1/4 Scale STITS Sky Baby

Model built by Luther Peters

Sport Scale Electric For Geared Speed 480-600

By Andy Clancy

STITS SKY BABY
Designed by:
Andy Clancy & Pat Trittle
TYPE AIRCRAFT
1/4 Scale/Fun Scale
WINGSPAN
26-1/4 Inches
WING CHORD
10 Inches (Avg.)
TOTAL WING AREA
520 Sq. In.
WING LOCATION
Biplane
AIRFOIL
Flat Bottom
WING PLANFORM
Double Taper
DIHEDRAL, EACH TIP
1/2 Inch
OVERALL FUSELAGE LENGTH
29 Inches
RADIO COMPARTMENT SIZE
12" (L) x 5" (W) x 5" (H)
STABILIZER SPAN
14-3/8 Inches
STABILIZER CHORD (inc. elev.)
7-1/4 Inches (Avg.)
STABILIZER AREA
100 Sq. In. (Approx.)
STAB AIRFOIL SECTION
Flat
STABILIZER LOCATION
Mid-Fuselage
VERTICAL FIN HEIGHT
3-3/4 Inches
VERTICAL FIN WIDTH (inc. rud.)
4-1/2 Inches (Avg.)
REC. ENGINE SIZE
Geared 480-600 Electric or .26
BATTERY/FUEL TANK SIZE
Eight 500-800 mAh/4 Oz.
LANDING GEAR
Conventional
REC. NO. OF CHANNELS
3
CONTROL FUNCTIONS
Rud., Elev., Throt.
C.G. (from L.E.)
1 Inch (top wing)
ELEVATOR THROWS
3/4" Up — 3/4" Down
AILERON THROWS
—
RUDDER THROWS
3/4" Left — 3/4" Right
SIDETHRUST
—
DOWNTHRUST/UPTHRUST
—

BASIC MATERIALS USED IN CONSTRUCTION
Fuselage ..... Balsa & Ply
Wing ..... Balsa & Ply
Empennage ..... Balsa
Wt. Ready To Fly ..... 32 Oz. (2 Lbs.)
Wing Loading ..... 8.9 Oz./Sq. Ft.

Why do I love weird airplanes so much? Maybe it's the rebel in me that admires those who succeed at what "conventional wisdom" says can't be done. The Stits Sky Baby is more than just an unconventional-looking plane; it was an actual World Record Holder, being the world's smallest man-carrying airplane of its time — a distinction it held for some 30 years.

My love affair with this aircraft began with *RCM*! Ken Willard's 1986 *RCM* article and plans for his 1/4 scale version of this plane went straight to my heart -- despite the fact that he had great difficulty getting it to fly. I remember Ken's wry comment that flying his .25 powered Sky Baby was easier than flying a 1/4 midget racer, but harder than a Quickie 500. There were many crashes and re-builds.

Ken's plans and article were my starting point with the Sky Baby. I first built a 1/8 scale R/C scale model of the Sky Baby powered by an .061 and flew it successfully. But flying it was a real stunt. It left my knees shaking after each flight!

This super lightweight 1/4 Scale Sky Baby design with its lightweight radio gear, efficient batteries, and electric motor enables most any R/C pilot to fly this magnificently rebellious aircraft. You just need to follow my instructions — and please, you must promise to tell no-one how easy it is to fly.

"Full Size" Sky Baby History

Ray Stits told me that he became interested in very small airplanes during some hangar talk in which his buddies said, "You can't do it!" The result was his first World's Smallest Plane, the Stits Junior. The Stits Junior was a low wing monoplane with a ten foot wingspan and a ten foot length. This success spurred him on to take things another step down in size with the Sky Baby. The Sky Baby had a 7 foot 2 inch wingspan (86") and a length of only 9 feet 10 inches (118").

The construction of the original Sky Baby began in April of 1951, and took about 13 months to complete. The plane was built as a joint venture between Ray Stits and Bob Starr. Bob supplied the Continental C-85 engine which was set up as a racing engine and was rated at 112 bhp! Ray mentioned that back then, to promote air racing, Continental would supply a special heavy duty crankshaft to would-be racers for half price — about $100.

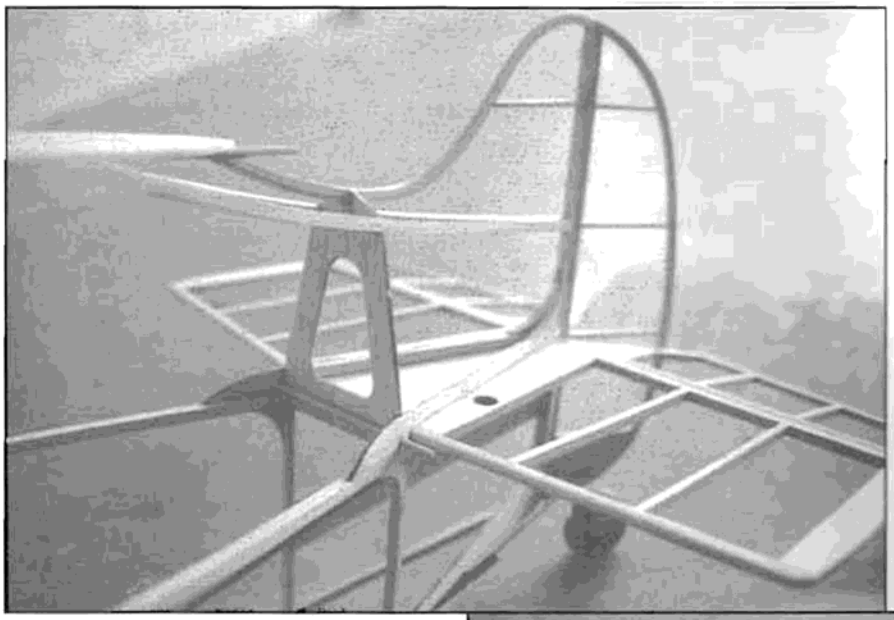
It was originally designed to have tricycle landing gear, but problems with the nose gear led to the adoption of a tail wheel. This reduction of weight in the nose and increased weight at the tail caused the plane to be somewhat tail heavy. To prevent the plane from being too tail heavy, only a light pilot could fly it. A pilot of only 140 lbs. would have given a perfect balance.

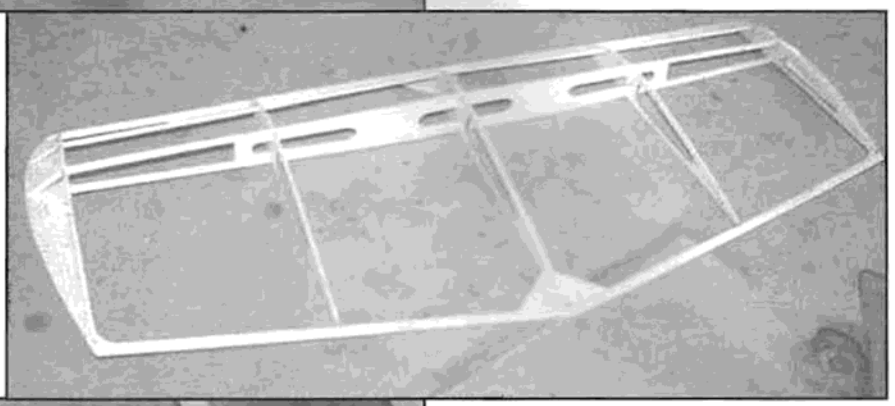
There are flaps on the top wing and ailerons on the bottom wing. It uses an NACA 2312 airfoil, which is a very stable airfoil that minimizes the problems caused by the plane's slight tail heaviness. This same airfoil was used on the Curtiss P-40.

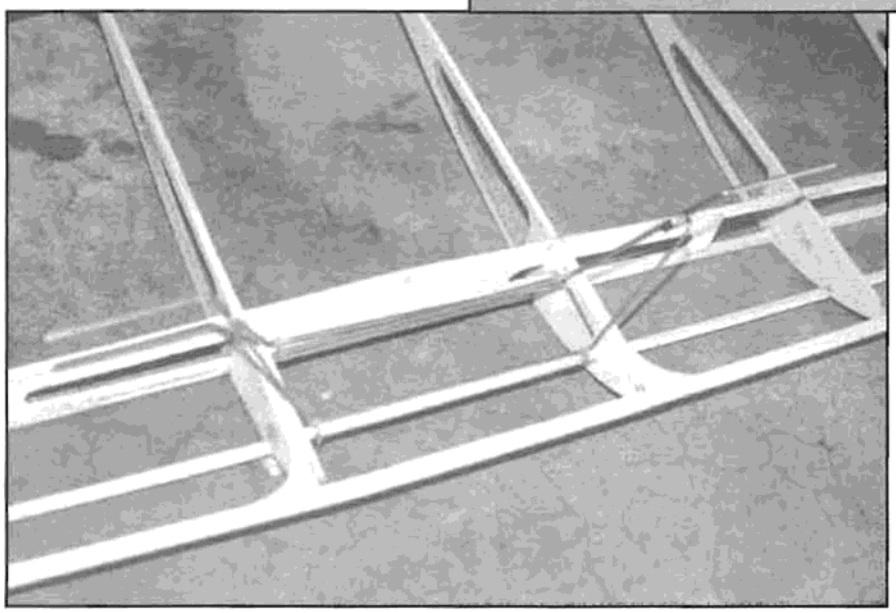
The plane is so small that the pilot's feet were on either side of the oil sump. An interesting feature of the original Sky Baby was that the outboard wingtips had leading edge slots to delay the stall. The landing approach was made at 80 mph and touchdown was at about 65 mph. Top speed was an indicated 250 mph. I say indicated because the airspeed indicator was never calibrated. Why calibrate it when the pilot is much too busy to ever look at it?

Only two pilots ever flew the Sky Baby. Bob Starr was the original pilot and he made most of the flights. Bob had flown Merlin-Engined P-40's for the Flying Tigers late in WWII, so he had some experience with the airfoil. The other pilot who flew her was Lester Cole. The smallest plane that Lester had flown before the Sky Baby was a clipped wing Cub. Unlike subsequent "World's Smallest Planes" -- which only made short hops in ground effect to set the record and get it in the books, the Sky Baby's flight characteristics were good enough for it to log ten flight hours.

The Sky Baby was never stalled in flight or flown "power off." The closest it came to an accident was at a Detroit Air Show. A group of 16 Canadian aerobic jets were running up their engines at the far end of the same runway from which Bob was just taking off. The heat from all these engines







ABOVE: The fuselage backbone, vertical fin/rudder and lower fuselage longerons are made up by laminating the balsa strips around forms prior to beginning assembly.

RIGHT: The wing assembly couldn't be much simpler. Note that the wings are flat on the top, but have a small amount of dihedral on the bottom due to the gradual tapering of the rib height.

BELOW: Landing gear is attached to hardwood dowels with thread and glue. (I used bamboo skewers on this model.)

produced a large visible heat wave (like you see on a blacktop highway on a hot summer day). When Bob flew through this heat wave, The World's Smallest Plane nearly fell from the sky! Its tiny wings couldn't produce enough lift to support itself in the thin air caused by the heat wave. The density altitude at tree top height must have been equivalent to about 20,000 feet in that heat wave! Bob managed to bring it through without crashing.

Ray Stits has had a very active career in aviation. His best known design is probably the Stits Playboy. This was a very popular home-built aircraft. Ray's biggest contribution, however, was the Stits covering that he developed. This has become the standard fabric covering used throughout the aviation world and has essentially replaced linen and dope covering.

A half a century after the Sky Baby, Ray Stits is still active in aviation giving more than a thousand young people the opportunity to fly in the EAA Young Eagle Youth Flight Training Program. Bob Starr went on to both design and fly subsequent World's Smallest Planes. Ray Stits' son has also held a World's Smallest record. The Sky Baby is now on display at the Experimental Aircraft Association (EAA) Museum in Oshkosh, Wisconsin.

Building The Sky Baby

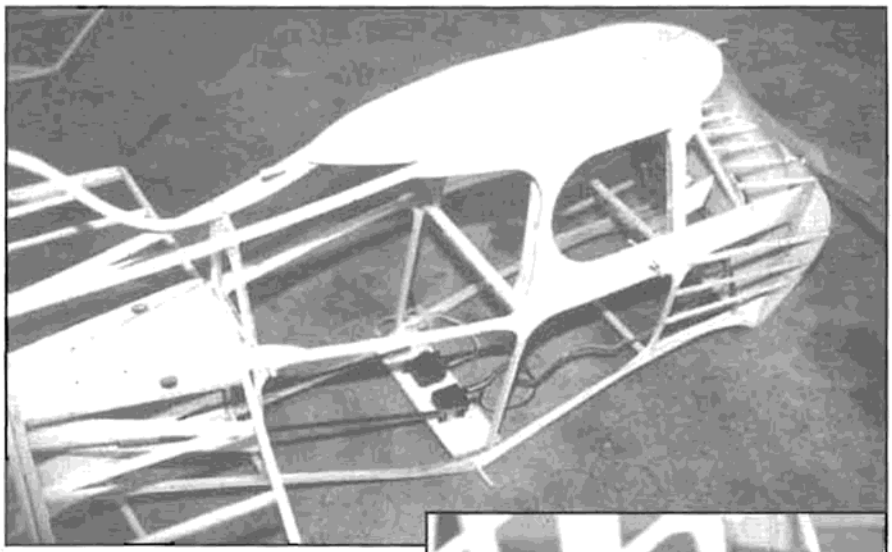
Before you begin building the plane you should spend some time studying the plans and photos. You should construct the entire plane in your mind before actually building it. This is the best way to avoid costly building mistakes later on. Laser-cut parts and a vacuum formed cowl will be available from Hobby People (800) 854-8471 for those who like to save time.

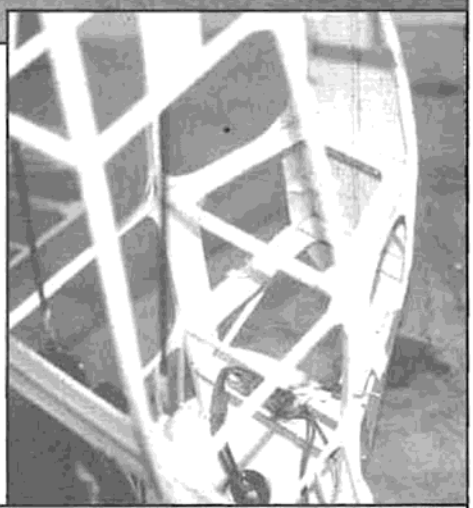
Laminating

Start by making the laminated parts. Laminating balsa strips together is the lightest and strongest way to build the curved parts: in this case, these are the vertical fin and rudder outline, the lower longerons, and fuselage backbone. I have tried a lot of different laminating methods, and the one which follows works the best.

Your first step is to make the laminating forms. I often make mine from corrugated cardboard because it is available at no cost (cardboard boxes from the grocery store). Some better, but more expensive materials are: plywood, particle board, and foam core board (available from office or art supply stores). The foam core board is the easiest to cut.

Make some laminating templates by tracing the part outline onto your laminating form material (i.e., foam core board, cardboard, plywood). Sometimes it is easier to make the

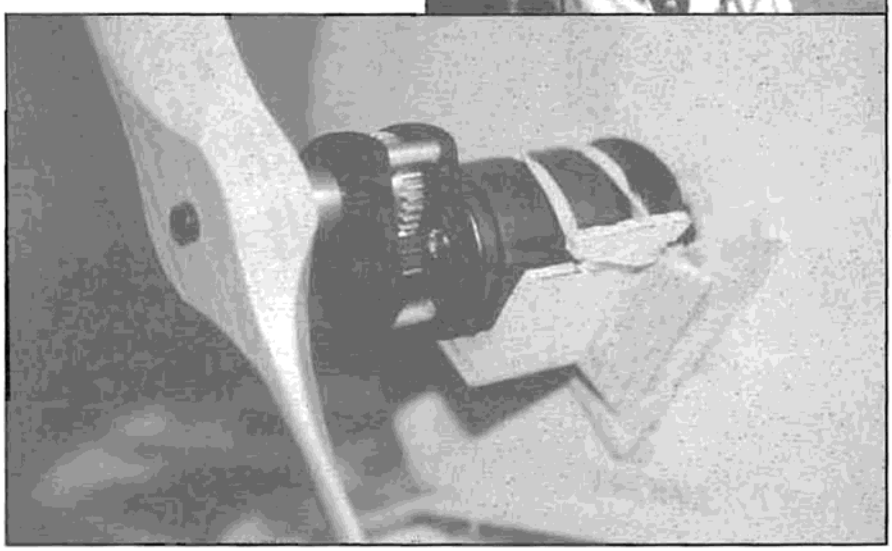




ABOVE: The rudder and elevator servos are mounted in the bottom of the fuselage to help keep the overall mass as low as possible.

RIGHT: The electronic speed control is mounted on the instrument panel, and the on-off switch is mounted on the lower canopy frame.

BELOW: A variety of motor/gearbox combinations can be used for power; even a glow engine if you are so inclined! See text for more information on power plants.



laminating form on separate sheet of paper (like tracing paper) and use a glue stick to paste the sheet onto your template material. Cut out the laminating form carefully. Use a sanding block to sand the edges smooth and square.

Next, cover the outside edge of the form with a strip of transparent packing tape (non-sticky side out) or iron a thin strip of MonoKote or similar product around the outside of the form. This keeps the laminated balsa from sticking to the laminating form.

Take the balsa to be laminated and soak it in hot water for 30 minutes. You should soak a few extra pieces in case some of the sticks break during the procedure. While the sticks are soaking, collect the following items:

- A bowl of thinned (~75% glue, 25% water) white glue (Elmers) & a sponge.
- String or thread, rubber bands, and pins.
- A pickle jar or similar container with a 5" or 6" outside diameter.

As you remove each balsa strip from the water, slowly and carefully bend the strip around the pickle jar while pulling on both ends of the strip. The key to preventing breakage is to keep tension present in the strip by pulling on it as if you were stretching a rubber band while bending it slowly around the curve of the jar. Once each strip has been bent around the jar, apply the thinned glue to the still moist strips using the sponge. Stack the strips on top of each other and wrap the stack of strips tightly around the laminating form. The strips need to be pinned to the edge of the form.

Once the strips are pinned in place, tightly wrap string, thread, or rubber bands around the form so that the stack of strips are held flush against the form at all points. Wipe off the excess glue from the strips and let them dry overnight. When dry, remove the laminated strips from the form and trim to length. The finished lamination should match up with the plans.

Notes: (1) Drying times vary with the weather, so if your lamination does not appear dry after setting overnight, you can dry the lamination in the oven on "Warm" (lowest setting) for around 20 minutes. You can also do this if you are in a hurry. Just be sure to check frequently! (2) You can use other glues, like wood glue or CA, but they make the sanding a lot harder.

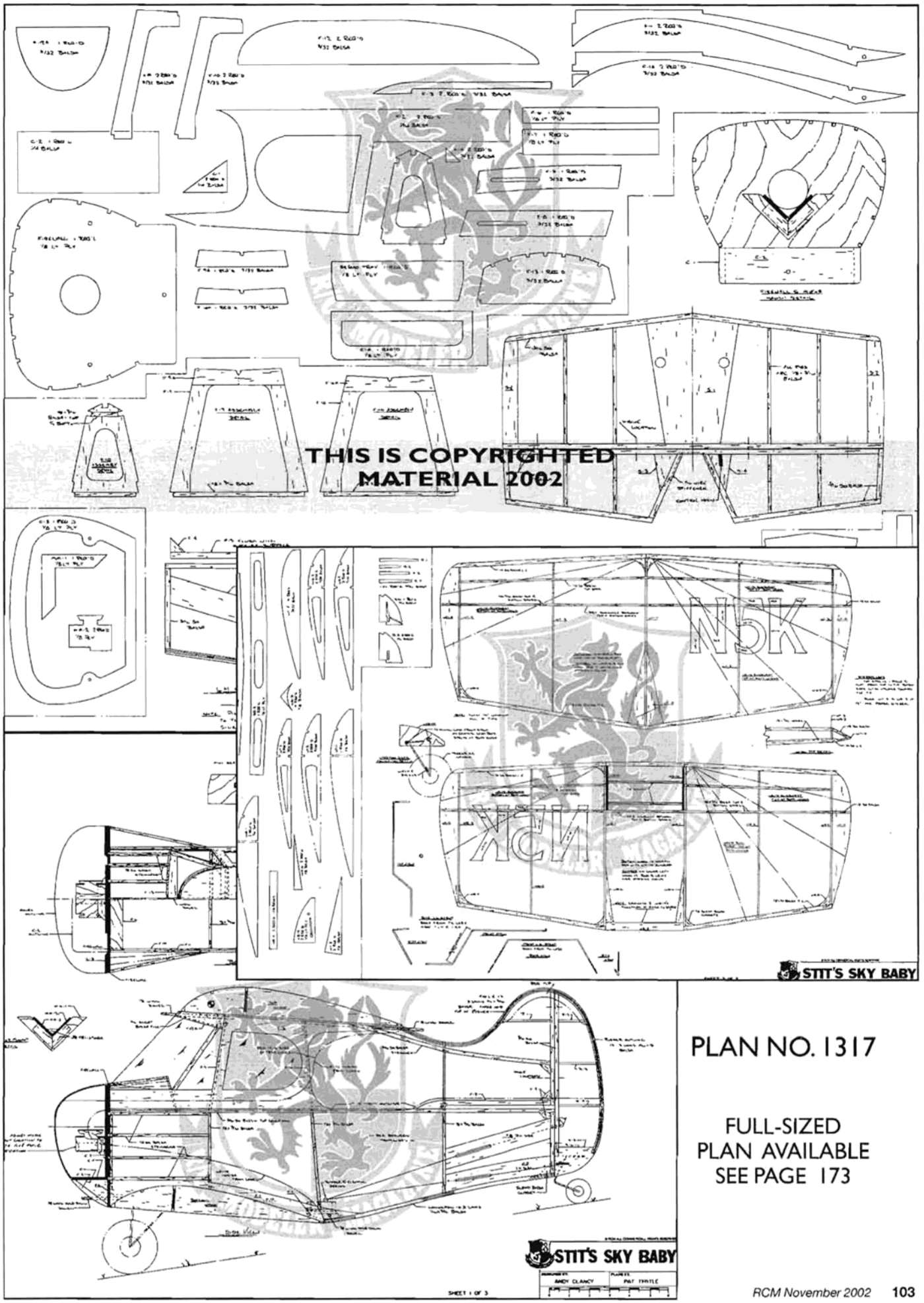
Framing Up The Fuselage

I like to build the first fuselage side frame directly over the plans. I then build the second side over the first. This ensures both are identical. Begin boxing up the fuselage at the forward end. Install the firewall formers and crosspieces back to the trailing edge of the wing. The longerons will need to make an extreme bend at this point to bring the tail post together. I wrapped wet strips of cloth around each longeron for a half hour or so to allow them to bend. The vertical fin should be pre-assembled over the plans before attaching it to the upper rear fuselage along with the remaining formers and crosspieces and stringers.

When building the forward fuselage, take extra care in the area of the upper front wing hold-down dowel. This area takes almost all of the stress of the top wing's lift, and in-flight structural failure here will result in total destruction.

Building The Wings

The wings are extremely simple on this ship with only five ribs on the top



PLAN NO. 1317

FULL-SIZED
PLAN AVAILABLE
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ABOVE: The lightweight structure is the key to a good flying electric model, and this one is built to fly.

RIGHT: Completed model, ready for paint and trim.

wing and six on the bottom. Note that we have cut lightening holes in the ribs on the prototype. After flying the plane for awhile, we decided to eliminate the lightening holes on the central ribs for both the top and bottom wing because the weight savings wasn't worth the loss in strength.

I always like to build my wings beginning with the leading edge and work my way back towards the trailing edge. You should use scrap wood shims under the wingtips to achieve the proper dihedral angle. Note: The wing is straight across the top. However, a small amount of dihedral is on the bottom surface of the wings due to gradual tapering of the outer rib height.

After the wings have been sanded you can install the landing gear wires lashed to the two bamboo skewers in the bottom wing with thread and glue. You should notice that the forward wire is lashed at the very center only to allow the gear to flex on a hard landing.

By the way, bamboo skewers are much stronger and cheaper than dowels and can be purchased at the grocery store. There are several sizes available. For this plane I recommend size #12.

Stabilizer

Build it directly over the plans in the usual manner. Use hard balsa for the spars and lighter wood for the rest.

Final Assembly

The motor is attached in its cradle with three No. 30 rubber bands. The stabilizer is held in place with two No. 30 rubber bands. The rudder is mounted with heavy duty hinges that have removable hinge pins. The cowl is held on with Du-Bro socket head sheet metal screws or small magnets that are sold in electronics' stores (like Radio Shack). Use five No. 19 rubber bands to hold the top wing on and four for the bottom wing. Always replace the rubber bands for each flying session. You'll be sorry if you don't. I get my rubber bands from office supply and paper stores.

Covering And Painting The Sky Baby

I highly recommend covering this plane with lightest possible covering. This plane has a lot of surface area, so the covering has a big effect on weight. The prototype used Oracover Light (available from Hobby Lobby). The whole airplane was covered in white and then the trim was painted on! Because this plane has such a light structure you must use finesse on the covering job. Both sides of a surface must be covered before any shrinking is done. You must also be very careful to avoid wrinkles when applying the covering, because using lots of heat to shrink out the wrinkles must be avoided to prevent warping. Using a lot of heat to shrink out the wrinkles on iron-on covering can cause the wrinkles to reappear on a hot day.

The technique of painting Mylar covering is to get the Mylar very clean by washing it with denatured alcohol and making sure not to touch it once it has been cleaned. The color scheme is masked using 3M automotive masking tape (the good stuff, about $10/roll). With this tape you won't get any bleeding under your mask lines, and it peels off easily without stretching your Mylar. Then give the plane a very thin and even coat of paint. A thick coat adds useless weight, it will not flex, and it tends to chip off from the Mylar.

The paint I used was a special flexible paint sold at auto specialty paint stores (called Color Coat, No. 15373 Flame Red). It is for painting flexible plastics and carpeting. It comes in a spray can and I highly recommend it. My second recommendation is the Testors Spray Enamel sold in hobby stores. The graphics are cut from self-adhesive vinyl.

Propulsion System

I flew the Sky Baby with several different motor systems. The minimum set-up used was the Dymond geared 480 with the 6:1 gear ratio turning an

APC 13 x 7 electric prop on 8 cells, either 500 mAh Sanyo or 800 mAh NiMH packs from Wattage. Keep in mind that if you use a cheap motor, weight is critical. A little too much paint or heavier covering and the plane won't climb well.

I also tested the Sky Baby with more powerful and expensive motors. My favorite is the Astro Flight 020 brushless with the 6:1 planetary drive using the same 13" APC prop on 8-cells. I also tested Astro Flight's geared Cobalt 035 and 05 motors, and the Model Electronics Turbo 10. Whatever motor you use, you will have to adjust the height of the motor mount. The gear ratio should allow at least 12 inches of prop diameter. Please remember that this plane is not meant to go fast. My fear is that if larger motors are used, the plane may be flown too fast!

The Sky Baby could also be adapted to glow power. The main problem is getting enough prop diameter. You'll need the prop to extend beyond the cowling in order to get enough lift. A 10 or 15 has more than enough power to fly a plane this size and weight, but it won't turn a large enough prop to clear the cowl. Diesels and small 4-strokes can turn fairly large props. You might be able to get away using a .20 or .25 2-stroke if you detune it to swing a larger diameter propeller than normal. By detuning, I mean reducing the compression ratio by adding extra head gaskets and/or glow plug washers. Even so, the plane would still be wildly overpowered. Some strengthening through the use of hard balsa is advisable when adapting this plane to combustion engine power. I would also strengthen the top forward wing attachment.

Radio And Equipment

The smaller and lighter the radio gear, the better. Especially if you are using the cheaper electric motors. You should mount all equipment as low as possible in the plane. Keeping the Center of Gravity as low as possible is the key to keeping this tall and stubby airplane from nosing over. Notice in the plans how the servos are shown mounted on their sides on the bottom of the fuselage. The battery pack is also mounted as low as possible, just above the LE of the bottom wing. I used about 3/4" of control deflection in either direction on both control surfaces.

A general rule I use when mounting radio equipment in a new plane before covering is to mount the equipment as far forward as possible. It is always preferable to end up nose heavy rather than tail heavy. A very nose heavy plane can be balanced with a tiny amount of weight added to the tail. But a slightly tail heavy plane requires a large weight in the nose to correct the balance. Of course, it is best to install equipment after covering and adjust its position to achieve a perfect balance without any ballast.

Flying The Model

I made my first flight at the model field. This initial test flight was made prior to the trim being added to the covering job — I couldn't wait to get it in the air! The plane is very stable on the ground. It tracks straight and goes where you tell it. The take-off run was only about 30 feet with just a touch of up elevator to lift off. Climb-outs could be made at a very steep angle and very slow speeds. If you try to climb too steeply, the plane goes into a nose-high mush toward the ground. Climbing at a shallow angle and at a higher airspeed doesn't seem to improve the climb rate much. Probably because flying faster produces more drag with the big fuselage.

This plane has a huge amount of roll stability, the most I've ever flown. I tried rolling at the top of the loop, while inverted: it stalls and snap rolls back upright. Next, I attempted a roll by first putting it into a powered dive to gain as much speed as possible, and then tried to roll. The result was a wild oscillation during which the wingtips of the top and bottom wings met on one side with a sharp bang! Fortunately, I was flying "one mistake high" and the plane recovered slightly above ground level. I didn't recover until 15 minutes later.

Stalls Are Interesting

You should always practice stalling a new plane before attempting the first landing. This is especially good advice when dealing with an unusual plane like the Sky Baby. Stalls with this plane are about as gentle as possible. In a high-power stall the plane mushes along because there's a lot of wing in the prop wash and this provides plenty of lift. In a power-off stall the bottom wing, being forward of the top wing and at a higher angle, stalls first. The forward loss of lift drops the nose and prevents the top wing from stalling. In other words, a stall is just a mushy, nose-high descent, which is a very forgiving stall.

You could also say that a stall abruptly turns your biplane into a high wing monoplane. The Sky Baby's stalling characteristics and high drag fuselage allow for very steep landing approaches and very precise landings.

My favorite landing with this plane is to put it into a nose-high mushing descent and then suddenly give a blast of power during the last few feet to slow the descent rate and give the elevator more bite to keep the tail down. Of course, this plane can make more normal landings, too. The only potential problem is nosing over. I find that a blast of propwash on the tail and lots of up elevator on touchdown easily prevents this problem.

The first flight went very well. It was so easy to fly and so predictable, slow and maneuverable that I made my second flight from my driveway. This is a place that many so-called Slow Flyers have had difficulty flying. Unlike a Slow Flyer, this plane is insensitive to wind and I had no problems flying this plane in such a tight space.

Conclusion

My heart has always gone out to the original stubby little Sky Baby which looks so unlikely to fly, and stands as Ray Stits' record-breaking reply to "You can't do it!" This model of the Sky Baby is very special, for its looks misleadingly suggest that it requires a high level of skill. Your flying buddies will be impressed that you can fly it so well, since their intuition will tell them that the Sky Baby shouldn't be able to fly at all. ✈