This remarkably scalelike CL Mustang with a 60-in. wingspan is set up for .30 to .40 engines. It is extremely lightweight, strong, fast building, low cost, and made almost entirely of corrugated cardboard. ■Chuck Felton

Cardboard P-51B

WIDELY CONSIDERED the most efficient single-engine fighter to have come out of World War II, the North American P-51 Mustang has become one of the most popular subjects for Scale model airplane builders—and justifiably so. Escorting bombers all the way from British bases to targets deep in Germany, this capable warbird was instrumental in gradually establishing Allied air superiority over the Luftwaffe.

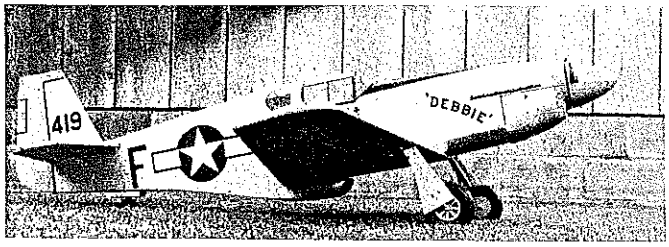
Thóugh the P-51 Mustang has been modeled many times, both in kit form and in scratch-built versions, the CL model presented here, being constructed primarily of ⅛-in. corrugated cardboard, is unique. The corrugated cardboard construction greatly reduces both building time and cost. The design exploits the specific properties of cardboard which allow it to be used in large sections and to be folded.

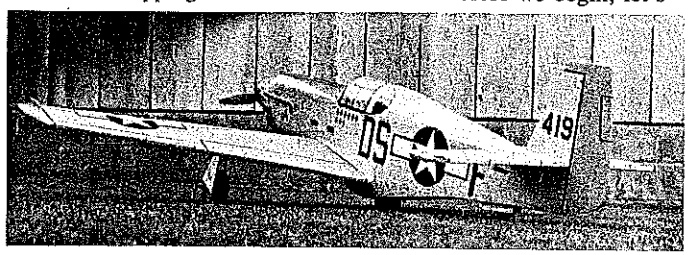
The wing, for example, is built of two large pieces of cardboard with cardboard ribs and a single spar, while the tail surfaces and fuselage are primarily cardboard with little internal bracing. The result is a low-cost, lightweight, fast-building model, notably scalelike in appearance, that can take plenty of punishment at the flying field.

Any ⅛-in. corrugated cardboard will do for this project, although the material does vary in weight. Sources for cardboard include box manufacturers and local shopping centers where you can find stacks of discarded boxes. Look for cardboard with brown paper on one side and a white finished paper on the other. The white paper on the outside of the model results in a smoother finish and neater appearance.

The model is built to a scale of 1⅝ inches to the foot, resulting in a wingspan of 60 in. and a length of 52 in. The bottom of the airfoil is flat with a curved upper surface, due to the scoring and folding technique employed. Engines of .30 to .40 size can be used. The Mustang's size and stability make it a good CL sport flying model.

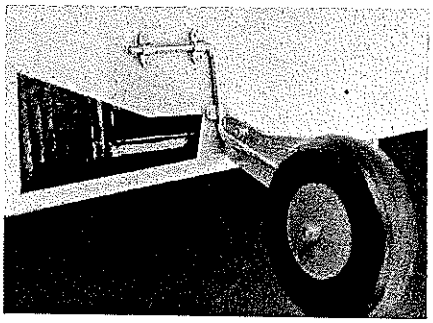
Construction hints. Before we begin, let's



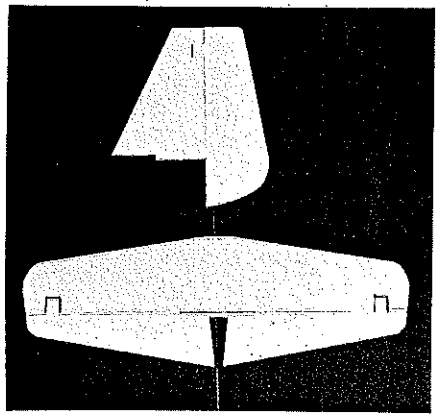


Three views of "Debbie," a semiscale P-51B Mustang ready for the CL circle. It was built to a scale of 1⅝ in. to the ft., and was constructed mostly of ⅛-in. corrugated cardboard using a scoring and bending technique described in the text. The cardboard was waterproofed with clear polyurethane diluted 75% before construction. The airplane was finished in a silver/blue paint scheme using two coats of clear dope as a base and three coats of color. Cardboard, however, can be finished using a wide variety of materials because of its smooth, nonporous surface. The final product, as you can see, is a great-looking and strongly built CL airplane that can take its share of punishment at the flying field.

The author proudly displaying his cardboard masterpiece. It's a real eye-catcher yet extremely simple, inexpensive, and fast building. Its size and stability make it a good sport flier.



Close-up of the main landing gear shows that it's a simple arrangement using 5/32 wire bent to shape and attached with nylon gear clips to a 1/8-in. ply insert in the wing. The model uses a 3¾-in.-dia. tire; the wheel fairing is 1/8-in. ply bolted to the gear wire. The dummy wheel well shape is painted black.



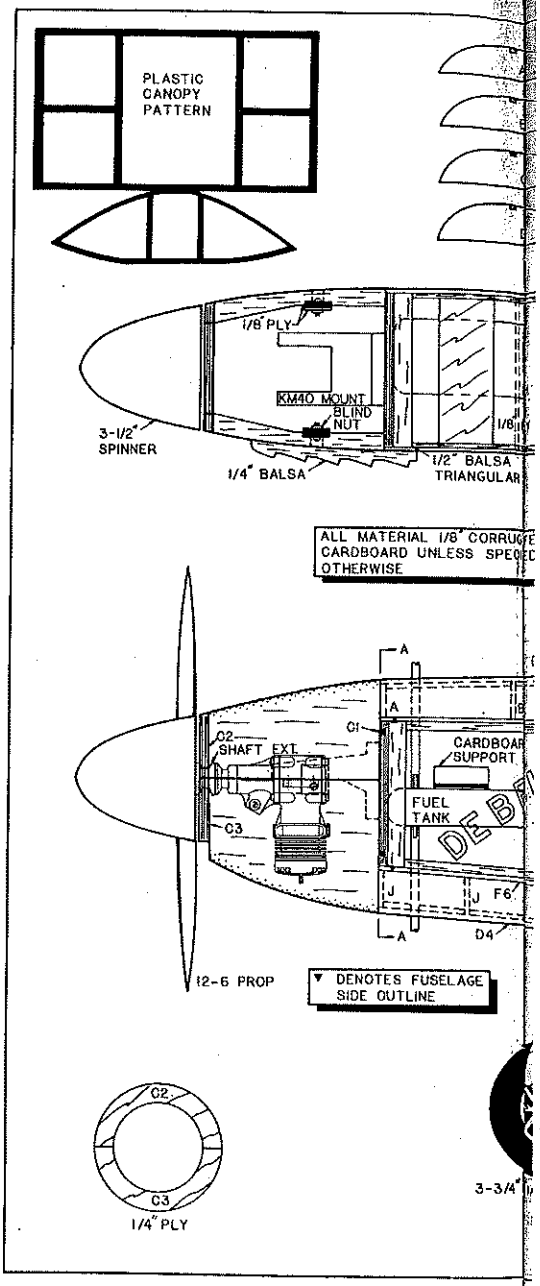
The empennage sections prior to final assembly. They're constructed by laminating two pieces of 1/8-in. cardboard across the grain to create ¼-in. surfaces. The leading and trailing edges are finished with 1/8 x ¼-in. balsa strips as per the plans. All raw edges are sealed with gummed paper tape, and the hinges are made from cloth strips.

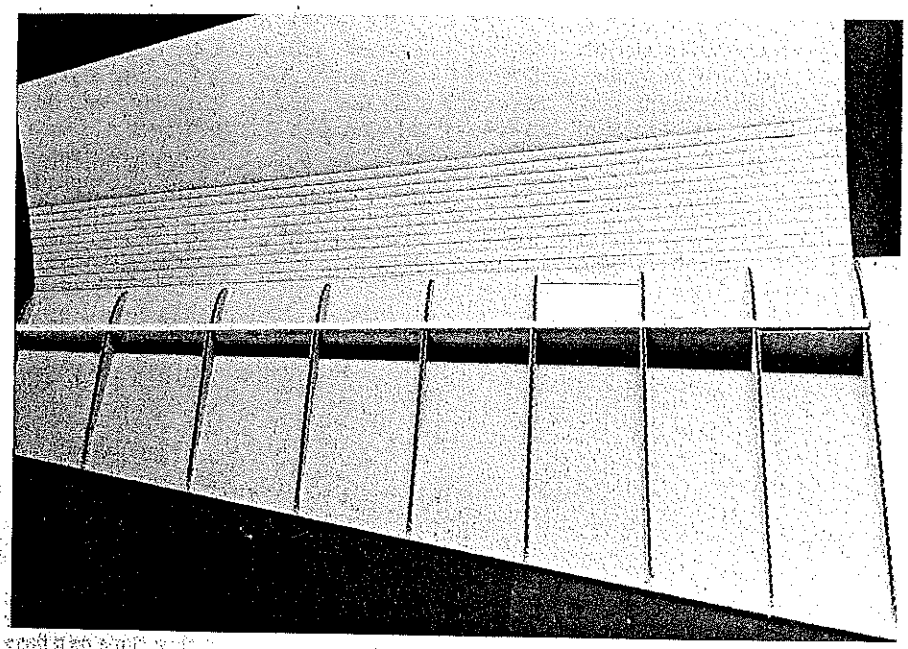
review these special tips for working with cardboard.

• *Glue.* Water-based glue, such as white glue or Titebond, is recommended. Contact cement is not recommended since parts cannot be shifted when gluing surfaces.

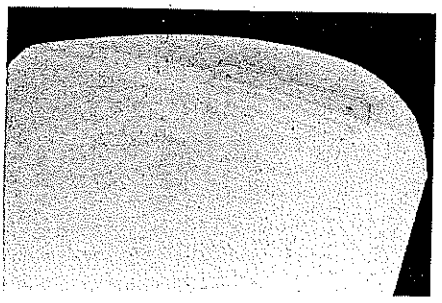
• *Folding.* The scoring of the fold lines is done with a screening tool that's available at any hardware store. It consists of a handle with a 1½-in. radius wheel at one end which is run along a straightedge on the fold line.

• *Waterproofing* of cardboard is quite sim-

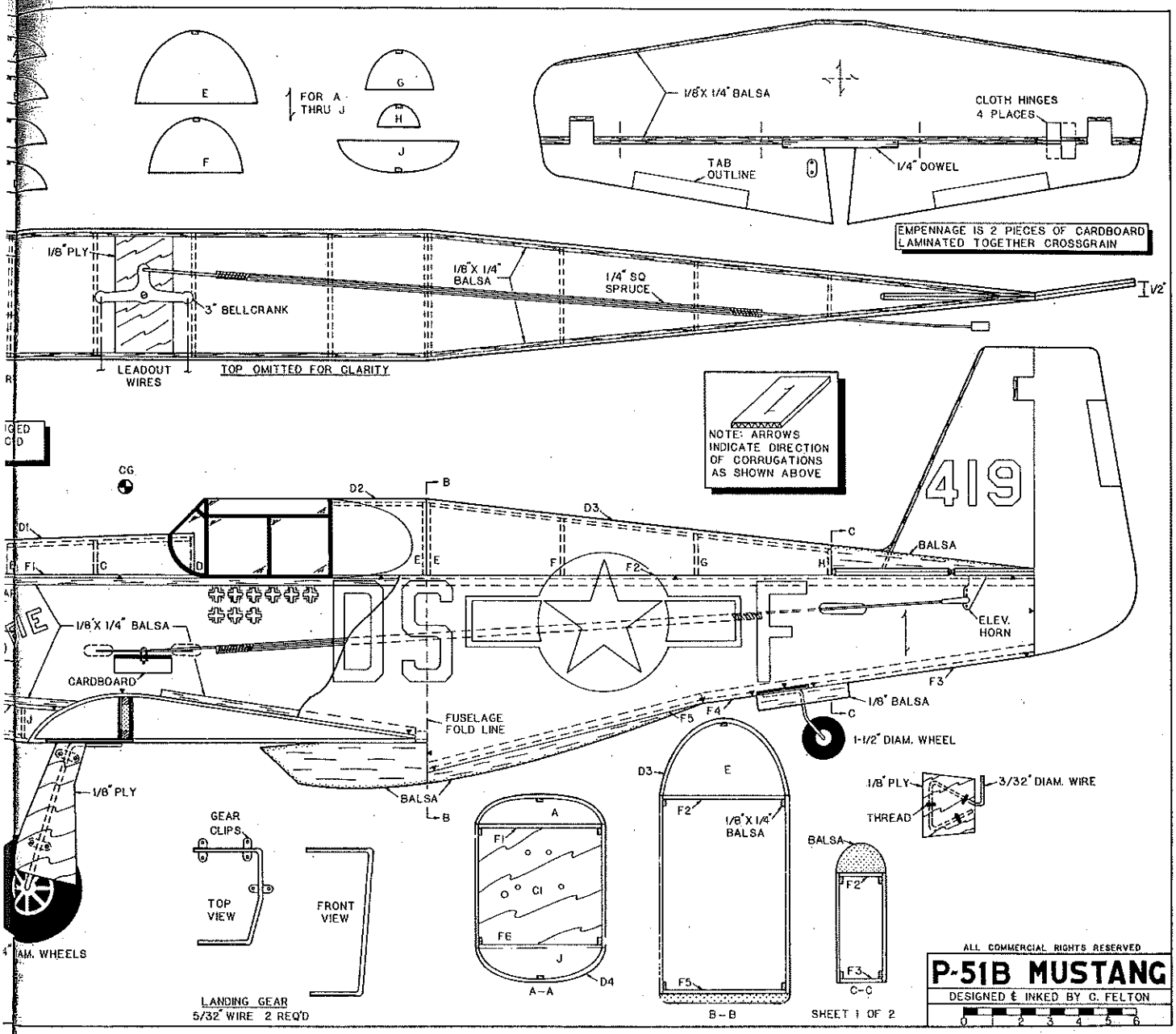




The left wing showing the interior structure and scored cardboard skin prior to final assembly. The balsa spar is capped with a spruce strip. The ribs and skin are all 1/8-in. cardboard.

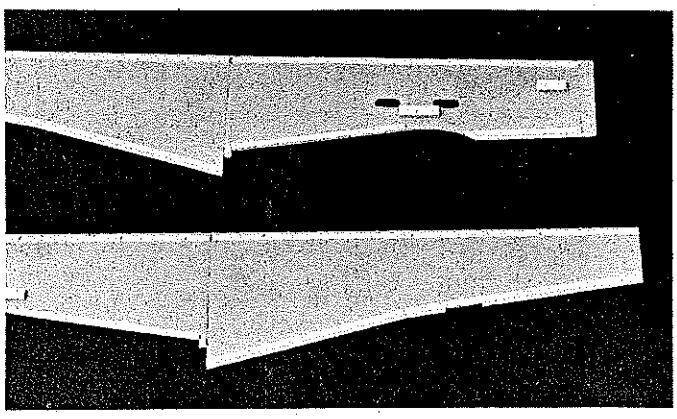


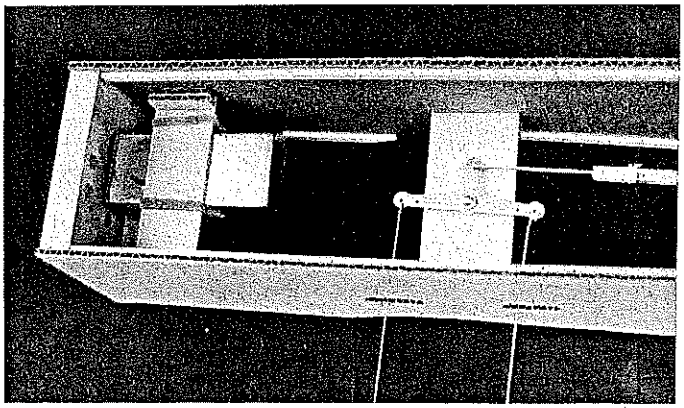
This close-up shows the finished wing tip ready for painting. Note the carved balsa tip. The 1/8-in. plywood line guide is in place, and gummed paper tape is sealing all the edges.



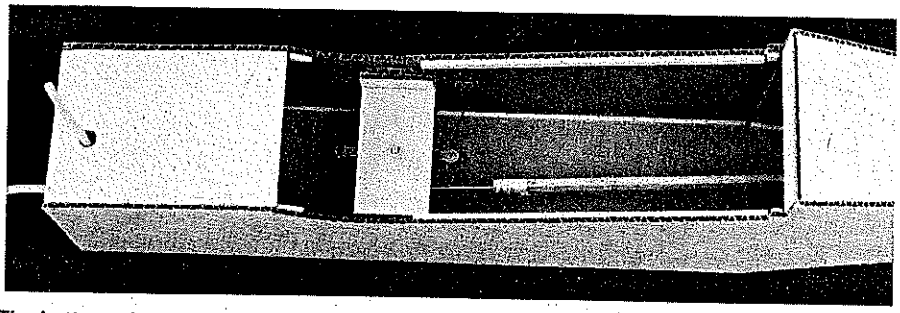
ple and can be applied to the raw material before you cut out the parts of the model. Thoroughly mix 25% clear polyurethane with 75% paint thinner. The latter can be the cheapest hardware store variety. Brush the mixture liberally onto the cardboard sheet and allow to dry for 48 hours. This adds no appreciable weight to the material and renders the cardboard completely waterproof. In addition, when you start cutting the treated cardboard, you'll find that it's as crisp as wood and divides sharply and cleanly.

• *Finishing.* Cardboard is nonporous and gives a solid surface with no open areas to cover. The easiest finishing method is to apply two coats of clear dope, sanding lightly between coats with 400-grit sandpaper, followed by three coats of colored dope. However, a wide variety of finishing materials

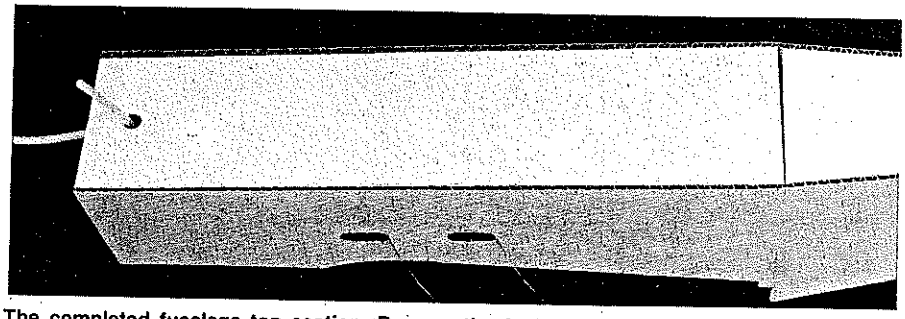




Left: The cardboard right and left fuselage sides shown ready for assembly with ⅛ x ¼-in. balsa strips attached to the upper and lower edges recessed ⅛ in. from the edges. Right: The front of the partially finished fuselage showing the fuel tank and bellcrank assembly in place.



The bottom of the fuselage box section in place. Fuel tubing is protruding from the firewall area. Notice the cardboard side supports for the ply bellcrank mount and the spruce pushrod.



The completed fuselage top section. Be sure the fuel tank and tubing, the bellcrank, ply mount, the pushrod, and control wires are all properly installed before closing this section.

may be used on cardboard. Coverings such as Solarfilm, MonoKote, and vinyl paper can be used. With any of these, it's recommended that the surface not be doped, which will result in a better bond.

• *Paper tape.* All seams, joints, and exposed edges of the model are covered with strips of gummed paper tape. Obtain a 1-in.-wide roll from a stationery store. Simply cut a thin strip to length, dip it in water, and smooth it over the seam.

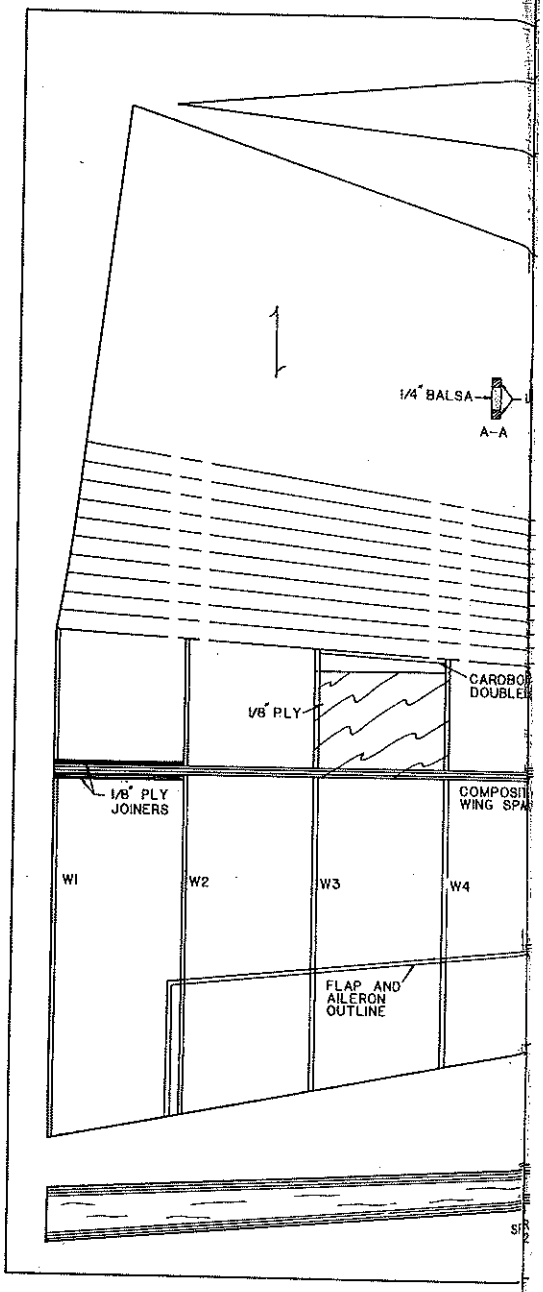
Construction. Cut out all cardboard and wood parts using the template outlines. Be sure to note the direction of the corrugations. Score and fold cardboard parts as indicated on the plans.

Empennage. The fin, rudder, stabilizer, and elevator are each made from two pieces of ⅛-in. cardboard laminated together across the grain to create ¼-in.-thick surfaces. Add a ⅛ x ¼-in. balsa strip to the fin leading edge, and round it off. Add ⅛ x ¼-in. balsa strips to the stabilizer leading and trailing edges, and round off. Glue the elevators to the ¼-in. dowel. Add ⅛ x ¼-in. balsa strips to the remainder of the elevator leading edge, and again round off. Seal all raw edges with gummed paper tape. Hinge the elevators to the stabilizer with cloth strips at four places.

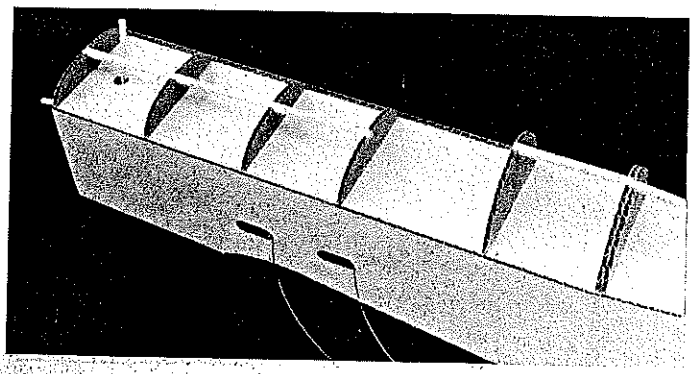
Wing. Make the spar by capping each ¼-in. balsa spar half with a ¼ x ¼-in. spruce strip on the top and bottom. Join the spar halves together with ⅛-in. ply front and rear at the centerline. Glue the ⅛-in. ply gear mount into each wing panel. Glue the right side of the wing spar onto the right-hand wing panel (W9). Fit and glue all cardboard ribs into place on the right wing. Add a cardboard doubler over the ply gear mount between ribs W3 and W4. Glue a one-ounce weight to the right wing tip.

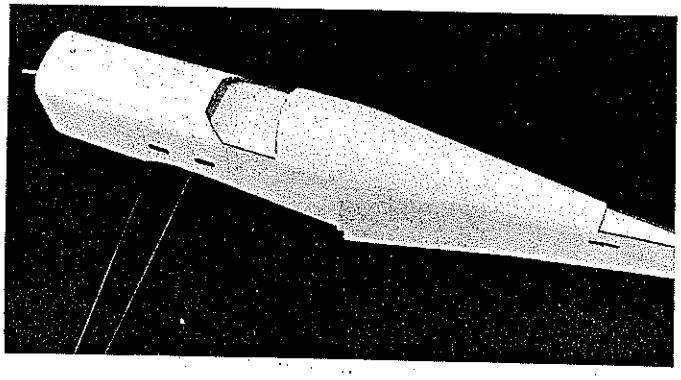
Glue the left wing panel to the left spar in a similar fashion. Add the ribs and gear doubler to the left wing. Apply glue to the top of the wing spar, the top of the ribs, and the trailing edge of the wing. Fold the top wing surface down, and pin it securely in place until dry.

Add the balsa tips to the wing. Make a line guide from ⅛-in. ply. Cut a slot in the left wing balsa tip, and glue the line guide in place. Cover the trailing edge and all seams with gummed paper tape.

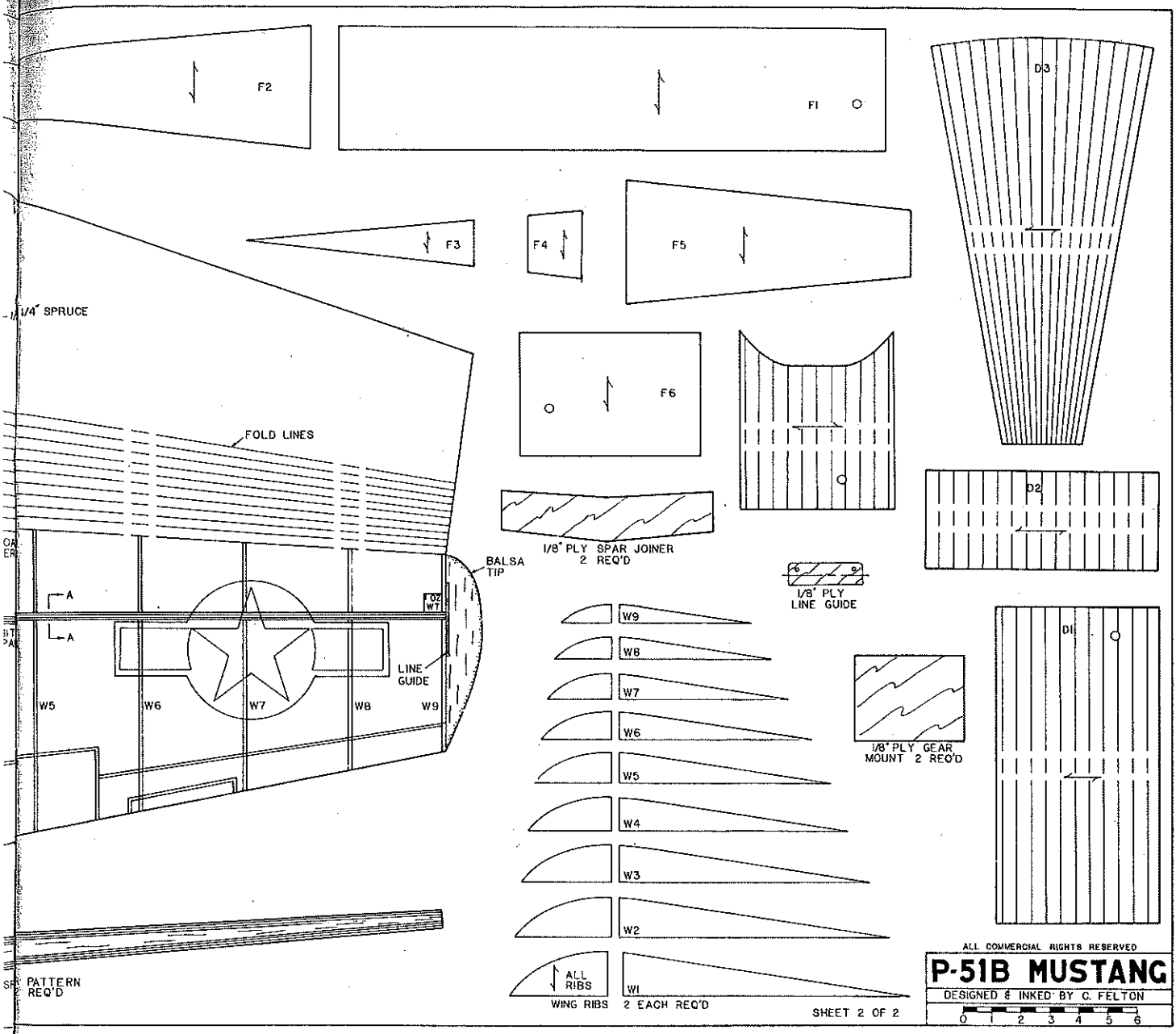


Fuselage. The fuselage sides are outlined with a triangular symbol on the drawing. Apply ⅛ x ¼-in. balsa strips to the upper and lower edges of each side, recessed ⅛ in. from the edges, as shown in the fuselage side view. Bevel the strips at the aft end of



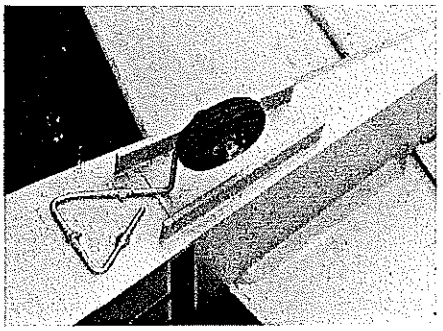


Left: The curved hood and turtledeck under construction. The cardboard formers are held in place at this point by a single balsa stringer along the centerline. Right: The finished hood and turtledeck. The cardboard is carefully scored to fit the curve, and the seams are covered with tape.



the fuselage so that the cardboard sides will come together. Add cardboard supports to each fuselage side above the fuel tank and below the bellcrank.

Make the firewall, C1, from ¼-in. ply. Locate the mounting holes for a KM-40 engine mount on the face of C1. Drill the mounting holes, and install blind mounting nuts on the back side of C1. Drill a hole in C1 for the fuel tubing exit. Brace all four back edges of C1 with ½-in. triangular balsa.



Close-up of the tail wheel gear. The wire is attached to a plywood base with nylon thread.

Glue C1 to the right side of the fuselage. When dry, glue the left side of the fuselage to C1. Attach the fuel tank to the ⅛-in. ply support with rubberbands. Make a pushrod from 3/32-in.-dia. wire and ¼-in.-sq. spruce, and attach it to the bellcrank along with the lead-out wires. Install the tank and bellcrank assemblies by gluing the ply supports to the cardboard supports on the sides of the fuselage. Glue the sides together at the tail.

Glue F1 and F2 in place to cover the top of the fuselage. Be sure to bring the fuel fill and overflow tubing out during all covering operations. Cover the bottom of the fuselage by gluing F3, F4, F5, and F6 in place.

Add bulkheads A through H to the top fuselage, adding ⅛ x ¼-in. stringers. Cover bulkheads A through D with D1, which has been scored and folded. Cover bulkheads E and E with D2. Cover bulkheads E through H with D3. Add the three J bulkheads, with

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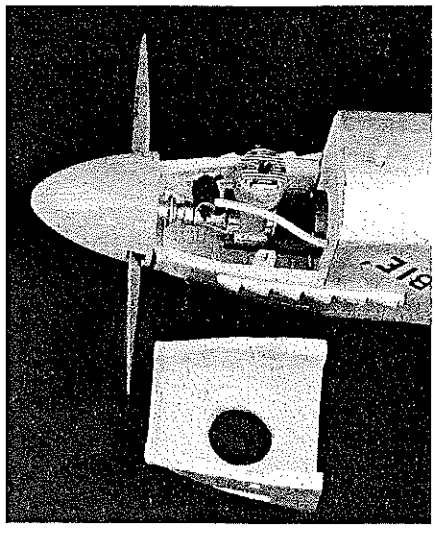

The business end of Debbie. The engine (.30 to .40 size range) is mounted upside down on a KM40 mount. A shaft extension must be used to achieve correct spinner clearance.

then, to Bill Booth, architect and mastermind for 1989; his business manager, Bob Beecroft; Lynn Martin; my new and good friend, Truman Puckett, *Chef du Taft;* and a whole passel of folks who reminded me by act and attitude that *Taft is a very special place.*

The roses really do smell, people. Plan for USFFC 1990 now. There's no telling if it'll be as cool as 1989, but it certainly will be groovy!

P-51B/Felton

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stringer, to the forward bottom fuselage, and cover with D4. Add the balsa sheet piece to the bottom of F5, rounding off the edges as shown in view B-B.

Build up the cowl from ½-in. balsa sheet as shown in the top and side views, then hollow it out. Glue the ¼-in. ply C2 piece to the front of the top half. Glue C3 to the front end of the cowl's removable bottom. Sand, carve, and hollow the cowl to shape. Add the ⅛-in. ply pieces to the inside of both the top and bottom halves at the cowl sides, as shown in the cowl top and side views. A blind nut installed on the inside of the top cowl ply and a 4-40 bolt through the bottom cowl ply form the cowl attachment. The top half of the cowl is then permanently glued to the nose of the model.

Test fit the engine in the cowl, then drill mounting holes in the KM-40 mount. Use a shaft extension to achieve adequate spinner clearance. Cut holes in the cowl block for the cylinder head, exhaust, and needle valve.

Glue the stabilizer to the fuselage. Add ½-in. triangular balsa to the bottom of the stabilizer at the fuselage intersection for bracing. Glue the fin to the fuselage. Add scrap balsa bracing between the fin and stabilizer intersection, and round off as shown in view C-C. Add the rudder to the fin with the trailing edge offset ½ in. to the outside of the flying circle.

Make the tail wheel gear from 3/32-in.-dia. wire. Bend the gear as shown, position it on the ⅛-in. ply support, and drill the holes. Attach the gear with nylon thread, gluing liberally. When dry, glue the unit in place in the bottom fuselage cutout. Add scrap balsa wheel fairings.

Make the main gear from 3/32-in.-dia. wire as shown. Make gear fairings from ⅛-in. ply, and attach with nylon gear clips. Attach the gear assemblies to the ⅛-in. ply supports in the bottom of the wing with nylon gear clips.

Finishing. The color scheme is silver overall with medium blue trim. Make the lettering and insignia from MonoKote. Make the canopy from thin plastic, and epoxy to the fuselage. Outline the canopy with strips of black MonoKote. The aileron and flap outlines are also made of black MonoKote.

Final assembly. Glue the wing to the fuselage. Make the air scoop from a hollowed-out balsa block, and glue to the bottom of the wing. Add balsa exhaust stacks to both sides of the forward fuselage. Pass the lead-out wires through the wing tip line guide, and tie them off. Attach the nylon control horn to the elevator. Hook up the pushrod. Attach 3¾-in.-dia. wheels to the main gear and a 1½-in.-dia. wheel to the tail gear. Attach a 12 x 6 prop and a 3½-in. spinner to the engine.

Be sure to balance your Mustang at the center-of-gravity shown on the plans. You're ready to take it to the flying field and see for yourself how rugged and lightweight this plane is.

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If you have any comments, suggestions, or questions concerning the cardboard P-51, please write to me at the following address: Chuck Felton, 19009 Laurel Park Rd., Space 86, Compton, CA 90220.

CL Aerobatics/Fancher

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one black, using 1¼-in.-high Clarendon Bold type (all capitals) with the name slanted 25° forward, and the AMA number slanted 25° backward.

Four working days later the appliques arrived in the mail, and an hour after that they were on the plane ready for clear coating. Application was as simple as it sounds, and they went on without a hitch. They looked *magnificent!* Just see the photo for yourself.

Since the pictures were taken I've clear-coated the ship using K&B SuperPoxy with absolutely no adverse affect on the numbers.

If, however, you plan on doping over them, be advised that unless applied cautiously dope will cause the letters to curdle. Clear dope must be sprayed on in several very light and dry coats to prevent this. If your spray rig allows you to vary the amount of liquid, use this method to apply mist coats. If you are using spray cans, spray the first several coats light and fast from about 18 in. away so that the paint is nearly dry when it hits the letters. After four or five coats like this, normal coats may be applied to the entire ship. Just be cautious not to load the lettered area down with wet dope which may soften the earlier coats.

The cost? $5.75 a set, about 15% of the $48 that Letraset would have cost. Try it, and I think you'll like it.

Speaking of finishing, let's talk a bit about the frustration I suffered as a result of the finishing process on my new Temptation. I'm going to talk about what Mike Keville referred to as the "F-word" in a letter on the subject the other day.

What is the "F-word," you ask? Through tightly clenched teeth I whisper, *"fillets."* That miserable, embarrassing area where the fuselage mates with the wings and tails. That exotic, sensuous, curved area everyone who looks at your airplane likes to caress in search of telltale blemishes. When they discover symptoms of such malignancy, they like to impale you with an evil grin and say pleasantly, "Had a little trouble with the F . . . . . s, didn't you?"

"Little!" Did you say a "little" bit of trouble? Would you call having Mt. St. Helens erupt in your backyard a "little" bit of trouble? Would you believe the name Temptation came from the many temptations I considered, each having to do with the untimely demise of this inanimate time-and-money sponge? Let me tell you about a "little bit of trouble" as it pertains to the "F-word"!

For a number of years I have been using Sig Epoxolite for fillets on my Stunt ships. This is an exceptional product which is extremely strong, of a reasonable weight, and which can be shaped to nearly final dimensions with a finger dampened in water before it cures.

While there are a lot of nice things to say about Epoxolite, one of them is *not* that it takes well to being covered with paint. Many a word has been written about the need to take extra precautions when painting over it. Here's why.

To successfully cover a fillet between two surfaces which are at angles to one another, it is imperative that the paint adhere aggressively to the fillet itself. Because all paints shrink as they age, they will tend to pull away from areas to which they are poorly attached if the adjoining surfaces are at significant angles to one another. When the paint adheres tightly to the fuselage and to the wing—but not to the fillet—it will leave flat, bubbled areas where it has pulled away from the smoothly radiused fillet. Because these flat bubbles become reflecting surfaces, they are extremely noticeable and severely degrade the appearance of an otherwise attractive airplane.

Because Stunt fliers historically use butyrate-type dopes for covering and basic filler-coating, and because butyrate doesn't stick well to Epoxolite, we have had to devise ways to get the finish to adhere. It has been found that both Aero Gloss and nitrate clears will adhere to the Epoxolite much more aggressively than will butyrates. Expert craftsmen will therefore apply two or three coats of the former over the bare Epoxolite to prime it for subsequent finishing coats of butyrate.

This approach has proven to be generally successful. It is important to remember that the Aero Gloss or nitrate dopes must *not* be used on top of any butyrate paints, as they will lift the butyrate. Butyrate can be applied on top of either, however.

Well, I had done that, using nitrate as a sealer and then proceeding with an all-dope finish. I had the entire ship painted white when the first rash developed. Numerous bubbles appeared over all the upper fillets. Don't ask me why, but the bottoms still looked pretty good. Attempts to readhere the paint proved futile (as they always do), and I finally gave up and stripped all the paint away clear down to the Epoxolite.

Thinking that perhaps I hadn't allowed the fillet to cure properly, I decided to insulate it from the paint by covering the entire filleted areas with a fairly thick layer of Model Magic Filler. This is a water-based material which is very light, sands

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