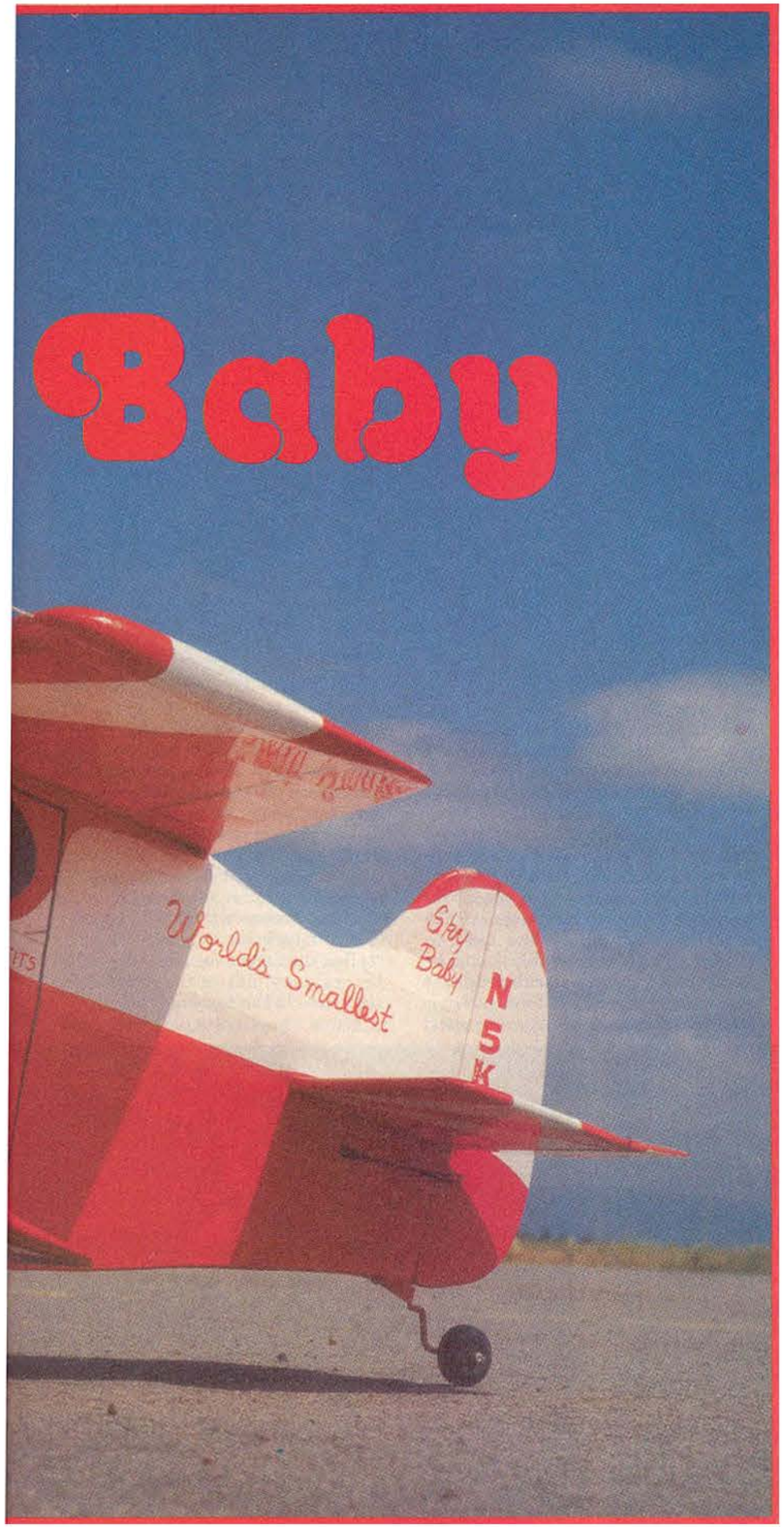
The recorded title of "World's Smallest Piloted Aircraft" for several years is presented in an accurate One Quarter Scale R/C building project.

Ken Willard's 1/4 Scale Stits Sky Baby



The full scale Stits Sky Baby was designed and built by Ray Stits and Bob Starr in 1952 for the express purpose of claiming the titie of "World's Smallest Piloted Aircraft."

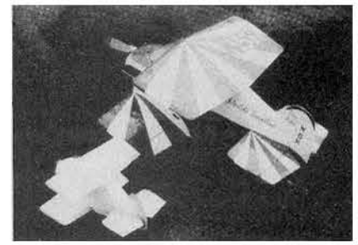
Only one was built, and only two men ever flew it. Bob Starr was the demonstration pilot at air shows, newsreel demonstrations, and various aviation gatherings. Lester Cole flew it on one occasion to demonstrate that any competent racing pilot could fly the little beauty. That is, if he wanted to.

No plans exist for the full scale machine. The structure was "lofted" on the hangar floor, and only rough sketches were made. The lofting was done in chalk, and gradually disappeared as people walked around in the hangar.

The Quarter Scale model was made from measurements and photographs taken at the Experimental Aircraft Association's Museum in Hales Corners, Wisconsin. Additional information was kindly offered by Ray Stits in response to my request. Later, when I sent Ray a set of the plans, he wrote back, "It sure is a strange twist of events when 30 years after I build an airplane I ask someone to send me the blueprints."

The specifications for the full scale Sky Baby are shown in Figure 1. They were provided to me by Ben Owen of the EAA.

Those of you who have followed the story of the Quarter Scale Sky Baby project are fully aware that it took over two years before successful flights were achieved. One reason for this was that I was determined to fly the model in a configuration exactly the same as the full scale aircraft. Several of you readers wrote in with suggestions to make it more reasonable in control, but that would have defeated the purpose, since it involved changing the aerodynamic shape --- most notably enlarging the vertical fin area, as suggested by Fred Reese.



Quarter Scale Sky Baby alongside 1/8 Scale foam version used to check balance and glide characteristics.

STITS "SKY BABY"

Designed By:
Ken Willard
TYPE AIRCRAFT
1/4 Scale Homebuilt
WINGSPAN
21⅛ Inches
WING CHORD
10 Inches (Avg.)
TOTAL WING AREA
430 Sq. In.
WING LOCATION
Biplane
AIRFOIL
Semi-symmetrical
WING PLANFORM
Double Taper
DIHEDRAL EACH TIP
None
O.A. FUSELAGE LENGTH
29⅝ Inches
RADIO COMPARTMENT SIZE
(L) 10" x (W) 4" x (H) 4½"
STABILIZER SPAN
14⅜ Inches
STABILIZER CHORD (incl. elev.)
7½ Inches (Avg.)
STABILIZER AREA
100 Sq. In.
STAB. AIRFOIL SECTION
Flat
STABILIZER LOCATION
Mid-Fuselage
VERTICAL FIN HEIGHT
4½ Inches
VERTICAL FIN WIDTH (incl. rud.)
4½ Inches
REC. ENGINE SIZE
.25
FUEL TANK SIZE
4 Oz.
LANDING GEAR
Conventional
REC. NO. OF CHANNELS
3 (4 w/Ailerons)
CONTROL FUNCTIONS
Rud., Elev., Throt.
BASIC MATERIALS USED IN CONSTRUCTION

Fuselage	Balsa & Ply
Wing	Balsa, Ply, & Basswood
Empennage	Balsa
Wt. Ready To Fly	**50 Oz. (3 Lbs. 2 Oz.)**
Wing Loading	**17 Oz./Sq. Ft.**

Enlarging the tail feathers of models is a common practice, and it works --- but I was stubbornly resolved to fly the Sky Baby in exact miniature. That was finally accomplished, and immediately after the successful flights, of which there were five, only then did I modify the controls and surfaces to make the model more

easily flown. Those modifications are described later, and are shown on the construction drawings. For those of you who want to try flying the exact scale model, the outlines are also shown on the drawings. And if you want to try it, go ahead, and good luck. It can be done --- but I personally don't want to do it any more. For those of you who just want a Stand-Off Scale configuration, you'll find the model touchy, but, in my opinion, flyable by any truly competent sport flier. If you've flown Formula I or Quarter Midget jobs, you should have no trouble. But it is harder to fly than Quickie 500 racers.

So be warned. You better be good at flying a very responsive model --- or you'll soon be very good at repairing it. I know; I repaired --- or rebuilt --- mine at least four times, with many intermediate minor repairs. But you won't have the same problem, because I'll give you the benefit of my experience and tell you the exact maximum throws, and method of control, that finally tamed the Sky Baby.

Oh, yes, there is one deviation from the full scale configuration that was virtually unavoidable due to the limitation of the model's engine. The full scale aircraft had a 60" propeller; at One Quarter scale, the prop would have to be 15" in diameter. Such a scale prop was carved for static display, but the largest prop that the Max .25 could reasonably swing is 10". If the engine cowl were to be exact scale in width, the tips of that size prop would just barely extend outside the cowl. So, to make the prop work at all, the width of the scale cowl is cut down 1/2" --- equivalent to 2" on the full scale. It is totally unnoticeable unless you actually measure it.

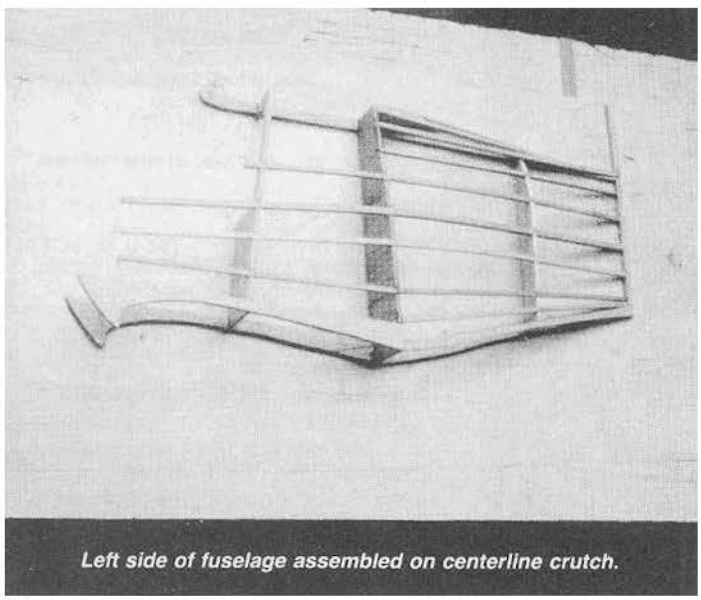
So there, in brief, you have the basic information pertaining to the Sky Baby and the Quarter Scale model, and here, for all of you who have written in for construction plans, is a set of plans and instructions for building a Quarter Scale Sky Baby --- a flyable model --- not a shelf model. Ready?

Sky Baby climbing up in banking turn on first successful flight.

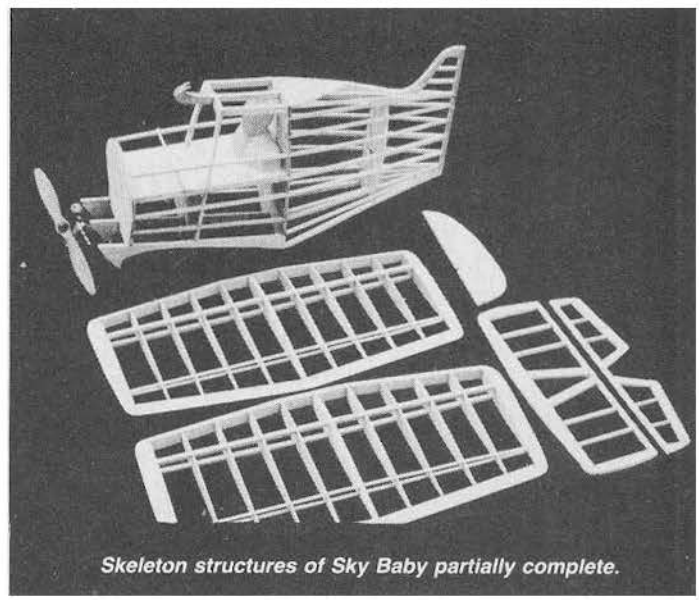
CONSTRUCTION

This is definitely not a model for beginners, so the instructions will be relatively brief, leaving certain details, which conceivably could be accomplished in several different ways, to the ingenuity of the modeler. And yes, the plans are "busy." At first glance, the structure looks complicated. It really isn't. Many of you, especially old time modelers, are familiar with the centerline crutch technique which was made popular by the old Cleveland Model kits; and, for those of you who are not, by carefully comparing the plans with the photos of the framework, it will be easy to get the idea. Probably the hardest part of the construction is installing the cooling duct from the firewall behind the engine cylinder to the outlet on the right side of the fuselage.

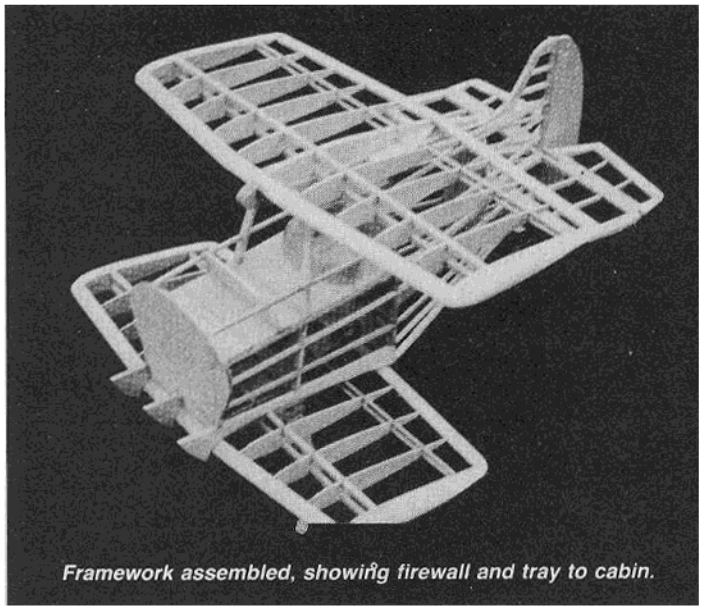
Since the fuselage is unques-



Left side of fuselage assembled on centerline crutch.



Skeleton structures of Sky Baby partially complete.



Framework assembled, showing firewall and tray to cabin.

Assembled framework with Quarter Scale pilot in cabin. Note center crutch and wing saddle extensions forward of firewall prior to filling in with block balsa and shaping.

tionably the most complex part of the entire structure, let's start with it and get it done. Then the rest will be easy by comparison. *(Editor's Note: complete parts kit available — see plans for complete information.)*

Fuselage:

Study the plans and photos of the fuselage structure carefully, and the job of putting it together will be a lot easier. As mentioned above, it is constructed around a centerline crutch cut from 1/4" balsa sheet stock. The crutch runs from the forward end of the fuselage on the bottom back to the tail, and the top piece runs from the top of the windshield back to the tailpost. Lay the plan profile on a flat work surface, cover the plan with waxpaper, pin the crutch pieces in place on the plan so they won't lift when you start inserting the stringers.

Cut out the formers. Note that they are made of three layers of 1/16" balsa, two transverse and one vertical. This is not mandatory; they could be cut out of 3/16" sheet. However, the three ply method makes them much stronger. Builder's choice.

Attach the left half formers to the crutch and tailpost, add the vertical fin structure that is forward of the tailpost, and insert the stringers and the 1/4" wing saddle for the lower wing.

Note the shape of the upper wing saddle, which rounds in to the center crutch at the front and tapers to the crutch at the rear.

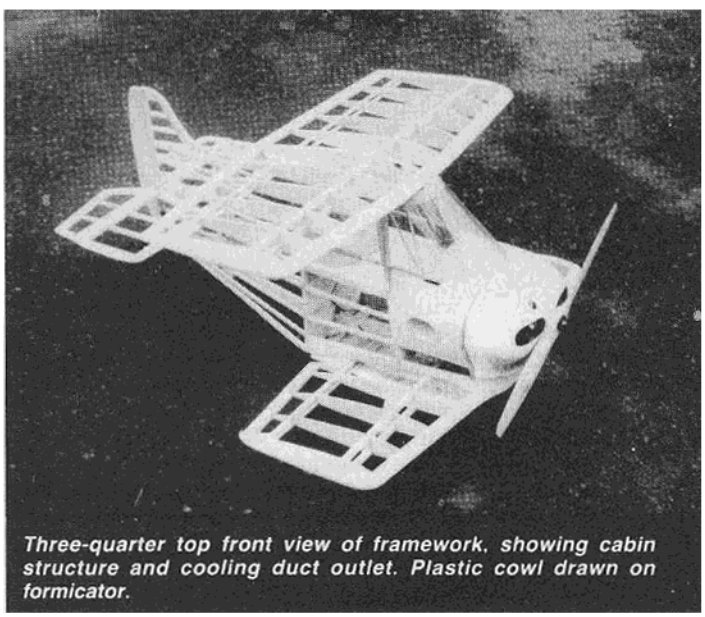
Remove the crutch and left half of the fuselage structure from the plans, and build the right half formers and stringers to the crutch. You now have the basic structure of the fuselage formed, and it's time to form the nose and cowl shape.

Cut out the firewall from 3/16" plywood. Note how it fits down on the center crutch, which extends forward, and also the wing cradles. Fill in the spaces between the crutch and the saddles forward of the firewall with medium hard balsa block stock. This is the surface that gets scraped whenever the model noses up, as it does rather frequently due to the short coupled gear.

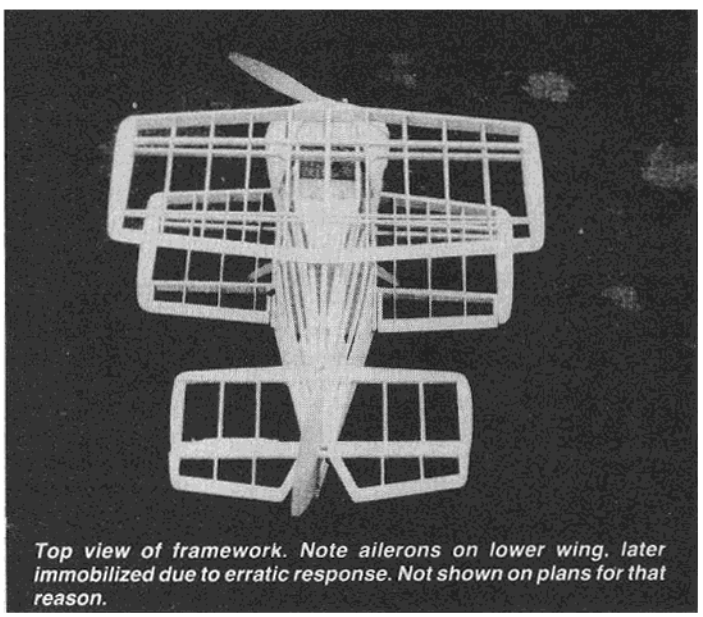
Shape the wing saddles to a rounded curve ahead of the firewall to the center crutch. The photos of the skeleton structure illustrate this.

The next step is to install the horizontal 1/4" balsa sheet "tray" which extends from the firewall back to the rear cabin former. Grain runs crosswise. A Williams Brothers' 1/4 scale pilot rests on this tray inside the cabin if you want realism. Some of you will recall that it was just such a pilot figure that I won as a door prize at the IMAA birthday party in 1982 which started this whole project.

With the tray in place, you can now install the 1/32" plywood forward deck



Three-quarter top front view of framework, showing cabin structure and cooling duct outlet. Plastic cowl drawn on formicator.



Top view of framework. Note ailerons on lower wing, later immobilized due to erratic response. Not shown on plans for that reason.

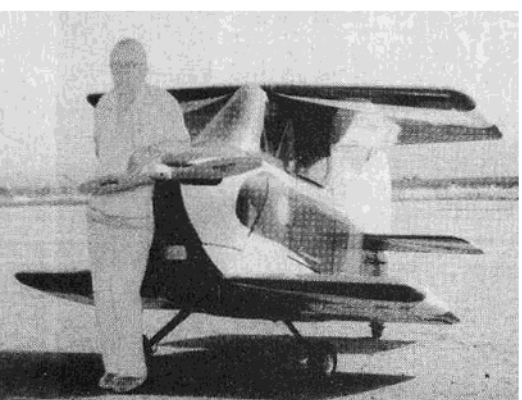
by first gluing the instrument panel to the upper stringers and then curving the plywood deck to fit the firewall and top of the instrument panel. Add the 1/8" dowels to complete the cabin framework.

The fairings to the cheek cowls are carved out of 1" thick soft balsa. Shape the blocks to rough configuration, then glue them to the stringers and carve and sand them to the final curvature.

Here's the toughie. Not really; just a bit tedious. On the right hand cheek cowl, draw the outline of the outlet as shown on the plans. You now have the entrance to the duct, cut-out on the firewall, and the location of the exit. The problem is how to cut away the balsa cheek and that part of the stringers which have to be removed to result in a tubular duct. How? Any way you can think of. I used a wood chisel and chiseled away at the approximate centerline of the duct, and then worked out from that to a line close to the duct wall. Then, with a rough rattail file, that was longer than the duct, I filed away until I had straight lines from the entrance oval to the exit oval. Finally, carefully rolling some 1/32" plywood into a tubular shape, I inserted the tube into the duct holes, with the ends of the rolled plywood extending out beyond the firewall in front and behind the exit hole on the side, then let the plywood unroll until it fitted snugly against the hole sides. Yes, at the center of this plywood tube, the plywood did separate slightly. Not to worry; when you epoxy it in place, fill the slightly separated area with epoxy. Oh yes, be sure the plywood roll overlaps about 1/4" --- even 1/2" is okay --- so you have a sort of cup-like area in which to put the epoxy and seal the duct.

Now that wasn't really too hard after all, was it? Okay --- so it was. But worth it in the long run; keeps exhaust gook out of the inside of the fuselage.

A four ounce tank fits nicely aft of the firewall and under the tray. Notice it is installed crosswise, and supported with another crosswise tray underneath it. The placement makes it ideal for the horizontally mounted engine, with the center of the tank lined up with the intake needle valve level. Make the fill and vent tubes long enough to extend out through the plywood deck, seal the openings, and you keep raw fuel out of the fuselage.



Quarter Scale Sky Baby with Quarter Scale "Sunday Flier."

FIGURE 1
STITS "SKY BABY"
"World's Smallest Airplane" — 1952

Wingspan	7 Ft. 2 In.
Length	9 Ft. 10 In.
Height	5 Ft.
Net Weight	452 Lbs.
Power	C-85 Continental "racing" engine
Power Loading	6.6 Lbs. H.P. (@ 100 H.P.)
Wing Area	36.5 Sq. Ft.
Wing Loading	18.3 Lbs. Sq. Ft.
Flaps	Upper wing
Slots	Both wings
Top Speed	185 mph
Cruise	165 mph
Landing Speed	80 mph
Rate of Climb	Over 500 fpm
Fuel	5 Gals.
CONSTRUCTION	
Fuselage	Chromoly tubing, fabric covered
Wings and Tail	Spruce, fabric covered

"Sky Baby" was designed and built by Ray Stits (Bob Starr participated) at Riverside, California, in 1952 as a research project and to claim the title of "World's Smallest Airplane." No blueprints distributed on either aircraft.

Your fuselage is now virtually complete, except for two items. One is the crosspiece inset on the top wing cradle which serves as a centering attachment for the top wing. Look closely at the plans, and the photo which shows the crosspiece, and firmly glue it in place. Later, when mating the wing to the fuselage, you can drill the aligning holes for the screws which go through the crosspiece and into the forward lower wing spar.

The other item is the engine cowl. On my model, the engine cowl was formed from ABS plastic, which was drawn to shape over a balsa mold. There are of course, several other ways, one is to make a mold of styrofoam, cover it with fiberglass, and then dissolve the foam, or carve a cowl out of solid balsa, then hollow out the balsa with a Dremel Moto Tool. The choice is up to you, and whatever means is available to you. But --- make a cowl; do not attempt to fly the Sky Baby without one. *(Editor's Note: fiberglass cowl available — see listing on plans.)* The flat plate area of the firewall creates too much turbulent flow. I know; I tried it --- and had a major repair job as a result.

The structure is now complete, but the windshield has to be installed. Before you do this, the cabin area should be painted and the instrument panel detailed. The interior cabin on the full scale Sky Baby is painted a light blue. Unfortunately, the photos of the instrument panel that I took are not clear enough to identify the instrument layout. However, the plans show the Quarter Scale instrument panel.

Installation of the windshield is relatively easy. Cut out a sheet of clear plastic to the shape shown on the plans (use a thickness that will hold its shape without buckling --- about .015) and Hot Stuff it to the forward framework.

Well, that's about it for the fuselage. Some details may have been overlooked, but you can solve them in your own way.

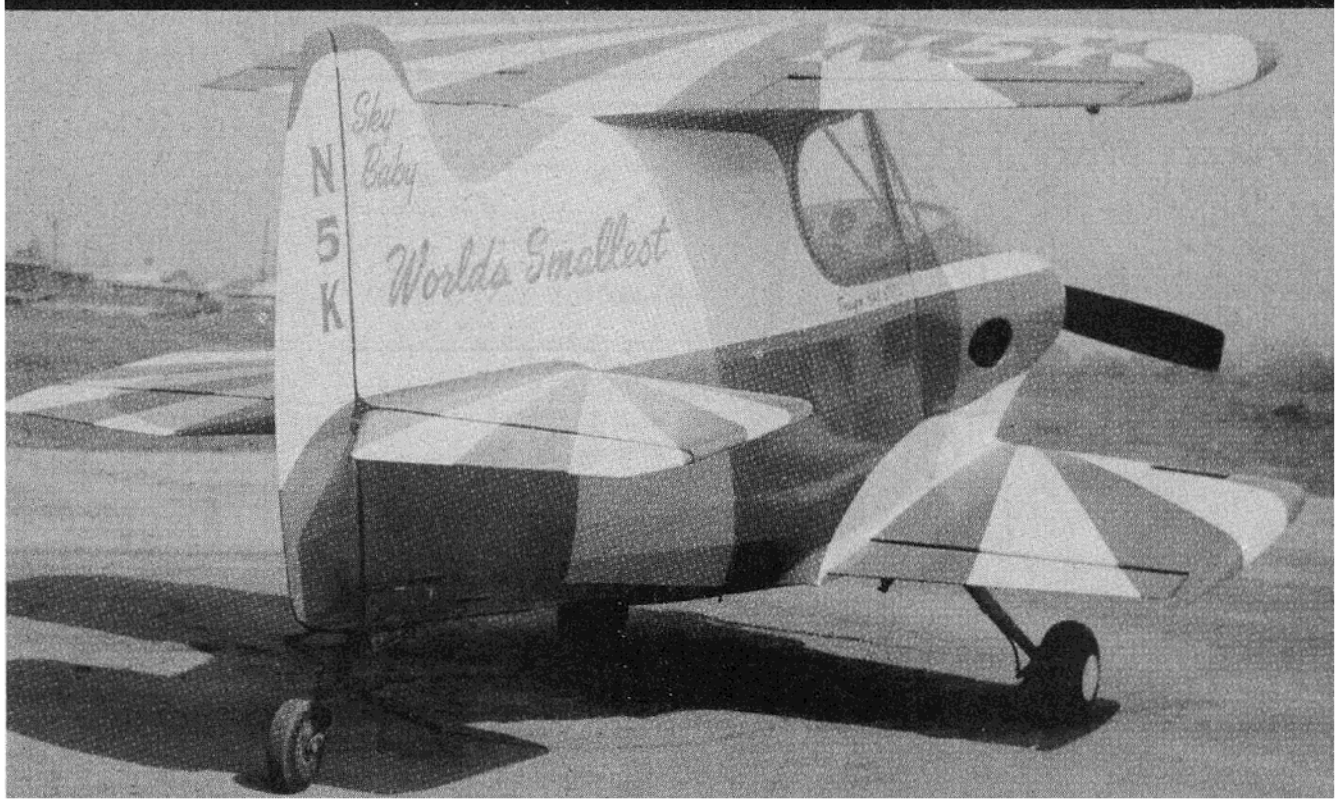
Tail Surfaces:

The stabilizer and elevator are constructed in conventional form, as is readily evident on the plans. Just be sure that the incidence setting is accurate for the stabilizer. It is critical because of the short coupling between the stab and the wings. The plans show the recommended enlarged vertical fin and upper rudder surface for reduced sensitivity in yaw. Also shown is the horizontal break in the rudder, with the upper portion actually fixed and in line with the fin. But, if you want to make the tail surfaces scale, the scale outline is also shown. The choice is yours, but be warned that with scale surfaces, the model is so responsive to rudder action that a 1/4" throw in either direction will result in an immediate snap roll. From my personal experience, I strongly recommend that you use the flight set-up as shown --- and it still requires careful control movements.

Wings:

The wings are identical in planform, and there is no dihedral. The taper from root to tip is uniform, with the top spar bending very slightly down and the bottom spar bending an equal amount up. Make both wings the same

Full Scale Sky Baby and Quarter Scale Sky Baby posed similarly on the flight line. Which is which?



to begin with, and then you have a decision to make with reference to the lower wing. Should you or shouldn't you add ailerons. I mention this here because I did cut out ailerons and install them on my model, but during the flight tests I found a curious thing. The ailerons were almost totally unresponsive when actuated to about ten to fifteen degrees of throw, then they became violently responsive. Why? I don't know, unless it was due to the wide cowl and relatively short flight prop giving an uneven slipstream action. This would not be true in the case of the full scale aircraft, but it was characteristic of the model. It was so unpredictable, in fact, that I finally flew the airplane essentially in a three control mode, connecting the rudder servo to the aileron outlet, and immobilizing the ailerons. Again, the choice is yours as to installation of ailerons, but I don't recommend trying to use them in flight. Strangely enough, with the split rudder, the model flies just like any three control sport model, albeit sensitively.

In any event, the lower wing has a substructure added to it to make it scale with the full size Sky Baby. That structure is depicted on the plans, and

it includes a crosspiece of basswood to which the landing gear is attached.

Mounting of the upper wing to the fuselage is accomplished with mounting screws through the crossbar in the top wing saddle, and a nylon bolt through the trailing edge and down into the center crutch. The lower wing is mounted by a dowel into the forward bulkhead in front and a nylon bolt into the bottom centerline crutch. This system is fully adequate for all flight loads, and provides a yielding structure for the wings to break loose in the event of a cartwheel on landing.

Landing Gear:

The landing gear is made by cutting a Hallco gear in half, so the wheels can be spread apart to the scale separation. The separate struts are then bolted to the basswood mounting block, using 3-48 screws and blind nuts.

The tail wheel strut is cut and bent to the shape shown to simulate the full scale shape. After shaping the wire and attaching it to the rudder, cut lengths of neoprene tubing lengthwise and fit them to the wire. Hold in place with Hot Stuff.

Radio Installation:

How you install your receiver, servos, and battery pack is again a matter of personal choice. I used a sort of hodge-podge --- Cannon micro receiver, two Cannon servos, one Airtronics' servo, and one Kraft KPS-18 that I had available. A 500 mA battery pack is strapped to the center crutch just aft of the firewall, the servos mounted to the rear cabin bulkhead with servo tape, and the receiver shock mounted with 1/4" foam insulation to the center crutch, held on with retaining rubber bands. Crude? Yes, but effective. The main thing is to mount the equipment in such a way that the C.G. is properly located.

Covering and Decorating:

The choice of covering material is yours. I used MonoKote primarily, except for the cowl, which is painted. The wings are first covered with red MonoKote, then the Sunburst effect is cut out of MonoKote Trim Strip and applied over the base. Cutting out the license is a bit tricky, since the numbers are part red and part white. Patience pays off in this bit. The other lettering is done by hand — and it does need a steady action with the brush. Yes, you can paint on MonoKote.

Flying:

Now comes the critical phase --- but at least you won't have to go through all the trials and tribulations that I did. In the first flights, I had surface throws which were proportional to those of the full scale Sky Baby, but the scaled down model was not dynamically scale insofar as weight was involved, so the response to surface throws was not proportionate. Also, the small diameter of the prop did not yield scale slipstream. All this I learned the hard way, and you reap the benefit.

Note the photo which shows the Quarter Scale model alongside a 1/8 Scale model that I put together to check out incidence and balance. The small model glided reasonably well, but when I added power, I soon found out that the directional control was very sensitive to slight movements in either direction of a small trim tab that I added to the rudder --- and that was the clue to the final successful flights. By cutting the rudder in half, and setting the servo linkage so that the absolute maximum throw was 1/4" in either direction, the response was tamed down to a reasonable sensitivity. However, it did create a side effect. Take-offs became difficult in calm air, because the tail wheel action was virtually ineffective, and the rudder didn't take hold until speed was built up. Thus, torque turns to the left were common. I finally made a decision to fly the model only if there was a headwind of around five to six mph right down the runway. I recommend you do the same. Also, do not try to fly the model in gusty winds. If the model is turning and goes broadside to the wind, a sudden gust will roll the model over beyond a vertical bank. No problem if you have plenty of altitude, but it will take about forty to fifty feet to recover. This characteristic is due to the stubby wings combined with the deep fuselage, which blank out the downwind panels when flying cross wind to a gust.

Finally, make sure that your engine will throttle down reliably without conking out. Although I've never had an engine failure with the Max .25, so I don't know from experience, it is my guess that if your engine should quit in flight, the glide angle will likely be around two to one, with little or no flare capability for a landing. □

From RCModeler June 1986