BUILD A Daydream Biplane

By BOB BENJAMIN. . .Our famous cover artist did a bit of daydreaming one day, and the result was this exquisite sport scale biplane, a fine flyer with the Saito 65 installed. Construction is detailed here.

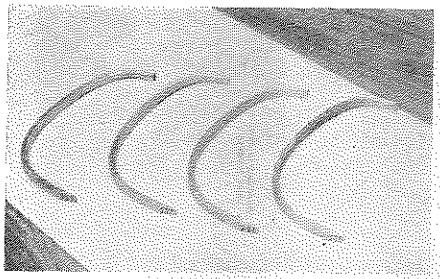
• Here's a true story about how one out-of-the-ordinary model airplane design came to be. About three years ago as of the time of this writing I was spending part of a sunny late spring morning taking a walk along one of the rural roads near my home. The current *Model Builder* cover painting under way in my studio was giving me fits, and I needed some time away from it to get the next steps sorted out. As those of you who have been here know, a sunny spring morning in Western Washington is a big deal, so it wasn't hard to play hookey!

When I finally did get to the drafting table after the neglected cover painting had been finished and shipped off to Bill Northrop, what started to take shape on my paper was a fairly simple two-winger that would have flown on a four-stroke .45. Sometimes, though, I have trouble letting things stay simple, and the first images got a little bigger and a radial configuration sorta grew into place, until I realized that I had come up with a suitable airframe for the Big Bore Five Technopower engine that had been waiting patiently in its box for too long. The result was an airplane with a span of just over 60 inches, which makes it "legal" for IMAA "Big Bird" events, and which can be described as a "could-be-scale" combination of features from DeHavilland, Great Lakes, and Waco designs that I like. Most of the people who see it for the first time think it's a Waco. You ask, "Why would I go to the trouble of building such an involved airplane if it's not scale?" Because I wanted to. It's my daydream. As a matter of fact, this design would make a good scale trainer, if you will, in that it is complex enough to require the kind of involvement that would be required to build a "real" scale airplane, and to inspire a little respect at flight time, but is in fact not at all tricky to fly. The best part of this sort of project is that you can let the airplane become whatever you want; I'm waiting to see who will finish one up as a pseudo-fighter in '30s Army colors!

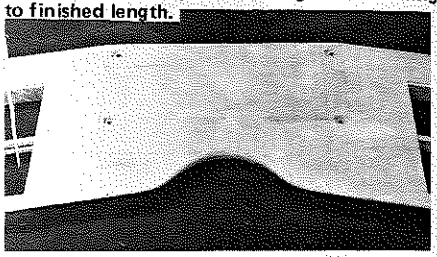
It does look scale up there; flying the Daydream is a daydream in itself. Flights are satisfying and completely enjoyable.

The Daydream first flew with the Technopower 5 and, in fact, took first place in the "Sport Biplane" category at the 1987 Northwest Model Expo at Puyallup in that configuration. It has flown many times with the radial, which produces enough power to fly the airplane quiet realistically. The Big Bore 5, when fully broken in, gave performance in the air on a 14-6 prop very close to what I subsequently got from an O.S. FS 61 four-stroke. The decision to remove the radial was based on two considerations. Although the Technopower is remarkably easy to start and flies the plane well, there are a number of details of construction and operation on the engine with which I'm not comfortable for frequent, long-term flying. This is not a criticism of Technopower, but rather a comment on the state of development of model four-stroke radials at the time these engines were developed. The other factor was the immediate request by Bill Northrop for the article you are now reading. I didn't feel that a Technopower-powered airplane would be the sort of project that a lot of modelers would want to get

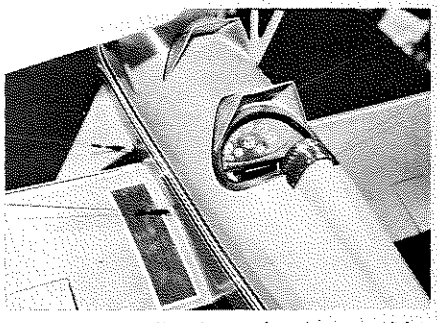
1891 1 of 4



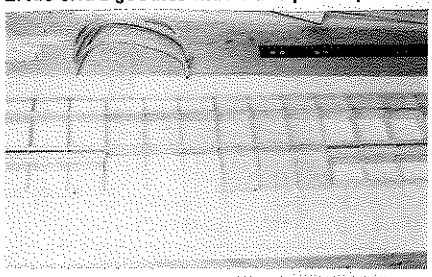
Wingtip bows ready for cleaning and trimming to finished length.



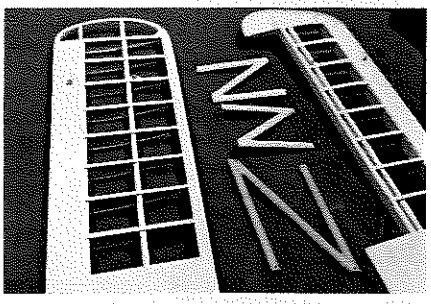
Bottom surface of upper wing showing cabane attach screw holes.



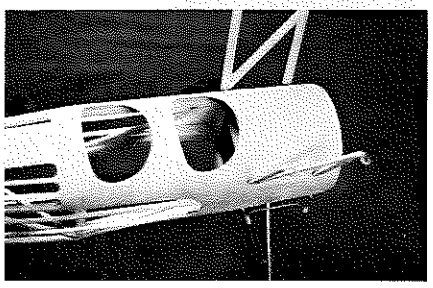
Little extra goodies that make plane special.



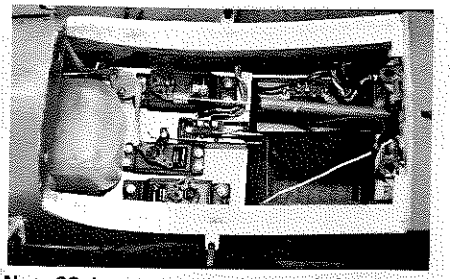
Lower wing prior to adding dihedral. Ailerons are in place.



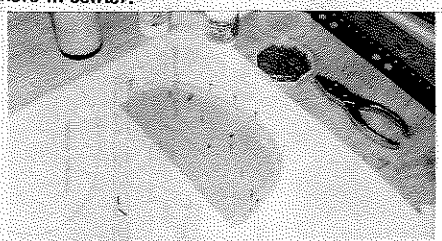
Wings and struts ready for covering.



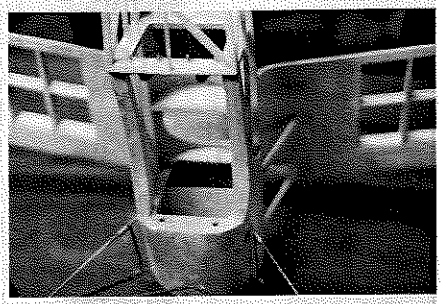
Cockpit cutouts with cabanes in place. Note filler blocks between stringers.



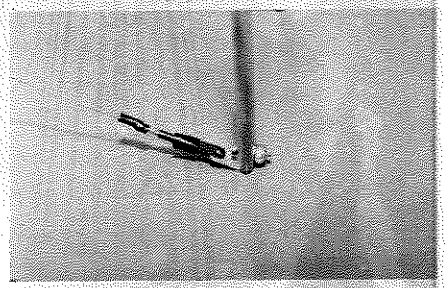
Note 90-degree reversing bellcrank for reliable link to throttle. Glow heater switch box seen here in center.



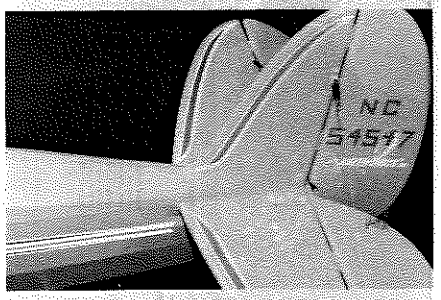
Forming a wingtip bow using cardboard form.



Lower wing saddle and landing gear in place.



Flying wire attachment at interplane strut. Aluminum tab is free floating.



Tail from above showing faired fabric fillet covering as described in text.

involved in, so I began a "retrofit" to present the Daydream as a practical design for an off-the-shelf four-stroke single. The result, after a little over a year of fine-tuning, is what you see here.

The Daydream as I'm now flying her is well matched to the Saito 65 four-stroke engine. I own several of these engines, have flown several more, and strongly recommend that you use one yourself should you build a Daydream. I have yet to find a mid-size model four-stroke that offers a better combination of excellent power output, docile handling characteristics, and reasonable price than the Saito 65. I'll go a bit further in discussing power options for this airplane. You don't need an .80 or .90. Period. The airplane is designed d loops without hitting the high end throttle stop. Once you have yours trimmed and are comfortable with her, you'll find that she likes to be flown low and slow and will make a fine "close-in" airshow or demo machine. The flat-bottomed airfoil means that you will have to work a little at outside maneuvers, but will return the favor by giving you very dependable low-speed handling. My airplane spins *very* fast and tight, but recovers readily, so don't be afraid of her if yours is balanced and riggedd loops without hitting the high end throttle stop. Once you have yours trimmed and are comfortable with her, you'll find that she likes to be flown low and slow and will make a fine "close-in" airshow or demo machine. The flat-bottomed airfoil means that you will have to work a little at outside maneuvers, but will return the favor by giving you very dependable low-speed handling. My airplane spins *very* fast and tight, but recovers readily, so don't be afraid of her if yours is balanced and rigged per the plans.

I suspect that an attempt to build a really light Daydream (mine has a "show" finish that cost me a pound or so) would result in an eight-pound airplane. I'd seriously recommend dyed, clear doped silk, or perhaps Micafilm, if you want to go this route. If you do build a lightweight model, you might want to try a Saito 50 (and send me pictures!).

Although I have written a couple of construction articles providing involved instructions for low-time builders, this isn't going to be one of them. If you haven't built an airplane from plans before, this isn't the one to start with. Moreover, the Daydream is not a beginning flier's airplane. Although she is undemanding to fly once trimmed, there is just too much there for her to work as a trainer. If you can handle a model like a Sky Tiger or one of the Sportster series, well, you should have no trouble with the Daydream. If you can't, *wait*, and enjoy airplanes like the Daydream when you are ready. I'd define ready as being able to do all the basic aerobatic maneuvers safely with an airplane like the ones just mentioned and to be able to do three good touch-and-goes on three successive passes. Think about that last one; it's a good measure of real flying ability.

Let's build! If you're with me at this point, I'll assume that you know how to pick good balsa wood. Use medium to hard wood for all primary structure and pick light stuff for all the outside sheets. I strongly recommend 3/4-ounce fiberglass put on with Hot Stuff to reinforce all the sheeted areas of the fuselage and both wings out beyond the center sections. Keep the wood light and let the high-tech stuff provide the rigidity. I'll recommend Hot Stuff Special T for all construction. The heavier body of Special T lets you put it exactly where you want it; you can then get a controlled cure using Hot Shot or Kick It.

TAIL SURFACES

The horizontal and vertical tail surfaces are both built flat on the board. We are simulating welded steel tube structure here, so there is no taper or airfoil to reproduce. Build the horizontal tail and elevator by laminating the outlines first. If you can get a long enough piece of wood, you can do the stab and elevator on each side in one piece. I used both heavy cardboard forms and later forming blocks pinned to the plan over plastic wrap and laminated the outlines with bass strips that had been sprayed with warm water and wiped dry.

When your laminates have set up, remove them from the plan, trim to exact lengths, and sand absolutely flat top and bottom. With the laminates finished, you can go on to build up the stab and elevator as indicated on the plan. Don't leave out the 1/8-inch ply doubler at the center of the trailing edge! Be sure you understand how R-1 will fit between the two center "ribs" of the stab. Don't forget the gussets.

Build the vertical tail and rudder in the same manner. Block sand all tail surfaces perfectly true after assembly, then round the edges to a constant radius, remembering that you are simulating a tube and fabric structure. Fine sand everything, make the necessary holes for control horns and hinges, and clear the board for the wings.

WINGS

The upper wing is built flat on the board. Start work by laminating the tip and center section bows so you will have them ready to go when you need them, and avoid having to pull the partially completed wing off the board to do the laminating. Lay out the bottom leading and trailing edge sheet, the capstrips, and all the center section sheet in place and glue the edges as appropriate. Note that the forward portion of the leading edge will have to be shimmed up to match the curve of the ribs. You may want to measure off some reference points on the plan outside the center section structure, or perhaps make a copy of the plan, so you can locate the center spars and ribs where the plan is covered by the bottom 3/32-inch sheet. Assemble all the lower 3/16-inch square spars in position, followed by all the WT ribs. Add the leading edge. Fit and glue the upper spars, followed by all ply doublers and spar webbing. Fit and glue the hardwood upper wing attachment blocks. If you fit, drill, and tap these accurately, you can install them predrilled and open up the screw holes in the bottom sheet after removing the wing from the board. The alternative is to leave the top center sheet off until after the wing is off the board and to drill and tap the blocks from the bottom.

The lower wing incorporates four degrees total dihedral (two degrees per panel), and is built flat as two separate panels and joined before the top surface sheeting is added. Lay out the bottom surface sheet, capstrips, and trailing edges as with the upper wing, and follow with the lower 3/16-inch square spars, all WB ribs, and the leading edges and then add the tips. Fix one panel to the board and block the other up at a four-degree angle, trimming as necessary to get a proper fit between the two WB-5 ribs. I would suggest that you cut out the lower spar doublers and joiners without adding the rib notches. Mark the rib notches using the actual locations of the ribs in your wing and cut on these marks. Install the doublers and joiners making certain that the dihedral angle is maintained as specified.

Add hard balsa filler blocks for the wing bolts to bear against at the center trailing edge. Make up and install the aileron horn assemblies, being certain that they are installed on the same centerline as the aileron hinges. When these are in place, you can go ahead and finish up the top surface sheeting and capstripping. Build the ailerons over the plan, trimming and fitting to match the wing panels. Now carve and sand everything to finished shape, giving the entire structure an extra pass with the fine sanding block when you have finished. Drill the leading edge and fit the 1/4-inch dowels as indicated. Locate and test-fit the aileron hinges. Make up and install the interplane strut tabs as you did with the upper wing.

FUSELAGE

As they say, this one is built up just like the good ol' rubber-powered scale models, only bigger. Start by laying out two identical side frames using hard 1/4-inch square balsa or, as I prefer, spruce. Note that the wing saddle pieces are part of the basic side frames; build the frames using 1/4-inch sheet saddle pieces, then add 1/2-inch "doublers" on the inside after the basic fuselage structure is assembled. When the frames are removed from the board, you can add the 1/8-inch Lite Ply doublers at the nose, being careful to make both a left and a right side. Make sure you leave room for the doublers to butt against the back side of F-1. Now join the sides at F-2 and F-3. Add the extra wing saddle material and then the plywood wing mount. Join the side frames at F-1, taking extra care with alignment. Using the top plan view as a guide to alignment, pull the sides together, and join with 1/4-inch square crossmembers top and bottom at F-4, F-5, and F-6, and at the tailpost; note that the inner surfaces of the side frames will need to be beveled to yield an outside width of 3/8 inch to match the rudder leading edge. Temporarily fit the lower wing, marking and drilling the holes in F-2 for the leading edge dowels. Following this you can add all the top contour formers.

Make up the landing gear, using hard solder on the joints. Fit the gear mounting blocks at F-1 and F-2. You might want to consider drilling and bushing these with metal tube to reduce the possibility of the holes wearing oversize.

In order to avoid extra complexity in assembling the gear and subsequent finishing operations on the nose, and to leave the battery/tank compartment free for a maximum of flexibility in equipment installation, I split the landing gear assembly on the prototype, eliminating the "crossover" portion of the front and rear legs. A little extra care taken in fitting the landing gear mounting blocks below the lower longeron, between F-1 and F-2, and reinforcement of the blocks with tubing as just mentioned, created an assembly more than capable of handling the vertical and twisting loads imposed on the gear assembly. All horizontal loads on the gears legs are handled by the "V" member between the legs. Over a year of flying has produced no signof strain on the installation. If you feel more comfortable with a one-piece gear, split the legs as mentioned at the centerline and rejoin them after assembly by soldering a tubing sleeve over each joint.

Add the doublers to F-1A and F-2 and drill them to accept the cabane struts. Make up the cabanes. I'd suggest that you start with just the fore and aft vertical members. Jig up the fuselage on the board with the landing gear hanging over the edge and level the top longeron parallel to the surface. Lay out a reference line at right angles to the fuselage centerline, in line with the upper wing trailing edge tips. Slip the separate cabane struts in place, mount the upper wing with 10-32 screws, and start adjusting until the lower surface of the wing rests at zero degrees incidence parallel to the top longeron and the tips line up with the reference line. Now you can add the cabane diagonals, wrapping the joints carefully with wire. Temporarily glue several hard balsa braces across the cabane assemblies, then carefully remove the upper wing and take the cabanes off the fuselage and solder the joints. You can fair the cabanes using spruce, basswood, or whatever once the soldering is complete and you have rechecked alignment.

Test-fit the lower wing in place. Block the fuselage up again and adjust the lower wing mounting for one degree positive incidence relative to the top longeron, as measured at the lower surface of the wing. With the incidence set, square up the wing relative to the fuselage centerline and drill the wing and wing mount for two 1/4 x 20 bolts. You may want to consider using threaded inserts as an alternative to tapping and reinforcing threads in the wing mount plate.

Now put the upper wing back on the airplane and recheck the entire assembly for alignment. When both wings are in place and you are satisfied that they are on correctly (and you have taken a break and relaxed!), go through the drill again with the horizontal tail, making sure that you have it shimmed off the top longeron extension for one degree positive incidence. Follow this with the vertical tail, which has only to be square to the stab. When you have checked everything once again, go ahead and make up the interplane struts. Note that the prototype flies well now without washout in either wing. When the flying surfaces are under control, mark and drill F-1 for the engine mount. Using the Saito 65, my airplane trimmed out comfortably using one degree each right and down thrust. If you use a significantly larger engine, you might want to add an additional half degree in each direction.

With the hard part done, you can finish up the fuselage structure. Add the tailwheel mounting plate and fill in the contours of the nose with the F-1F and F-2F formers. Fit the turtledeck stringers, noting that the top stringer is 1/4 inch sq.; all the rest are 1/4 x 1/8 inch. I'd suggest spruce to resist bowing under the tension of the covering. Fit the filler blocks behind F-3A and sand them to contour, noting that the top center blocks extend rearward to provide a mounting sur-

face for the headrest. Add the side stringers. These extend forward to F-2 and are relieved to accept the side sheeting. Add a 1/4 x 1/8-inch strip of balsa across the bottom of F-3, tapering it to fair into the lower longerons so it matches the contour of the lower wing trailing edge. Add a 1/4 x 1/8-inch belly stringer from F-3 to the cross member at the F-6 station; I relieved mine to allow it to fit progressively deeper over the belly crossmembers so that it tapers smoothly into the tailwheel mounting plate. Add the two 1/4 x 1/8-inch fabric attachment strips to the top center section of the horizontal tail; these should fair smoothly into the vertical tail trailing edge and lie flush with the outside of the top longeron at the front. Include a small block of scrap at F-6 to provide a continuous base for attachment of the covering. The 1/4 x 1/8-inch strips on the stab are necessary to allow you to do a faired fabric fillet with the covering. This is much easier than it sounds and looks spectacular; the whole idea is to cover the area between the top longeron and either side, the top center turtleback stringer, the vertical tail trailing edge, and the vertical tail leading edge with one piece of material. (Now you can see why you need the extra strips; without them the covering would have no place to go at the base of the vertical tail.) The trick to the whole thing is patience in stretching and attaching the covering. Believe me, it *will* work; this is the way many of the older biplanes and virtually *all* classic lightplanes are covered. When you are done being worried about this coming test of your covering skills, add the 3/32-inch sheet balsa inlays on either side of the fuselage below the tail to serve as control rod exit fairings.

Drill the requisite holes to route your fuel system plumbing and test-fit the tank. Depending on the particular arrangement of your airplane, I'd suggest either a floor or roof of 1/8-inch Lite Ply for the tank compartment to isolate the tank from the battery. When you have all the internal cutting and fitting complete, go ahead and close up the nose by adding all the 3/32-inch balsa cowl sheet. This extends back over the bottom of F-2, back to the curved outline shown on the plan on the fuselage sides, and back to a butt joint flush with the outside edge of F-3A. While you are at it, make up the lower wing center section fairing.

I built the cowl on my airplane in two sections; a fixed base or "dishpan" cowl and a removable portion, to replicate the appearance of the full-scale airplanes after which the Daydream is patterned. You can build the entire cowl in one removable piece if you choose, at the expense of having it appear rather deep. If you go the route I did, make and attach a 1/8-inch Lite Ply base cowl mounting ring and construct the base cowl "dishpan" to fit over it. I cut two rings of 1/4-inch balsa on the jigsaw, laminated them, relieved the rear edge 1/32 inch, and wrapped a cowl body of 1/32-inch ply around the balsa rings using a circle drawn on a sheet of paper as a pattern. Sand the leading edge of the laminated portion to a smooth, rounded section and give the entire assembly a covering of 3/4-ounce fiberglass attached with CA, or, if you prefer, resin. If you want it to appear to be a removable base cowl section, don't attach it to the fuselage until after your finish is complete. There is no reason for it actually to be removable.

The main cowl is made in the same manner. If you can find a metal pot to fit, or want to mold a glass cowl, have at it. This is where the "daydream" part of the project takes over; do what turns you on. If you want rocker box fairing blisters, try what I came up with. I found an old metal spoon of the proper size (small) and used it to press female mold depressions in a smooth block of non-oily potters' clay. I then mixed up a batch of polyester resin with lots of extra catalyst and poured fourteen spoon-shaped depressions full. (I had no trouble, but epoxy might be less critical to work with.) The cured resin "spoons" were pulled free of the clay, cleaned up, and trimmed to fit closely against the cowl, where they became instant rocker box blisters! The cowl on my airplane is mounted to three brackets cut from 1/4-inch ply; these are drilled for 4-40 screws which go through the rear edge of the cowl and into a blind nut on the inside of each bracket. The brackets are mounted to the base cowl with sheet metal screws and cyano. Give each one a good shot of cyano after drilling, before the blind nut is installed, and run the drill through it again, and you'll have a really tough, oil-proof mounting system.

Make up a headrest from light balsa, cut out the cockpit openings, and sand, sand, sand everything in sight. Extra attention paid to the sheeting on the nose and to the stringered portions of the tail will pay big dividends when you have the finished airplane out in the bright sun for all the other guys at the fly-in to see! Fit the hinges and horns to the control surfaces and do a trail mounting of your radio system. I prefer to get everything cut to size and working before beginning any covering or finishing in order to avoid nasty surprises later when trying to make control rods and other goodies fit where there isn't room. I used fiberglass push-pull rods with 2-56 hardware on the prototype.

The flying wire rigging on my airplane, as seen in the photos, is semi-functional but not necessary. It is intended to carry a load should something in the primary structure fail, but the airframe is intended to fly safely without it. I made it up using ordinary hobby shop music wire, 2-56 threaded fittings and clevises, and thin aluminum tabs shaped to fit inside the strut ends or to bolt in place as shown in the photos. If you are going to use the rigging, make it up now to avoid messing up your finish later.

My airplane is covered with Sig's Koverall (Dacron polyester) and finished with two coats of nitrate clear dope followed by K&B epoxy primer and a Superpoxy color finish. I went all-out for "show finish" (three colors and a clear top coat) and came out at a gross weight of 9-1/2 pounds. This worked out to something like a 24-oz. per sq. ft. wing loading, and the airplane is very comfortable flying at those numbers. It has, in fact, been loaded up to 10-1/2 pounds and flown without problems. I suspect that a nice finish could be done using one of the pre-colored dacron fabric coverings, trim striped, and given a clear finish for a significant weight saving. Another super bet for a really lightweight finish would be dyed, clear doped silk. I have proven to my satisfaction that a well done clear dope and silk finish is no heavier than the loudly touted "light" film coverings, and a whole heck of a lot stronger and longer lasting. Whatever you choose, I strongly suggest that you cover the center section of both wings and the fuselage back to F-3 with 3/4-ounce glass cloth. Done correctly, this process adds a few ounces at most, but imparts tremendous strength. I would not build an airplane without it.

Now put the whole thing together. Set up your balance and control throws as shown on the plan. I built in aileron differential (that is, the ailerons go up further than they go down). My airplane is rigged with about a two-to-one differential and exhibits no tendency to develop adverse yaw. You could accomplish the same thing with a rudder-aileron coupler if your radio has one, or by coordinating the sticks the way we're supposed to know how to do. The built-in differential seems the neatest solution to me, since the problem never develops. You might want to increase the aileron throw, although the movement shown yields nice, scale-like maneuvers. The balance shown is at about 30-percent of the projected chord and results in docile handling characteristics at low speed, yet gives a clean spin entry and a spin rate that will stand your hair on end. Move it back if you must, but experiment a little at a time.

My flying is being done with the aforementioned Saito 65 running on Red Max 15-percent nitro four-stroke fuel, which is all I have used for the past several years. I have recently started ordering my fuel mixed on a castor-oil base and feel that the slight extra cleanup effort that results is well justified by the extra margin of protection my engines get. The prop I have settled on is a Graupner 15-7 (yes, that much prop). The airplane will take off at under 3/4 throttle and will do sequential big, hundred-foot-high loops without straining. I have read that the Saito 65 likes to work best at moderate rpm on large props, and this setup seems to prove it. What's really neat is that it is *quiet*! Control is by Airtronics in the person of one of my ol' reliable Championship 7 systems. The whole point of my having set the airplane up this way is to fly it like an old-time biplane, not some hot-dog mosquito. Long, smooth takeoffs, with power added gradually, not jammed in, will really make you look like you know what you're doing. Learn to fly the airplane comfortably at reduced power and to make smooth sweeping turns instead of jerky reversals at the far end of the field. Big round loops with power reductions on the down side will get you into the spirit of the thing, and a long, straight final approach followed by an old-time wheel landing, carrying just a little extra power until the wheels touch, and letting the tail ride high for a few seconds will bring the house down. Do it with finesse and a light touch, and be one of the good guys! •

1891 4 of 4