

Stealth-E

by JEFF HOLAN

Silent Assault

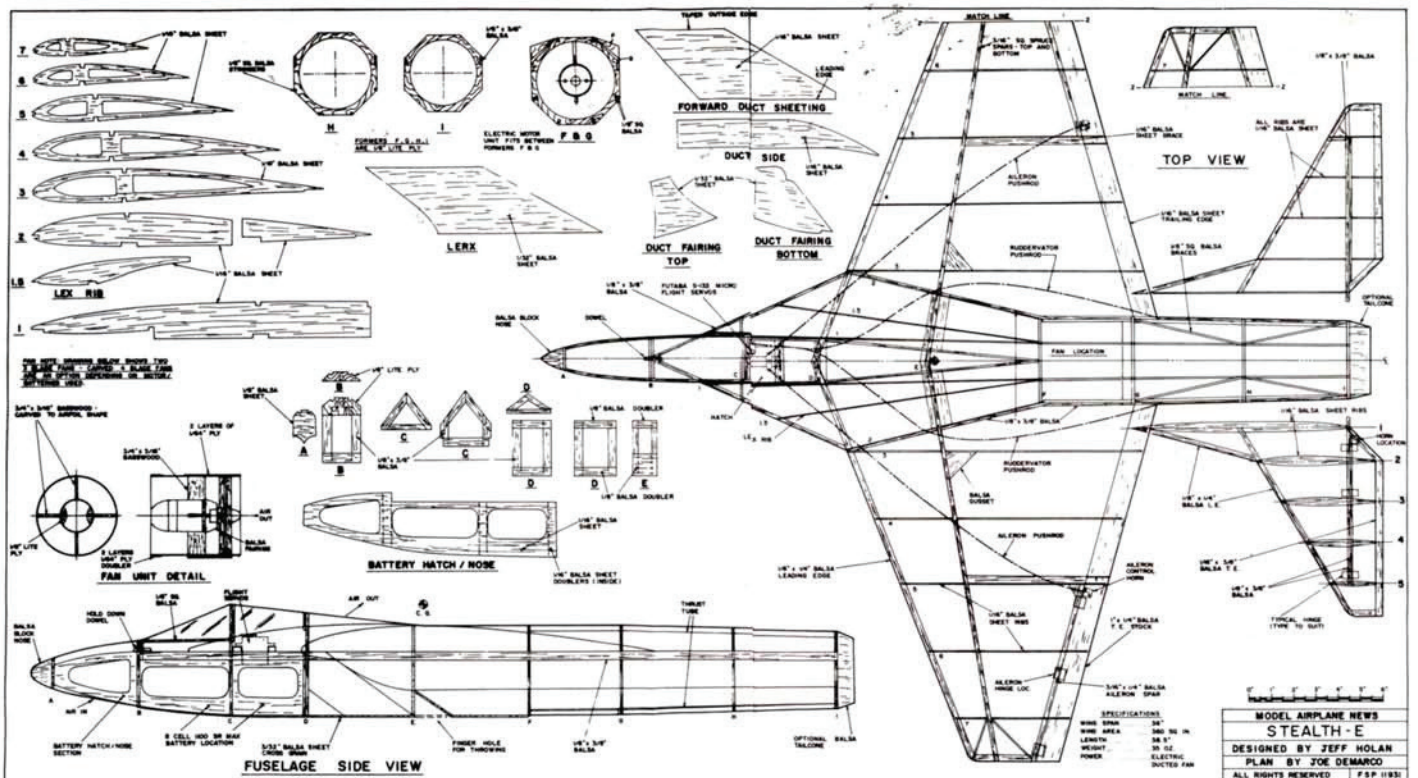
DESIGNED THE STEALTH-E because I wanted a jet-style aircraft without the hassles that are associated with ducted fans. I was impressed with the performance and style of the planes at a local club's fan-fly, but I was discouraged by the gas, the noise, the glow plugs, the amount of fiddling and all of those starting probes and gadgets. It didn't look like fun, and some of the planes never did run right. I began to think about alternatives. How about an electric ducted fan? You just switch it on and throw it in the air! I already had my feet wet with electric planes, and I had a good idea of the sizes and weights needed for a flyable/fun plane.

Then the Gulf War started, and the new breed of high-tech weapons with surgical precision and deadly accuracy came to prime-time TV—Stealth technology! The F117A started the "stealth look," and the YF22 and the YF23 are nasty-looking fighters. I started sketching an electric ducted-fan Stealth. I read about the second Great Design Contest in *Model Airplane News*, and the race was on to design, build and fly this plane by the August deadline.

The Stealth-E prototype's first flight was like that of a powered paper airplane that didn't have enough power to sustain flight. (It demonstrated, however, a graceful, full-power,



1 first place
DESIGN
CONTEST
winner

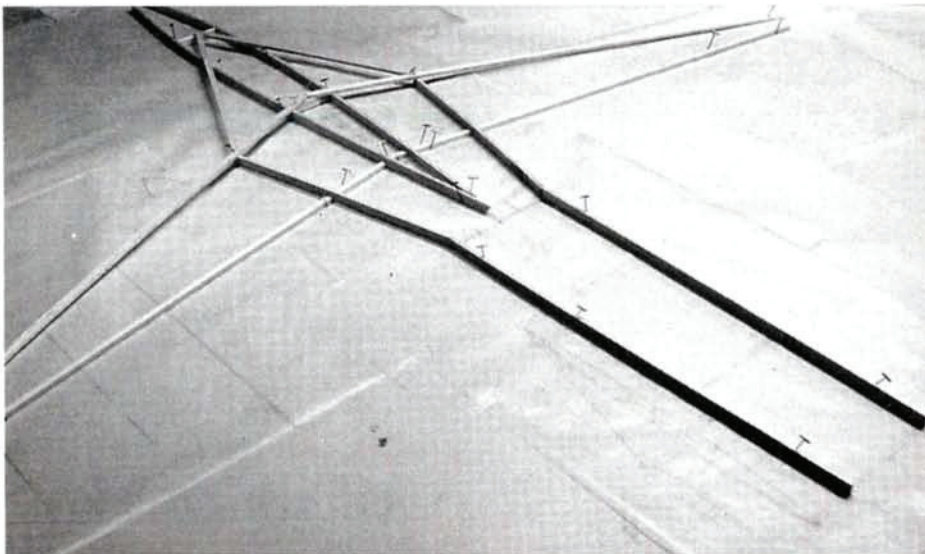


ORDER THE FULL-SIZE PLANS...PAGE 109...
FSP11931...\$10.

flare landing.) I discovered later that the single, three-blade fan developed more thrust with the access hatch removed, thereby producing a cheater inlet.

One week before the contest deadline, the prototype flew three successful "sorties." With my friend Tom at the sticks (I was a basket case), I ran, threw the plane and frantically grabbed my camera. With the increased thrust, the Stealth-E flew quite well and proved that

Start building the plane by laying out the outline structure. The top and bottom fuselage structure is built around this frame. The longeron-like pieces on either side of the fuse are referred to in the article as the "fuselage spars."



an electric ducted fan was possible. Tom did a great job keeping the plane circling around us so that I could get some flight shots to prove that this thing could really fly; we had a hard time believing it ourselves! Its flare for landing was a thing of beauty. It would just hang in the air—nose high—and bleed off speed until it floated onto the grass. A week or so later, I flew it for a fourth and fifth time. My landings weren't so graceful, and the abuse showed on the plane. I crunched the prototype on flight 5½ with a stall after a bad throw. The plane stopped on the ground, but the battery kept going. I picked up the remains and shelved them.

I decided to do some more research and make the necessary design changes on the plans but to wait to build another plane. I

didn't want to use any cheater holes in my design (they actually decrease top speed), so I made some changes to improve the intake volume and the airflow. I hadn't thought about how to hold the model to throw it; there wasn't a place to grab on to for a good throw. I slanted the intake duct edges toward the rear and added a finger hole. I fixed the structural (design) problems with the ruddervators and added the airfoil shape to them. To increase lift, I also changed the wing shape to an Eppler 197.

Good news: I won the design contest! Bad news: I have to build another plane and clean up my plans so that someone else can make some sense out of them. The plans are derived from the third version of the Stealth-E. It has the same profile and size as the prototype, but it flies much better. Experiments with different props ranged from single and double three-blades to the current four-blade. I used a plastic beer cup for a fan shroud in the prototype and a less than precise way to hold the motor inside it. The newer, rolled-plywood-tube fan unit is stronger, more efficient and makes motor timing a breeze. I added more performance by switching to SR 1100 Max batteries with Sermos* connectors. The change increased the thrust 37 percent—from 8 to 11 ounces, and it decreased the weight by 1.5 ounces. I timed the motor for the highest rpm by turning the brush housing while the fan unit was running. Thrust is currently about 12 ounces, and the flight performance has improved greatly. If you build a Stealth-E, use light wood! Build it to fly—not to crash.

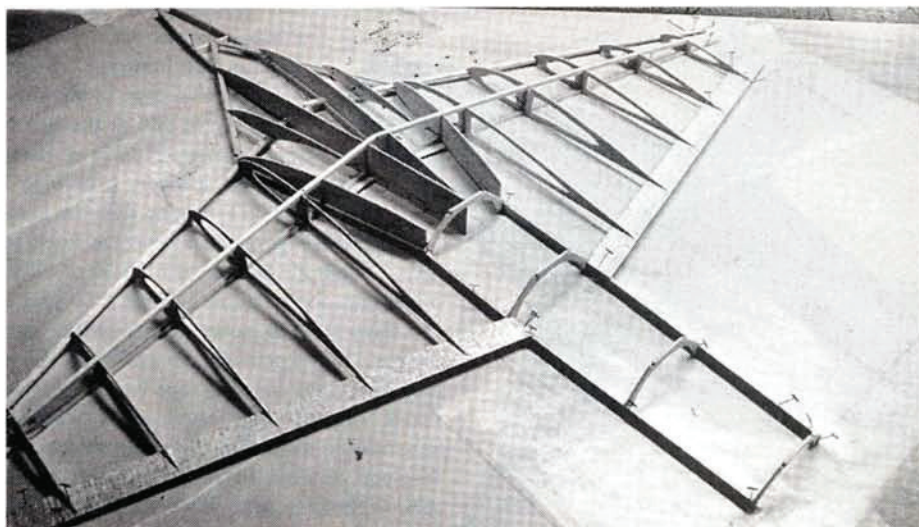
The one-piece upper fuse and main wing is taking shape.

UPPER FUSELAGE/WING

Roll out the plans on a board, and cover them with wax paper. Pin down the $\frac{3}{16}$ -square spruce wing spars and the $\frac{1}{8} \times \frac{3}{8}$ balsa rear fuselage spars. Make duct spars and forward fuselage spars out of $\frac{1}{8} \times \frac{3}{8}$ balsa and notch them to fit over the wing spars. Glue and pin them down, and add spar connectors at B and D. Add the $\frac{1}{8} \times \frac{1}{4}$ -inch balsa leading edge to the wing and the root extension. Cut F, G, H and I out of $\frac{1}{8}$ -inch light plywood, and glue them onto the fuselage spars. Cut out the trailing edge from $\frac{1}{16}$ -inch balsa, and notch it where it connects to the G former. Cut out the ribs, and check for fit. You'll want to sand a knife-edge to the inside of the no. 1 ribs for a smooth exit into the fan. Make the stringers from the main spar to I out of $\frac{1}{8}$ -inch-square balsa. Add $\frac{1}{8}$ -inch-square balsa diagonal braces from F to G, G to H and H to I. Pull out your pins and remove the model from your board. Sand the leading edges of the wing and root extension, the main spar and the ribs where they contact the sheeting. Return the plane to the board, and pin it down over the plan. Remember to place the spacers under the wingtips and trailing edge. Glue and pin the $\frac{1}{32}$ -inch top sheeting onto the wing from ribs 2 to 7. Use the pattern for the LERX and cut two out of $\frac{1}{32}$ sheet. Sand a knife-edge on the bottom of the LERX where it overlaps the wing sheeting at rib 2. The sheeting will be much easier to bend and glue if you wet the top of it with water and let it sit for a few minutes. Glue $\frac{1}{32}$ -inch sheeting between F and G. Complete the sheeting by connecting the main spar at E and back to F. Sheet the remaining triangles between the LERX and the main spar.

RUDDERVATORS

The ruddervators (vee-tail setup) are made out of strips of $\frac{1}{16}$ balsa and $\frac{1}{8} \times \frac{3}{8}$ balsa spars at the hinge lines. You can save time by making two of everything and building both sides simultaneously. Cut the hinge line spars to length, and pin them down on the plan. Cut out ribs 3 through 5 from a strip of $\frac{1}{16} \times \frac{3}{8}$ balsa. Put the leading edges together, and cut a $\frac{1}{8} \times \frac{5}{16}$ notch for the leading-edge spar. Repeat this process for the trailing edges, but make the notch $\frac{1}{16} \times \frac{3}{8}$. Ribs 1 and 2 are made out of $\frac{1}{16} \times \frac{1}{2}$ balsa. The notches are different sizes because of the angles, so use the pattern on the plan. Set them all in place over the plan and make sure you have a good fit at the $\frac{1}{8} \times \frac{1}{4}$ leading edge, the $\frac{1}{16} \times \frac{3}{8}$ trailing edge and the tip. I left the leading edge in one piece and cut it later after I sanded the ribs to an airfoil profile. When you're satisfied with the fit, glue the



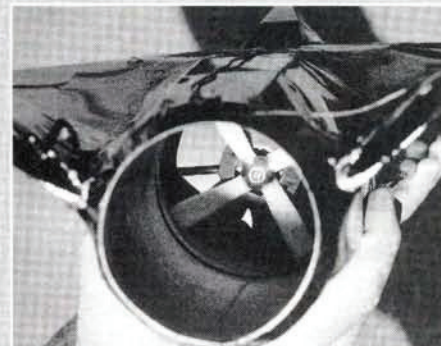
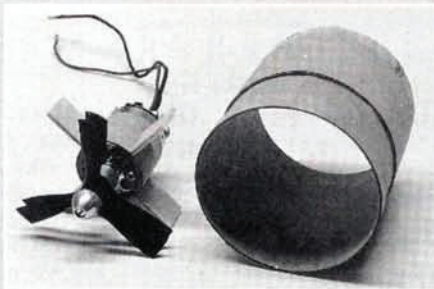
Scratch Build A Fan Unit

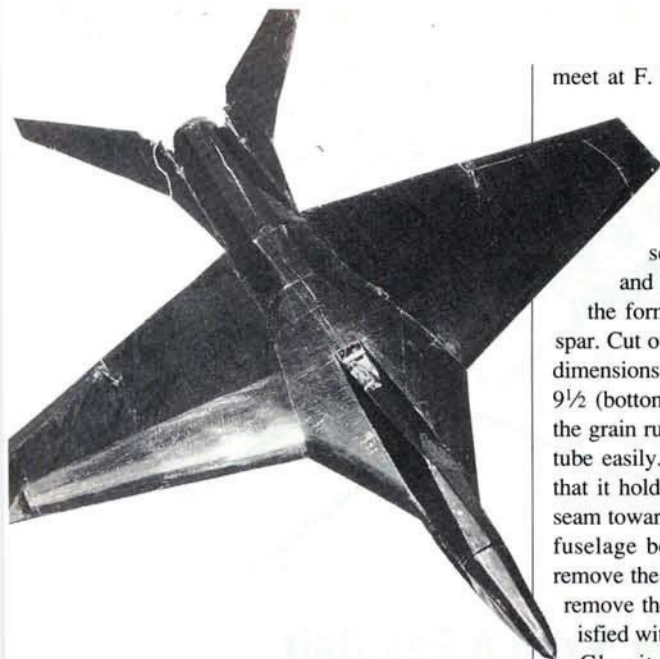
Cut out a 4-inch-wide piece of $\frac{1}{64}$ ply, and wrap it around a $3\frac{1}{2}$ -inch-diameter form. (I used a plastic peanut butter jar.) Put a couple of rubber bands around the tube to hold the ply in place. Wrap a $2\frac{1}{2}$ -inch-wide strip of $\frac{1}{64}$ ply around the rear edge of the fan unit, and roll a couple of rubber bands over it to hold it in position. Repeat this process with a piece that's $2\frac{1}{2}$ inches wide and another that's 2 inches wide. Perform this procedure using $\frac{1}{2}$ -inch-wide strips for the intake side. Cut out a $1\frac{1}{4}$ strip of $\frac{1}{64}$ ply that's long enough to wrap around your electric motor twice. Glue it while holding it in place with rubber bands. When it's dry, remove the tube and set it over the front view on the plan. Cut out the stators ("mounting fins") from $\frac{1}{8}$ lite-ply (or $\frac{3}{16}$ -inch basswood), and sand the edges to shape. Glue the stators to the motor tube at the positions shown on the plan, using a triangle to keep them square. Add $\frac{1}{8}$ ply motor mounts to the inside of the motor tube as shown on the plan. Measure and drill the mounting holes to fit the motor.

To make your prop/fan, you can either use two- or three-blade props stacked on one another, or make a four-blade prop. [Editor's note: Model Airplane News does not endorse re-engineering or modifying commercially available propellers.]

The double three-blade is easier, but the four-blade seems to create more thrust. Take two $5\frac{1}{2} \times 4$ props and cut off the tips so that they have a $\frac{3}{16}$ inch diameter. I cut them a little longer so they can be fitted to the fan tube at final assembly. Fit the fan-to-shroud clearance by trial-fitting the motor/stator assembly in the fan tube. Gradually, reduce the diameter of the fan blades by spinning the motor and shaving off small amounts of the fan against a sanding block. The clearance between the blade tips and the fan should be as small as possible for maximum efficiency. The clearance must be wide enough so that the blades don't touch the tube at higher rpm, i.e., owing to blade stretch/distortion.

After the final assembly and the initial full-power runs, they'll "buzz themselves down" to the final length. The stators should be sanded so that they fully contact the fan-tube walls without distorting the tube. Spin the prop, and adjust the unit as necessary to achieve equal tip clearance around the entire tube's circumference. Tack-glue the motor/stator assembly into position $1\frac{1}{2}$ inches from the rear edge. When it's set, add fillets of glue around the joints to strengthen and streamline them. Drop the fan unit into the fuselage and align its rear perimeter with the front of the thrust tube, and its front with the intake-duct walls. Glue the spruce-spar mounting rails to the tube exterior so that the fan can be bolt-mounted to the fuselage spars.





ribs, leading edge and trailing pieces together per the plan. Sand the ribs to an airfoil shape as shown on the plan, and then cut the leading edge just inside rib 5 so that rib 5 can pivot with the ruddervator after the installation of the subspar and the ruddervator leading edge. Sand the hinge-line spars to the shape on the plan.

LOWER FUSELAGE

Make formers B, C, D and E out of $\frac{1}{8} \times \frac{3}{8}$ balsa as shown on the plans. Cut A out of a solid piece of $\frac{1}{8}$ balsa. Make formers F, G, H and I out of $\frac{1}{8}$ light plywood. Flip the plane onto its back and glue formers D2, E, F, G, H and I (make sure that they're perpendicular to the fuselage spars). Cut out a piece of $\frac{1}{6}$ balsa to measure $2\frac{1}{2} \times 10\frac{1}{4}$ for the inner walls of the intake duct. Sand a knife-edge where the two

meet at F. You'll have to put a notch in the rear bottom corner where it meets F. Glue it to formers D, E and F, on the bottom to the fuselage spar, and at the notch where it meets F. Glue $\frac{1}{8}$ -inch-square balsa stringers from E to I and from F to I, making sure you keep the formers perpendicular to the fuselage spar. Cut out the thrust tube from $\frac{1}{64}$ ply. The dimensions for the thrust tube are $11\frac{1}{4}$ (top) x $9\frac{1}{2}$ (bottom) x 10 inches (length). Make sure the grain runs lengthwise, so it will roll into a tube easily. Put masking tape on the ends so that it holds its shape, and insert it (with the seam toward the bottom of the plane), into the fuselage between formers G, H and I, and remove the tape. After you've checked for fit, remove the tube and sand it until you're satisfied with the fit.

Glue it in place using clamps and pins where necessary. Cut off the extra ply on the thrust tube, and sand it smooth with the former ends. Sand the inside edge of F to fit the $\frac{1}{32}$ balsa intake sheeting. Follow the patterns on the plans for the top and bottom, make two of each and glue them into place. Add duct walls from D to E. Sand the forward edge of the duct spar to match the profile of ribs 2 and 3. Clean up the intake as much as possible by sanding any rough edges and filling any seams before adding the $\frac{1}{6}$ forward duct sheeting. Add the triangle-stock, leading-edge reinforcements to the duct sheeting, and sand the intake opening to a smooth bell-mouth shape.

BATTERY HATCH/NOSE

Cut out the nose profile from $\frac{1}{6}$ balsa and lay it over the plan. Add $\frac{1}{6}$ balsa doublers



SPECIFICATIONS

TYPE: Electric ducted fan/sport.
WINGSPAN: 36 in.
WING AREA: 360 sq. in.
WING LOADING: 14 oz. per sq. ft.
LENGTH: 38.5 in.
WEIGHT: 35 oz.
MOTOR: .05 electric, 12-turn quad, ball bearings, wet magnets and advanced timing
FAN/PROP: 3.5-in. diameter four-blade (or double three-blade)
BATTERIES: 8 SR 1100 Max
CONTROLS: aileron, elevators and speed controller
CONSTRUCTION: all balsa and light plywood with iron-on covering

(remember to make a right and a left side). With the right side on the plan, tack-glue on the left side of formers D1 and B1, and put into position on the plane. Pin them in place, and add formers C and A. When you're satisfied, run a bead of glue around all the joints, but be careful not to glue this assembly to the fuselage spar. Add the $\frac{3}{32}$ sheeting to the bottom of the hatch with the grain running sideways (not lengthwise).

RADIO INSTALLATION/FINAL ASSEMBLY

Install your radio equipment as shown. The radio and the speed controller may be posi-

FLIGHT PERFORMANCE

by David Baron

• Test flight

The model tends to lose altitude slightly after release, so launching it off a small rise may give you some insurance. Allow the model to fly level for a few seconds to gain speed before you attempt a climb. It doesn't accelerate quickly, so be patient. The model is very stable throughout the launch, but the controls will get mushy if you ask it to climb before it's ready. It doesn't show tendencies to stall violently or snap roll.

• Launching/takeoff/climb-out

I don't recommend that the pilot hand-launch this model. It needs a first-rate hand toss, and I think having the transmitter in one hand and the plane in the other invites disaster.

• Low-speed stalls

As with any jet, this plane lacks a surplus of wing area, and as with any

electric, it carries a load of batteries. Both of these factors raise the wing loading, and while they don't necessarily change the stall speed, they do affect how much altitude is lost when a stall occurs. Owing to its length, the model has a very predictable stall that falls almost straight ahead. Expect to lose altitude and you won't have any other surprises. Strive to maintain air speed throughout the flight, and you'll be rewarded with increased duration.

• High-speed stalls

The model will begin to mush if you ask it to perform a loop or a hairpin turn that's too tight at full speed. This may be eliminated by reducing the elevator throw, but it would have an adverse effect on the model's aerobatic performance.

• Speed range

I'm not knocking the designer's

accomplishment (which is nothing short of incredible), but it would fly much faster if there were 10 more mph of thrust through the fan unit. This would be a fertile area for enterprising scratch builders to explore, whether with alternative glow or electric power systems. If you are a speed demon, this may be the ticket.

• Low-speed control sensitivity

The model descends rather quickly, but it's predictable in the controls. Remember to save a little air speed for your flare, and you'll be pleased by the speed with which it touches down.

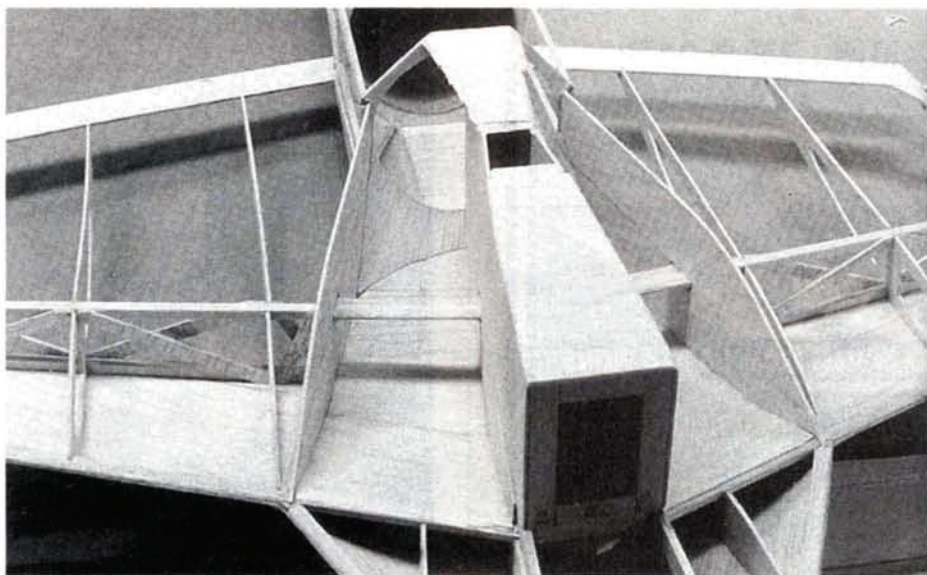
• Aerobatics

Rolling maneuvers are a cinch, but you'll lose altitude if you don't maintain air speed. Looping maneuvers are less than perfect, but they're easily accomplished with ample speed

and altitude. Keep in mind just how revolutionary this design is, and it will produce awe by just taking to the air.

• Overall characteristics

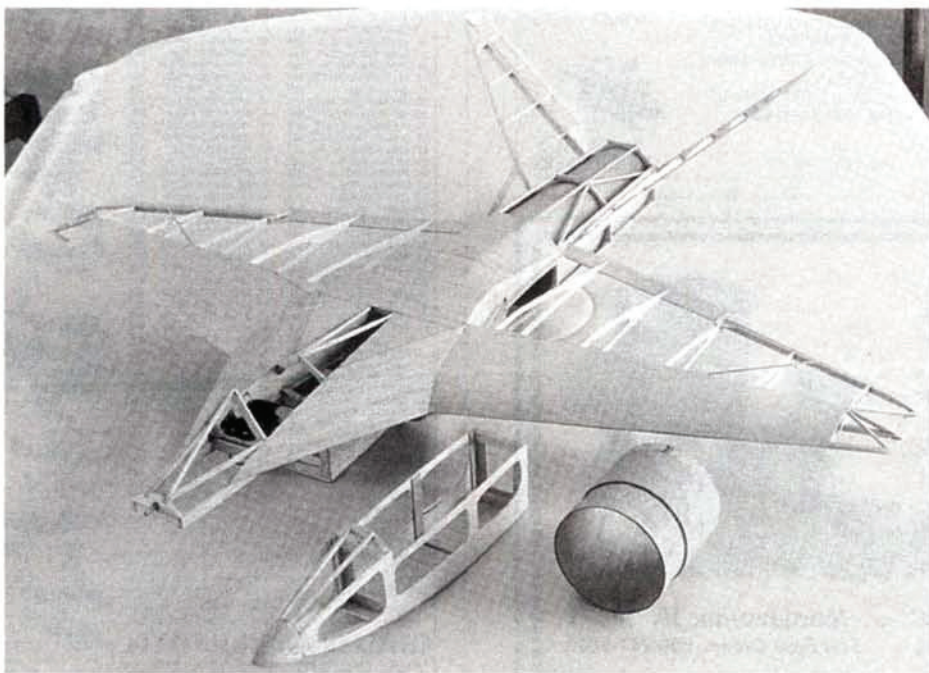
The Stealth-E turns heads and gains acceptance by all who see it. Its docile flight characteristics are the icing on the cake. Remember that anything you do to reduce vibration will go a long way toward maximizing the motor rpm. Be especially fanatical about how you balance the propeller, and be sure you run it before installation. Vibration reduces both thrust and duration, so it's worth the time to get it right. The Stealth-E features a superb collection of ideas for weight reduction and airflow around critical components of the radio and power system. Its design and efficiency is brilliant. Flights are short, but you must keep in mind the power system efficiencies.



This view of the inverted plane's front end shows the inside of the ducts before the fuse bottom has been put into place. The battery compartment/nose is not shown.

tioned in the canopy area. Use small cable-type pushrods for control-surface actuation. Be sure to glue them to the structure every couple of inches, because they're flexible and can flap around. Solder the ends of the cables to stiffen them. I set the aileron throws at $\frac{5}{16}$ inch up and $\frac{1}{4}$ inch down. Use two pushrods for ruddervator control. Solder them together at the servo end so they'll move together. A throw of $\frac{5}{16}$ (up and down) seemed to give enough throw to loop and fly while the plane's inverted without being too sensitive. Add $\frac{1}{16} \times \frac{1}{4}$ strips around the perimeter of the wing and the ruddervators where they con-

This photo of the completed skeleton shows the battery compartment/nose separated from the front of the ship. The fan-unit tube is also shown.



nect to the fuselage so the covering has something to grab onto.

FLYING

If you jumped right to this section, good for you! I built this plane to fly, and fly it does. You can go the field and have a couple of flights before anyone even has his plane gassed up and started! On its first flight, have a buddy throw the Stealth-E for you. For the best launch, throw it from a five- or six-step running start level and into the wind. We came up with a countdown: the "Stealth-Chucker" counts down from five as he starts to run. At three, start applying throttle, and he throws it on one. As with any ducted fan, you should let it build up some speed before climbing out and circling back across the field. After you get it trimmed and get acquainted with it, you'll be able to launch it yourself. The Stealth-E will climb out very



The battery compartment/nose has been removed. A small dowel is inserted into a hole in the back face of the removable nose, and a small Carl Goldberg hatch lock locks the rearmost piece of the battery compartment to the fuselage with a sideways movement of the compartment. A hard landing will dislodge the battery compartment without damaging the plane.*

well from a good launch; I've been able to launch it, climb out and split-S into a low flyby without circling for altitude. Rolls, Immelmans and loops are all possible, but you must maintain air speed. I usually dive before a maneuver to gain speed and because the Stealth-E sounds so mean screaming by at an unbelievable rpm. Most people who have seen it fly say they like the way it sounds (as if it's a "hair dryer with an attitude.") Be sure to check out the slow speeds at which the Stealth-E can fly before you land. It flares very nicely and doesn't tend to tip stall. Land on grass to avoid scraping the belly. Throttle back and bring it in. Flight times last about $2\frac{3}{4}$ minutes at full throttle, and they still leave enough juice for a short landing approach.

SPECIAL THANKS

Getting the Stealth-E off the board and into the air wouldn't have been possible without help. I'd like to thank my wife, Heidi, who puts up with my hobby and me; my flying buddies—Earl Ludeke (the "Stealth-Chucker") and Tom Kandel (the test pilot)—who helped me with flight testing; and John Seger, who took many photos. I'd also like to mention Larry Sribnick of SR Batteries* and John Sermos of Sermos R/C Snap Connectors who were very helpful and whose products have performed well in the Stealth-E.

* Here are the addresses of the companies mentioned in this article:
Sermos R/C Snap Connectors, Cedar Corners Station, Box 16787, Stamford, CT 06905.
SR Batteries Inc., Box 287, Bellport, NY 11713.
Carl Goldberg Models, 4734 W. Chicago Ave., Chicago, IL 60651. ■