

Miss Los Angeles



.61 Powered "Golden Era" Racer

Dedicated To The Memory Of Bill Winter

Brown B-2

By Al Holmes



The model described here is the 1934 B-2 designed by the Lawrence W. Brown Aircraft Co. of Los Angeles, California, for pilot Roy Minor. Harold A. Osborne rendered the drawings I used as reference, and they were published in the November 1972 issue of R/C Modeler magazine. The drawing is 2-3/4" to the foot and so is the model. You may well ask, why not go to 1/4 scale? The reason is simple -- the available sizes of wheels and spinners.

The 1934-38 version was painted bright red with gold leaf graphics. There was also a 1939

modification that was international orange with gold lettering.

There is not a lot of accurate or reliable information to be found, other than the above-mentioned drawings of the original B-2. There are a good number of photos and some background information that can be had from the Air and Space Museum in Washington, D.C. There are some 3-views around, most of them giving what seems to be conflicting information. This is not hard to understand, as this airplane went through what I described as "modification of the week." Original construction drawings just don't

seem to be available. If you come up with a source, please let me know about it. You have to be careful when ordering photos from the Air and Space Museum, because as with many aircraft of this type and vintage, you will notice modifications made after the fact. The pictures range from original factory photos, to shots made by the aircraft owners, to photos of a home-built reproduction of the B-2. The choices of modifications to pick from are almost endless.

The B-2 was designed to make a direct challenge to the larger, more



The author with his Brown B-2.



Wing center section with clamps holding the spar doublers in place.

powerful racing planes of the day. Most of these planes were much heavier with a lot more power, some as much as a 1000 plus hp. The flat-out speed was indeed in favor of the more powerful planes, by as much as 20 to 30 mph on the straight-aways. Because the B-2 was small, lightly loaded, and very agile, she could just about kill the competition in the turns, with a top speed in the 270 mph range. Speed, combined with its turning ability, made the Miss Los Angeles very competitive.

The design of the wing was also somewhat of a departure from the norm. The leading edge was covered with two plies of cloth instead of plywood or metal. This was done to assure a smoother leading edge contour and resist the tendency of the fabric tearing. The airfoil was a modified Curtiss racing curve with an unusually sharp leading edge. The ribs were unevenly spaced at increasing intervals from root to tip.

Miss Los Angeles

Specifications:

Designation — Brown Special
 Wingspan — 19'-3"
 Overall Length — 19'-10"
 Empty Weight — 882 lbs.
 Gross Weight — 1299 lbs.
 Wing Area — 60 sq. ft.
 Propeller — 6'-6" Story Special
 Blades/Hamilton Standard Hub
 Engine — Super Charged,
 Menasco C6S, 300 Plus hp
 Top Speed — Apx. 270 mph
 Landing Speed — W/Flaps
 59 to 60 mph

Perhaps a more sensible way to make a scale model of the B-2 would be to use the modern replica that was built in the early 1970's or thereabout. A good reference article can be found in the November 1972 issue of *Private Pilot Magazine* (Miss Los Angeles is Alive and Well in San Francisco) by Bill Turner. Contact almost any aircraft photo service for a very fine set of color photos of this plane (B-2 Racer N255Y).

Using the modern B-2 would have made it a much simpler model to scale. The addition of the tail wheel would make for improved ground handling and the missing two rows of cooling vent louvers on the left side, thirteen in each row, would indeed make the cowling simpler to duplicate. However, I went the hard way. I guess I'm just a glutton for punishment. The Miss L.A. is a very classy lady! *

The B-2 managed two second place wins, one in the Thompson Trophy of

1934, and the other in the Greve Trophy of 1935. There was even some thought given to developing a fighter from this design. The B-2 was designed and built for race pilot Roy Minor. After his death, pilot Marion McKeen owned, modified, and raced Miss L.A. with some success. The aircraft was borrowed by pilot Lee Williams for the 1939 Greve Trophy race, and destroyed in a crash at the scatter pylon. Williams was killed in the crash.

To help a little in detailing the cockpit, the only instruments on board were Air Speed Indicator, Oil Temp. Indicator, Oil Pressure Indicator, Cylinder Head Temp., Altimeter and Tachometer.

I once asked Bill Winter why I never saw a scale model designed by him. His answer was two-fold: "I would rather push the envelop to new design frontiers. Besides, you never seem to finish the darn things, you just stop, at some point, and fly them."

This last statement was indeed the case with this project. The more information I was able to find, the more I seemed to need. This could have gone on forever.

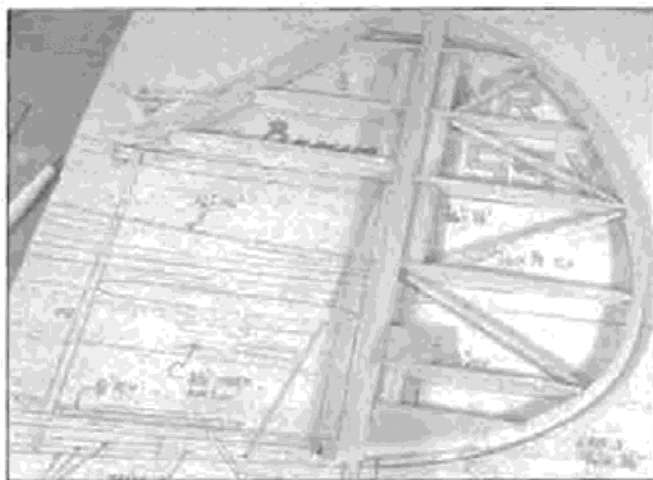
September 26, 1999. This is an important date for reasons well beyond the first flight of the B-2. Everyone reading this article is, I am sure, aware of the influence upon our hobby of the late, great, Bill Winter. His friends and associates have gathered, on or about this date, for the past few years to celebrate his friendship, guidance, inspiration, and passion for life and the hobby. Bill Winter has been an influential part of my modeling life as far back as I can remember.

Almost two years ago to the day, I asked Bill to take a look at my drawings and the incomplete fuselage of the B-2. With a serious expression, he considered my efforts. After what seemed like forever, a smile came to his face, he looked up at me and said, "Very nice." To me it was like God had said, "You are now in heaven." I told him of my concern about the balance point. With no hesitation at all, he said, "About 22% should do it." He also suggested building a "test" model to work out any problems that might crop up. I took his advice. John Hunton suggested making a hand launch glider to test different balance points; if nothing else, it would give me a good starting point. Guess what? It flew just great, the first time at 22%, so did the test model.

On September 26, 1999, John Hunton, life-long friend of Bill Winter, dedicated the flying field at his farm as "Winter Field."



Horizontal stab and elevator still pinned over the plans.



ABOVE: Fuselage box frame, built upside down over the plans.
LEFT: Vertical fin and rudder ready for sanding.



Completed front end is very rigid.



Finished and polished cowling plug, ready to lay up the female mold.

So on this day, at the field named after one of my heroes, the "test" model B-2 was test flown by John Hunton. Everything was set up the same way on the test model except for the engines and prop. Engine was a Rossi .61 swinging a Top Flite 12 x 6. The test model weighed 7-3/4 pounds, for a wing loading of 33-1/2 oz./sq. ft. Things could not have gone better. The day was clear and bright with fair winds. The B-2, after a failed first take-off try (it tipped in the grass) took off, with flaps up. To quote John, "it flew like it was on rails." There were no trim changes, it flew right off the board, there were to be no design changes. It balanced at 22% and the weight was 7.75 lbs.

The aircraft is very fast and without bad habits. The stall was straight ahead without any spin tendencies. The recovery was quick. It has surprisingly good slow speed flight responses. The roll rate is impressive. One thing that was surprising was, after deploying full flaps, almost no elevator trim was needed. This well may be because of the high wing loading. The landings are no problem, with full flaps. It just flies straight ahead with no tendencies to tip stall. As of this writing, no landings have been tried without flaps, but I bet you only need to be faster and flatter.

Test Flight No. 2:

With the test aircraft weight increased to 9 lbs., the same as the scale model, the second test flight session was off the ground. The flight went just as the first one did. Without the tripping in the grass. All flight responses, take-off and landing seemed about the same. The extra weight didn't seem to have any meaningful effect on flight performance.

One nice thing about having a test plane is you get flight experience without putting the scale model in jeopardy. So, John was ready to fly the

real thing, calm, cool, and having no doubts at all. I, on the other hand, was terrified! Sweaty palms, shaking hands, the whole nine yards. Then in the middle of the flight photo session, the camera battery died. Nothing was going well for me. But John and Miss Los Angeles did great!

Miss L.A. flies a little faster than the test craft did, other than that, it was like flying the same plane. It handled much like the old 40-powered Formula One racers did, maybe a little slower. Unlike the old Formula One racers, it flies beautifully at half throttle. Like the old racers, it is recommended you get plenty of ground speed before lift-off and don't use any flaps. Landing with full flaps is a joy. Just remember to pay attention to the elevator, hold a little power and keep up elevator pressure all the way through the roll-out.

This scale model is not for the faint of heart. No scale model worthy of the title is! But, it's not a great challenge to fly, despite its racer looks and heavy wing loading. On the other hand, I will concede the construction is a challenge, but it is fun to build and a project you will be proud of when it is completed.

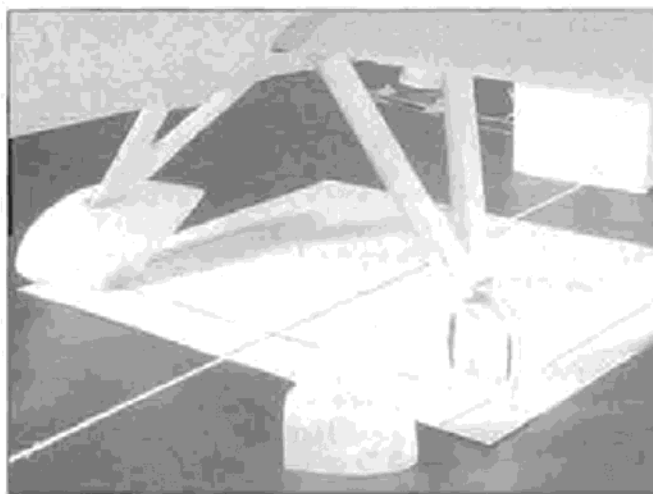
I think that's enough history.

CONSTRUCTION

The building procedures for the B-2 can be a bit complex, so I strongly suggest reading all of the building instructions before you start this project.

I find the easiest way to build from scratch is to make a "kit" out of the project. First, fabricate what parts you can for the entire aircraft up front. Then separate the parts into plastic food bags. Make one for the wing, stab, etc. Please do not substitute balsa wood where spruce and basswood is called for!

Make all the laminated parts first. Be sure to cover the building board with waxed paper and wax the forms for the wing, stab, and rudder so the glue-



Assembling wheel fairings on the yokes, over the layout sheet. Note the dark area where the epoxy paste is applied.

soaked laminations won't stick to them. For these laminations you want to use 1/16" basswood strips cut from 1/16" basswood sheet. You will have to splice the strips to make them long enough. First, soak the strips in hot water, cover evenly with white glue; while still wet, force them around the forms. Hold the laminated wood tight to the forms and the building board with "T" pins or brads until completely dry. This will make very strong, lightweight parts that will hold their shape perfectly. I suggest starting with the wing.

Wing:

Gang cut the wing ribs. Make the trailing edges for the flaps and ailerons from 1/16" balsa on top and bottom with .007 carbon fiber strips sandwiched in-between. Laminate with slow cure CA and weight this down on a flat surface. Make the trailing edge for each wing in one piece, and cut it apart later when instructed to do so.

Cover the plans with waxed paper. Make two rear spar washout shims using one 1/8" x 1/4" and one 1/4" x 1/4" balsa strips. Taper them from 3/8" at the outboard side of W-10 to 1/8" at the outboard side of W-3. Position the shims over the plans. W-3 does not rest on this shim. Remember, there is no dihedral in this wing, and the right and left panels are built together as one piece. Position a 1/8" x 1/4" strip over the front spar location, from the outboard side of W-3 to W-10, to raise the ribs 1/8" above the building board and cover with waxed paper. Mark the location of W-3 on the bottom of both the front and rear spars and slide them into position. Do not glue until instructed. Position the spars over the shims and pin in position with "T" pins. Use a W-4 rib to space the spars out at the tip of W-9. Secure the spars firmly

to the building board. Remove the W-4 rib that was used as a spacer. Make sure the spars are straight. Use a long straightedge; there should be no sweep to the wing at all.

Carefully slide the top front and rear spars through W-3. Check to make certain W-3 is in the proper position and glue to the bottom spar only, using medium CA. Do not glue the spars together at the wing center at this point. Temporarily position W-7 (do not glue) between the spars, to correctly position the top spar. Now glue the W-2 rib in place. Position and epoxy the W-1 ribs in place. Note only the W-1 ribs will touch the building board. Position the ribs starting from the inboard W-4 through W-7 (on both wing panels). Do not glue the ribs yet. Make sure all the ribs are perpendicular to the building board and at right angles to the spars. Now, join the spars of the left and right wing together. Make a filler block from 1/2" x 1/2" balsa to fit between the top and bottom front spars, between the two W-1 ribs. Using 3/8" x 3/8" balsa, do the same thing between the two W-1 ribs at the rear spars. Do not put in the 1/8" plywood spar ties until the landing gear mount has been fitted to the bottom of the W-1 ribs.

Make the wing mounting block from a 9/16" x 1-1/2" hard wood, to fit between the trailing edge of the W-2 ribs. You may substitute balsa wood for this part, if you cover both sides with carbon fiber mat using thin CA. The balsa is much easier to carve to shape. Before you start carving the block to shape (while it is still square) drill the 1/4" bolt holes, cut the slots for the ends of the W-1 ribs and carve the clearance space for the flap operating horn. Add the 3/4" trailing edge and glue in place using 30-minute epoxy.

Epoxy the 1/4" x 3/4" hardwood leading edge between the W-2 ribs,



Bare bones, almost complete. Take some time to admire your work.

even with top of the front spar. Clamp in place until the epoxy cures.

Check the position of each W-4 rib and glue in place with CA. Position ribs W-5 through W-10, one at a time, allowing each rib to dry before going to the next. This will keep the front spar from bowing. Remove any "T" pins holding the bottom spars, from W-5 outboard. Shim up the tip of the front bottom spar, with a wedge made from scrap, so the spar bends up at the tip to meet the notches in the ribs. The bend in both top and bottom spars should be the same.

Glue the 3/16" sheet vertical grain webs between all ribs from the outboard side of W-3 to W-10 on both sides of the front spar and W-3 to W-8 on the rear spar. The webs must not extend above or below the edges of the spars. In the places where "T" pins are in the way, skip putting in the webs until the wing is removed from the building board. Then install those webs from the bottom, before the bottom capstrips are in place. If you cut 3/4" high webs they will fit just right on the front spars all the way out to W-5. The same is true for the rear spars if the webs are made 9/16" high.

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MISS LOS ANGELES (BROWN B-2)

Designed by:

Al Holmes

TYPE AIRCRAFT

Brown B-2 (2.75"=1")

WINGSPAN

53.5 Inches

WING CHORD

10.375 Inches

TOTAL WING AREA

530 Sq. In.

WING LOCATION

Low Wing

AIRFOIL

Curtiss Racing Airfoil

WING PLANFORM

Constant Chord

DIHEDRAL, EACH TIP

0 Degrees

OVERALL FUSELAGE LENGTH

55.5 Inches

RADIO COMPARTMENT SIZE

9.5" (L) x 3.375" (W) x 3.75" (H)

STABILIZER SPAN

19 Inches

STABILIZER CHORD (inc. elev.)

7.3125 Inches

STABILIZER AREA

130 Sq. In. (Approx.)

STAB AIRFOIL SECTION

Flat

STABILIZER LOCATION

Mid-Fuselage

VERTICAL FIN HEIGHT

10.125 Inches

VERTICAL FIN WIDTH (inc. rud.)

9 Inches

REC. ENGINE SIZE

.61

FUEL TANK SIZE

13 Oz. Hayes

LANDING GEAR

Fixed

REC. NO. OF CHANNELS

5

CONTROL FUNCTIONS

Rud., Elev., Throt., Ail., Flaps

C.G. (from L.E.)

2-1/4" to 2-1/2" (22%-25% Chord)

ELEVATOR THROWS

1" Up — 1" Down

AILERON THROWS

1/2" Up — 1/2" Down

RUDER THROWS

2" Left — 2" Right

SIDETHRUST

0°

DOWTHRUST/UPTHRUST

0°

BASIC MATERIALS USED IN CONSTRUCTION

Fuselage Balsa & Ply w/F.G. Cowl
Wing Balsa, Ply, Basswood, Spruce
Empennage Balsa, Basswood, Spruce
Wt. Ready To Fly 144 Oz. (9 Lbs.)
Wing Loading 39 Oz./Sq. Ft.

Add all the 3/16" cross braces between the ribs. As with the missing vertical webs, the cross braces that cannot be put in place can be installed from the bottom after the wing has been removed from the building board.

Using 1/4" x 5/8" balsa, make the trailing edge of the wing and the leading edge of the flaps and ailerons. Make the flap/aileron leading edge in one piece, 1/8" shorter than the wing trailing edge. Using Ambroid or Sig-Ment, glue a 1/16" spacer between the wing trailing edge and flap/aileron leading edge. The flap/aileron leading edge should be 1/16" shorter on each end of this assembly. Check the trailing edge of all the ribs to be sure they line up. When the fit is perfect, glue the flap/aileron leading edge — wing trailing edge assembly to the wing. The top edge of the wing trailing edge should be a minimum of 1/16" above the tops of the ribs.

Lay the wing leading edge/tip lamination over the ribs in as close to perfect position as you can. All cuts made in this step must be right the first time! There is no way to put back the wood once you have cut it off. When the position is right, make a square cut at the leading edge root where it meets W-3. Try and keep all these cuts a little long, that way there will be enough material left for "truing-up" the final fit. With the leading edge up against W-3, mark the spars where the tip crosses them. Trim the spars a little at a time until the fit is perfect. The trailing edge tips of W-9 and W-10 do not need to touch the laminated wingtip. When everything fits, mark the cut at the trailing edge using W-8 as a guide. Glue the lamination to all rib leading edges and spars. Make sure the leading edge is a minimum of 1/16" above the ends of all the ribs from W-4 to W-10. Install the balsa gussets. Using CA, glue the 1/16" x 3/16" basswood capstrips to the tops of all the ribs from W-4 through W-10. Both the front and rear spars must be tapered at W-9 and W-10 for the capstrips to fit correctly. Check the cross section.

Remove the wing from the building board, turn it over and complete the webbing and cross braces. Add the capstrips to the bottom of the ribs, from W-4 through W-10. Don't forget to taper the spars at W-9 and W-10.

With the capstrips all in place, take an 18" steel straightedge, and using a sharp pencil, mark the rear of the flap/aileron leading edge to match the top and bottom of ribs W-3 through W-8. Use a balsa plane and sanding bar to bring the wing trailing edge and

flap/aileron leading edge to the correct taper.

Cut the flap/aileron trailing edge to fit tightly between the tips of the plywood W-2 and W-8. Glue in place with medium CA. Glue the 1/16" ply W-3A to a 1/2" x 5/8" balsa block. Carve the balsa block to match W-3A. Using Ambroid, glue a 1/16" spacer between W-3 and W-3A. Using medium CA, glue W-3A and the balsa block to the flap leading edge. Carefully check the alignment of the trailing edge between W-3 and W-8. Capstrip the inboard edge, top and bottom of W-8A and fit between the trailing edge and the aileron leading edge. Use a 1/16" spacer between W-8A and W-8. Capstrip all of the flap and aileron ribs, top and bottom with the exception of four W-4A ribs (set them aside). Next, mark the position of the space between the flaps and ailerons (1/16").

Now, using the four W-4A ribs you left out in the previous step, capstrip to the right edge of two of the W-4A and to the left edge of the remaining two. You will use one mixed pair for each wing panel. Glue a 1/16" spacer between each pair and glue them in place on the marks you made showing the separation between the flap and aileron on the leading edge. Using the wing ribs for alignment, glue the rest of the ribs in position. Fitting the ribs is very simple. First, sand the capstrips at the leading edge flush with the front of the rib, then mark and trim the leading edge with a razor saw. Take care to put the ribs in right side up. Use thin CA to apply the capstrips and medium to secure the ribs in place. Using this method, you won't need to use any pins or clamps. Put in the balsa corner gussets and the 1/16" x 1/16" cross braces.

Trim away the capstrips on the two bottom inboard ribs, as required to fit the 1/8" ply aileron control horn mount between the ribs. Using 1/8" balsa, similarly fit the cable tube exit mount between the corresponding wing ribs and rear spar. Then cut the slot for the tube. Slide the tube through the holes in the ribs and out the bottom of the wing. Use medium CA to glue the tube in position, then cut it off flush with the bottom of the wing.

Using scrap left over from the spruce spars, cut off squares and glue them in place on the top and bottom of each spar, on the inboard side of the last (outboard) W-4. These will become the mounting hard points for the flying wires.

Next comes the two-piece landing gear mount. Use slightly oversized material. Take the 5/32" plywood top

and the 1/8" plywood bottom and tack glue them together. Cut them to size at the same time. Locate and drill the twelve 1/8" holes through both pieces at the same time. Mark the location of the two W-1 ribs on top of 5/32" ply part. Now cut two grooves, 1/16" deep, down the length of this part so the W-1 ribs fit in the grooves. This is simple to do on a table or radial arm saw, equipped with 1/8" thick blade.

Separate the top and bottom mounting plates and glue a 1/8" x 1/4" spruce strip down the center of the bottom (1/8" part). Using 4-40 screws at each corner to keep the two parts aligned, glue the top (5/32" part) in place on the 1/8" x 1/4" spruce strip. Use 30-minute epoxy to mount this assembly to the bottom of the W-1 ribs. Use deep throat "C" clamps to hold things tightly in place until the epoxy cures.

Make the 1/8" balsa braces to fit between W-1 and W-2, glue in place and sand to match the tops of the ribs.

Install the 3/32" balsa sheeting on the top of wing, between W-1 and W-2. Do not sheet the bottom until the flap control rod has been installed.

Place the 1/8" ply spar splice doublers on the front and rear spars. Use 30-minute epoxy for this. Be sure the doublers are glued firmly to the top of the landing gear mount.

Use a small, sharp, block plane to shape the leading edge of the wing. Don't even try this with a balsa plane. Sand the entire wing, starting with a medium grit and finish up with a fine (120) grit. When you are satisfied with the shaping and sanding, install the false ribs. Adjust the length of the outboard false ribs as needed, to fit. Use a long sanding bar to bring the tops and bottoms of these ribs down to match the contour of the wing.

It's time to remove the flaps and ailerons. Use a razor saw to cut through the trailing edge at W-8A and W-3A. Use dope thinner to separate the flap/aileron from the wing trailing edge. Separate the flaps from the ailerons and sand the ends smooth. Temporarily install the hinges and control surfaces.

Remove the flaps. Install the flap control rod in the bottom of the wing between the W-3 ribs using 30-minute epoxy. Sheet the bottom of the wing with 3/32" balsa, between W-1 and W-3.

Landing Gear Struts:

Make the struts from two pieces of 1/8" (.125) "hard" (T-6 or better) aluminum. Cut each blank to 9-1/4" x 6-1/2". Using a sharp scribe,

draw the outline and the inside cutout. Cut the trailing edge angle and other outside trims with a hacksaw. Drill 3/16" holes all around the inside cutout, then hacksaw from hole to hole and remove the center section. Clamp both struts together in a bench vise, and use a smooth file to bring the struts down to their finished size at the same time. Bend the struts to the angle indicated on the plans. You could take the struts to a local sheet metal shop with a bending jig, and have them do it for you. I made my own bending tool using 1" x 2" maple and 1/8" plywood spacers. Be sure to make one right and one left strut! Check the drawings for the location, on the right strut, for the pitot tube. Then cut a slot 1/4" deep in the strut. This will eliminate the need to drill a hole in the leading edge later on.

Check the fit of the landing gear struts in the wing mount. If all is well, spot drill each strut at two corners and remove from the mount. At these spots, drill 1/8" holes. Reinstall the landing gear, using 4-40 bolts and blind nuts (blind nuts on the bottom). Then spot drill the remaining bolt locations, and repeat the above procedure. Install the landing gear struts.

Make the wheel yokes from aluminum bar stock. You will need a milling machine to produce these parts. If you don't have one, find a friend who does, or a machine shop that will do the job for you. The yokes must be welded to the struts, solder just will not do.

A drawing for a semi-scale landing strut is included for you folks who wish to go the "sport scale" route.

Put the wing assembly aside, and build the horizontal stab and elevator.

Horizontal Stab And Elevator:

Construct the center section first. Glue the 1/4" sheet center section to the bottom 1/16" sheet center section. Note the 1/4" section is in two parts, front and rear. Cut the 1/4" x 1/4" spruce spar to size, center in position and glue in place. Put this assembly aside.

Make all the ribs and half ribs from 3/32" x 3/8" balsa. Check the fit of the ribs on the 1/4" spruce spar, the leading edge sub-spar assembly, S-1 and S-2, and the 3/32" x 3/8" trailing edge sub-spar. Do the same with the elevator. Pin the center section assembly with the spruce spar in position over the plans. Slide the ribs into position on the spruce spar. Do not glue these parts together!

Pin the leading sub-spar (S-1 and S-2) in place. Make sure the rib leading edges and the sub spar are in alignment.

When everything is in position, glue all the parts in place with medium CA. Glue the half ribs in place.

Use a sanding block to make the trailing edge straight and at a right angle to the building board. Fit the 1/4" x 3/8" balsa trailing edge and glue in place. Using Ambroid, or some other acetone-based cement, glue a 1/32" scrap strip to the stab trailing edge. Using the same glue, secure the 1/4" x 3/8" elevator leading edge tight against the 1/32" spacer. This spacer will be removed after the assembly has been sanded to its finished shape. Put the elevator ribs on the leading edge sub-spar and pin into position on the back of the leading edge. Check the fit of the trailing edge sub-spar (S-3 and S-4). Glue the ribs to the sub-spar and the 1/4" x 3/8" leading edge. Sand the stab leading edge sub-spar and the elevator trailing edge sub-spar to match the outline on the plans. Trial-fit the basswood laminated leading/trailing edge. When satisfied with the fit, block it up with 3/32" scrap and glue in place with medium CA. Install all the 3/32" x 3/32" cross bracing.

Trim the trailing edge flush with the inboard elevator ribs, and then glue the 3/8" sheet elevator fairing in place. When everything is dry, remove the assembly from the building board, turn it over and glue all the joints on the underside. Don't forget the 1/8" blocks for the brace wires. Inset the 1/8" ply control horn mount on the bottom of the right elevator.

Sand the stab/elevator assembly to shape. Remember the leading and trailing edges should be round; to resemble a round tube after it is covered. Try not to remove any material from the top or bottom of the ribs near and over the 1/4" spar. The elevator can be sanded to a near taper, from its leading edge to its trailing edge, keeping in mind the "round tube" look. Use dope thinner to separate the stab from the elevator. Before cutting the elevator halves apart, install the 1/8" music wire joiner, using 30-minute epoxy. Installing the joiner this way ensures the two halves will remain perfectly aligned when the spar center section is removed.

Locate and temporarily install the elevator hinges. I like to use CA hinges, and I used them everywhere. They are very easy to install and almost gap-less. If you use a Slot Machine for the installation, you can't help but get great results. Put the stab and elevator aside.

Rudder/Vertical Fin:

Pin the 1/4" balsa leading edge over the plans with 1/16" shims under it.

Block up the 3/16" fin tip with 3/32" shims, and glue to the leading edge. Using Ambroid, tack glue the 3/16" x 3/8" fin trailing edge and rudder leading edge together, pin into position and glue to the fin tip. Make a slot in the 3/8" rudder bottom block, to accept the laminated rudder trailing edge. Carefully trim the trailing edge to fit, block it up with 3/32" scrap shims and glue in place. Glue the 3/16" x 3/8" bottom fin rib in place first, then all the other ribs in both the rudder and fin.

Shim the 3/16" x 3/8" hinge blocks with 3/32" scrap and glue them in place. Add all the 3/32" x 3/32" cross braces. Finally glue in the 1/4" ply control horn block, on the left side, then the 3/32" triangle fillet at the trailing edge. Remove this assembly from the board and sand to shape. Leave the fin and rudder attached. Don't hinge them until the assembly is fitted to the fuselage.

Fuselage:

Using 3/16" x 3/16" strips, build one side of the frame. Don't forget the 3/16" gussets at station F4. When dry, lightly sand. Place waxed paper over the frame just constructed and build the second side directly over it. This will ensure both sides are the same. Remove both side frames from the board and decide which is going to be the right and left side. Lightly sand the inside of each side. Using 30-minute epoxy, attach the 1/16" ply web on the inside of each frame. Check twice! Make certain you have one right and one left side.

Using the top view as a guide, cut all the 3/16" x 3/16" top and bottom crosspieces. Make the first seven top/bottom crosspieces exactly 3-7/8" long. Place the two sides upside down over the top view, with the ply webs facing inboard. Starting at the front and using a square, glue the first six pieces in place. That will be at stations F2, F3, and F4. Note that there are three crosspieces at F4. This should make up a nice square box. Make a wedge out of a piece of 1/2" trailing edge stock, and pull the aft end together, to make the tail post. Make sure you are over the centerline. With this assembly firmly fixed to the board, start putting in the other crosspieces, working from the aft end forward. Keep checking as you go along, to be certain this structure is straight and square. Now add the 3/16" x 3/16" diagonal cross braces. When the assembly is completely dry, remove it from the board.

Glue the top half of the 3/16" sheet stab support in position. Take a notch out of the tail post wedge, if needed.

With the fuselage upside down on a flat surface, position the horizontal stab and check that it is level tip to tip, and leading edge to trailing edge. Do not glue in place yet!

Using the hardwood wing mounting block as a gauge (do not glue in place) mark its exact position on the inside of the 1/4" wing saddles, and remove them. Trim the aft end of the saddles, with the saddles extending 3/16" inside of F4. Then trim them to fit flush with the front of the framework. Make a 1/16" x 3/16" notch in the aft end of the saddles, to fit inside the frame at Station F4. This notch makes up for the 1/16" ply web. Check the position of the wing saddles using the station drawings for F3 and F4. Glue the saddles in place using 30-minute epoxy.

Now, trial-fit the hardwood wing mounting block in the notches cut in the 1/4" balsa supports that fit under it, between the two 1/4" saddles. These parts fit together much like the wooden ball puzzles we all have worked on. First, put the hardwood mounting block in place, then the 1/4" ply brace is slipped in place and finally the 1/4" balsa sections. When satisfied with the fit of things, glue everything together with 30-minute epoxy.

When the epoxy has cured, check the fit of the 5/8" wing saddles. They should fit perfectly between the upper and lower 3/16" x 3/16" stringers. Trim as necessary to get that perfect fit, using 30-minute epoxy and glue them in place.

With the fuselage still upside down, use heavy weights to hold it in place. Slide the horizontal stab into position. Use 30-minute epoxy to glue it in place. Check to make absolutely certain it is level, spanwise, fore and aft and square with the centerline. When the stab has cured, glue the bottom section of the 3/16" stab support in place. Cut a 3/16" slot through the tail post to clear the 1/8" wire elevator joiner.

This is a good time to install the pushrod outer tubing for the rudder and elevator. At this stage of construction the inside of the fuselage is still easy to get to. Decide at what level you are going to place your servos. Take your time, keep the tubes straight and support them solidly at every station.

All the parts in the following assembly process should be made using lightweight aircraft grade plywood. If you can't find light 3/8" ply, make F1 by epoxying two 3/16" blanks together, then cut out the part. Do not cut out the square center hole at this time.

Get all the parts together for the fuel

tank compartment and engine mount. Build this assembly using only 45-minute (or slower curing) epoxy. It must be built absolutely square and straight! Using a square, mark the center and thrust lines on all the parts, except the side braces. Use "C" clamps to hold everything in position. Brace the inside of every corner with 1/4" triangle stock. Check again that the assembly is straight and square before the epoxy has hardened. When this has cured, paint the inside of the "box" with epoxy, thinned with isopropyl alcohol.

It is easier to cut an accurate center square hole for the engine mount box through F1/F1-A if they are first glued together. Before F1-A is glued to F1, sand an angle at the bottom of F1-A so it matches the top of the wing. Check the center and thrust line on both parts, and epoxy together. Check the fit of the engine mount assembly through the assembled F1/F1-A. If all is okay, remove. You will need to draw two lines all the way around the bottom (aft) end of the engine mount box. Make the first line 1-1/16" up from the bottom edge and the other line 9/16" below the first line. These lines locate the exact position of F1/F1-A. Epoxy angle braces "B", "C", and "D" to the box so their rear ends just touch the edge of the 1-1/16" line. When they are cured, clean up any dried epoxy behind the angle braces that could interfere with the accurate positioning of F1/F1-A. Epoxy F1/F1-A to the box and angle braces. Tape it in place until dry. Add the 1/2" triangle supports next to "B" angle braces, tight up against the bottom of the box. Add angle braces "A".

Make sub-assemblies of the two M4's and the 1/2" x 2-3/4" ply strips. Put them aside to cure. Mark the thrust and centerlines on F2 and the centerline on F2-B. Glue F2-B on top of the fuselage frame, flush with the front edge. Use medium CA. Mark the thrust

line on both sides of the fuselage. Epoxy F2 into position, paying particular attention to the center and thrust lines. F2 must be lined up with, and perpendicular to, the thrust line.

Using 30-minute epoxy, install the two M5 sub-assemblies through F2, inside the fuselage and tight against the 1/16" ply webs. Let this all cure.

Take the engine mount assembly and slip it between the exposed ends of the two M5's. It should fit flush up against F2. If it does not, sand the ends of the M5's until it does. There should be a 1/2" space between the back of F1-A and the front of F2. The two M5's need to be tight against the sides of the engine mounts. Check that the thrust line marked on F1 lines up with fuselage thrust line, and is perpendicular all the way out to the underside of the engine bearers. Locate and drill holes in F1 and F2 for the throttle pushrod. When everything is in perfect alignment, glue together with 30-minute epoxy. Hold all this together with clamps between F1-A and F2 until cured.

If this procedure was followed with care, you now have a perfect alignment between the tail-plane and engine with no side up or down thrust offset. Now, go find the wing.

Put two or three layers of masking tape on front of the leading edge spar, to act as a shim. Position the fuselage upside down over the edge of the workbench with F2-A off the bench. With the top of the fuselage flat on the bench, the thrust line is now parallel to the bench. Place weights on top of the fuselage to keep it from moving.

Place the wing on the saddle, center it and measure from each tip to the tail post, making sure the measurements are the same. Fix the wing in place with "T" pins. The hardwood mounting blocks in the fuselage and wing should line up with each other. With the wing still pinned in

position, put an incidence gauge across the wing chord next to the root. It should read -1 degree. If it does not, make it so. Make the height of each wingtip above the workbench top the same by adjusting the appropriate saddle. Check all the measurements again, just to be sure.

From this point on there is no going back!

Draw a centerline on the hardwood mounting block in the wing. Measure forward from the front of F4 to the exact center of the mounting block in the fuselage. Use this measurement to mark the position of the holes on the bottom of the wing. Mark the center for the bolt holes 1-1/4" each side of the centerline, so the bolts will end up being 2-1/2" apart.

Use a 1/8" bit to drill the pilot holes through the wing and into the mounting block in the fuselage.

Measure down the centerline on the front of F1 to a point that is in the center of the front wing spar. Use a 1/8" bit to drill a pilot hole straight through F1 into and through the front spar. Use a small triangle when drilling these holes, to help keep them straight and square. Remove the wing and set aside.

Progressively enlarge the pilot hole in F1 to 1/4". Using the same progressive drilling method, enlarge the two holes to be tapped in the mounting block to 3/16". Tap these holes with a 1/4-20 tap. Clean up the threads by running a 1/4-20 bolt through them. Then harden the threads with thin CA.

Remove the masking tape from the front of the wing spar and enlarge the pilot hole to 1/4". Epoxy a 1-3/8" long 1/4" dowel through the leading edge spar, leaving 7/16" protruding. Next, enlarge the mounting bolt holes in the wing to 17/64".

Position the fuselage upside down, as you did before and reinstall the wing, securing it in place with 1/4-20 nylon bolts. Check all the dimensions to be sure nothing has changed. If you wish, you can enlarge the 1/4" hole in F1 and install a 1/4" inside diameter brass tube. This way the hole can never be distorted. Some folks see this as an overkill, but that's what I do on every plane I build.

With the wing still in place, using 3/32" sheet, plank the space between F1 and F2. Start at the top of the wing and go up to the top of the fuel tank box. Fill the space between the planking and the box with 3/32" scrap. Using soft balsa, carve the false leading edge to match the wing leading edge and glue it to the front of F1. Be careful not to glue the wing to the planking or false leading

edge. Remove the wing.

Cut and fit the 1/8" plywood tail skid mount. Make the skid from 3/32" music wire. Heat one end red hot and hammer it flat, then file it to a tear drop shape. Bend the wire to shape and install. Add the 3/8" balsa bottom block.

If you choose to use an internal antenna, this is a good time to install the tube. Run it from station F3 and out the bottom of the block at the tail.

Use a straightedge to mark the location of the bottom 1/2" x 3/32" stringer, on both sides of the fuselage. Mark the location of the other stringers on each side using the bottom stringer location as reference. Put a stringer on each side, one at a time, so you don't build in a twist or force a warp. The 1/2" stringers will have to be tapered at the aft end, use a plane, so they will bend without breaking. The aft end of the stringers should fit inside the tail post. As you install the 1/2" stringers, glue the 1/4" x 3/16" and 3/16" x 3/16" stringer spacers between the stringers from F2 through F6. Check the station views. These spacers will keep the stringers from deforming when the covering is applied. Do not sand to shape until all the stringers and formers are in place.

Glue the top formers F2-B through F8-A in place. Add the 1/4" x 1/4" top stringer, from F2-B to F4-A. Install the 1/8" sheet sides from F5-A to the tail post. Make the 1/2" top block that will be positioned on top from F5-A to the tail post. Carve it to its rough shape, hollow it out as indicated and glue in place. Glue the stringers on both sides of formers F5-A through F8-A. Start at the top with the 1/16" x 1/8" stringers, then add the 3/32" x 1/4" stringers. Take your time, and carefully install the 1/16" x 1/16" strip planking from F5-A to the tail post. Use either Ambroid or white glue for this process; the sanding will be easier than when using CA. The strip planking is not nearly as hard to do as it looks, and will sand into a beautiful, graceful curve.

With 3/32" sheet, plank the front top deck from F2-B through F5-A. Use two pieces that meet at the center of the 1/4" stringer. The sheeting should be even with the top edge of F5-A. Don't cut out the cockpit opening until after final sanding. Make a form the shape of F2-B, just a bit wider than the space between F1 and F2-B. Use this form, and a heat gun to make the .010 ABS hatch.

Make two wing bolt blocks from 1" balsa cubes. Drill a 1/2" hole halfway through each block. Using that hole as a

guide, drill a 5/16" hole the rest of the way through. Cut two 1/2" lengths of 5/16" brass tube and insert them up through the blocks until they are flush with the bottom of the 1/2" hole. If any tube extends below the bottom of the block, remove it. The tubes will keep the bolts from compressing the balsa blocks when tightened. Glue the tubes with thin CA. Insert the nylon bolts through the blocks and position them on the bottom of the wing, perpendicular to the centerline. Tack glue in place. Remove the bolts and securely glue the blocks to the wing with medium CA.

Install the landing gear struts, and bolt the wing to the fuselage.

To make the wing belly, glue formers F1-B, F2-C, F2-D, F3-B, and F9 in place. Be sure to put a 1/16" spacer in front of F1-B and behind F9. Shape the bolt blocks to conform to the formers. Mark the location of the 3/32" sheeting and stringers that will cross the bolt blocks. Cut slots in the blocks for the stringers to fit into, and clearance for the sheeting. Install the sheeting on the sides, between F2-D and F9. Glue all the 3/32" x 1/4" stringers in place. Remove any sheeting or stringers that interfere with the removal of the wing bolts.

Sand the wing belly and fuselage bottom before removing the wing; now sand the completed fuselage to shape.

Install the vertical fin and rudder, being careful not to glue the rudder to the tail post. When the fin is lined up, straight down the centerline, with the rudder lined up with the tail post and 90 degrees to the horizontal stab, glue the fin in place. Reshape the bottom block, if necessary, to match the bottom of the rudder. Remove the rudder and temporarily install the hinges.

Cowling & Wheel Fairings:

Most scale builders have their own methods for making fiberglass parts, so

I won't bore you with a lot of details. I do, however, highly recommend the method described by the Fibre Glast Development Corp. (800-821-3283) in their video on molding fiberglass cowls. The company also supplies all the necessary products, and phone support. I found them very helpful. This was the first time I used their system and all the parts came out perfect the first time.

When making the cowl plug, don't try to carve in the louvers. One, you will never get them all the same shape. Two, there is a good chance you will not be able to release it from the mold. Instead, only mark the locations of the louvers on the plug and deal with making louvers after the part is pulled. Score the panel lines; and mark the positions of the exhaust stacks, rivets, and screws. Do the same with the wheel fairings. Be careful not to make any reverse angles on the side of any openings that are carved in the plugs.

To make the louvers, you will need to draw a template of the opening, somewhat like a half moon. Using the location marks on the left side of the cowling, trace the outline of the opening at each mark. Using a small Dremel tool, cut out the holes. Make a die, the shape of the louver on a strip of 1/4" plywood, long enough to attach to the edge of the workbench. Cut a 1-1/2" square from thin ABS (one for each louver). Clamp it in place over the die with clothespins. Make a "finger" from a length of 1/8" x 1/4" spruce, taper and round off one end. Heat the ABS with a heat gun and use the round end of the "finger" to smooth the ABS into the die. Allow it to cool. This way all the louvers will be the same. Trim and position them behind the holes in the cowling and tack in place with slow CA. After all the louvers are positioned, secure them in place using epoxy and micro-balloons. Use epoxy and micro-

balloons to fill any imperfections on the outside, sand smooth and you're done.

When casting the wheel fairings, keep in mind that they are both the same. You will pull two from the same mold. The only time you need to think about right and left is when they are mounted on the struts.

This is as good a time as any to complete the struts. Using 30-minute epoxy, cover both sides of each strut with 1/8" x 1" strips of spruce. When dry, sand to a streamlined cross section. Use 3/32" ply and do the same to the tail skid. Glue a small piece of ply on top of the flattened part and sand to a "half-egg" shape. Cover both struts and tail skid with lightweight glass cloth and epoxy. When dry, sand smooth.

Mounting The Wheel Fairings:

Carefully cut the wheel fairings in half, along the parting line. Use a fine-tooth razor saw or thin Dremel cutting wheel. Take your time, keep the cut straight. Cut a 1/2" strip from a .015" fiberglass sheet, long enough to go completely around the inside of the rear half of the fairing. Draw a line down the center of the strip. Using CA, glue the strip to the inside of the rear half, with the line you drew along the edge of the parting line. Now you have 1/4" of the strip extending, as a ledge, forward of the parting line. Trial-fit the front half over the ledge and check the fit of the two parts. If things fit okay, reinforce the strip with 5-minute epoxy, inside the rear half.

The wheel fairings must be lined up perfectly. Following the procedure described here will make the process easy.

Tack-glue a 1/2" x 1/4" block, on its 1/4" edge, centered under the axle hole of each wheel yoke. Mount the struts in the wing. The 1/2" blocks will place the yokes at the proper height (1/2") above

the work surface. Attach the wing to the fuselage.

Place the aircraft on a flat surface (a Ping-Pong table works great) and block-up the tail until the top front deck is perfectly level. Use a small spirit level.

Take a sheet of heavy paper, 14" x 18" and draw a straight line 2" from the edge, along one of the 18" sides. This will be the front edge. Measure 9" along that line and draw another line perpendicular to the 18" line, to make a large "T". Measure the distance between the centers of the wheel yokes. Divide that measurement in half, and draw a line at that dimension from each side of the centerline, parallel to the centerline. This will locate the positions that will line-up the wheel fairings.

Place this paper grid under the struts, centering the cross points made by the outside lines under the yokes, at the axle centers.

Cut slots in both the front and rear fairing halves, to clear the strut. When you have done both fairings you will now have one right and one left.

Make a thick paste of 30-minute epoxy and micro-balloons. Fill all the holes in the yokes with clay, then coat the entire yoke with Vaseline, as a release agent. Position the rear half of the fairing over the yoke. Line up the fairing squarely with the lines on the paper. Press the paste between the fairing and both sides of the yoke. Do not get any paste on top of the yoke! Use plenty of paste to be certain the space between the two parts is completely filled. Some of the paste should ooze over the rear of the yoke. Any excess can be cleaned up after it has cured.

When the epoxy is hard, remove the rear half of the fairing from the yoke. Clean the Vaseline off of everything. Clean the clay from the holes in the yokes. When all is clean, place the rear half of the fairing back on the yoke and test-fit the front half. If all looks good, locate two holes, one on each side, where the 1-72 x 1/2" mounting screws will go. Drill through the front half, into the flange and through the yoke. Remove the fairing. Tap the holes in the yoke with a 1-72 tap. Put things back together using the screws, and repeat this process for the other two screws. The remaining twelve screws in the fairing are fake. Just glue the screw heads in position for scale effect. Don't make the cut-outs for the flying wires until after the wings are rigged.

Rigging The Flying Wires:

I used all Proctor products for the rigging on my model. However,

something new and interesting has hit the market. Nelson Hobby Specialties offers some really fine scale-like "flying wire." I probably would have used them, had I discovered them earlier in the design stage. But after designing, building, and discarding two wings already, I was not about to go through that a third time. I'll leave that choice to you. It really shouldn't be that big a deal.

I think the rigging process is pretty clearly described on the plans. Make the four small cable anchors. Don't make the wires overly tight, you don't want to warp the wings. Make them just tight enough to "ping" when plucked. Start at the wire between the wheels. Remember, none of the wires under the wing need be removed to take the wings off. Install the four turnbuckles for the top wires. Attach the flying wires and tighten the turnbuckles. Check the wing with an incidence gauge to make sure a warp is not pulled in. Install the wires under the wing, just tight enough to get that "ping." Recheck the incidence, and safety wire the turnbuckles. If this procedure is followed, you won't have to adjust the tension on the wires every time the wing is removed. Simply remove the four screws holding the wires on the top of the outer panels of the wing. When the wing is reinstalled, the tension will be just as it was before when the screws are tightened.

With all the rigging wires attached to the wheel yokes, grind off any screws protruding through the inside of the yokes, which might interfere with the wheels.

Make the axles as described on the plans and install the wheels, they must not rub against the yoke. Make the notches in the fairings to clear the flying wires. Attach the wheel fairings. Make sure the wheels spin freely.

Make the pitot tube, fuel tank cap, and breather tube. Install them after the model is finished.

Finishing:

I finished my B-2 with silk and acrylic lacquer. Use whatever finish you like. Keep it light. Personally, I would never use iron-on film on a scale model. Weight does not seem to be much of a factor. My model came in at 9 lbs, ready to go, less fuel, and flies as if it were on rails! I am sure you can come up with a lighter finishing process than I did.

The graphics were made for me by Pro Mark Model Graphics, 751 Airport

Rd., Metropolis, IL 62960. They make a "Dry Transfer" product. The process gives a very thin, borderless application which can be sprayed over. It works very well, if you follow their instructions and take your time. You will never get the lettering to conform to the shape of the louvers, just let them "float" over the openings. Then use a sharp razor blade to cut them along the straightedge of the louvers and burnish in the loose ends. Touch-up the lettering with Testers Master Model Gold Enamel. Pro Mark's graphics make a pretty fair representation of gold leaf lettering. Contact them for ordering information.

It's getting close to the point where you are going to have to fly this puppy, so let's mount some servos and stuff.

Mounting the servos is pretty much straightforward. The receiver is placed up front, behind the fuel tank compartment. The receiver battery pack and the 1500 mAh glow driver battery are aft of the wing, under the cockpit. I used an EMS Glow Driver; it is a very nice, lightweight unit. The cockpit has a split, 1/8" ply floor (so it can be removed) with the switch, charging jack, and glow driver charging point mounted on it. The pilot is held in place with Velcro. The windscreen is also removable, held in place with three screws, one on each end and one in the center. The other screws are fake.

The fuel tank is a 13 oz. Hayes, pushed as far aft as it will go. This will help keep the weight of the fuel closer to the center of balance. It also moves it further away from the engine and with some engines this might cause fuel-draw problems. I had no problems with the O.S. 61 FX. Adding a small "pony" tank ahead of the main tank may help solve fuel draw problems. A Great Planes fuel filler valve was positioned behind the number three exhaust stack. You will need to solder a length of brass tubing to the filling plug to reach the valve inside the cowl.

Suggested Control Throws —
Elevator: 1" U/D; Rudder: 2" R/L; ailerons: 1/2" U/D; Flaps: 45°.

These control throw numbers are a suggested starting point and are measured from the widest point of the control surface.

The B-2 didn't need any weight added to get it to balance. The aircraft balanced right on the mark as built (pure luck!).

I hope you enjoy building and flying your B-2 as much as I have.