The Tern

Performance On A Budget!

Bill Winter's .28 Powered Sport Flier

By Bill Winter

Plans And Flight Test By John Hunton

Field Photos By Bernie Stuecker

Tern is an airplane whose time had come. It is not a "fashion figure" because emphasis is on its flight envelope and handling. After viewing a flight demonstration tape, your editors approved Tern as a project because of how it flies. Since form follows function: outlines only bow to basic cosmetics. When it comes to flying, it is a feisty critter.

In searching for an "optimum flying airplane," I have asked myself myriad questions: "Is it possible to have a toss-around aerobatic machine that is also trainer stable and stays where it is put?" "Can hands-off flight dihedral be employed without detracting from aerobatics?" "How fast?" "How sensitive?" The result is not a primary trainer. Tern is easy to fly, but it is for people who have soloed.

Provided that one determines precisely what is wished in every respect from take-off to landing, it is feasible to write a prescription for performance which is based on hands-on experience. There are many fine model airplane designs of all types, but the aim of this design is to tailor one popular type precisely to optimize the result.

The .28 powered Tern is a happy combination which is sized between the .40 jobs and the .15s. Tern is just as capable as the bigger .40 models with its 18 oz. wing loading, but it is simpler, quicker, more transportable, less expensive, and actually more crashworthy than a bigger ship. Compactness and proper mass distribution are important for the desired handling.

The technical details are: aspect ratio of 5.3, 580 sq. in. wing area, an NACA 0015 fully symmetric airfoil (the same family of foils that was used for the B-17) set at 2° positive, a compact tail moment arm with a horizontal stabilizer area of 130 sq. in. (22.5% of the wing area), a vertical fin area of 8% of the wing area, a long, high nose with slight down thrust (to minimize power variation tran-

THE TERN

Designed by:
Bill Winter

TYPE AIRCRAFT
Sport

WINGSPAN
54-1/2 Inches

WING CHORD
10-5/8 Inches

TOTAL WING AREA
579 Sq. In.

WING LOCATION
High Wing

AIRFOIL
Symmetrical

WING PLANFORM
Constant Chord

DIHEDRAL, EACH TIP
1-5/8 Inches

OVERALL FUSELAGE LENGTH
36-1/4 Inches

RADIO COMPARTMENT SIZE
(L) 10" (W) 3-1/8" (H) 3-3/4"

STABILIZER SPAN
21 Inches

STABILIZER CHORD (inc. elev.)
6 Inches (Avg.)

STABILIZER AREA
126 Sq. In.

STAB AIRFOIL SECTION
Flat

STABILIZER LOCATION
Top Of Fuselage

VERTICAL FIN HEIGHT
7-3/4 Inches

VERTICAL FIN WIDTH (inc. rud.)
5-3/4 Inches (Avg.)

REC. ENGINE SIZE
.28

FUEL TANK SIZE
6 Oz.

LANDING GEAR
Conventional

REC. NO. OF CHANNELS
4

CONTROL FUNCTIONS
Rud., Elev., Throt., Ail.

C.G. (from L.E.)
3 Inches

ELEVATOR THROWS
5/8" Up — 5/8" Down

AILERON THROWS
3/8" Up — 3/8" Down

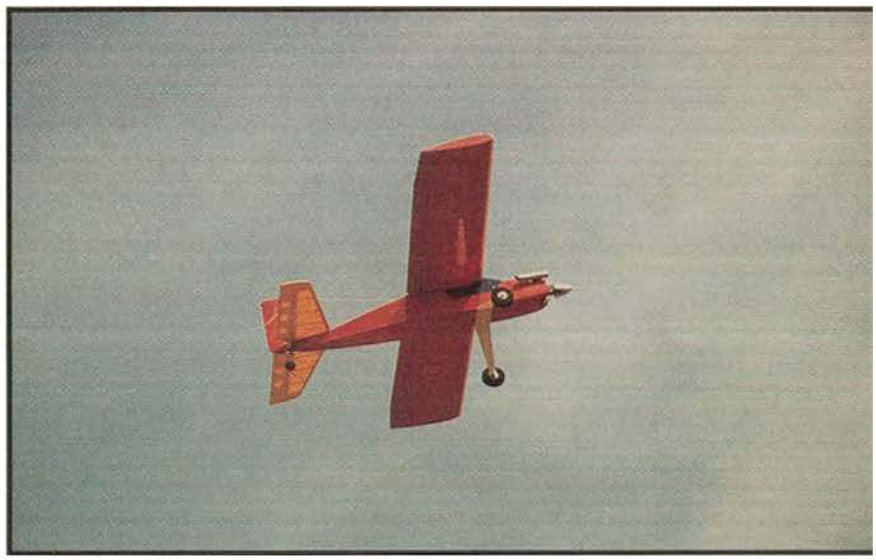
RUDDER THROWS
1" Left — 1" Right

SIDETHRUST
NA

DOWNTHRUST/UPTHRUST
NA

BASIC MATERIALS USED IN CONSTRUCTION

Fuselage ..... Balsa, Ply
Wing ..... Balsa, Ply, or Optional Foam Core/Balsa
Empennage ..... Balsa
Wt. Ready To Fly .. 73 Oz. (4 Lbs. 9 Oz.)
Wing Loading ..... 17.8 Oz./Sq. Ft.



sients), "overstable" rigging with the C.G. at 27% of the chord, 2-1/2° of dihedral, all coming together to make the Tern as harmonious in every respect as possible.

Tern has the right balance between sensitivity and smoothness with small area maneuverability. It will turn without dropping its nose because of the relatively high forward profile and low rear profile, also because of the thrust line, C.G., and decalage relationships. All of these and

Tern sits at an ideal angle for easy take-off and landings. The 15% thick symmetric airfoil is from the NACA series used on the B-17. Prop is 10 x 5 antique Master Airscrew.

other aerodynamic "tricks" are common knowledge, but how they are combined is equally as important.

The short tail moment facilitates pretty free-style, off-the-cuff maneuvers, close-in and low-down if you are given to hot-dogging. All formal stunts — loops, inverted, rolls, outsides — are nimble and precise, and to ice the cake, an 83 year old can reduce power to cruise and enjoy. Some may wonder about the lack of a long tail moment, considered essential by some for good directional stability. I prefer adequate directional stability, yes, but too much is overkill, showing up in certain maneuvers on a windy day.

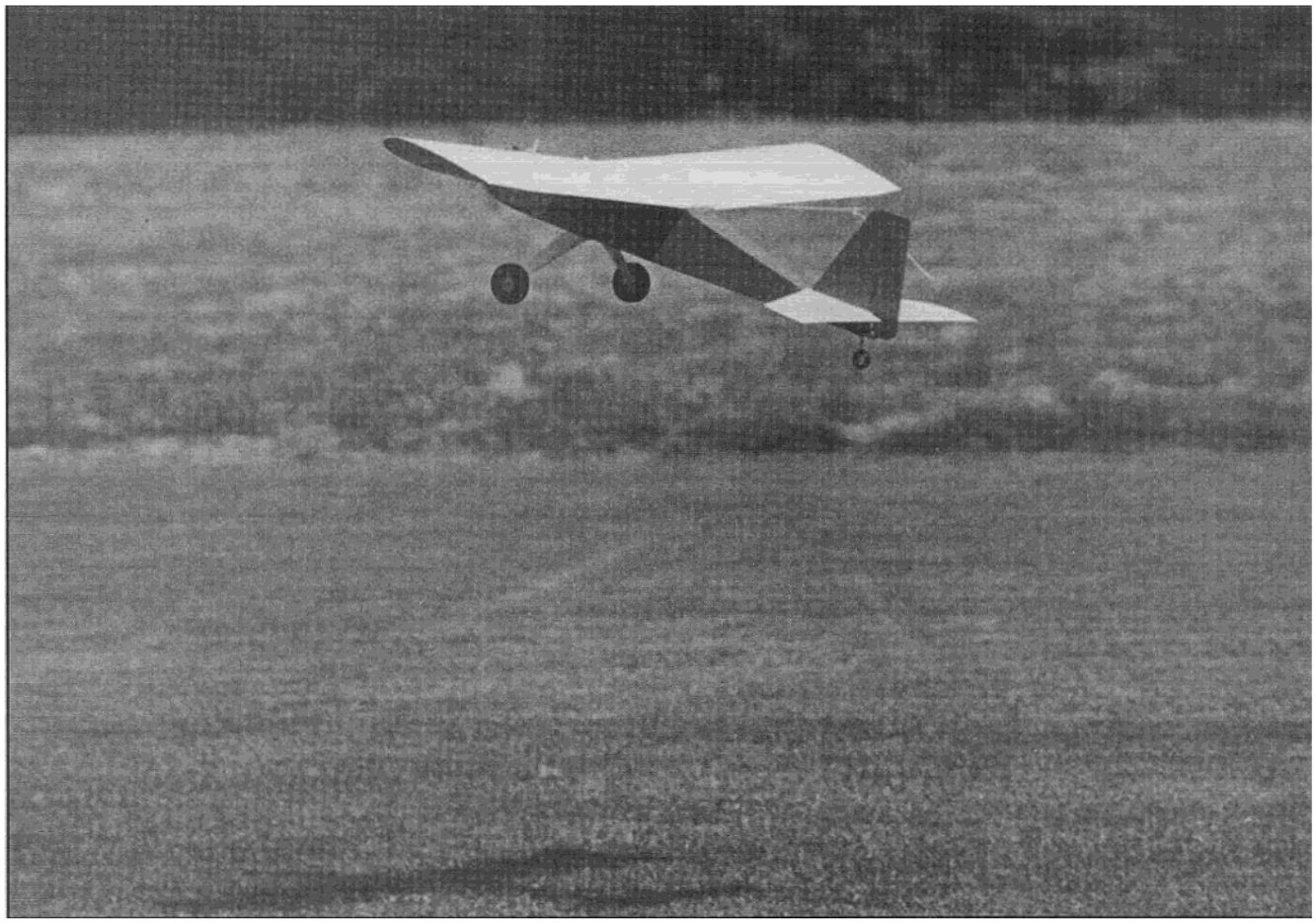
CONSTRUCTION

Careful wood selection is vital for minimum weight. Consider that if a cubic foot of balsa was required to build the model, the wood weight would be 4-6 lbs. if light wood was used. That weight would probably be doubled if all hard balsa was used. Fuselage sides, doublers, and all blocks must be quite light (but not mush). Sheeting can be light. Longerons are medium. Wing leading and trailing edges and aileron spars are medium, wing skinning is light. Stab and fin spars are hard, with medium leading edges and light cross members.

Fuselage:

Sides are 1/4" sheet, back to the wing trailing edge. Longerons run aft to the rudder hinge line. Note how the longerons

Generous tail feathers contribute to rock-steady trainer stability in a very agile aircraft. Moderate dihedral in this configuration does not detract from formal aerobatics.



Quick take-offs are a forte. Note that control surfaces are already neutralized. Foam wing — built-up for optional — with open skinning ensures accuracy of foil from tip to tip.

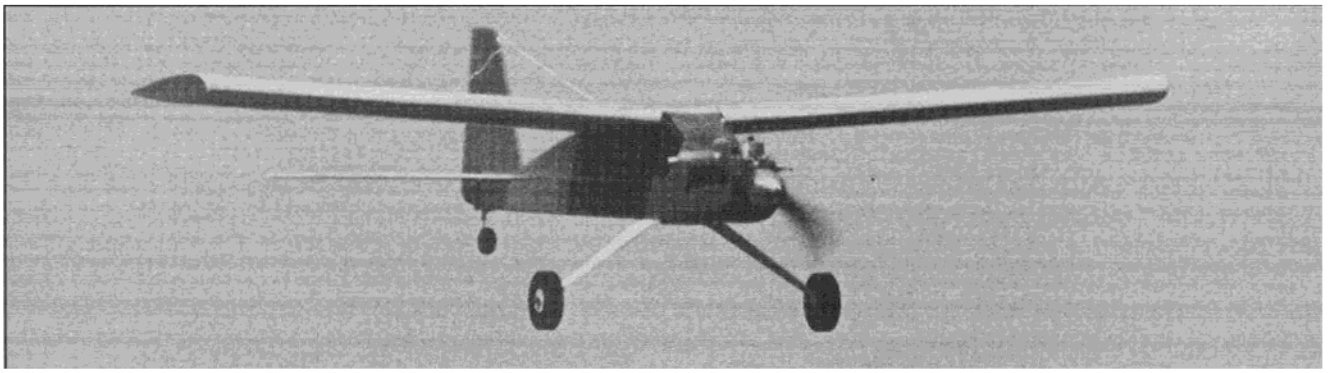
are let into the forward sheet portion. Assemble each fuselage side on wax paper over the plan. Butt glue 1/4" sheet to build up the required sheet widths. Patterns are given for the 1/4" sheet inside doubler which butts and structurally traps the fire wall and main cabin former. Use spray-can adhesive (3M suggested) for laminating.

Before joining the sides together, prepare the 1/4" ply fire wall, 1/4" ply landing gear plate (drill for and install required blind nuts for these parts), and 1/8" ply cabin former. Note that aft of the landing gear mounting plate, the sides butt against a 3" wide balsa bottom sheet; whereas, forward of the gear, the bottom sheet is 3-1/2" wide and extends to the outer surface of each side. Position and glue the cabin former to one side, aligning it accurately with a triangle (do not use the fire wall for initial alignment because of the thrust offsets). Install the fire wall.

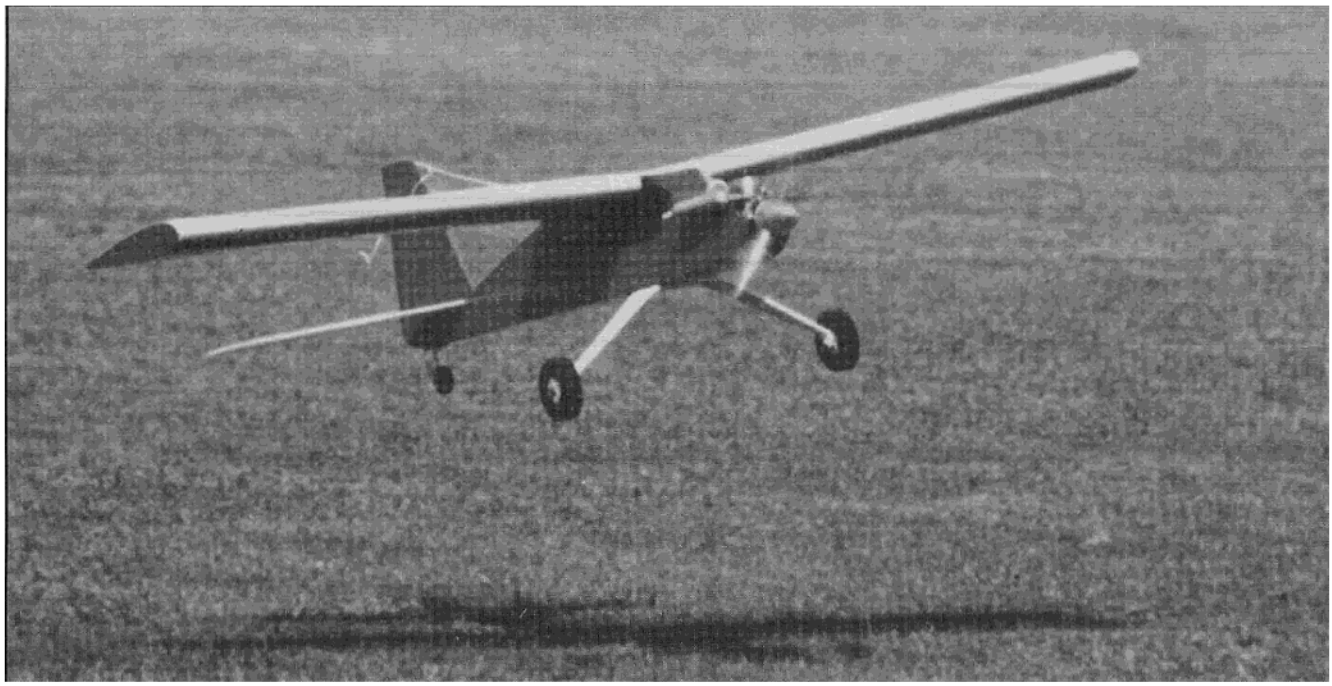
> "Is it possible to have a toss-around aerobatic machine that is also trainer stable and stays where it is put?"

Ends of all crosspieces should be trued by placing the end at the edge of the bench and dressing with a fine sanding block. Trial fit all crosspieces. There is one admonition: One of the prime causes of misaligned wings and tails, and the resulting trim compromises, is failure to get the rudder post precisely over the centerline. To guard against this, the fuselage should be fastened down over the top view plan, the tail ends of the sides pinned, but not glued. Check vertical alignment with a triangle. When satisfied that everything is right-on, glue the ends together.

For the rear fuselage crosspieces, you may match the drafted alignment or just let the sides take their natural bend, provided the sides bend equally, and begin



Coming at camera slightly nose-down reveals the low-cabin wing position to minimize trim requirements — also reduces drag. You can hide antenna if you wish.



Tern can be landed in a slowed, nose-up attitude for a perfect three-pointer without any risk. It turns here toward camera.

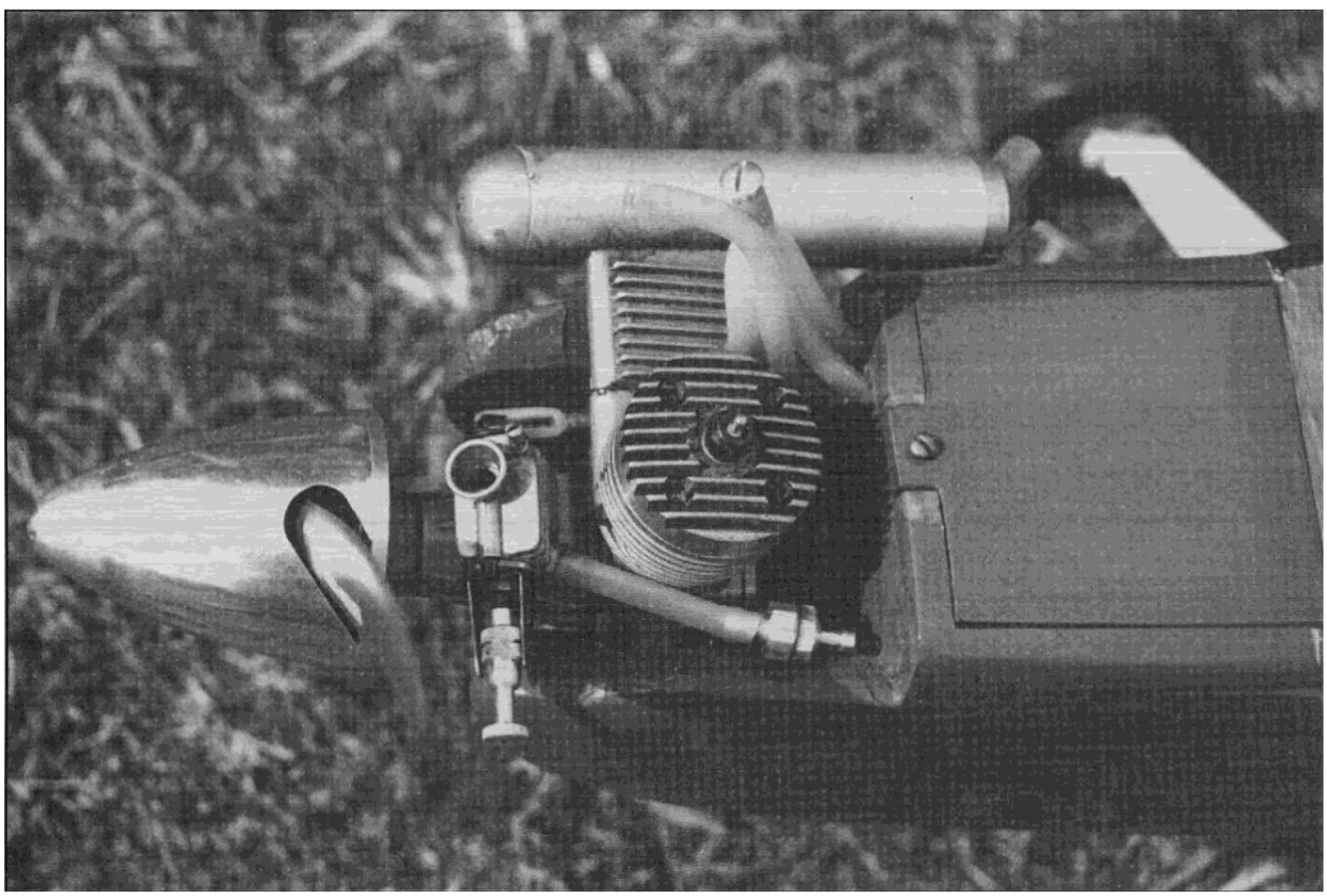
with crosspieces halfway between the wing TE and tail post.

Cut and trial fit the 1/2" thick soft balsa top and windshield blocks. The thickness facilitates shaping. Note the hollow line on the side view. Do not glue into place yet.

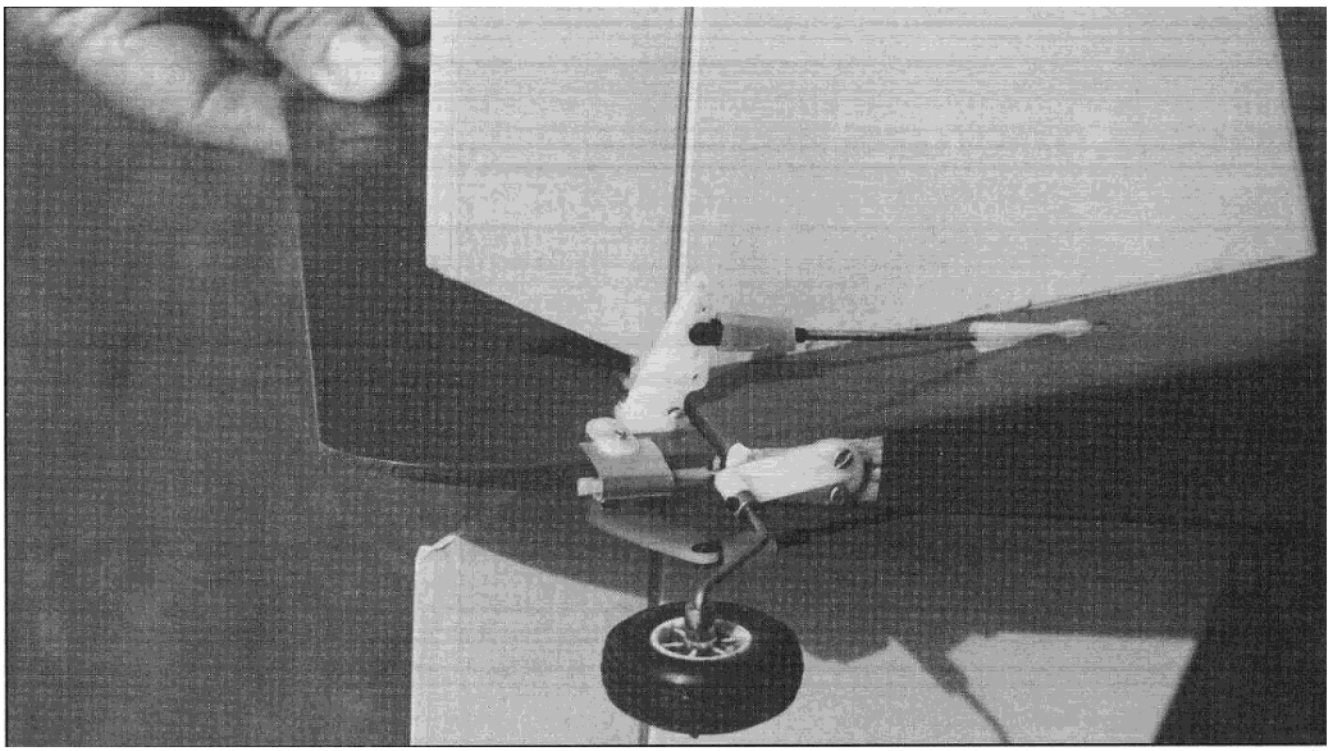
After the wing is built and before the fuselage is finished, bolt the wing into place, and while holding it down at the leading edge, bore the dowel hold-down hole from the front of the cabin former into the wing, being careful that the drill is held straight. Begin with a small drill and progressively work to a 1/4" diameter to minimize damage to the plywood. For the rear hold-down, drill 3/16" holes with the wing in place and tap the block to accept 1/4-20 bolts. Drill the wing holes to 1/4" with clearance for the dowel.

When this task is completed, glue on the nose and windshield blocks. Epoxy the landing gear mount block into place. A Klett landing gear is shown because it is trouble-free and recovers its shape nicely.

The Du-Bro steel wire pushrods (No. 102) are aligned for perfectly straight runs and cross to opposite sides



No frills, fully accessible installation of K&B .28 Sportster. Three-line fuel system shown. Hatch permits quick inspection for pinched lines, etc.



Mechanics of horns and taildragger tail wheel. Note holes used in the long horns for control. Tiller covered with plastic sheath to avoid metal-to-metal contact with bracket.

as shown on the plans (if free floating balsa pushrods are your preference, use firm 5/16" sq. and arrange them to avoid conflict). The one-piece 1/4" plywood wing hold-down plate releases better than the more typical separate blocks.

Shape the nose before final fuselage sanding with medium/coarse grit to hog it to shape, then use finer grades for the complete fuselage as desired.

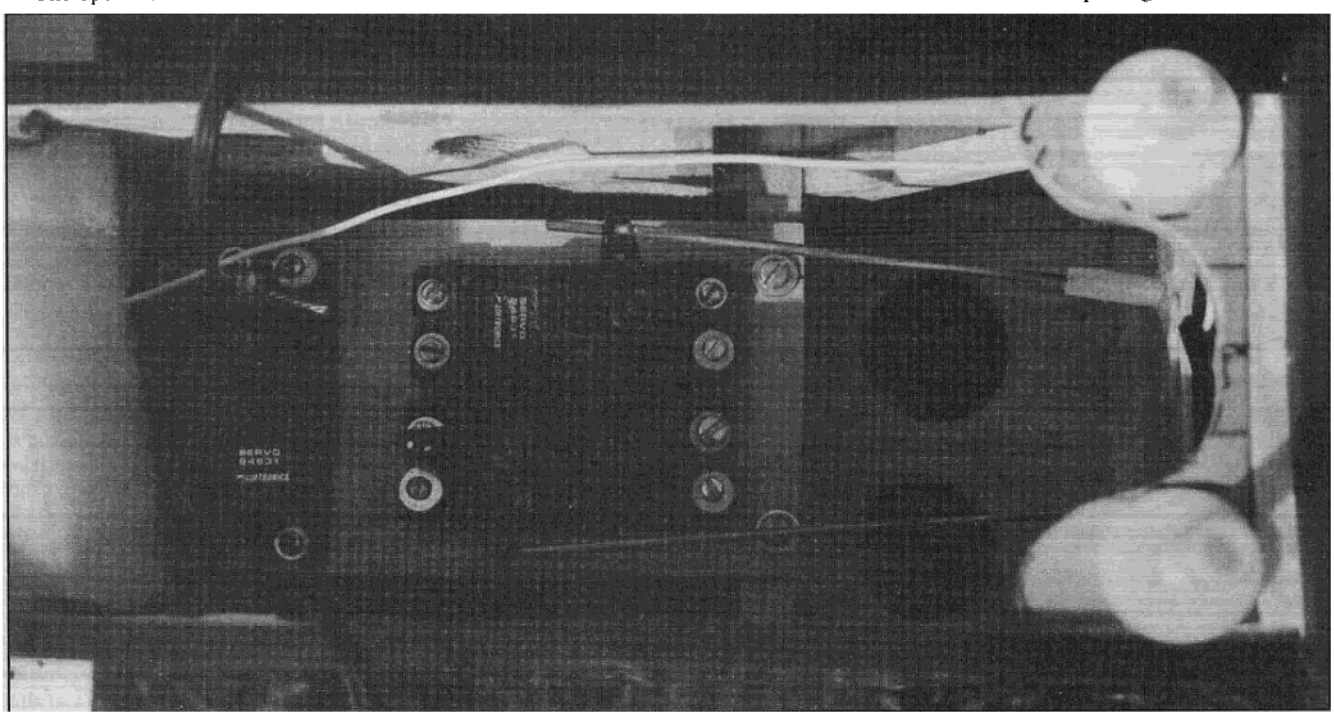
Tail Surfaces:

The open frames are assembled flat on the bench in the usual way. Remember that it takes three times as much ballast weight in the nose to offset tail heaviness, so wood selection is nowhere more important than for the horizontal and vertical tail surfaces. The sheet elevator must be light wood. Block sand the elevator and rudder to the cross sections shown, a knife-edge taper is not desirable.

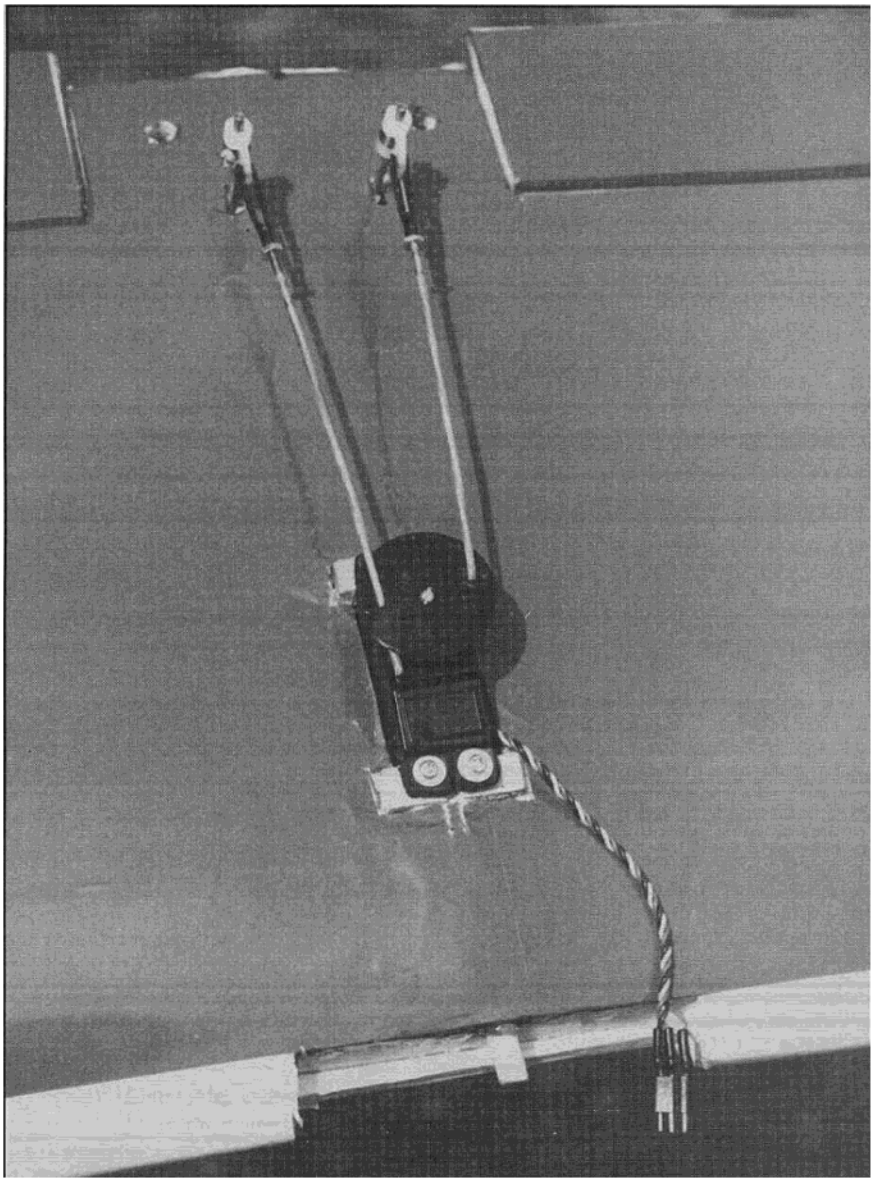
Rocket City nylon hinges were used on the prototype. Insert hinges into slits cut with a No. 11 X-Acto blade and secure them with a drop or two of instant CA on each side. Make the slits before covering the surfaces. After covering, expose a bit of wood at each slit. Also drill for the horns before covering. When installing tail surfaces, be sure to remove the covering at mating surfaces to provide wood-to-wood contact for gluing.

Wing:

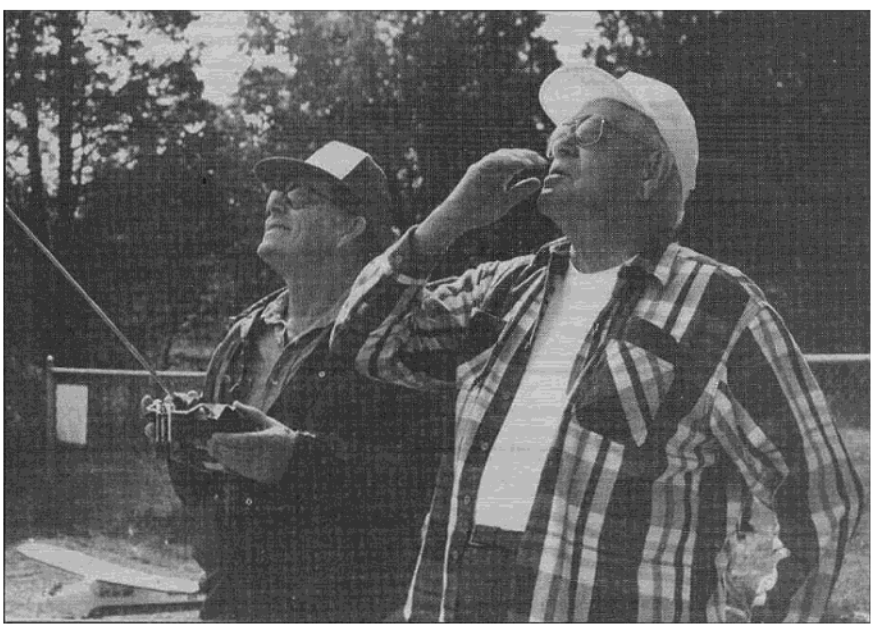
A foam core, open skinned (with capstrips) wing was used on the prototype (an alternate built-up wing is also shown on



Two-plus-one arrangement of standard Airtronics servos on removable plywood tray. One piece hold-down screw block would release well in cartwheel (ship never has, however).



Conventional mounting of single aileron servo. Designer favors generous sized ailerons, use of smaller stick movements. Note locknuts on clevis arms and recommended Z-bends.



Winter, right, seems concerned as Hunton seems pleased in stretching the flight envelope.

the plans). Foam cores are available from a number of manufacturers whose ads detail ordering information. Select pliable 1/16" balsa sheet for bending over the forward portion of the profile curvature. The skins can be applied with any advertised skinning adhesive, with spray-on adhesive (be sure it is compatible with the foam), or with thin transparent two-sided tape such as Core-Film. Also there are instant glues, such as UFO, which do not attack foam. Our friend Bill Evans (Evans Aircraft) cut our cores (he has the profiles), provided Core-Film, and X-hinge for the ailerons (these tape hinges seal the aileron hinge-line gap). Granite State R/C Products also has iron-on hinge material.

Attach the inner leading edge and trailing edge aileron spar parts. Sand both edges to conform to the airfoil shape. The sheet balsa skinning overlaps and is glued to the balsa inner leading and trailing edges. After skinning, the leading edge proper is glued to the front of the wing, then shaped and sanded. Install the capstrips using yellow glue. Note that the portion of the wing which extends beyond the aileron is balsa triangle stock, which is butt glued to the trailing edge, then block sanded for flow-in contours. An important factor in the anti-tip stall flight envelope is "washout," which is sanded into the rear outer portion of each panel as shown on the plan.

Join the wing panels with 30-minute epoxy, after sanding the butt joints flat and at the proper angle. Some precautions: When jointing the root, fasten one panel flat on the bench and block up the other tip for dihedral. If the panels do not dry-fit precisely, block up each panel with its root at the straight edge of the bench and carefully dress the root with a sanding board held squarely against the bench edge. Install the ailerons after joining the wing halves and before covering.

Since the ailerons are solid balsa, the wood must be light. Taper in cross section using a sanding board. Install the ailerons with linkage in place and hinge each with the X-tape which irons on easily. Iron the tape to the wing first, using a few pins to align it so that the sewn seam is at the middle of the aileron spar face. Pin the tape to the ailerons in the same manner,

and pin the ailerons to the wing to position for ironing. Be sure that the ailerons are tight to the wing when ironing. Other hinge systems may be substituted as desired, but X-hinging seals the gaps.

Glue pieces of trailing edge stock to the center section trailing edge to lock the aileron linkage in place. Recess them for the linkage. Be careful not to get glue between the torque rods and their bearings. Install the 1/16" ply plate over the centerline trailing edge section, cracking the plywood to conform to dihedral. Install the center ply joiner at the center leading edge. To recess the leading edge for this joiner, cut through the leading edge with a razor saw at the ends of the joiner. Note that the joiner is installed at a 2° angle to match the fuselage cabin former. Glue the short leading edge pieces back in place after the joiner has been epoxied. The dowel hole is drilled as described earlier, before covering the wing.

To help you build the opposite side built-up wing panel, we suggest spraying the plan with WD-40 which makes it transparent, then build over wax paper.

Covering:

Bright yellow and red Oracolor from Hobby Lobby was used for film covering on the prototype (or use your favorite). Oracolor is applied in a different manner, so trust the instructions. It is pleasant to work with. Be careful not to press hard on wing covering when ironing to avoid accidental sticking to foam between the capstrips.

Flight Tests:

The prototype was flown on 10% fuel and a 10 x 5 Master Airscrew. Preflight the C.G. location and correct if necessary. Initial flight tests on the Winter built "first article" quickly showed that this was a model that handled exceptionally well. I mean rock solid. No nose drop in turns, no trim changes with power changes, minimal trim changes with velocity changes, no twitchiness, no nervousness, just good, solid feedback-filled flight. It has good tracking as in consecutive rolls. This with a model that has a symmetric airfoil and can be wrung out.

As the old instructor said:

"Your airplane."

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