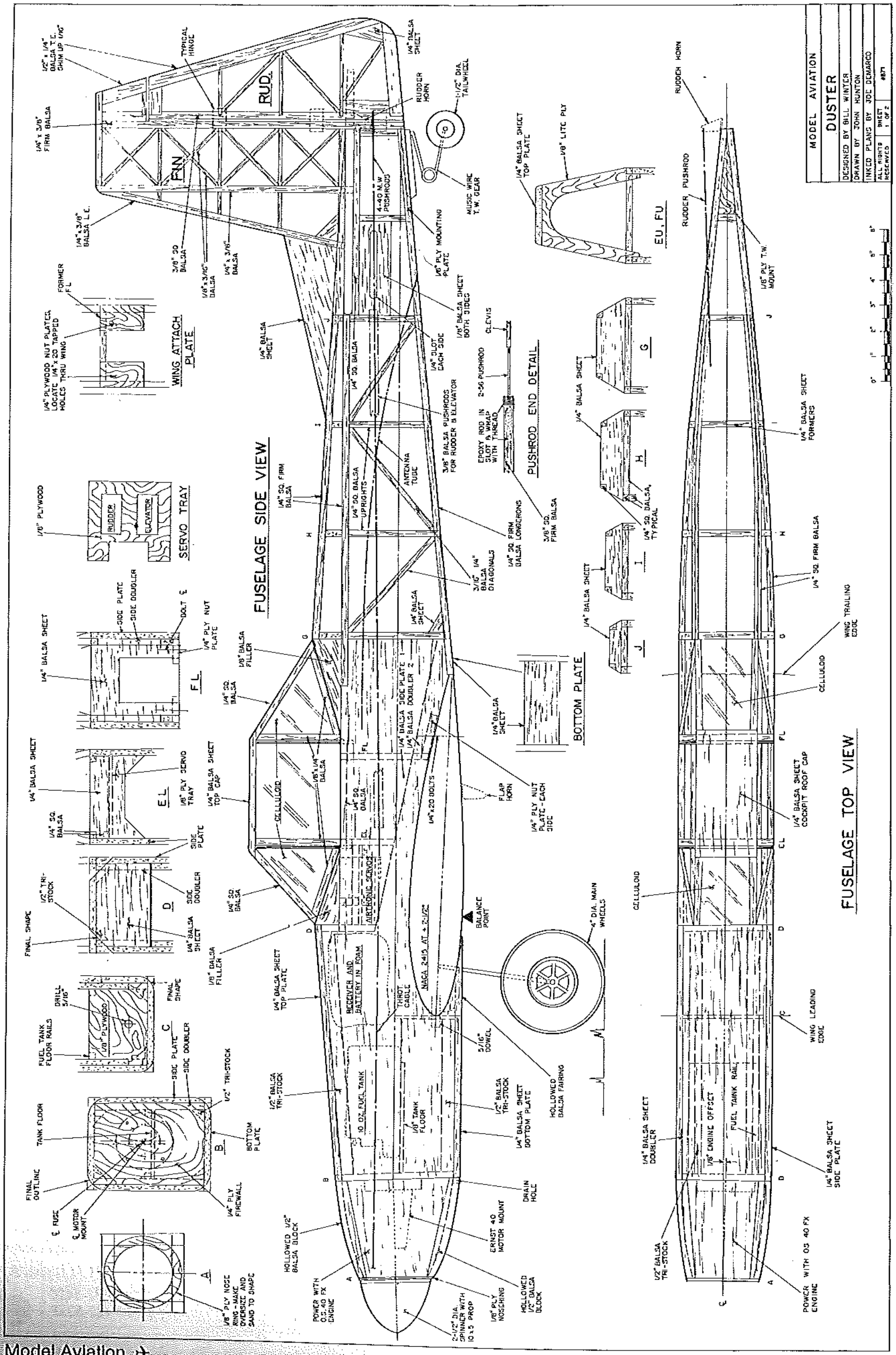
If Duster is flying in a properly trimmed condition at cruise, and the flaps are deployed, the model will balloon somewhat because of the additional lift. Let the model settle into its new trimmed speed, which will be much slower than cruise. There is no need to retrim if you change speed to compensate for the flaps.

Takeoffs are a bit unusual in that Duster will lift its tail, but do not be alarmed; this is just because of the incidence setup. As with any tail dragger, use some *up* elevator for the initial run, but let off elevator to keep from taking off prematurely. When you have speed up, lift Duster off the ground with a little, or it will take off by itself quickly with flaps half-deployed.

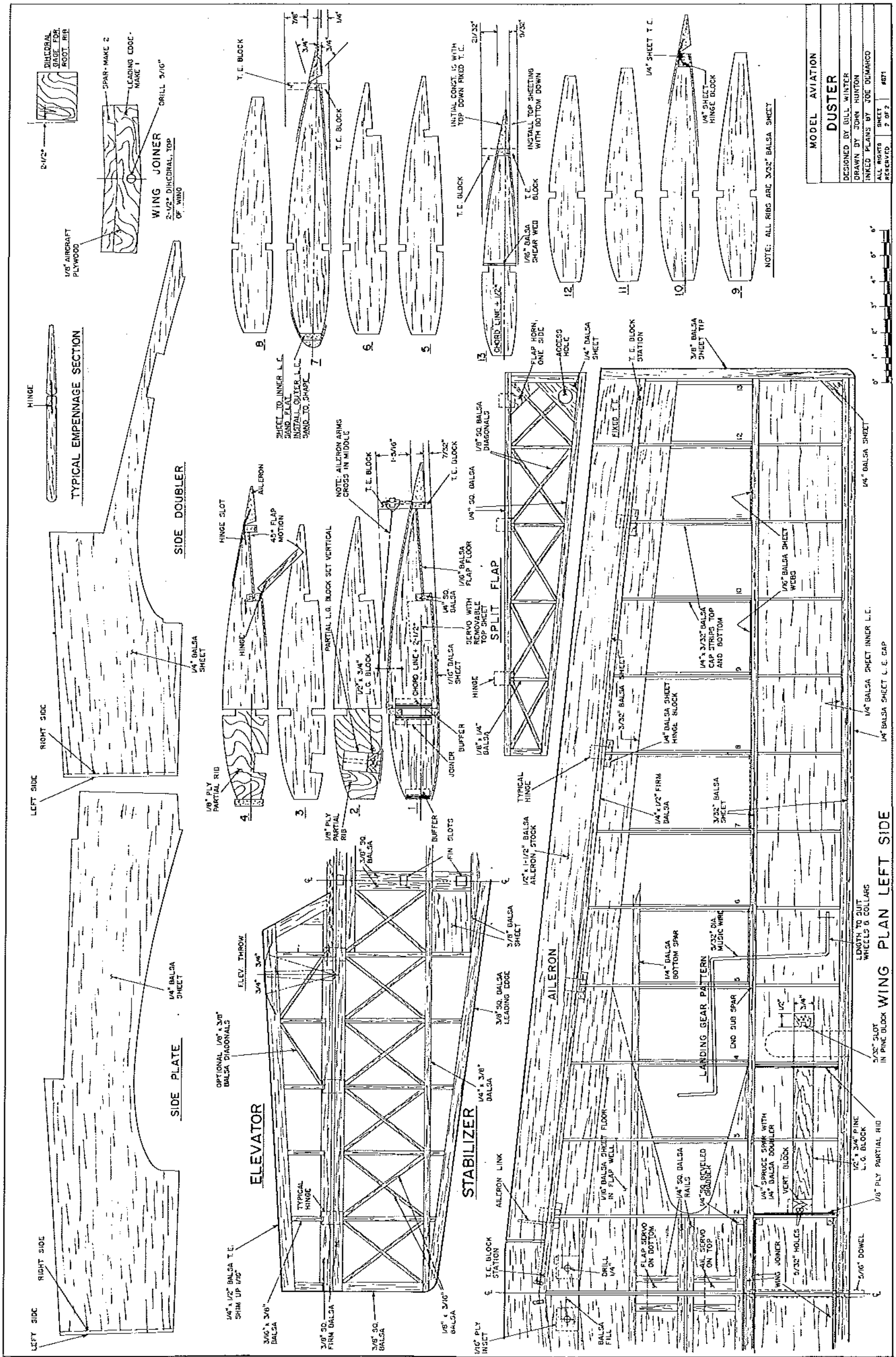
Duster can land shorter than any trainer-type model. With full flaps, the approach to landing can be made at a much steeper angle than normal. The flap does not allow the model to pick up excess speed. While most modern models can take off and climb at a steep angle, Duster can land out of a steep angle. This is a truly balanced STOL-type model. ✈

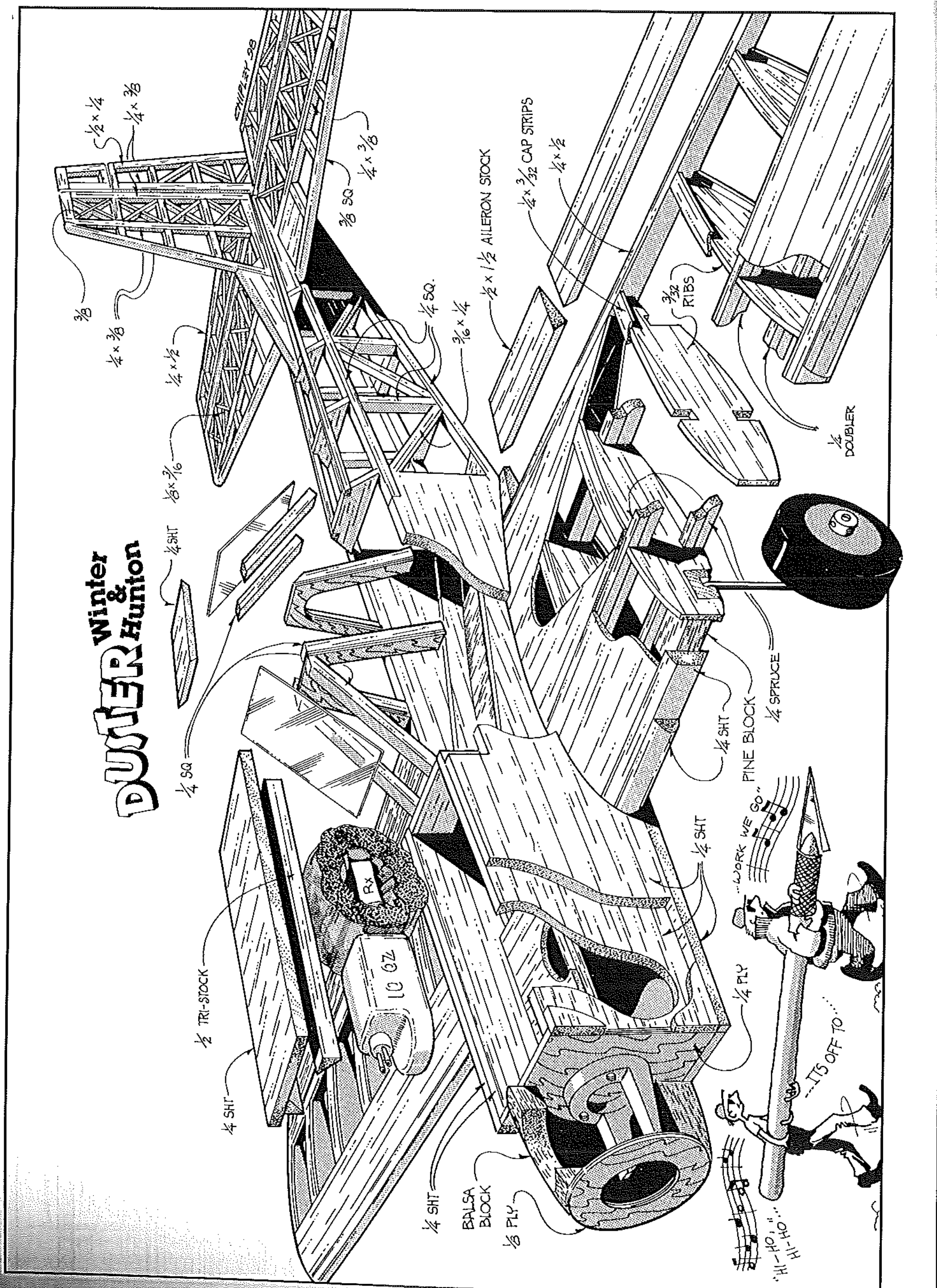
Bill Winter
1912-1998

John Hunton
9154 Rixeyville Rd.
Rixeyville VA 22737


MODEL AVIATION
DUSTER
DESIGNED BY BILL WINTER
DRAWN BY JOHN HUNTON
INKED PLANS BY JOE DEMARCO
ALL RIGHTS RESERVED
SHEET 1 OF 2
#871
FUSELAGE SIDE VIEW
FUSELAGE TOP VIEW
FIN
RUD.
TYPICAL HINGE
1/2" x 1/4" BALSA T.E. SHIM UP 1/16"
1/4" BALSA SHEET
1/4" x 3/8" FIRM BALSA
1/4" x 3/8" BALSA L.E.
3/8" SQ. BALSA
1/8" x 3/16" BALSA
1/4" x 3/16" BALSA
RUDDER HORN
1-1/2" DIA. TAILWHEEL
MUSIC WIRE T.W. GEAR
4-40 N.W. PUSHROD
1/16" PLY MOUNTING PLATE
1/16" BALSA SHEET BOTH SIDES
1/4" SLOT EACH SIDE
1/4" BALSA SHEET
1/4" SQ. BALSA
3/8" BALSA PUSHRODS FOR RUDDER & ELEVATOR
ANTENNA TUBE
1/4" SQ. BALSA UPRIGHTS
1/4" SQ. FIRM BALSA
3/8" SQ. FIRM BALSA
1/4" SQ. FIRM BALSA LONGERONS
3/16" 1/4" BALSA DIAGONALS
1/8" BALSA FILLER
1/4" SQ. BALSA
CELLULOID
1/4" BALSA SHEET TOP CAP
1/4" BALSA SIDE PLATE
1/4" BALSA DOUBLER 2
1/4" SQ. BALSA
1/4" x 20 BOLTS
FLAP HORN
1/4" PLY NUT PLATE - EACH SIDE
AILERON SERVO
BALANCE POINT
NACA 2415 AT + 2-1/2°
RECEIVER AND BATTERY IN FOAM
THROT. CABLE
1/4" BALSA SHEET TOP PLATE
1/8" BALSA FILLER
5/16" DOWEL
HOLLOWED BALSA FAIRING
4" DIA. MAIN WHEELS
1/2" BALSA TRI-STOCK
10 OZ. FUEL TANK
1/8" TANK FLOOR
1/2" BALSA SHEET TRI-STOCK
1/4" BALSA SHEET BOTTOM PLATE
DRAIN HOLE
ERNST 40 MOTOR MOUNT
HOLLOWED 1/2" BALSA BLOCK
POWER WITH O.S. 40 FX ENGINE
2-1/2" DIA. SPINNER WITH 10 x 5 PROP
1/8" PLY NOSERING
CLEVIS
2-56 PUSHROD
EPOXY ROD IN SLOT & WRAP WITH THREAD
PUSHROD END DETAIL
1/4" BALSA SHEET TOP PLATE
1/8" LITE PLY
EU, FU
1/4" BALSA SHEET
G
H
I
J
1/4" SQ. BALSA, TYPICAL
BOTTOM PLATE
1/4" PLYWOOD NUT PLATES LOCATE 1/4" x 20 TAPPED HOLES THRU WING
FORMER FL
WING ATTACH PLATE
1/8" PLYWOOD
RUDDER
ELEVATOR
SERVO TRAY
SIDE PLATE
SIDE DOUBLER
BOLT
1/4" PLY NUT PLATE
FL
1/8" PLY SERVO TRAY
EL
1/2" TRI-STOCK
D
FINAL SHAPE
DRILL 3/16"
1/8" PLYWOOD
FUEL TANK FLOOR RAILS
C
1/2" TRI-STOCK
TANK FLOOR
BOTTOM PLATE
B
FINAL OUTLINE
1/4" PLY FIREWALL
FUSE
MOTOR MOUNT
A
1/8" PLY NOSE RING - MAKE OVERSIZE AND SAND TO SHAPE
RUDDER PUSHROD
1/16" PLY T.W. MOUNT
1/4" BALSA SHEET FORMERS
WING TRAILING EDGE
1/4" BALSA SHEET COCKPIT ROOF CAP
WING LEADING EDGE
FUEL TANK RAIL
1/8" ENGINE OFFSET
1/4" BALSA SHEET DOUBLER
1/4" BALSA SHEET SIDE PLATE
POWER WITH O.S. 40 FX ENGINE

Full-Size Plans Available—see page 173




DUSTER
Winter & Hunton
1/4 SHT
1/8 x 3/16
1/4 x 1/2
1/4 x 3/8
3/8
1/2 x 1/4
1/4 x 3/8
SHIPLEY 98
1/4 x 3/8
3/8 SQ
1/4 SQ.
3/16 x 1/4
1/2 x 1 1/2 AILERON STOCK
1/4 x 3/32 CAP STRIPS
1/4 x 1/2
3/32 RIBS
1/4 DOUBLER
1/4 SPRUCE
PINE BLOCK
1/4 SHT
1/4 SQ
1/2 TRI-STOCK
Rx
10 OZ
1/4 SHT
1/4 SHT
1/4 PLY
1/4 SHT
BALSA BLOCK
1/8 PLY
...WORK WE GO
...ITS OFF TO
"HI-HO," HI-HO...