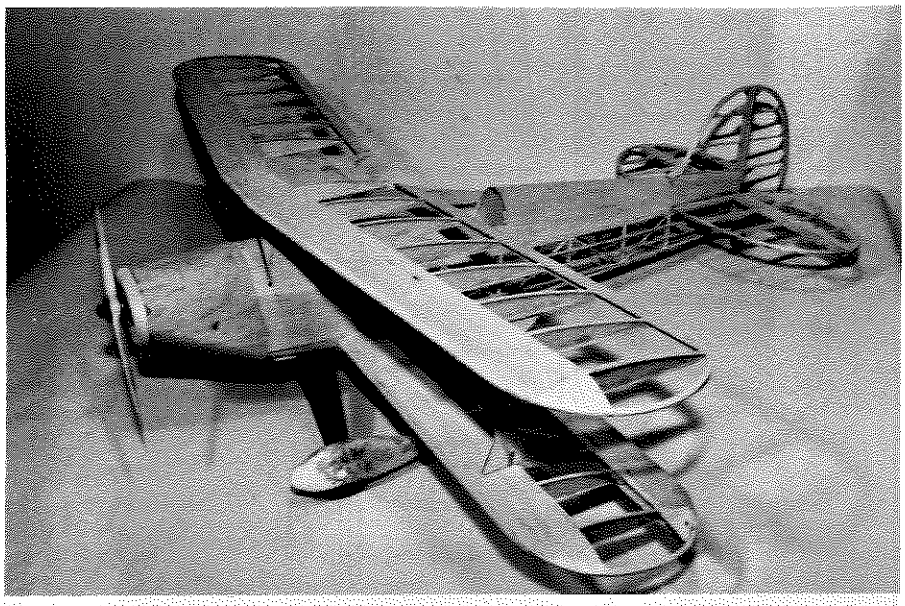
STEEN SKYBOLT

By Johnathon McPhee



The completed Skybolt, test-assembled, and ready for finishing and detailing.

• "Big is beautiful," they say, but I'm increasingly partial to "Small is sensible." I live in a city apartment, drive a small car, and have such trouble storing and transporting large models that I've unloaded most of them. But I still love a good-flying plane, and this "Small Standoff Scale" Skybolt is one.

For a couple of years, until a low-level Split-S re-kitted it, I enjoyed a Sig Skybolt immensely. So what if it ate a buck and a half of fuel on every flight? So what if I had to take it apart and screw it back together every time I wanted to go flying? Climbing axial rolls and occasionally superimposed and symmetrical loops were payback enough, until space and time started to get tight.

I regressed to smaller stuff, schoolyard scale and electric power that freed up those summer evenings from the heavy routine of loading up the car with the big stuff. But I loved the way the Skybolt flew, and an urge to build a more manageable version itched away at me until I produced the plane you see here.

It borrows a lot from Sig's Skybolt, and version one included a lot of Sig's construction details, reduced in scale. But that one weighed some 37 ounces, just too much for my O.S. Max .10 FSR except off a long smooth runway—and it would snap-roll like that if you lost flying speed. Strong construction (it survived a couple of headers into the dirt with practically no damage), but the experience retaught me another lesson: *lighter flies better.*

Mark II, the version you see here, is a major redesign. Sticks instead of sheet, a little extra thought on which structures can be pared down or dispensed with, and a final weight, with a light radio and the .10 FSR, of just 28 ounces. And she flies just like the treasured Sig plane.

Some of the pictures show the heavy version, though the construction details are similar (but much lighter) for Mark II. The principal differences are in fuselage construction (a balsa truss rather than slab sides) and in rib placement, spar dimen-

sions and amount of sheeting on the wing. Believe me, the lighter construction is more than tough enough. Design them to fly, not to crash, and you will crash a lot less and a lot softer—inertia goes up quickly with increased weight, and it's inertia that does the damage.

This is a design for someone who will take pains in building it. You can finish off a Sweet Stik in a couple of evenings, but this one has a lot of little pieces that need to be carefully fit and glued with a minimum of adhesive. Wood selection is very important here too. Ribs should be medium hard quarter-grain, and the wing and fuse sheeting should be light A-grain stock. Select your spruce carefully for straightness and for tight, clear grain. Pick your accessories with an eye to weight too—get the lightest stuff you can. Extra fractions of an ounce left out (or built in) add up quickly to better (or worse) performance.

CONSTRUCTION

Now for the sticking-together part. Let's start with the top wing.

Cut out all the wing ribs using your favorite method. I used a 1/16 ply template, then attacked the cutouts and sanded out the imperfections. Note the different thicknesses called for. Use a simple jig, like the one pictured, to cut a sheaf of spar webs. Slice the 3/32 inner leading edge (LE) to the width shown. Shim the lower spar up 1/16 inch to allow the trailing edge (TE) sheet to lie flat. Don't put the pins *through* the spar but *next* to it or through hard 1/8 scraps straddling the spar. And don't forget Saran Wrap between structure shims and plans.

Pin down the TE sheet and start adding ribs, using Jet or Hot Stuff at the TE and aliphatic glue (Titebond) at the rib-spar joint. Stick a shear web between each rib as you go, and the fitting process will be easier. Sand or trim all the web tops even and to the right depth, then add the top spar. Accuracy in these joints is critical to wing strength. Add the inner LE with Titebond. Cut and fit the scabs and reinforcements in the center section, then add the 3/32 hard balsa spar splices.

Laminated structures are showing up regularly on models now, and that's good. They are a little more work but a lot stronger than large chunks of balsa flying in formation. For the wing tips you need three plies of 1/32 x 5/16 medium soft A-grain balsa, and an inner ply from 1/32 x 5/16 plywood. Use a stripper or straightedge to make same. Make a form the shape of the wing tip (see photo) out of corrugated cardboard and cover the edges with masking tape. Shim the form up about 3/32 above the plastic you laid over the plan. Cut a strip about two inches longer than enough to go around the form. Holding one end, with the balsa strip flat on the table, *gently* rub the side of your knife or similar shape down the strip. Just like "zipping" a Christmas ribbon: it will start to take a curl as you compress the wood fibers.

Now use three or four pins to hold the plywood strip vertically, tight against one end of the form. Keep a couple of pounds' pull on the other end of the strip, and gently pull it around the form. Start adding the balsa strips. You will probably break a few, if you are new to the technique, before you get the hang of it. When all the strips are in place, carefully flow Jet (the "loose" kind) around the top edge of the laminations. When it's kicked, lift the tip bow you just laminated and Jet the other side too. Same principle as fiberglass and resin: Jet is the resin, the wood fibers are the glass. And no waiting overnight for the stuff to dry.

While you're at it, do up forms for the fin/rudder, stab/elevator and access cutout for the top wing TE and knock them out too. A short evening will suffice for all your flying surface outlines.

Now add the tip bows and sand their tops and the outer portion of the inner LE to proper bevels for the wing sheeting. Unless you carefully cut the top bevel on the inner LE before you glued it on, you will have to use a sanding block or razor plane to shape it now. My sanding block is a piece of 3/4 x 2 x 11 clear pine molding that I got as a cutoff at the lumber yard, with 120 and 220 grit aluminum oxide paper rubber-cemented to either side. If you use rubber cement you can replace the paper easily as it dulls. Sandpaper, like all your cutting tools, should be kept sharp. Use Slo-Jet on the gluing surfaces, and if you work fast enough you may be able to get everything lined up before it kicks off. Note that the sheet doesn't completely overlap the spar. This saves weight and allows an extra "dovetail" for the cap strips. While everything is still pinned down, cut and add the top LE sheet (don't trap any pins).

Sand the bottom TE sheet's rear edge to a taper with your sanding block, to blend with the top contour of the ribs, and add the top TE sheet. Please don't sand the ribs, though—all my work plotting the NACA 2415 airfoil will go for naught. Now cut and fit the center rib reinforcements. Use hard balsa, since they take the point loads from the wing attach bolts.

Lift the wing off the plans. Trim the bottom edge off the inner LE and plane or sand to the bevel shown. Fit and glue the bottom LE sheet and cut and fit the center section sheeting. Add the 1/32 x 1/8 cap strips. Sand the LE sheet flush with the inner LE piece, being careful not to round the corners. Cut and fit the 3/32 hard balsa LE, starting with the outer pieces. Sand a flat again even with the inner center LE, then add the center outer LE and sand everything smooth. Carefully shape the LE to the contour called out on the plans. A small template accurately cut to the LE shape from 1/32 ply will help get it right.

The bottom wing carries the ailerons, which complicates the construction. The original aircraft had upper and lower ailerons, joined by a pushrod. I deemed the added work, weight, and drag not worth it. The TE sheet is much wider, to allow cutting out the aileron from the basic structure. Build this wing just like the top one, but don't try to add the aileron spars until you've cut the ailerons free and trimmed them as shown on the plans.

Mark the parting line for the aileron even with the front edge of the aileron cutout spar, then use a straight edge and sharp knife to cut just the sheet surfaces. Now pull the blade out of an old razor saw, or use a double-edge razor blade (carefully!), slid through the two cuts, to sever the ribs. Trim the cutoff piece for the spar, add the hinge point reinforcements, and glue on and sand the spar. Add hinge reinforcements to the wing itself, sand to shape and add the filler spar. Cut the waste off the front and ends of the aileron pieces, add the hinge and torque rod reinforcements, and then the 1/16 spar and tip ribs. Groove the aileron for the torque rod. Mark and pre-drill the holes for the hinge points and torque rod in the ailerons and the wing, taking care not to drill out through the wing or aileron surface. Fit the hinges and torque rod but do not glue. I like Robart's Mini Hinge Points, because they simulate the real hinges and are easy to install.

If you want to save weight, you can build up the ailerons using structure similar to the wing. I tried this first, and they seemed a little too flexible to me. Maybe with the stiff covering like Micafilm they would work all right.

Cut a strip out of the top sheeting for the aileron torque rods. Slip the 1/16 ply bushings onto 1/16 the Du-Bro 1/2A torque rods and bend to shape, observing the angles shown.

Build the tail surfaces over the plans, using pins liberally to make sure that the laminated pieces follow the outlines. Add the various reinforcements and sand to shape. Install but don't glue the hinge points. Note that the front edges of both the elevator and rudder are vee'd to allow clearance for control surface movement. Cut small notches to clear the heads of the hinges so they won't bind. The lower rudder hinge is a small Goldberg/Klett pin-type hinge. It is lined up to clear the tailwheel tiller and be directly under the rudder horn base, so the horn screws will pass through the hinge as well for strength.

The fuselage is a modified truss from 1/8 square hard, stringy balsa with 1/16 x 1/8 hard balsa diagonals. Use Titebond for all joints here, pre-gluing the uprights and crosspieces with a dab allowed to set for a few minutes. Cut out the forward 1/8 medium fuse sheet, noting the indentation at the lower forward corner on the right side for the muffler clearance box. If using an engine other than the .10 FSR, or no muffler, you can omit the little box and the fuse sides will be identical. Build one side over the other, separated by plastic wrap to keep them separate but identical. Be sure to mark the locations of the side stringers on the uprights to ease alignment and installation later. Shape the tailpost ends of the fuse with a sanding block as shown, then join with Titebond and a couple of clothespins while keeping everything square. Drape the front of the fuse top view plan over the end of your workbench. Add the cross-grain 1/4 triangles to the front fuse sides, and sand them flush and smooth. Note the detail drawing showing how to cut the cross-grain triangles from the ends of 1/4 and 3/16 sheet with a razor saw. If your hand is unpracticed, make up a little miter box to guide you.

Square the fuse sides upside down over the plan, using pins *next* to the longerons to establish the curve. Starting from the tail,

add identical crosspieces top and bottom and the ply and balsa formers, using pins, a small drafting triangle and blocks of balsa to keep everything aligned. Add the firewall with Slo-Jet, being careful to preserve alignment. Now lift the fuse off the plans and sand well to both smooth the structure and reduce weight. Cut and laminate the top formers. Install them, the 3/32 square top stringer and the cross-reinforcements and corner triangles called for (observing grain direction). Drill the firewall as indicated (modify hole locations to suit if not using a Kraft .09 mount) and install the blind nuts behind it. Fuelproof the firewall with epoxy on both sides, also the fuel tank area.

The cabane strut mount details are a little fussy, but the structure called for is light and plenty strong for the task. Carefully observe the grain direction called out for the forward fuselage sheeting and the various corner reinforcements. Fit and add the 1/16 ply forward fuse floor and 3/32 ply landing gear mount platform. Drill and mount the blind nuts to landing gear platform, using holes drilled first through the Hallco B105-3 landing gear or a gear blank you have bent up yourself. Note: you will have to drill the wheel hubs out if you use this gear. Cut and fit F3 through F6; the arrows on the plan call out the outlines to cut them to. Note the various bevels, which you should mark and sand in using your sanding block. If O.S. had just provided a little more stretch in their muffler standoff. . . .

Now fit the lower wing to the wing saddle, being careful to preserve the incidence angle, and add the 1/32 ply scabs, hold-down bolt blocks and wing dowel. Use sharpened 1/8 dowel that just protrudes from the wing, with a dab of paint or ink on the end, to locate the hole in F13, and drill. Spot and drill the wing bolt holes (yes, 4-40 is plenty strong enough) and tap the blocks, or install blind nuts after clearance-drilling them.

The tailwheel bracket is a cut-down Goldberg item. Bend the wire gear leg to fit and drill the rudder to receive the tiller portion. The assembly is mounted with #2 wood screws to a wedge of 1/8 spruce between the longerons.

Add the stabilizer and fin with Titebond, being sure that the fin is aligned precisely on the center line and that the stabilizer is at zero degrees and right angles to the fuse top.

The turtledecks are sheeted with 1/32 medium soft A-grain balsa. Sheet half the front first, forward of bulkhead F9, working with a piece cut slightly oversize and cut or sanded to fit right down the middle of the 3/32 square stringer. Using a sharp single-edge razor blade, trim the bottom edge to a rough fit. Then use a sanding block to get the final fit against the top longerons. Repeat the process for the other panels. The fitting around the tail surfaces is just cut-and-try. A strip of 1/16 square sanded to the approximate intercept angle of the turtledeck sheet and fin can be glued to the fin or stab to help line things up. Full any gaps with your favorite filler.

Use a pin and a light from inside the fuse to locate and cut the cabane mount holes through the turtledeck. Bend the cabane struts from 1/16 wire over the plans, as accurately as possible, and check their fit in the tubing mounts. The front and rear wires are identical except for their upper bend angles. Add the 1/16 wire diagonals, held in place with a few turns of thin copper wire. Tack solder 4-40 blind nuts front and rear to the left cabane, and check the fit of the upper wing and adjust till everything fits and is aligned. Then fully bind and solder the diagonal joints. Tack solder the blind nuts to both upper cabane sides. Mark and drill the upper wing bolt holes, and make sure everything is still aligned. Use a 1/4-inch drum burr and Dremel tool to make the recesses for the bolt heads.

Lay out and mount your radio gear as far forward as possible. This plane will carry the larger servos and such, but it will do best with a micro set. I have an Ace kit with their miniature servos, with a flying weight including 225 mAh battery of only 7-1/2 ounces. Route and fit the pushrods (I used Sullivan's cable-type medium size Gold-N-Rods), roughening and gluing the plastic guides at both ends with Slo-Jet. Don't do like I did and glue the cable into the guide! Install the Sullivan slant-style 20-ounce fuel tank, routing the vent and feed tubes out through the top of the firewall. Add the shape-forming 1/16 and 3/32 stringers to the fuse sides and bottom. Now sand everything smooth, blending the forward side sheeting carefully into the top contours and tapering the stringers as shown. Use a light touch with the sanding block—there's not much room for error.

Screw on the landing gear and fit the lower fuse fairing blocks. Mount the bottom wing to the fuselage. Cut the 1/4 sheet lower fairing sides and F14 and F15. Shape and glue to the wing bottom, then cross-sheet with 1/32 medium. Sand to the contours shown. Use plastic film between wing and fuselage so you don't accidentally make the joint permanent. Cut the bolt head recesses. Add the cabane wire temporarily. Add the fairing strips to the wires with Slo-Jet and sand smooth. Remove the cabane until covering is done.

Making the interplane struts is another cut-and-try process. The shape shown on the plans is taken from my plane's actual struts; but unless you accumulate the same minor deviations I did, they probably won't work for you. I suggest making up a couple of pieces of heavy cardboard roughly to the shape shown but splitting them crossways with an overlap secured by a clothespin to allow final adjustment of the shape. Use these patterns to hold the wing spacing constant while you finalize the incidence adjustment. Then cut and laminate the final pieces. If you drill the wing holes for the 1/8 dowel pins slightly undersize, or give them a couple of shots of Jet allowed to set up thoroughly (you should do this anyway for fuelproofing), you will have a nice tight friction fit that is more than enough to secure the struts against air loads.

I made the wheel pants using the Hobbypoxy Easy-Does-It method over waxed, plaster-coated rigid urethane foam forms, sanded to the indicated contours, with two layers of 1-1/2-ounce fiberglass cloth. Scabs of 1/16 ply were bevelled and epoxied to the mounting points, then 1-72 brass railroad screws were used to secure them to the gear legs after cutting the fairings to clear the wheels and axles.

The cowl was made from 1/64 ply, cut per the template and fitted to the cowl formers called out on the plans. Note that the outer ply grain must run fore and aft. A strip of 1/64 ply 5/16 inches wide was used to join the seam at the bottom center. Three 1-72 roundhead screws secure the cowl after cutting it for head and muffler clearance and carb and needle valve access. I don't generally fly with the cowl and pants installed, since my fingers are too large to get at the engine easily, and I fly off grass. She does look prettier with them installed though. I also carved a well-hollowed balsa pilot figure to add realism.

Final-sand all the pieces and cover. I used Supergloss Coverite and Pactra urethanes on version one and MonoKote on version two. Micafilm and Balsarite might be best—no unnecessary adhesive to carry around. Despite what they say, Coverite is heavier than most films. Epoxy the control surface hinges in place, keeping glue out of the hinge joints. Don't forget to plug the torque rods and tailwheel tiller into their respective control surfaces before gluing.

Add the cockpit coaming of split 1/8-inch black rubber tubing. Mount the windscreen using your favorite method (I just hold it in place, squirt Jet and hope—Wilhold RC-56 is supposed to be better). Simulate the forward cockpit cover with a piece of contrasting covering material. Finish your radio installation, including switch and antenna.

Be sure to check the wing incidence per the plans. Mount and hook up the engine, and test run it to make sure it's gonna go *before* you leave home. I used both 7/6 and 8/4 props with success. Also check out the radio gear to be sure all the control surfaces and the throttle go the right directions.

Assemble the plane and balance at the location shown on the plans for early flights. As you get accustomed to this actively aerobatic bumblebee, you can move the CG back in small increments to increase the plane's sensitivity. Initial control throws were 3/8 inch up and down on elevator, 1/4 inch up and 3/8 down on aileron (this differential is needed to avoid adverse yaw on aileron deflection and is achieved by angling the torque rod ends forward) and 3/8 inch on rudder. You may want to start with a little less. The plane will do almost any maneuver, or just putt around the sky, but she is not a trainer and has only neutral to slight positive stability. Snap rolls and knife-edge flight are particularly fun, and if you build light, she will land at a surprisingly slow speed.

A word of advice: As with the full-scale plane, there are several "No Step" areas. Don't try and pick the plane up by the fuselage behind the wing or you'll crack the stringers, and take it easy on the turtledecks. I carry mine by a couple of fingers inserted under the top wing cutout straddling the cabane. As the photos show, the whole shootin' match fits easily into my trunk.

Good luck, good flying, and think safety!•