Stephens Akro

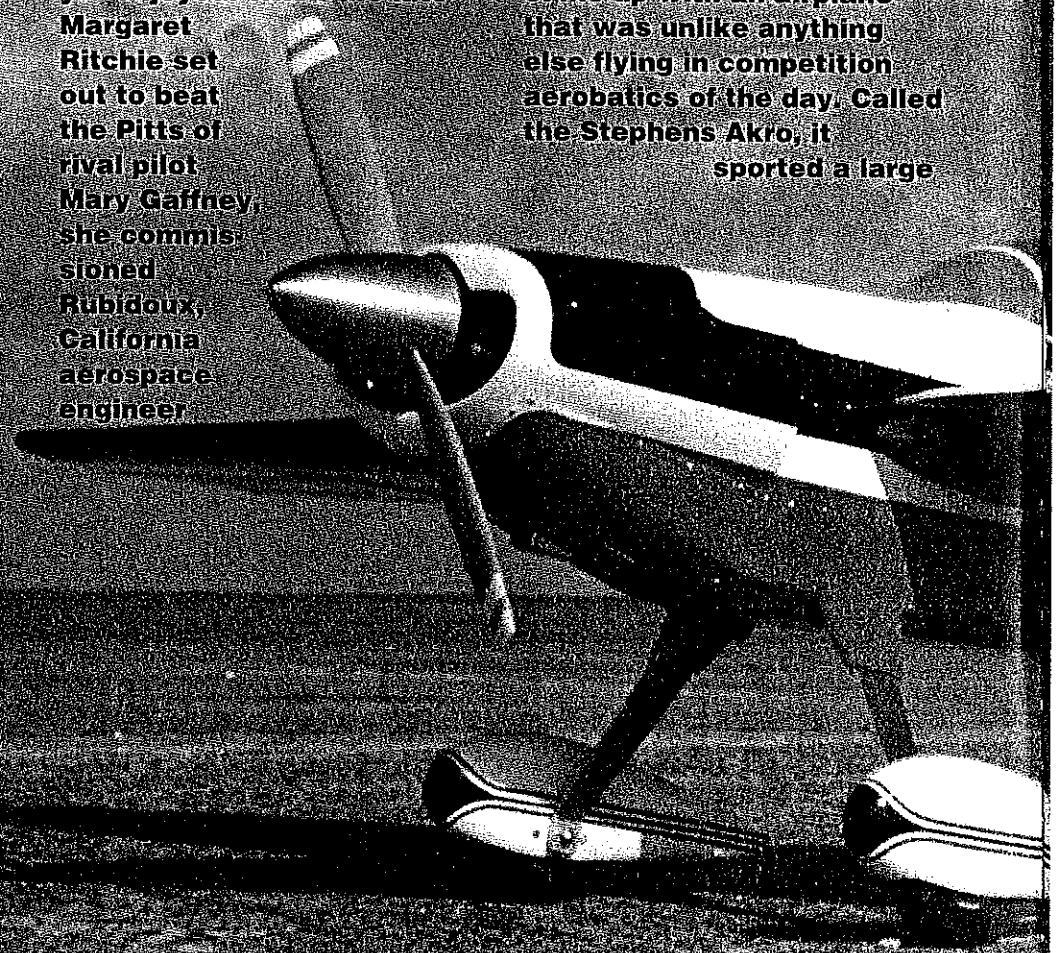
#215

This 1/4-scale sport model of a seminal 1960s design makes for hot aerobatic performance.

■ **Brad Shepherd**

IN the late 1960s, an aeronautical engineer with no aerobatic experience designed a full-scale competition plane with aerobatic performance superior to any its pilot had yet enjoyed. When the late Margaret Ritchie set out to beat the Pitts of rival pilot Mary Gaffney, she commissioned Rubidoux, California aerospace engineer Clayton Stephens to design and build a better aerobatic performer than the 150-hp clipped-wing Taylorcraft she had been flying at the time.

Ritchie didn't regret her choice. Having no preconceived ideas about what an aerobatic craft should look like, Stephens discarded the idea of two wings, and even rejected, despite its proven track record in Yaks, Zlins, Spinks, and Chipmunks, the concept of a single wing on the bottom of the fuselage. Using only his aeronautical training, slide rule, and drafting skills, Stephens came up with an airplane that was unlike anything else flying in competition aerobatics of the day. Called the Stephens Akro, it sported a large



greenhouse canopy stuck on top of a slender fuselage with skinny legs.

If Stephens's design was radically original, his construction methods were not. Like many other home-builders working out of garages across the land, Stephens used welded-up chrome-molybdenum steel tube fuselage members and fabric-covered tail surfaces.

One key to the airplane's performance was the plywood-covered wing with a single, beefy spar that crossed the middle of the fuselage directly in front of the pilot's knees. By thus having the wing attached directly through the thrust line, the Akro could do outside, or negative G, maneuvers with the same amount of control force or movement as for upright, or positive G, maneuvers.

The Stephens Akro prompted a host of spin-offs, including two world champions and several that earned national titles. The single individual most responsible for elevating Stephens's airplane to a world-class aerobatic performer was pilot Leo Loudenslager.

Through a long series of modifications from 1971 through 1975, Loudenslager transformed a stock Akro (registered N10LL) into an entirely different airplane, later renamed the Laser 200 by a Canadian air show promoter.

Loudenslager's airplane beat all 20 Pitts Specials in the 1975 championships to win the first of a string of national Unlimited titles. In 1980, under the title of Laser 200, the plane became World Aerobatic Champion.

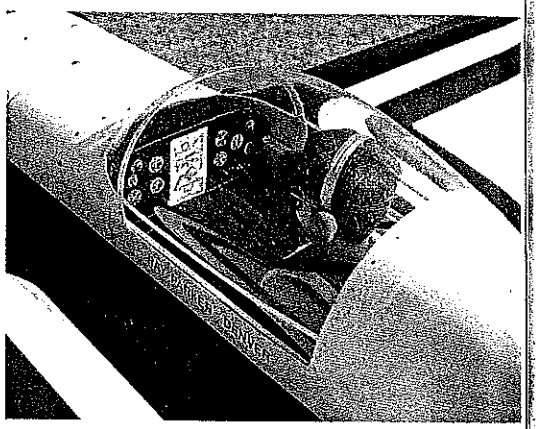
Among the other competition aircraft that trace their ancestry to the Stephens are the Haigh Super Star, Diabolo, Extras, Wigins Z, Rebel 200 and Rebel 300, French TR, and the Australian Laser Aerobatics Model Z.

Nowadays, many versions of the Stephens Akro can be seen flying in air shows and as sport aerobatic aircraft. Each is a little different, reflecting the personal touch of its owner/builder. The quarter-size sport Scale model presented in what follows is based on a variant designed by Ray Parker. I chose the plane because of Ray's subtle mod-

The Stephens Akro ready for flight. The author chose Ray Parker's version of this influential 1960s design for its subtle structural modifications and attractive paint scheme.

Three-quarters rear view of the model. Differences between this variant and the original Stephens Akro include a raised turtledeck and slightly enlarged tail surfaces.

Top: Custom details turned a Williams Bros. 3-in. scale pilot into Ray Parker's likeness. Bottom: Canopy is by Fiberglass Specialties T&D. Ray's name is done with Presto vinyl stick-on lettering.

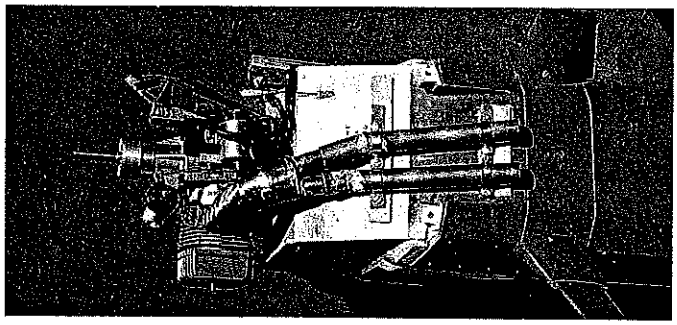


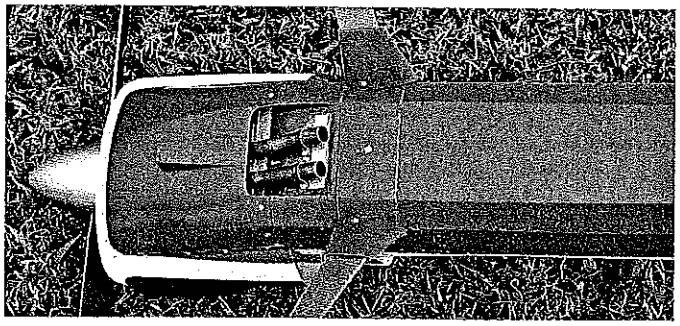
ifications and the very attractive paint scheme.

Ray had reduced the full-length bubble canopy to a partial bubble and raised the turtledeck. He also had slightly enlarged the tail surfaces, and redesigned the square tips. Internally, he had revised the fuselage framework a bit and redesigned the controls for better feel and optimal performance. In a letter, Ray wrote that while he has built and restored other aircraft, the Stephens remains his favorite, and he flies it often.

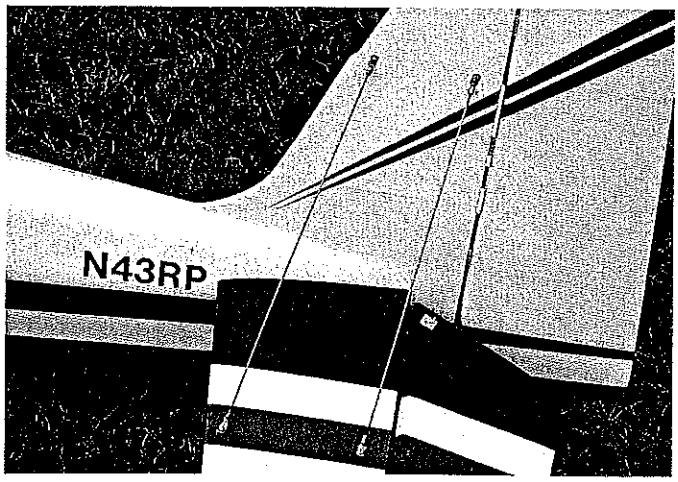
Some of my readers may already be familiar with Ray Parker's creative talents and super craftsmanship abilities from the article about his close copy of the Sperry Messenger in the December 1974 issue of the EAA publication *Sport Aviation*. Ray had used three-views and information gleaned from an article by Pete Bowers, along with some eyeball engineering and guesstimation, to develop the plans for this post-World War I single-place Army biplane.

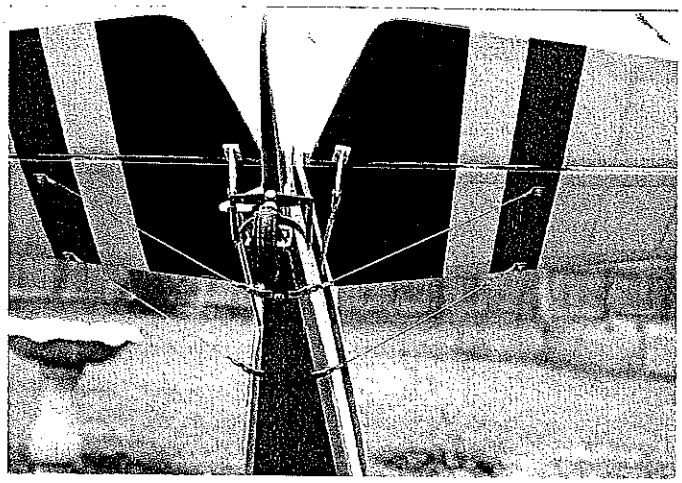
Ray began his career in aviation in 1940 at a flying school in Missoula, Montana. He progressed to Army Air Corp flying schools and graduated as a photo-reconnaissance pilot flying P-38 photo planes in the Pacific theater of World War II.





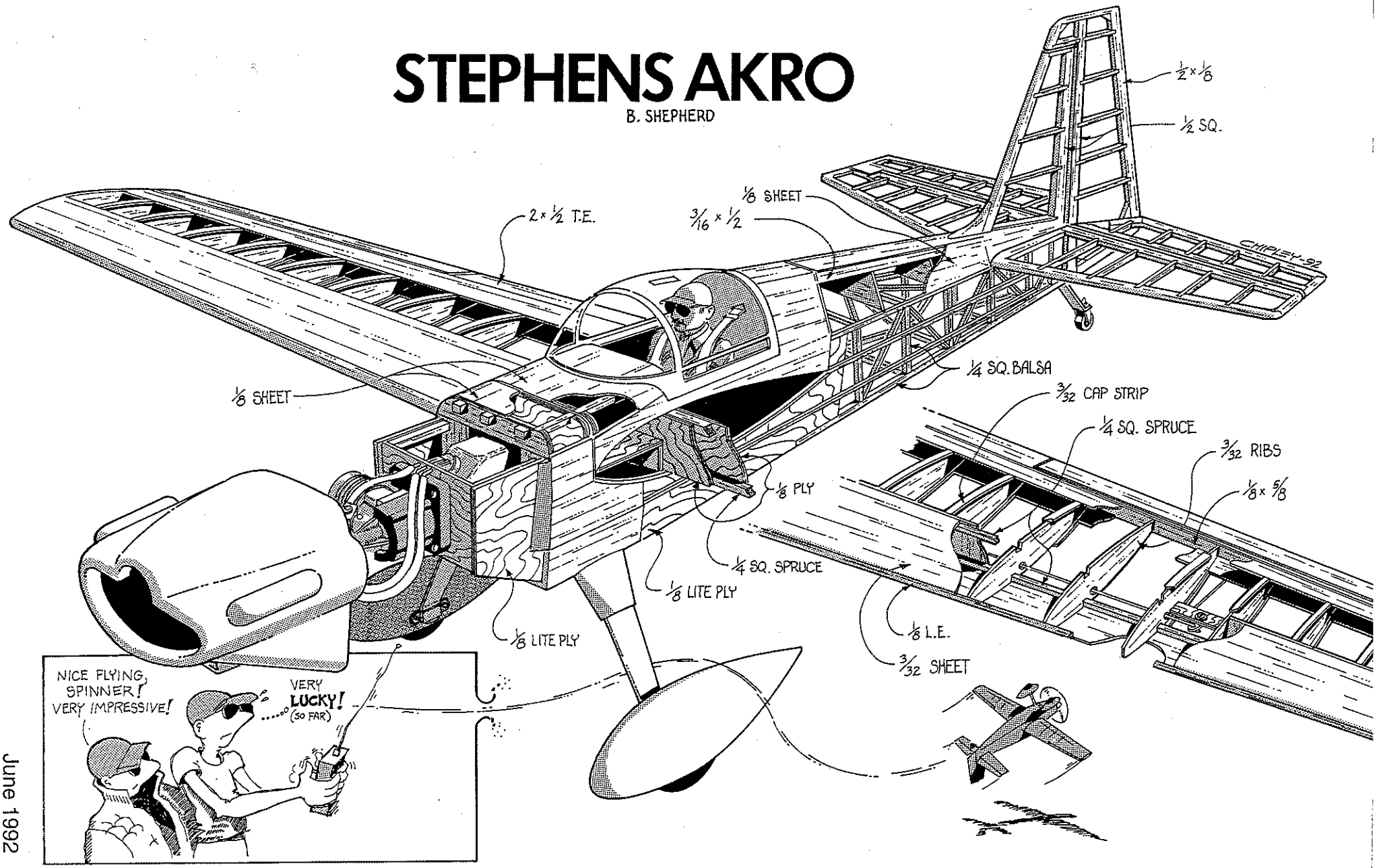
Above left: The original SuperTigre .90 installation included provision for a smoke system. Above right: Scale twin stacks are made from K&S brass tubing. Bottom left: The brace wires for the tail surface wires are secured to the bottom of the fuselage with brass strips. The rudder horn and twin elevator horns are driven by a single servo. Bottom right: Archer male quick disconnects (Catalogue #64-3038) are soldered to the ends of the 3/64 music wire tail braces for attachment to the fuselage and tail surfaces.

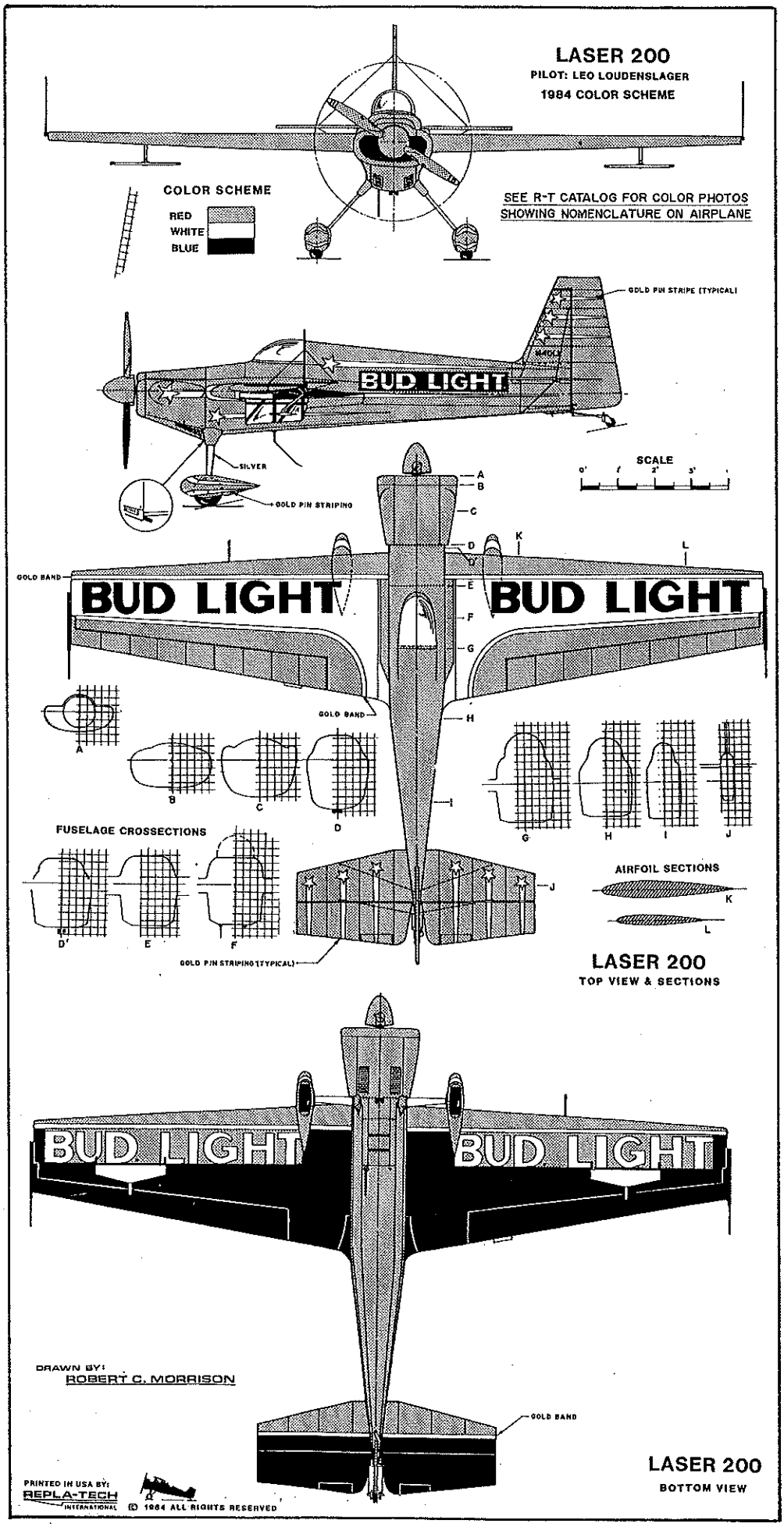




STEPHENS AKRO

B. SHEPHERD





RC Stephens Akro

Type: Sport Scale

Wingspan: 72½ inches

Recommended engine size and type: Saito .80 GK
Range: .75 -.90 two-stroke; .80-1.20 four-stroke

Number of RC channels recommended: Four

Expected flying weight: 9 lb. 2 oz.

Type of construction: Built-up

Type of covering/finish recommended: Sig Koverall; MonoKote; paint (Cheveron Perfect)

After the war, Ray studied at the universities of Montana, Indiana, and Columbia, earning a Ph.D. in geology, then moved on to a career flying all over the world with the U.S. Geological Survey. He is now retired to a residential airport community in Ocala, Florida.

Ray recently restored a Piper PA-22, converting it to a Pacer. At this writing, next on his agenda is an RV-6.

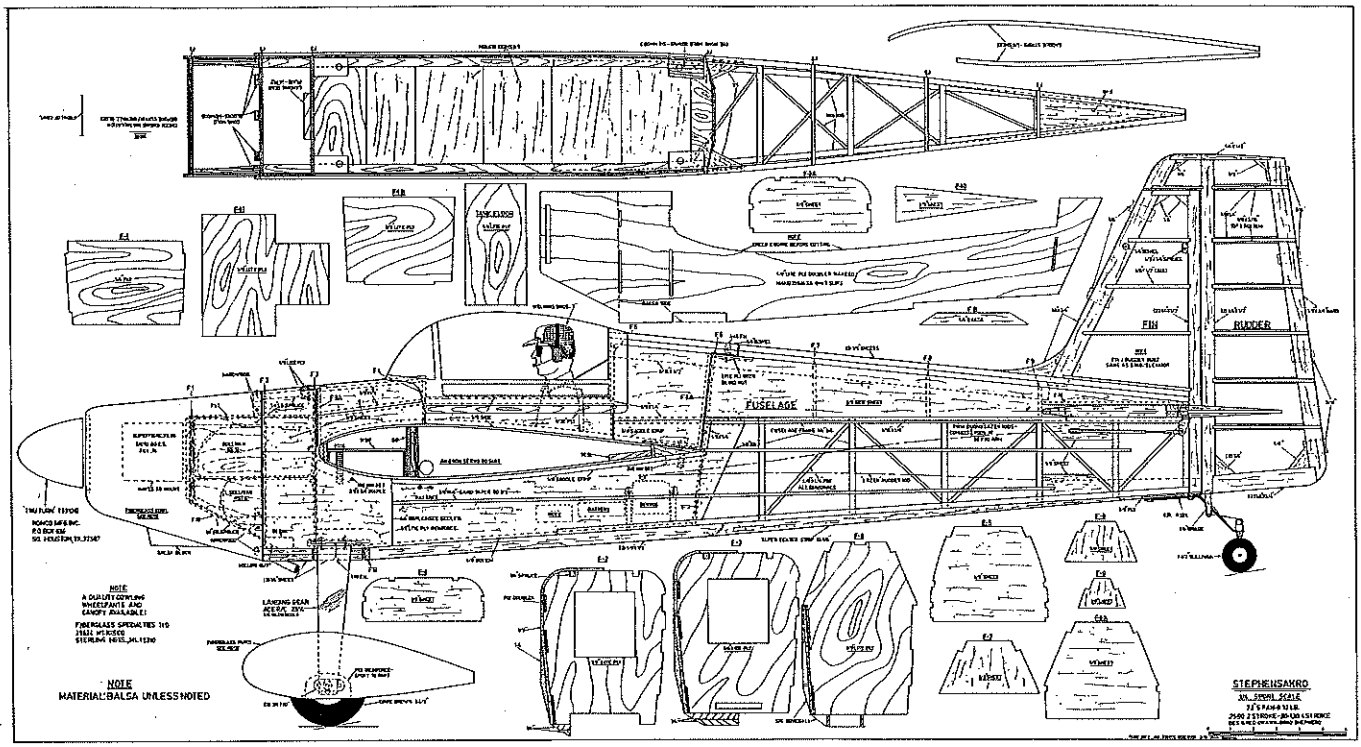
Many admirers of the Stephens Akro have requested airframe kits for the plane, and over the years Ray has welded at least 15 kits. Several went to Australia, several were for U.S. modelers, and one was shipped to England.

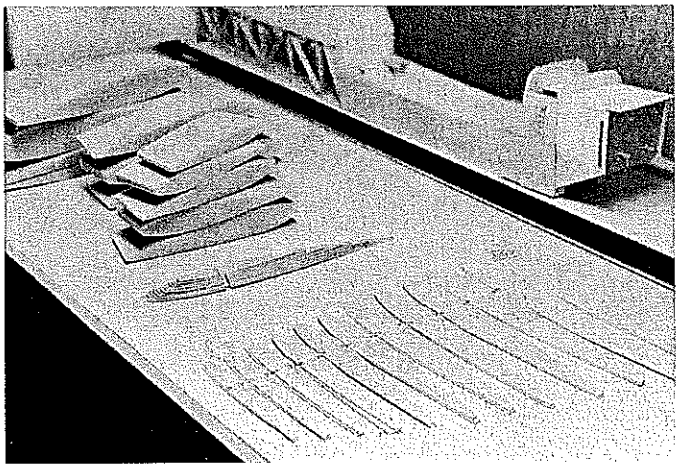
My decision to replicate Ray's Stephens was based not only on the good looks of the midwing and paint scheme, but also on the fact that it could be built with common, off-the-shelf model materials. This would ensure a light, strong craft that could do aerobatics without the addition of a lot of extra horsepower in the firewall.

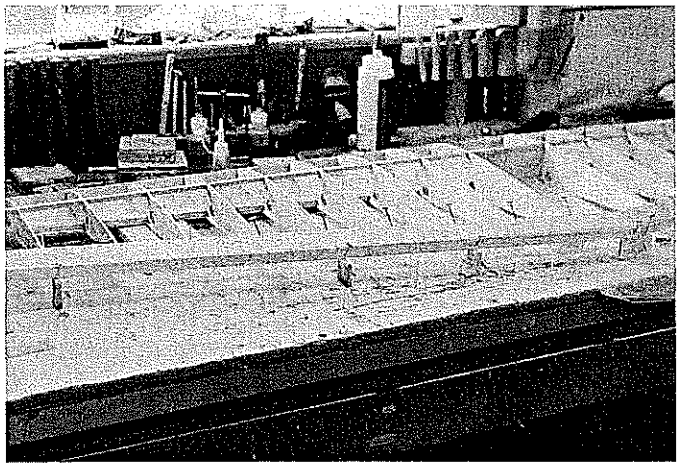
Indeed, the model delivers good aerobatic performance when fitted with any of a wide array of engines. I tried a SuperTigre .90 for the first few flights, and, using the throttle for speed control, found the plane capable of handling that level of power through any aerobatic routine. From the first flight, the model flew as well as the full-scale prototype, with no need to use the trim levers on the transmitter to line it up. I'd done rolls and vertical *up* rolls, loops, snaps, and knife-edge flight, and was planning to try a stall and slow flight, when the engine flamed out.

I tweaked open the needle valve and took off for a second flight. The model went straight ahead in the stall; slow flight was very stable, with no sign of tip stalling.

To check the performance with a different power installation, I removed the SuperTigre and added a Saito .80 GK



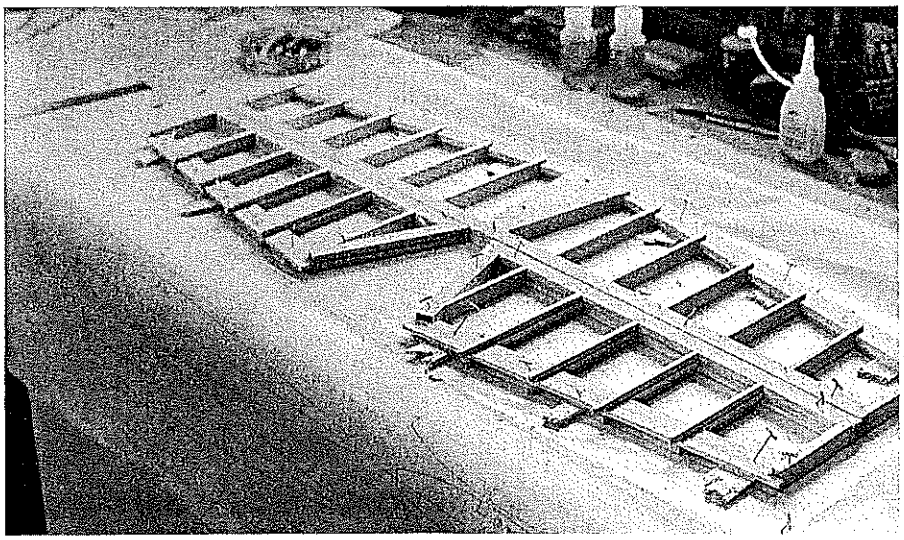




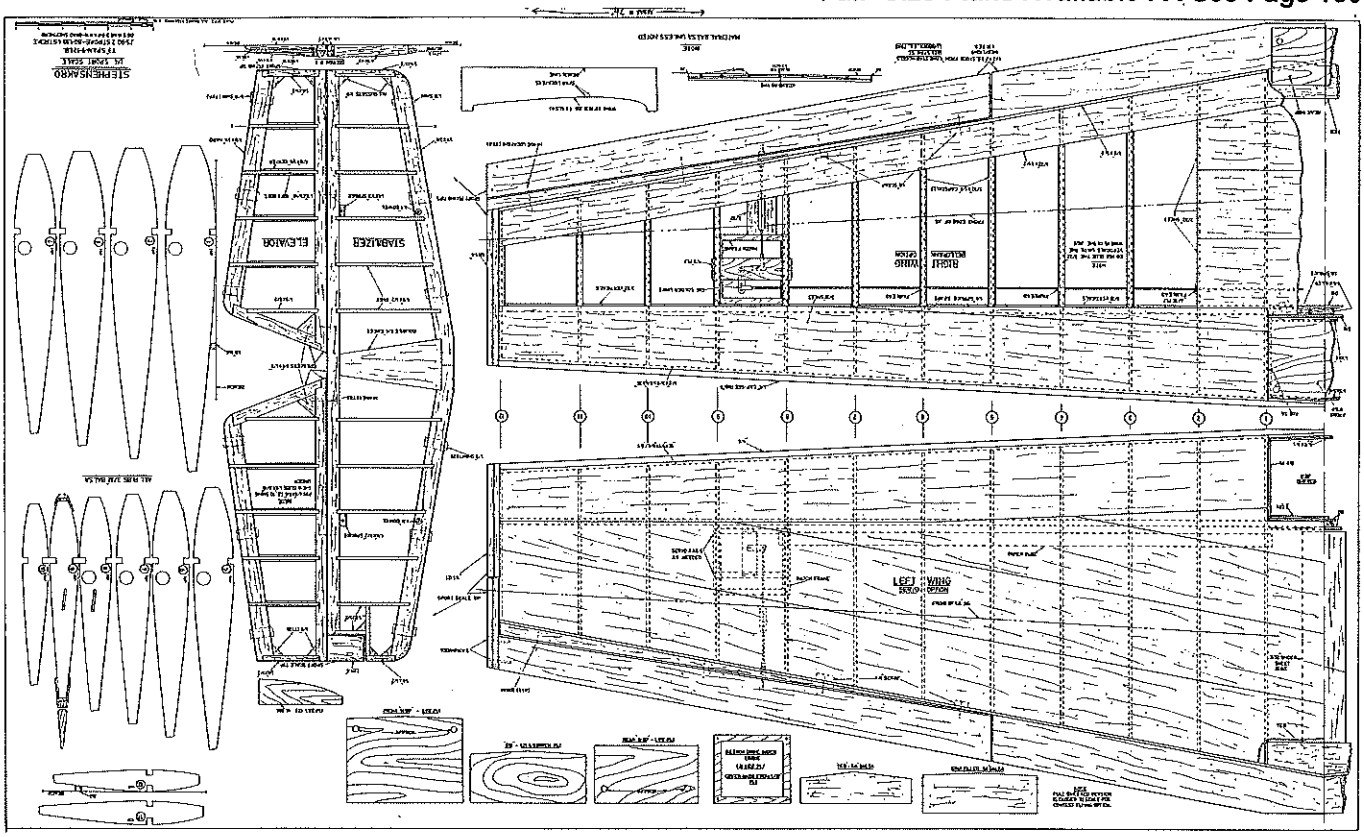
Left: The foam wing panel core has been cut up in sections for making a set of 1/32-ply master ribs. Right: The wing panels being assembled over a piece of Celotex™ secured to the workbench. The trailing edge has been shimmed prior to attaching the top sheeting.

four-stroke. The Hayes .60 mount remained in place. The plane proved every bit as gung ho for aerobatics as it had been with the ST .90. Be aware that the Saito's

Open-frame wing has 90° bellcrank mounted with the Sig soldered clevis on a plywood plate. Note the Lite Ply frame for crank cover.



Proven stab/elevator building technique achieves lightness with strength. Here, structures have been partially completed, with the balances not yet built onto the tips.



steady during all maneuvers, making aerobatics a pleasure. The smoke system I'm planning to install should heighten the enjoyment even more.

Construction

Take the time to cut out a kit of parts before assembling the major components. This gives you a good feel for the finished product, minimizes mistakes, and makes scratch-building a lot easier and more enjoyable. Trace the parts outlines from the plan, then affix them to the wood using low-contact cement.

Wing. To achieve an accurately tapered wing using built-up construction, I had talented modeling buddy John Rimmer hot-wire one wing panel out of foam. I used this to make a set of 1/32 plywood rib patterns, as follows:

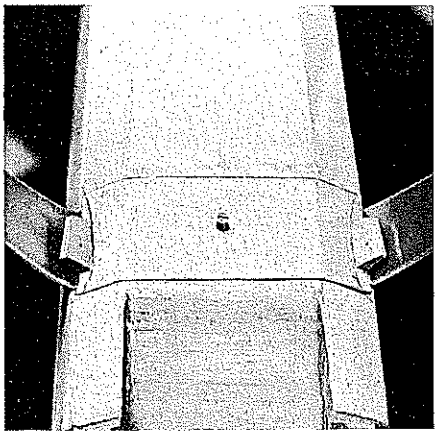
First, I laid out and marked the foam panel at each rib station. Then, using a fence on a band saw to keep the cuts square, I cut a slice of foam at each rib station, traced the outline at each station from the foam slice to 1/32 plywood, and *carefully* cut the plywood to the exact shape of the foam. After securing the ply templates to the 3/32 balsa sheet using two thumbtacks for each, I was ready to cut out a set of ribs.

The time you invest in making a set of master ribs will be time well spent, since they can be used for future tapered-wing models.

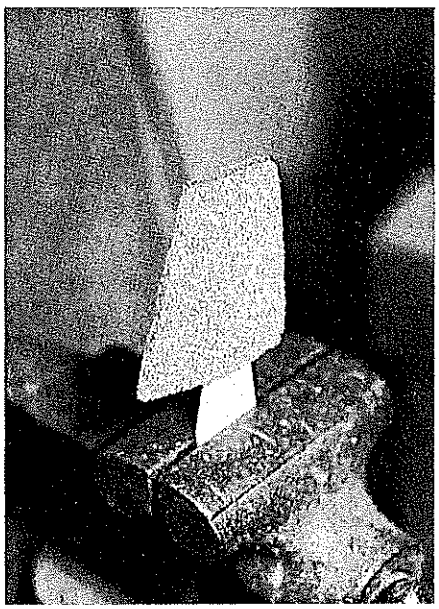
Make sure the ribs are marked for the *up* position, since the wing progresses from fully symmetrical to semisymmetrical at the tips

The wing panels are built upside down in the initial phase in order to keep the ribs at 90° to the top spar. Select four straight, 1/4-in.-sq. spruce sticks for the spars, and pin one of them to the plan at the spar location.

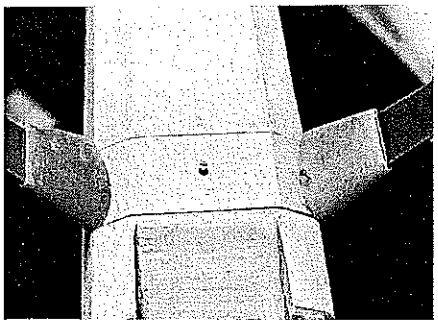
Continued on page 34



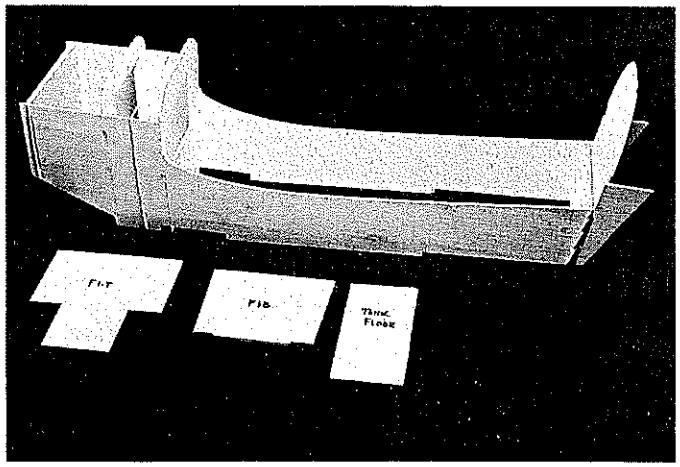
The fairing block covering the landing gear has been shaped, with the hold-down blocks for the LG cuffs installed.

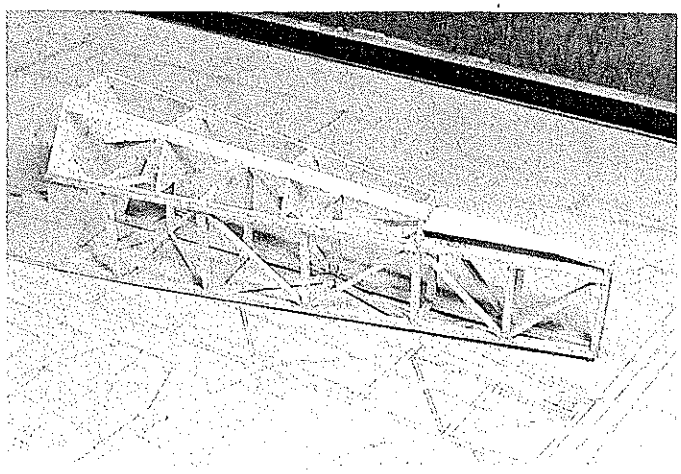


The foam form for the landing gear cuff has been shaped prior to being covered with fiberglass cloth and epoxy.

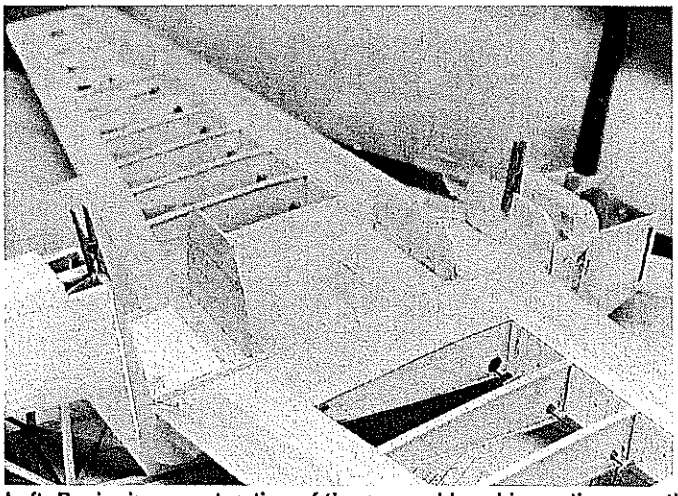


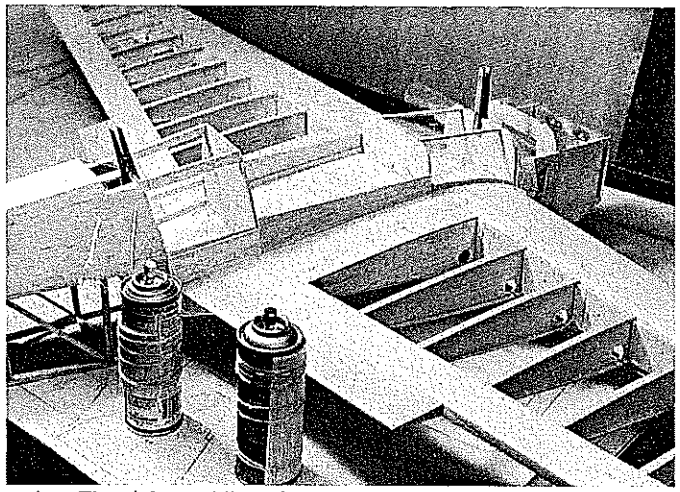
Fiberglass cuffs for the landing gear have been faired into the fuselage and held in place with sheet metal screws.





Left: The ply parts for the strong forward fuselage box. Right: The completed fuselage frame. Stab will fit in the 1/2-in. gap between the F-10s. Note the 1/16 x 1/8-in. strip glued to the top longeron as a base for the turtledeck side sheet.



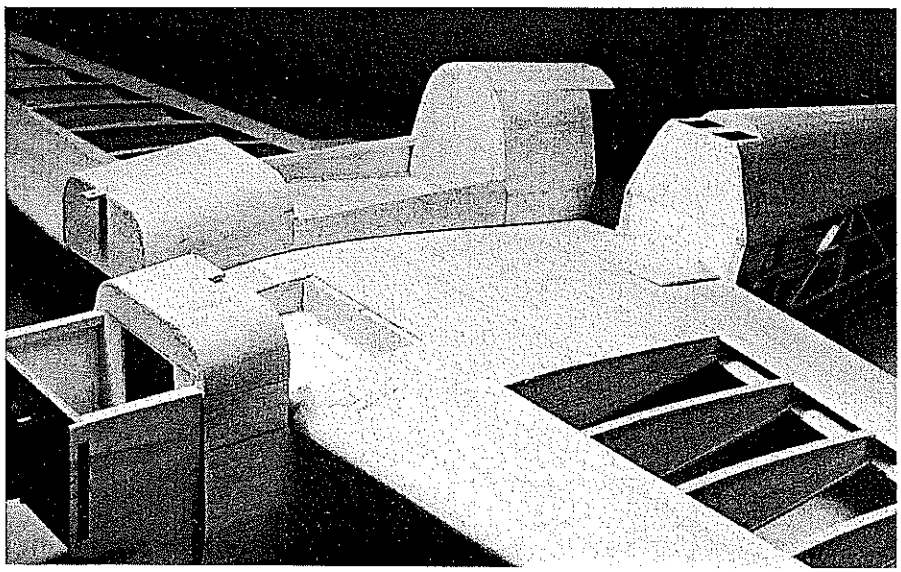


Left: Beginning construction of the removable cabin section over the wing. The 1/8-in. saddle strips serve both to align the formers and to provide a base for the 1/8-in. cabin area sheeting. Right: Balsa top sheeting is wrapped around paint cans to form the curvature.

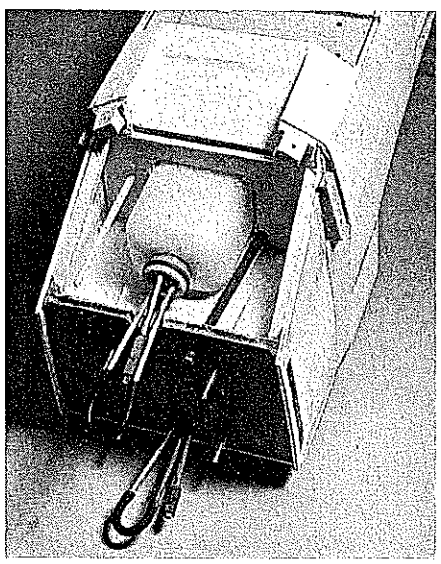
shaft protrudes a little farther than that of the SuperTigre.

In fact, I recommend that you check your engine selection against the plans before cutting out the Lite Ply doublers, adjusting the firewall slots as needed to keep the spinner backplate flush with the front of the cowl. The plans indicate a .75 to .90 size range for two-stroke engines and an .80 to 1.20 range for four-stroke ones. I think, however, that the model would fly quite well on a potent .65-size two-stroker, provided you kept the weight under nine pounds.

The Saito .80 four-stroker, used with a 14 x 6 Master Airscrew prop, has proven ideal for the airplane's nine-pound, two-ounce flying weight. The engine runs



The removable cabin section partially completed. Note the hold-down tab on the front and the extended top sheeting that anchors the section at the rear.



The bottom blocking forward of the landing gear has been installed and shaped. Note the smoker tank installation.

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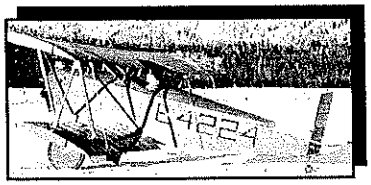
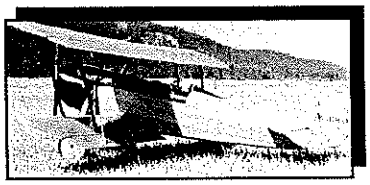
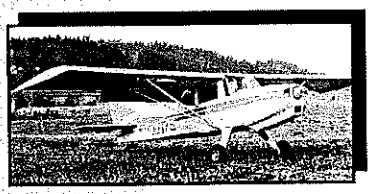


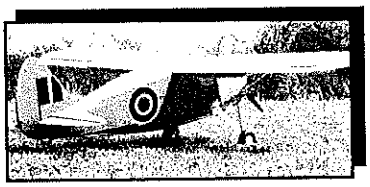
WACO 10
1/5 SCALE 73"

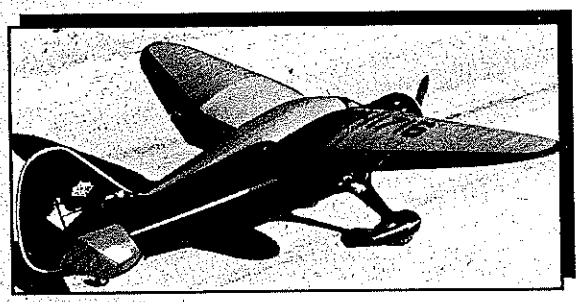


MAULE M5/M6 ROCKET
1/4 SCALE 98"



FAIRCHILD 24
GIANT SCALE 90"





STINSON SR-8
1/5 SCALE 100"

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thick CyA along the 1/8-in. leading edge strip. Pin the sheet along this strip, run a bead of thick CyA along the spar, then curl the sheet over the ribs and pin it to the spar. Cut a wedge from 3/32 sheet to fill the space between the number 1 and 7 ribs, and glue it in place. If you're building the open-frame wing, cap-strip the ribs and remove the panel.

With both panels finished to this point, draw a straight line at least 72 in. long on the workbench. Mark the position of each number 12 rib on this line, and pin the tip jigs in place. Place the wing panels on the line, orienting them so that the rear edge of each bottom spar is directly in front of the line; pin the panels down at the centerline of the spars and at each tip jig.

Shim the center trailing edge of the panels one inch, and pin them securely to the bench. Place a straightedge on top of the trailing edge, and shim the latter in four or five places. Firmly pin down the trailing edge to maintain straightness throughout the remaining steps.

Once the assembly is firmly pinned down, epoxy the 1/4-in. balsa wing spar filler in place between the spars. Accurately fit the 1/4-in. balsa TEB to the 1/8-in. trailing edge, and epoxy it in place. Epoxy the 1/8-in. ply DB pieces to either side of the spars and filler piece. Trim the 3/32 top trailing edge sheet to fit squarely against the 1/8-in. trailing edge, then secure it to the panel with aliphatic glue and thick CyA.

Sand a bevel in the top of the 1/8-in. leading edge to conform to the shape of the ribs, then glue the 3/32 leading edge sheeting to the ribs just as you did the bottom sheet. *Do not*, however, sheet the area between the number one ribs at this time.

Make sure the wing remains firmly pinned down before continuing with the next step: Until the verticals between the ribs have been glued to the spars, it is still possible to twist the panel; after that step, it's virtually impossible to do so.

Continued on page 38

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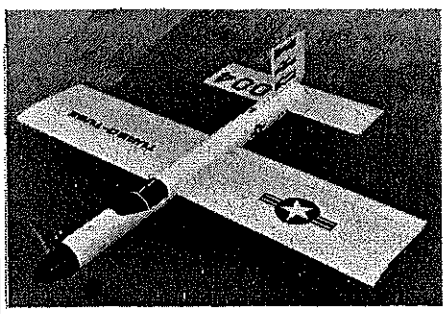

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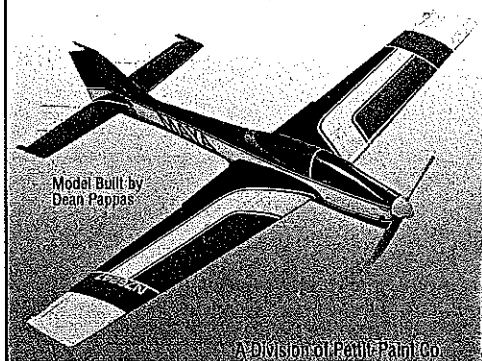

HOBBYPOXY
STICK WITH THE BEST

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Stephens Akro/Shepherd

Continued from Page 19

Use waxed paper to protect the plan from glue spills.

Pin down a 1/4-in.-sq. balsa stick to the bench so that it runs along the location marked "jig" as shown on the plan. Trial fit each rib on the top spar, trimming as needed, and pin the ribs to the balsa jig behind the spar. Using a 90° triangle, check that the rib is perpendicular to the bench. Place the bottom spar in the rib cutouts, and use thick CyA (cyanoacrylate glue) on all the joints.

If you're building the model for sport flying, you'll probably want to use the open wing structure with cap strips. In that case, glue a piece of 1/8 x 5/8-in. strip to the edge of the 3/32 x 1 1/2-in. balsa sheet trailing edge. On the other hand, if you're planning to use the model for sport Scale competition, you'll probably want a fully sheeted wing. In that case, glue the 1/8-in. strip to the edge of a 3-in.-wide balsa sheet.

To ensure an absolutely straight trailing edge, use a straightedge as you glue the strip to the sheet. Since the trailing edge is a little over 36 in. long, you'll have to splice some wood unless you're using 48-in. stock. Attach the trailing edge sheet to the ribs with aliphatic glue, butting the 1/8 x 5/8-in. strip firmly to the rear of the ribs and pinning it in place. Position the straightedge along the front edge of the ribs, then trim any overlength ribs until all are flush with the straightedge.

Slice two pieces of 1/8-in. balsa sheet to 3/4 x 3/8 x 36-in. lengths for the leading edge strip. Pin this strip to the ribs, and glue with CyA. Using a long sanding block, bevel the strip to conform to the shape of the ribs; this will provide a good gluing surface for attaching the leading edge sheeting to the panel.

Position the 3-in.-wide, 3/32-in. leading edge sheeting over the ribs, mark the location at which the sheet meets the rear of the spar, and trim this wedge from the sheet. Use aliphatic glue on each rib where it contacts the sheeting, and run a bead of

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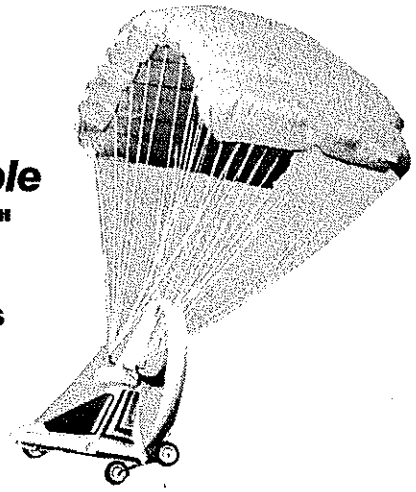

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Continued from Page 35

Glue the verticals in place. Add the top cap strips and then the top center section sheet aft of the spars.

Epoxy ribs 1-A flush with the bottom of the number one ribs. Glue the 1/8 x 3/8-in. ply pieces to the leading edge so that the tops are flush with the top of ribs 1-A. Epoxy WBP to the 1-A ribs and to the ply pieces at the leading edge. Epoxy the rear WBP to the top sheet.

Remove the wing from the workbench, turn it over, and sheet the bottom center section. Using a long sanding block, finish sand the 1/8-in. trailing edge flush with the 3/32 sheeting. Cut one of the 1/2 x 2-in. trailing edge pieces into two 15-in. pieces, being certain to cut in the proper angle for a good fit at both the center section and the aileron position.

Lay a piece of waxed paper on the bench, turn the wing upside down, press down firmly at the trailing edge, and trial fit the 1/2 x 2-in. trailing edge pieces against the wing trailing edge; they should be a flush fit. Make any necessary adjustments, and glue the seam with CyA. Repeat this procedure for the other panel.

Cut the remaining two trailing edge 1/2 x 2-in. pieces to length, fit the angle at the aileron joint, and attach the pieces to the trailing edge as noted above.

When the glue has dried, mark the aileron on each panel with a ball-point pen, then cut out the ailerons using a sharp blade and a straightedge. Sand a bevel in the aileron leading edge, and set the ailerons aside.

If you haven't already done so, decide at this point whether your wing tip is to be of the scale or sport type, then build the tip accordingly.

Tail surfaces. I worked out this construction technique on previous designs. It's simple, and produces a strong, straight empennage. All the construction information you'll need is shown on the plan. If any questions arise during assembly, a close look at the section drawing should clear them up.

Fuselage. Begin by gluing the 1/8-in. balsa sides to the Lite Ply doublers with contact cement; seal the edges with CyA.

Build the right side directly over the plan, then build the second side atop the first after covering it with a sheet of waxed paper. If your Lite Ply is less than a full 1/8 in. thick, you'll need to shim the forward area of the side so that the 1/4-in. built-up rear portion on the left side is flush with the 1/8-in.-sheet fuselage side.

Remove the sides from the plan. Separate the sides, and pin down the top view of the plan from the F-6 former to the tail post using the inside lines on the plan as a guide. Install this former in the slots in the ply doubler, and glue it in place. Install F-3, pin the sides to hold it in place, and glue. Install F-2; before gluing it in place, pull in the sides by using pin and rubberband persuaders across the top.

I secured the engine mount to the firewall using a method that effectively seals the front end from fuel entrainment into the model structure. After inserting bolts through the firewall, I soldered wire across the head slots, epoxied the wire liberally,

Continued on page 40

C-130 "HERKY-BIRD"

	1:30	1:18
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Wing area	272.sq."	752.sq."
Wing load	33.5 oz	33. oz.
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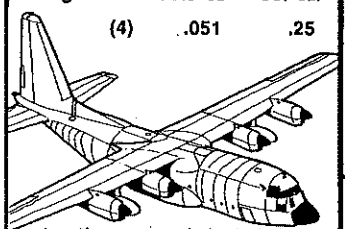

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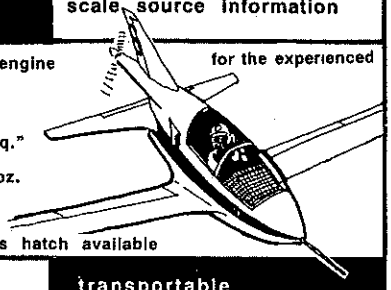

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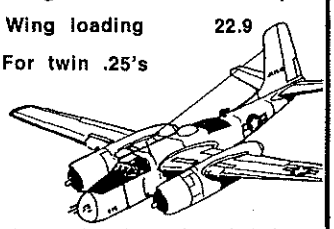

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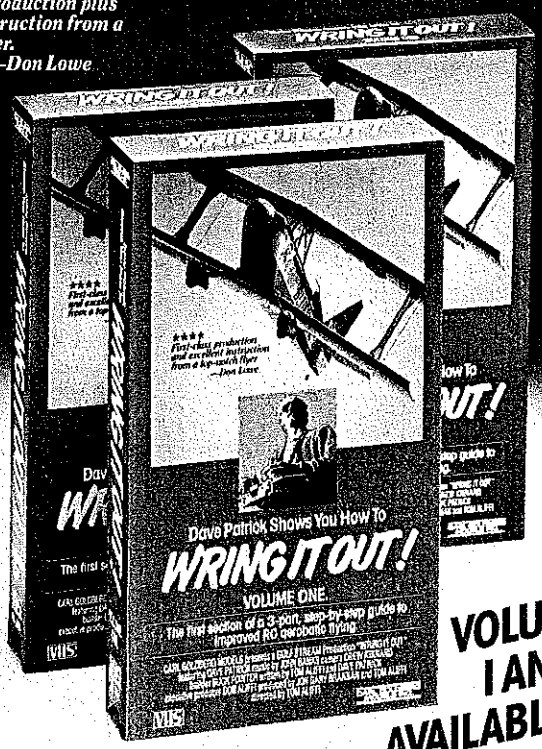

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Stephens Akro/Shepherd

Continued from Page 38

and then epoxied the firewall into the Lite Ply slots with Sig Kwik Set. I pulled in the sides by hand until the epoxy had set.

Cut the 1/4-in.-sq. balsa rear fuselage crosspieces, and glue them in place. Note that the top pieces are slightly longer than the bottom ones. Glue the diagonal braces in place.

Install LGP with epoxy; sheet the bottom inside the Lite Ply doublers. Glue the 1/8-in.-sheet F-10 in place. Remove the fuselage from the plan, and position and glue F-9.

Install the 3/16 x 1/2-in. top rear turtledeck stringers between formers F-6 and F-9. Fit and glue formers F-7 and F-8.

Glue the 1/8-in. medium-weight balsa sheet to the turtledeck sides. Sand the sheets flush with the 3/16 top stringers, then glue the bottom layer of the top 1/4-in. turtledeck sheet. Pin some 1/2-in. scrap balsa on top of the longerons at the stabilizer position, and glue the top F-10 to the 1/4-in.-sq. tail post and F-9.

Finish sheeting the turtledeck over the stabilizer, and remove the 1/2-in. shim scraps. Glue the 1/4-in. spruce braces between formers F-2 and F-3.

Now is a good time to shape the 1/8-in. A-grain balsa sheet that will cover the corners of the fuselage top. Cut the sheet a little longer than necessary to cover the corners between the formers, wrap it around some spray paint cans, and secure the assembly with rubberbands until dry.

Cut the maple wing hold-down blocks for each corner of the fuselage opening, and install them with epoxy. When the blocks are dry, place the wing in the saddle, true it up with the fuselage centerline, and pin it firmly in place. Cut three pieces of 3/16 dowel about 3 in. long, drill a 3/16 hole through one of the wing ply hold-down plates and the maple block, and insert the dowel. Repeat this procedure until all four holes have been drilled.

Remove the three dowels, and unpin the wing. Tap the maple blocks with a 1/4-20 tap, and check the threads with a nylon bolt. Drill the holes in the wing plates to 1/4 in., position the wing on the fuselage, and bolt it down. Place waxed paper or plastic wrap over the wing center section and formers F-3 and F-6, then position formers F3-A and F6-A and clamp them with clothespins.

Place the 1/8-in. saddle strip over the sheeted wing, pin it down, and glue it to F3-A and F-6A. Position formers F-4 and F-5, glue the 1/8 x 1/4-in. strips between them, and begin sheeting the cabin section. One of the photos shows the balsa sheeting wrapped around some paint cans to form its curvature. Continue sheeting until the whole cabin section is complete, including the hold-down tab on the front and the dowel and bolt at the rear. Sheet the area between F-2 and F-3, remove the cabin section, and unbolt the wing.

Install the tubes for the throttle pushrod, and make provision for a smoke system if one is to be installed. Assemble and install the fuel tank and the optional smoke system tank. Install the bottom double 1/4-in. sheet between F-2 and F-3, along with former FB and the bottom stringers.

Position the landing gear, and drill the mounting holes. Shape the balsa forward of the landing gear to blend with the cowl and former FB; use the illustration and dashed line on the plan as a guide in shaping the channel.

Bolt the engine and spinner to the firewall. Position the cowl, using a straightedge along the top side, so that it fairs into the 1/8-in. top sheeting between F-2 and F-3. Trim the cowl if necessary. Epoxy the hardwood cowl hold-down blocks to F-2, replace the cowl, and drill holes for the sheet metal screws through the cowl and cowl blocks.

Pack foam around the fuel and smoke system tanks, and glue the 1/4-in.-sq. spruce corners to the doublers between F-2 and F-3. Epoxy F-1T and F-1B in place. Fuel proof the entire front end forward of F-2 with a coating of epoxy.

Build the landing gear fairing from 1/4-in.

Continued on page 48

Stephens Akro/Shepherd

Continued from Page 40

balsa. Sand the fairing flush with FB and the forward block, and install a 1/4-in. dowel in the center. Drill through the dowel and landing gear, and tap the gear for a 4-40 bolt to secure the fairing.

To make the landing gear cuffs, I sanded some foam to shape and mounted it on a piece of Lite Ply scrap. This was covered with fiberglass and epoxied. When the epoxy had dried, I "hogged" the foam out of the fiberglass, then gave the cuffs another coat of epoxy inside and out. I glued hardwood blocks to the landing gear fairing blocks, and attached the cuffs with sheet metal screws.

Covering and finishing

I gave the fuselage and tail surfaces two coats of Sig nitrate dope, sanding off the fuzz between coats, then covered the structures with Sig Koverall. I attached the Koverall dry, brushing nitrate through the material wherever it contacted the nitrate-doped wood.

After installing and gluing the fin, I tightened the covering using an iron set on medium heat. Take care to avoid excess heat on the Koverall; since the material is tough, you could distort the underlying structure simply by going a little too far when tightening it.

I gave the fuselage and tail surfaces five coats of nitrate dope, then painted them with Cheveron Perfect paint in colors to match the Super MonoKote used on the wings.

Starting with a Williams Bros. three-inch scale pilot, I turned it into a likeness of Ray Parker with a custom-made cap, headphones, and shoulder straps. The cap was made from a piece of cotton painted blue, with nylon screening for the mesh and 1/32 plywood for the band and visor. The headphones are balsa, with a bag tie for the band. A neck strap from a Futaba radio set was perfect for the shoulder straps. I painted the instrument panel with flat black dope, then cut out Gorham Model Products instruments and glued them on.

Steve Durecki of Fiberglass Specialties T&D makes the cowl and wheel pants and pulls the canopy from butyrate sheet. These products are of the highest quality.

Bob Obenberger of Romco created the Tru-Turn nose art. It's almost exactly scale and really puts the finishing touch on the Akro. I found Bob, Steve Durecki, and Ray Parker most pleasant to work with.

I think I can objectively say that this is the best flying of all my models, including the Lark and the TR-260. If you plan to enter it in Scale contests, a set of color photos suitable for a presentation folder is available from Jim Pepino of Scale Plans and Photo Service.

Continued on page 80

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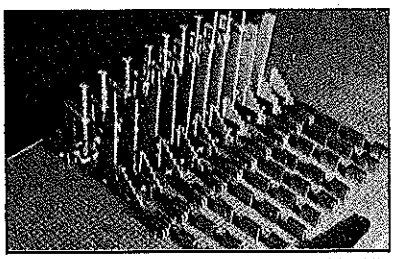

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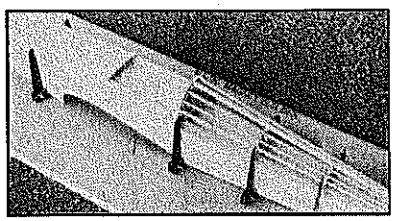

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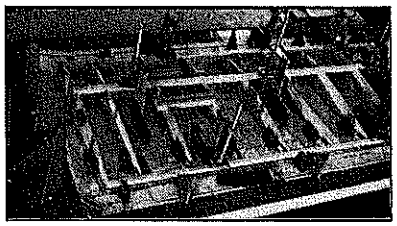

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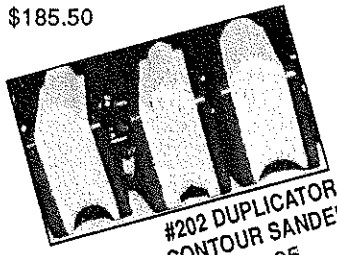

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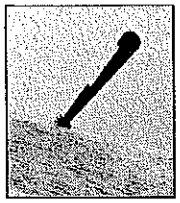

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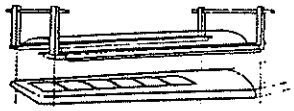

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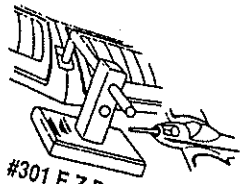

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Continued from Page 48

If you happen to live near Ocala, Florida, consider paying a visit to Ray Parker, the fine craftsman and gentleman without whom this version of the Stephens Akro would not exist. Contact Ray at Leeward Air Ranch in Ocala.

If, like me, you enjoy crafting balsa-and-plywood models and love aerobatic flying, building a Stephens Akro will be time well spent on the bench. This model does it all.

Acknowledgements. Bud Davisson, Emily Zimmerman, and Ray Parker contributed some of the information for this article. I want to publicly thank them for helping this project come alive. ✈

Poor Man's Prop/Hughes

Continued from Page 63

Note the small block at the prop hub that raises the prop off the base to allow insertion of the triangle. The prop is held in place with a conical nut from a prop balancer. This prop pitch gauge is simple and inexpensive to construct.

Pitch is measured by slipping various triangles under the prop until you find one that bottoms in the base plate slot and matches the propeller angle. You will have to construct triangles for the pitches you wish to measure.

Fortunately, the geometric basis for pitch calculation is pretty simple, and I've reduced it to triangle dimensions rather than using trigonometry or angles. Just plug numbers into this equation (the triangle base always has a length of 100 millimeters):

$$\frac{\text{pitch}}{3.14 \times \text{dia.}} \times 100 = \text{triangle height in mm}$$

For example, if you wish to make a triangle representing 7 in. of pitch at the 4-in. radius (which you must multiply by 2 to get the "diameter" to use in the formula), the formula yields 28 millimeters for the height. The base is always 100 millimeters. Just construct a 90° right triangle with these dimensions from cardboard such as that found on the back of paper tablets.

The triangle for 6-in. pitch at 3-in. radius (multiply by 2 for use in the formula) would be 32 millimeters by 100 millimeters. One of the photos shows templates for some pitch angles that I commonly use.

You will want to check at least two points, and probably more, on the blade radius. Make as many templates as you need, as they sure don't cost much and don't even take much time. Some typical templates are shown in one of the photos. Shallow angles may require constructing the triangle on a rectangle as was done for the 5 1/2-in.-pitch, 3 9/16-in.-radius template, so that the template will come up to the bottom of the blade.

The propeller being measured in another of the photos is a Kyosho for Electrics. One blade was 8-in. pitch, and the other was 8 1/2 in. The easiest way to correct this unbalance is to make the pitch of both blades 8 1/4 in., splitting the difference between 8 and 8 1/2 in. Do this by shimming the back of the hub with masking tape (an easier alternative to beveling a prop that is not made of wood).

Wood props can be sanded or filed to the proper hub angle. Just be sure to keep the hub surface flat.

If you want to know what's going on with your propellers, you'd best make or purchase a prop pitch gauge. ✈

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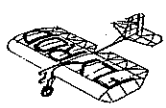

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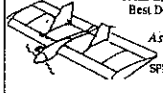

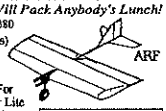

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