SR-71

BLACKBIRD

After my previous article, the F-117A stealth fighter was published in the February '97 issue, I received quite a lot of feedback from readers expressing their interest in the SR-71, the once highly secret airplane with several world records. Unfortunately, there is no commercial kit of this aircraft available for sport fliers.

I had this project on the drawing board for several years, but it was a difficult job to simplify the construction and to ensure the performance. I saw the ducted fan version; it flew great, but obviously was not suitable for most sport fliers. I was also told that it was unstable at high angles of attack because the main wing is blanked by the wake from the fuselage.

In order to study the behavior of this unique aircraft, I built several hand launched models; the test flights were carried out in my 10' x 10' x 15' wind tunnel. (Just kidding, it's my room that allows me to fly during the cold Canadian winter.) I discovered an even worse problem. It rocked side to side at high AOA (angle of attack), then sank like a fallen leaf. I believe it is the conflict between the fuselage (lifting body) and the wing. At a high AOA, the wing stalls first while the fuselage continues to lift. Thus, the nose keeps going up and reaches an even higher AOA. This is opposite to a canard design in which the foreplane stalls first and lets the nose drop to recover by itself.

Sport Scale Model

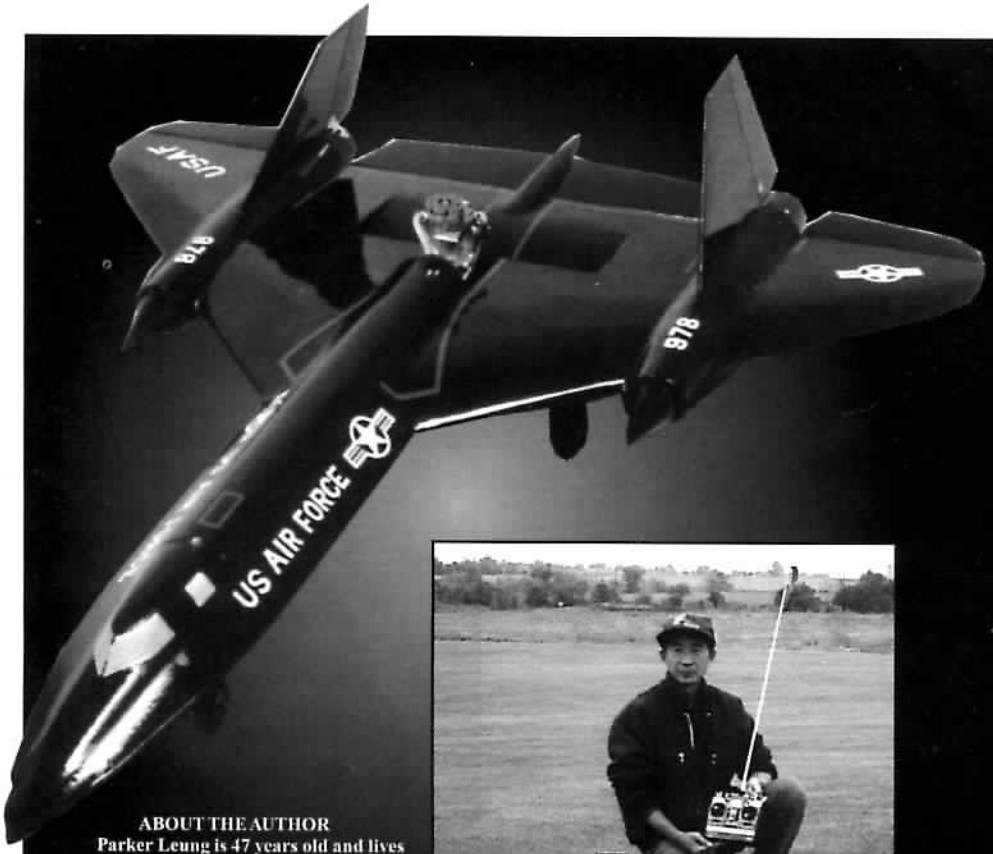
By Parker Leung

SR-71 BLACKBIRD
Designed by:
Parker Leung
TYPE AIRCRAFT
Sport Scale
WINGSPAN
38 Inches
WING CHORD
16 Inches (Avg.)
TOTAL WING AREA
475 Sq. In.
WING LOCATION
Low Wing
AIRFOIL
Flat Bottom
WING PLANFORM
Delta
DIHEDRAL, EACH TIP
0
OVERALL FUSELAGE LENGTH
49 Inches
RADIO COMPARTMENT SIZE
Ample
VERTICAL FIN HEIGHT
7-1/2 Inches (x2)
VERTICAL FIN WIDTH (inc. rud.)
9-1/2 Inches (Avg.)
REC. ENGINE SIZE
.40-.46 2-Stroke
FUEL TANK SIZE
8 Oz.
LANDING GEAR
Tricycle
REC. NO. OF CHANNELS
4
CONTROL FUNCTIONS
Rud., Elev., Throt., Elevons
C.G. LOCATION
2 to 2-1/2 Inches (forward of firewall)
ELEVATOR THROWS
3/4" Up — 3/4" Down
AILERON THROWS
5/8" Up — 5/8" Down
RUDDER THROWS
1" Left — 1" Right
SIDETHRUST
—
UPTHRUST
2°

BASIC MATERIALS USED IN CONSTRUCTION

Fuselage ..... Balsa & Ply
Wing ..... Balsa
Empennage ..... Balsa
Wt. Ready To Fly ... 76 Oz. (4 Lbs. 12 Oz.)
Wing Loading ..... 23 Oz./Sq. Ft.

For .40-.46 Power



Bill Of Materials

Balsa Block
1-1/2" x 3" x 3", 3/4" x 1" x 6" (2)
3/4" x 2" x 6-1/2", 1/2" x 3" x 9"

Balsa Sheeting
1/16" x 4" x 36" (13)
3/32" x 4" x 36" (3)
3/16" x 4" x 36" (2)
1/4" x 4" x 36" (1)
3/8" x 4" x 36" (2)

Balsa Stick
1/4" x 1/4" x 36" (1)
1/4" x 3/8" x 36" (4)
3/16" x 3/16" x 36" (2)
3/16" x 3/8" x 36" (2)

Balsa Triangle Stock
Plywood/Hardwood
3/8" x 3/8" x 36" (2)
1/8" x 12" x 36" (lite ply)
1/4" x 3" x 4"
1/2" x 1" x 12" (hardwood)

Miscellaneous Hardware
5/32" nose gear
5/32" x 36" piano wire
4 pieces elevon torque rod
(2 of 3/32" and 2 of 1/8")
spinner nut (1)
8 oz. tank (1)
2" wheel (1)
2-1/2" wheel (2)
Covering material, NyRod, hinges, horns, screws, collars, clevises, glue, fuel tube, prop engine, and R/C equipment, etc.

ABOUT THE AUTHOR

Parker Leung is 47 years old and lives in Ontario, Canada. He is married and has two children. He likes to design special models that no one has designed before, yet is suitable for the average sport flier. He also runs a part-time hobby business in order to support his hobby.

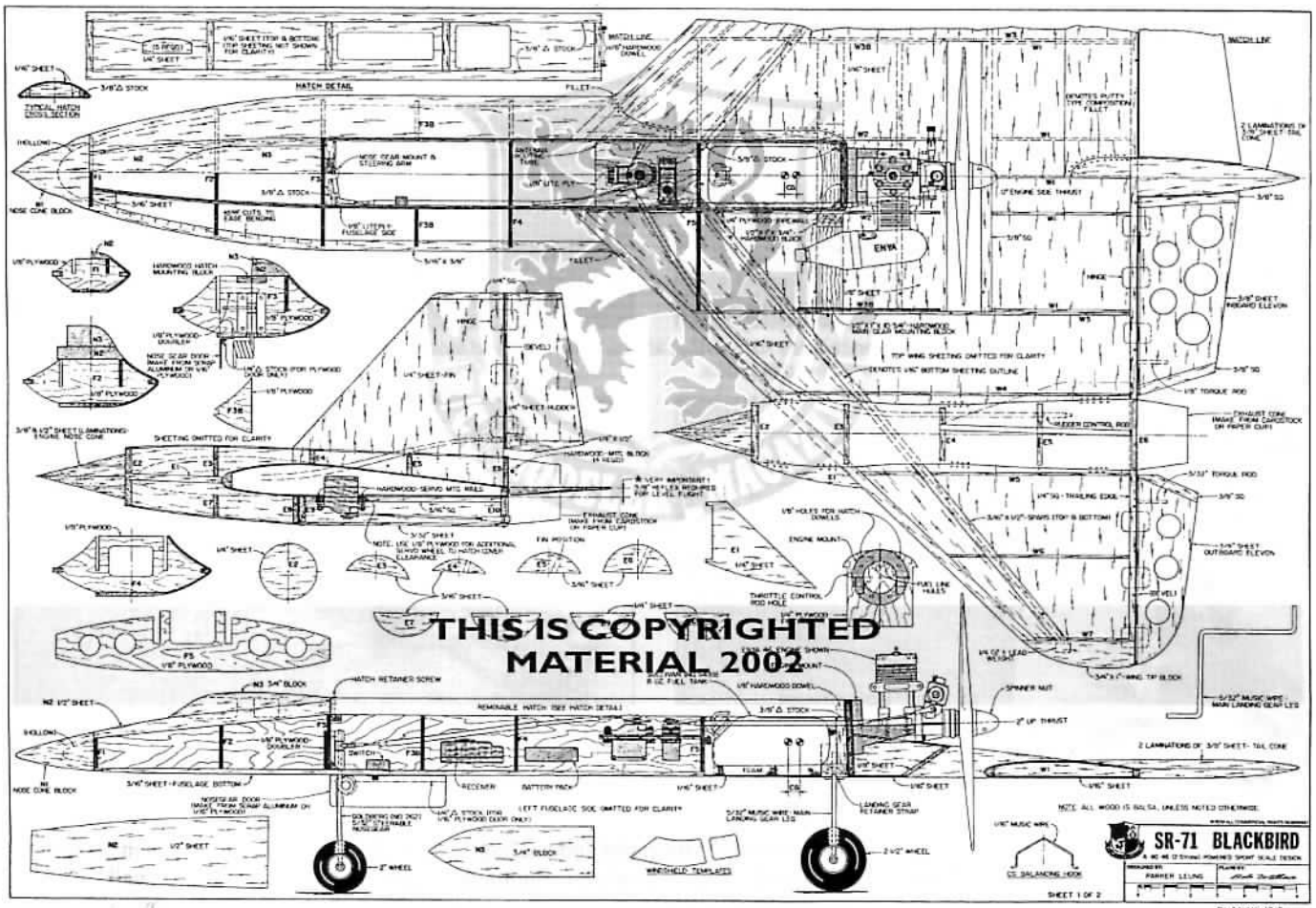
These problems may not affect the full-scale aircraft, but it is really a challenge for a scale model. Furthermore, I haven't come across any suggestions nor solutions from the books. Well, one of the advantages to designing a sport model is the flexibility to do whatever I want. Therefore, I shortened the nose and the width of the fuselage as well, and the nose cone was slightly dropped, the cross section is pretty true to scale.

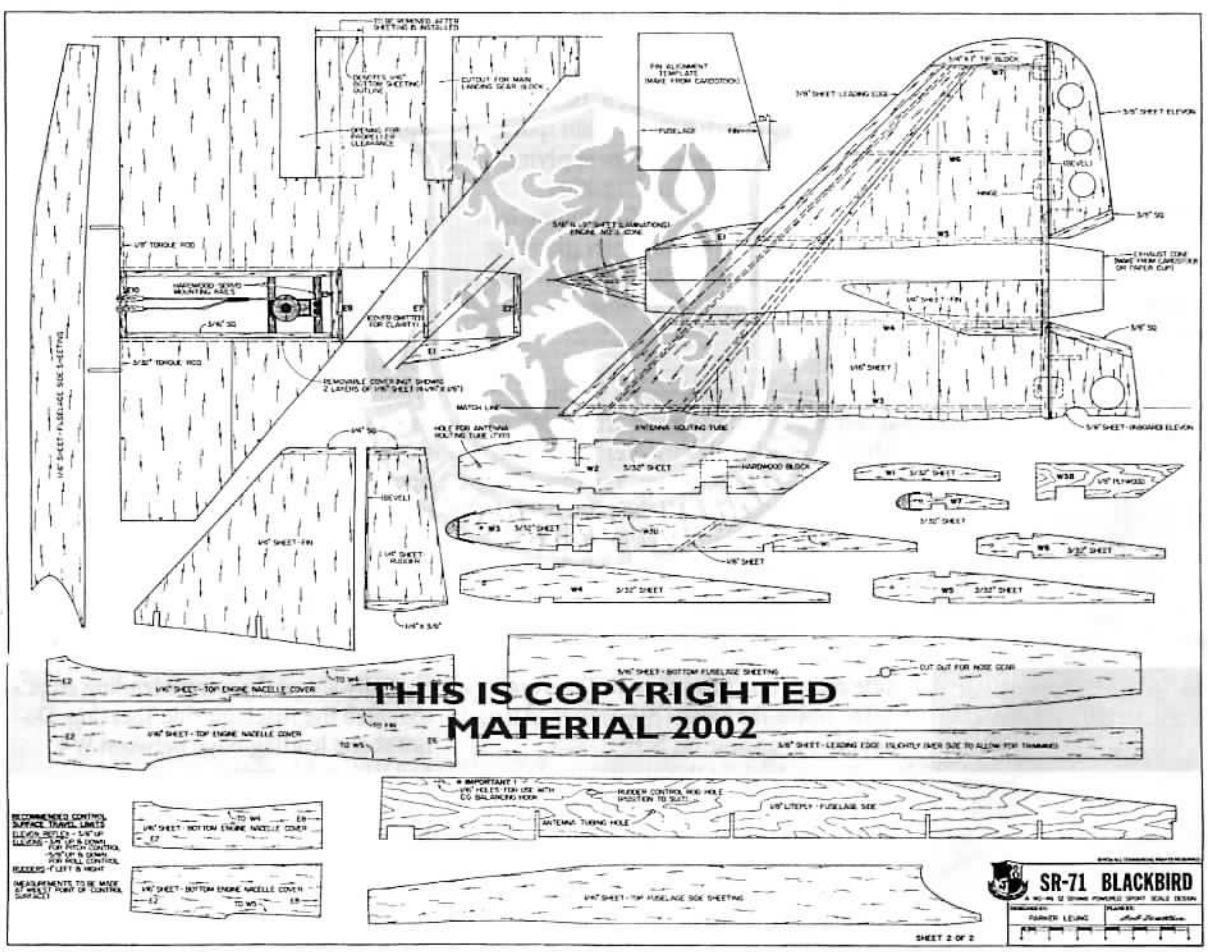
All these modifications improve the model's performance. Another bonus is that the model is small enough to store in my trunk. Since I am not interested in high speed, the wing is relatively thick so as to enhance better handling during take-off and landing. It is not practical to locate the engine at the nose or the tail because it might cause severe balance problems. Instead, the engine has been installed at the mid-wing position, and the fuel tank is close to C.G. point. By the way, I would like to give the credit to a famous designer, Mr. Laddie Mikulasko. He has designed a lot of unique models with a mid-engine configuration; most of them were featured in magazines.

CONSTRUCTION

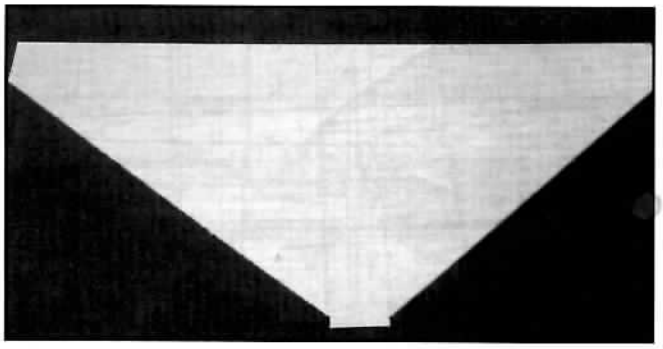
Due to the unique appearance and flight performance, the model is not recommended for beginners. Experienced builders are suggested to study the plans

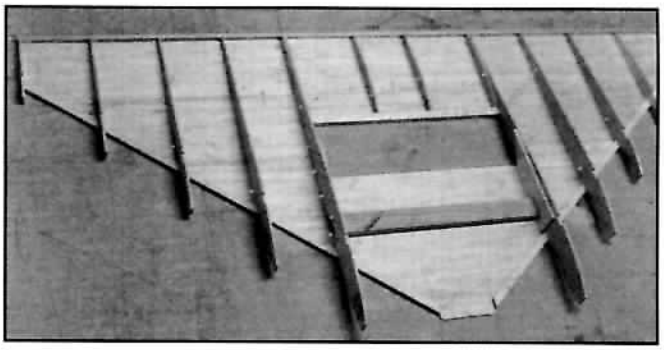
Performance:
All basic maneuvers, such as invested flight, roll, loop (both inside and outside) stall turn, etc. Capable to fly at very high angle of attack. Doesn't stall.



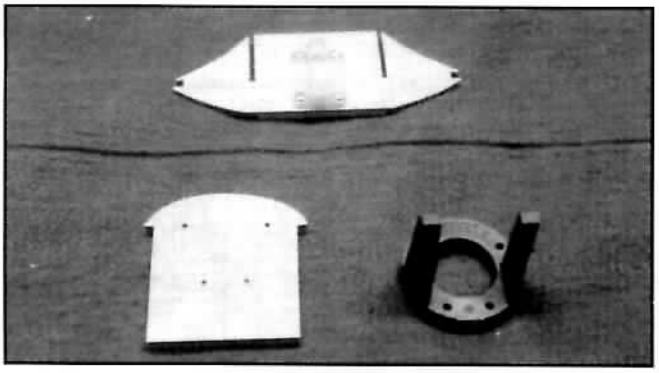


PLAN NO.1313
FULL-SIZED PLAN AVAILABLE, SEE PAGE 173





LEFT: Prepare bottom wing skin. Mark reference lines for all ribs, spars, prop slot and landing gear block. RIGHT: All ribs (except W2), main spar, trailing edge, and landing gear block glued in place.



LEFT: Engine mount and firewall shown. The openings for fuel tube, throttle pushrod and hatch dowels were drilled later on this prototype (see text). Nose gear mount has been installed on W3. RIGHT: Construction of fuselage, make sure everything is built flat on building board.

and this article thoroughly before they begin. Any experience from model boat building helps. Plan any modifications for your favorite engine and radio equipment before starting.

The construction is easier than it appears because I have done as much as possible to simplify the structure. For instance, the entire wing and fuselage is built on a 3' x 4' building board. Be sure the board is straight and warp free.

Wing:

Prepare the bottom wing skin, which covers from tip to tip and from trailing edge to only half the width of the bottom wing spars. Mark reference lines for all ribs, spars, prop slot, and landing gear block on the skin, then cut openings for the prop slot and landing gear block. Protect the plan on building board with wax paper, etc. Cut openings for the rudder cable, servo lead, etc., on W2, W3, W4. Glue two W3B (plywood reinforcement) to W3. Make sure you make a right and a left piece. Bevel the rib's slots to match bottom main spars; trial-fit them in place before applying any glue. Shape W1 leading edge (3/8" x 3/8") properly before gluing in place. I used yellow carpenter glue that allows me to work slowly. Note: W2 is not glued in place at this time.

Fuselage:

Prepare all components for the fuselage. Cut the firewall from 1/4" plywood, drill holes for engine mount, pushrod, and fuel tubing, and two 1/8" holes for hatch. Install the nose gear mount on F3. Drill holes in W4 for nose gear pushrod as well. All formers and fuselage sides are made of 1/8" lite ply. Drill holes on fuselage sides for rudder cable and antenna tubing (right side only); don't forget to drill several 1/16" holes for balance purposes. Also, cut nose gear hole on N3.

Again, trial-fit these parts in place before applying any glue. Lay down N3 bottom sheet in place, followed by formers, fuselage sides, W2, etc. Now you might appreciate having a flat building board.

Bevel the top slot and leading edge of the ribs to match the top main spars and 3/8" leading edges. Usually, I cut the leading edge slightly oversize to allow extra material for shaping later on. Epoxy-glue two hardwood blocks onto landing gear block and W2. Prepare two pieces of fuselage longeron from 3/16" x 3/8" balsa strips. Cut slots at the front half so that they can be bent easier, then install F3B in place.

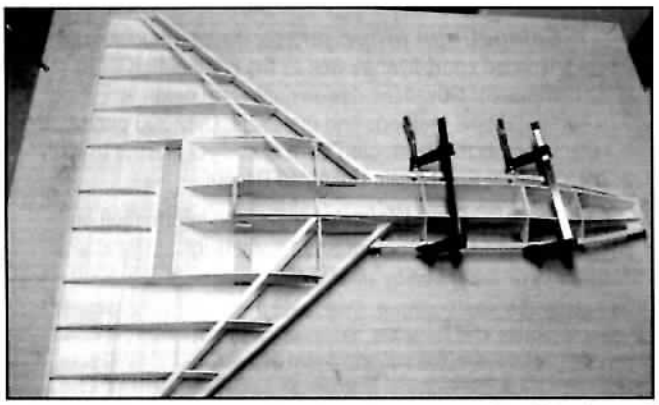
Covering the Wing:

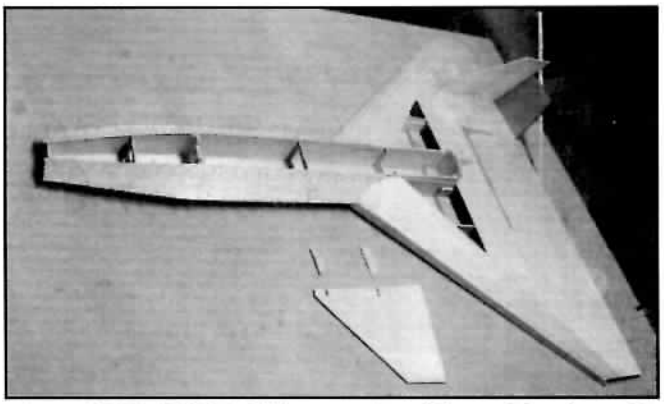
Slightly touch up the top surfaces with a long sanding block. Apply balsa sheeting from leading edges to half width of top main spars. Then, cover the rest of the wing from firewall down to trailing edge. There is a triangular opening left uncovered; this provides easy access to the rudder cable and servo leads. Cover the front half of the W1 area.

Cover the fuselage sides with 1/16" soft balsa. Choose balsa sheets that are easier to bend. It is necessary to partially shape the wing's leading edge to match the fuselage side sheeting. Do not shape leading edge between W4 and W5 at this time.

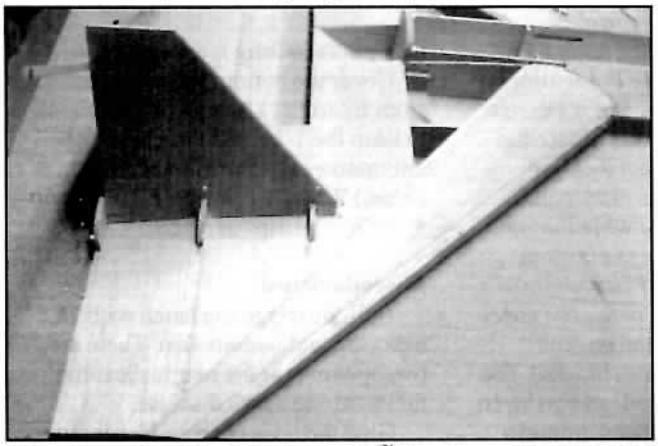
Fin:

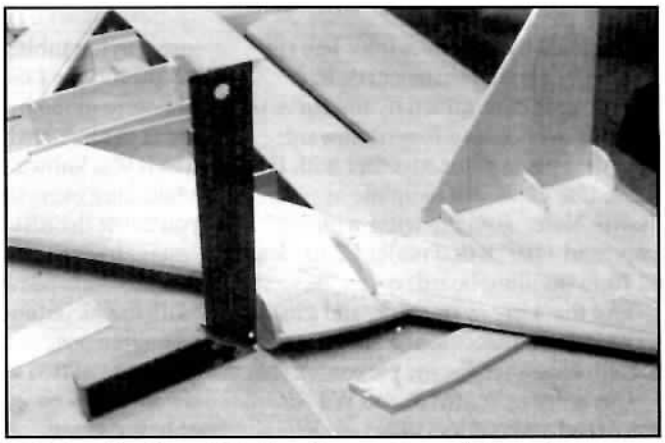
Prepare two sets of fins from 3/16" balsa sheet. Cut slots for E4 and E5. Prepare E1 to E10 parts, mark the fin position on top of the wing skin. Don't



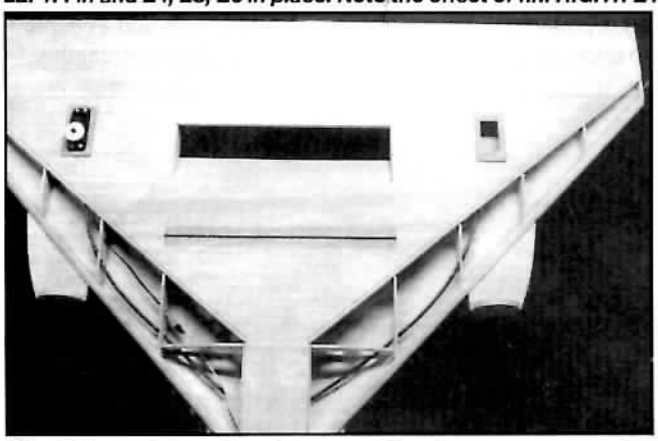


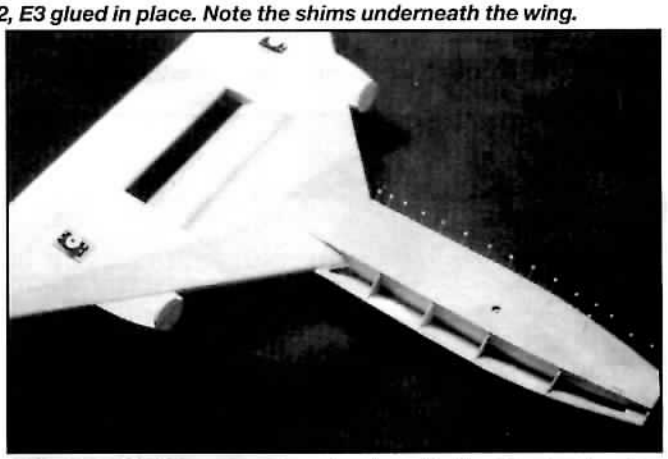
LEFT: Leading edges and fuselage longerons glued in place. When dry, add F3B. RIGHT: Add upper wing skins and fuselage side panels. Use template when gluing fins in place.



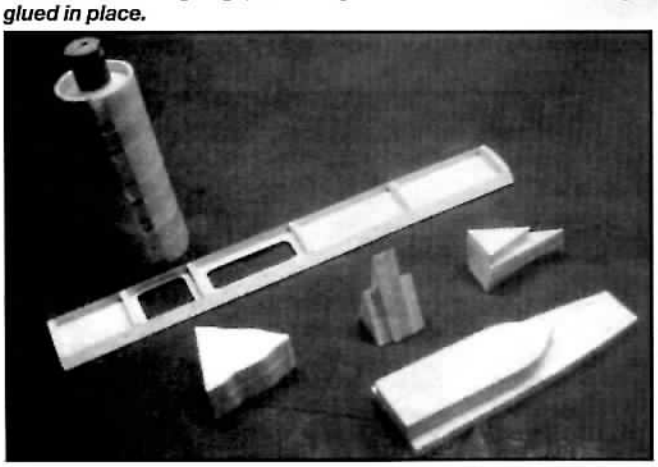


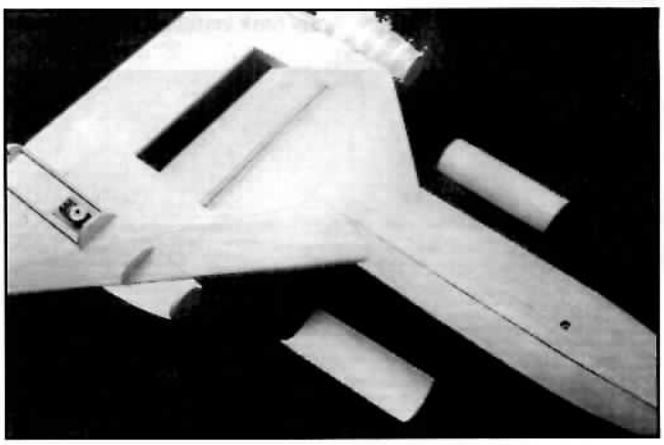
LEFT: Fin and E4, E5, E6 in place. Note the offset of fin. RIGHT: E1, E2, E3 glued in place. Note the shims underneath the wing.





LEFT: Plywood mounting plates used for elevon servos on author's original model. Plans now show hardwood rails. Prior to sheeting the bottom leading edge, there is good access to the rudder NyRods and servo extensions. RIGHT: Bottom fuselage side panels being glued in place.





LEFT: Elevon servo cover (wrapped around bottle). Fuselage hatch, nose cone, cockpit and jet engine cone. RIGHT: E7, E8, E9, E10 glued in place, together with 3/16" balsa strips. Note the ready formed servo covers.

be confused by the offset line. The fin is actually parallel to the curve line. The offset is determined by the curve of the wing section and fins tilt inward. Glue the fins in place together with E1 to E6. Use cupboard template as shown. Note: shim the wing with 3/8" wood and 1/16" wood under E2 to clear E2 from building board.

Flip the wing over, mark, and glue servo trays in place. Make sure there is enough clearance for the elevon servos.

Cut holes in W2, W3, and W4 for servo lead and rudder cable (see R/C installation). You might need an extension cord for the servos; if so, tape the plugs for security. Also, at this time, insert nylon tubing for the antenna. In my prototype, I cut these holes after the ribs were glued in place, but it's easier to cut the holes when you prepare the ribs if you know the exact location. Make sure everything is okay before you cover the rest of the wing bottom. Again, trial-fit and glue the bottom fuselage side panels in place.

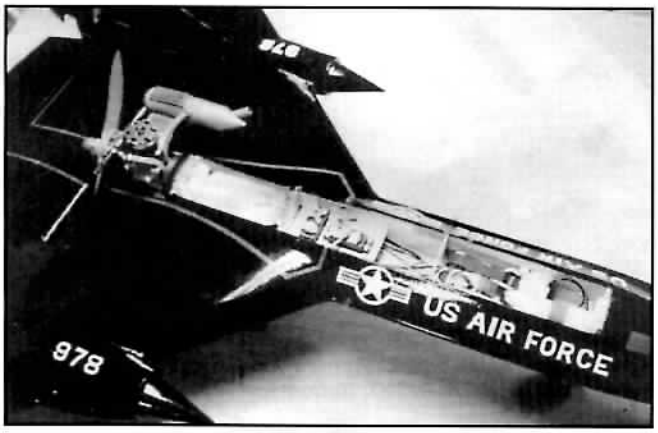
In the meantime, prepare nose cone, jet engine nose cones, and cockpit (laminate of two soft balsa blocks). The elevon servo cover is made of two layers of balsa, glued and wrapped around a 2-1/2" dia. bottle. A slightly smaller bottle (2-1/2" dia. or less) is preferred because the cover tries to open up when heat-sink covering is applied.

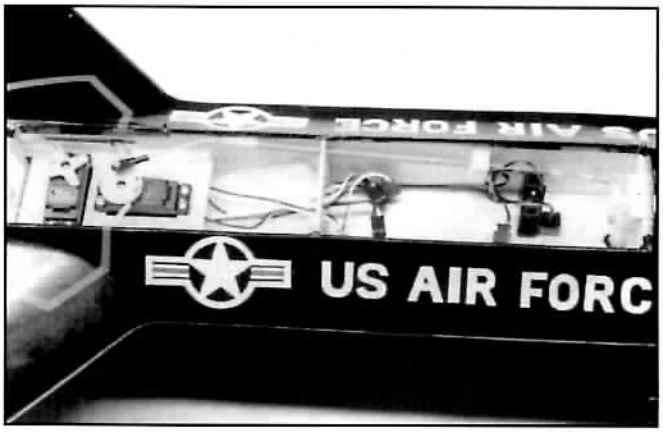
Cover the bottom jet compartment from E2 to E8. Use lots of pins and tape to keep the 1/16" skin in place. (An alternative is to cover it with balsa strips.) When dry, install E9, E10, and 3/16" balsa strips in place.

Miscellaneous:

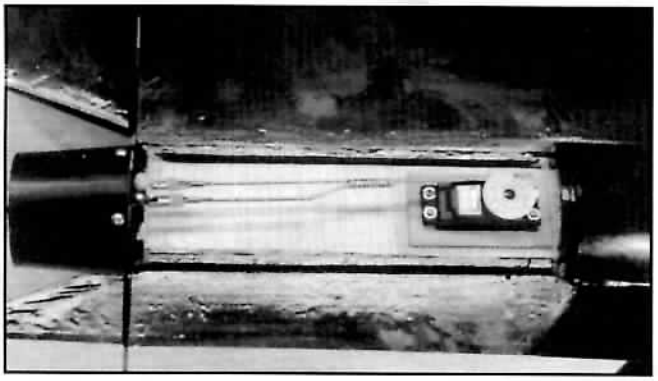
Build fuselage top hatch with 1/16" balsa top and bottom skin. There are two openings at the rear to clear the fuel tube and servo disc, etc.

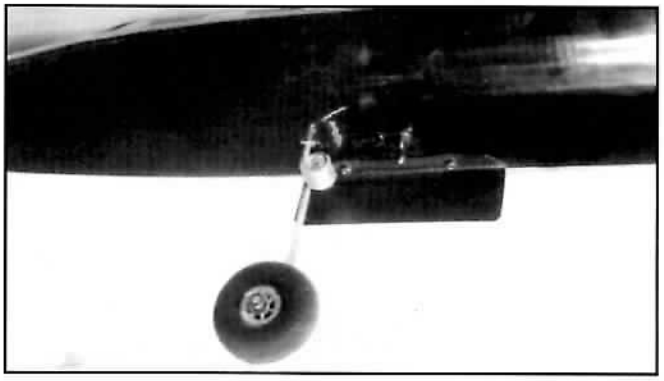
Glue the nose cone and jet engine cones in place and sand to proper shape. It is a good idea to add a couple of drops of thin CA glue to strengthen





LEFT: Engine, prop, muffler, and fuel tank installed. RIGHT: Linkage for rudders and nose gear shown. Note the position of RX switch and charging jack.





LEFT: A standard size servo activates both inboard and outboard elevons through a "Y" pushrod. RIGHT: Nose gear door bolted in place. It also provides a protection for RX switch.

the nose point. Prepare all control surfaces such as rudders, inboard and outboard elevons. Sand all components into proper shape and smooth. The jet exhausts are made of paper cups. Clean the surface with lacquer thinner or acetone to remove the wax. Reinforce the inside with a layer of 6 oz. cloth and resin. Add several small hardwood (or ply) blocks around E6 and E10 to provide a mounting for the exhaust cup.

Finishing:

Sand all parts smooth and apply light modeling putty along marked area to provide a smooth transition, such as the wing joint, jet engine compartment joint, etc. Cover the putty area with a coat of Balsarite to provide a better contact for covering material. Also paint the firewall area and fuel tank with Balsarite to fuelproof this area.

I used black EconoKote to cover the whole airplane. It goes around the compound curve pretty well. It's easier to cover the wing joint and jet engine joint first with a narrow strip, so EconoKote before you cover the rest. After completing covering, apply red stripes, white letters and decals.

Spray the exhaust cone with black fuelproof paint. Caution: avoid long exposure under strong sunlight or the model will be cooked! Install all control surfaces in place. Use stronger torque rods (1/8" wire) for inboard elevons. Make sure they move freely. If you prefer to paint the whole model, always keep it light.

I used two wide strips of yellow MonoKote under each wingtip to improve the orientation. Again, it's personal choice.

Another optional part is the nose gear door. I made it by using "L" shaped fiberglass. Another easy way is to cut one from 1/16" plywood and glue it in place with a 1/4" triangle stock. This tiny door improves direction stability and it doesn't spoil the scale appearance. But if you don't like it, just forget about it and the model still flies well.

Installation:

Bolt the engine mount to firewall, followed by your favorite engine. Any .40-.46 2-stroke engine works fine. I used my ten year old ASP 46, which is strong enough to swing a 10 x 7 or 10 x 8 prop. For a .40 size engine, 10 x 6 is preferred. Make sure the propeller is located in the center of the wing slot.

Fuel Tank:

An 8 oz. Sullivan fuel tank is recommended. If other types of tanks

are used, make sure there is clearance for the throttle cable. Connect fuel tubes properly and make sure the top hatch doesn't touch the fuel tubes.

Radio:

I used a standard size servo to activate both rudders and the nose gear, but it's a little bit tricky to link three pushrods on a single servo. First bolt a ball joint at the right spot on the servo disc, then connect a NyRod to the nose gear and check for a straight nose wheel. Next, disconnect the ball joint and hook up the control cable (NyRod) to one rudder, then check for proper movement and centering, again disconnecting the linkage. Repeat the same procedure on the other rudder. Finally, reconnect all linkages.

Suggestion: If I did this again, I would use individual servos for each rudder (I have some GWS mini servos on the shelf), hide the servos inside the jet engine compartment.

I used two standard size elevon servos. Make sure they don't touch the cover. Solder a "Y" pushrod together to activate both inboard and outboard elevons. Again it's a little bit too late, but I have some GWS low profile servos, which are thinner and easier to nest in the wing. By the way, GWS seems to be a new brand to some of our readers. As a matter of fact, I believe they are one of the biggest aftermarket servo manufacturers in the world. You might be using their product under a different brand name.

When hooking up the elevons, it's very important to dial in up trim (reflex) to maintain level flight. Check with the plan very carefully. I had complaints from my previous designs, the Space Shuttle (RCM Feb. '92) and F-117A Stealth Fighter (RCM. Feb. '97), that some of these models were difficult to rotate and maintain level flight. Those readers simply ignored the reflex. In one case, a builder was advised by "an expert" to drop the elevons to increase lift. Big no-no! Bear in mind that the elevon works like an elevator. When it drops, the nose drops too. Therefore with the elevon servos at neutral, set up the reflex first.

This prototype was guided by a Futaba 7 VAP that provides more than enough mixing for this application. Nowadays most R/C systems provide elevon mixing. I recommend setting up the inboard elevon first, so the outboard elevon will move with the same amount of deflection as the inboard one. Dial in the proper movement for pitch control. Move the stick forward and backward to check the proper deflection as suggested. All control surface movements are measured at the widest chord. Then release elevator stick; repeat the same procedure with aileron stick. Finally, apply full up and down, right and left at the same time to drive the servos to their extreme positions to check for any servo binding. If it happens, reduce servo throw. By the way, it is recommended to dial in exponential, especially on roll control. Set 80% low rate on elevator and 60% on aileron for your maiden flight.

C.G. Balance:

Due to the unique configuration, I developed a special way to check the C.G. point. Make an inverted "V" shape hook from scrap 1/16" pushrod. Sharpen the ends, then insert it into the proper fuselage hole (hopefully you didn't forget to drill these holes on the fuselage sides).

Place top hatch, across F3. Then support the hook by a piece of dowel or screwdriver. Relocate the RX and battery for proper balance. Try the forward C.G. point for the initial flight. One click or two elevator up trim is required to compensate this slightly nose heavy setting. Eventually, move the backward C.G. point, but only after you are familiar with the plane's performance.

Another bonus of the balance hook is to laterally balance the model. I usually add 1/4 to 1/2 oz. of lead under the right wingtip to compensate the muffler weight.

Preflight Check:

Check all linkages for slop-free movement. Make sure they move in the right direction. Check R/C range, etc. Top up the tank. Try to start the engine without connecting the battery. Make sure you are comfortable flipping the prop by hand or with a starter, without hitting the fins or wing accidentally. Hook up the battery and fire the engine. Readjust the needle valve setting because the air is moving the opposite way. Drop the nose to check engine lean out.

Flying:

Try several taxi runs on the runway to get used to the ground handling and orientation. It takes about 200 ft. to rotate on a grass runway. Avoid sharp turns and trim for straight and level

flight. It's not a bad idea to have a spotter beside you in case you lose the orientation. On a cloudy day it's difficult to tell which wingtip is higher than the other, therefore apply aileron stick gently. Like most pattern planes, the wing doesn't level by itself. Sound scary? Not at all. Once you tame it, you will be amazed how stable it is.

High Speed Flight:

I like to fly at 3/4 throttle; it's easier to handle at this speed range. It performs most basic maneuvers, such as inverted (with adequate forward stick), rolls, and loops (both inside and out). Start to loop at a safe altitude until you are familiar with it. The rudder response is positive and a stall turn is not a problem.

Low Speed Flight:

The full scale aircraft holds several speed records. However, this model is designed to behave well at low speed, as this is very important for average sport fliers. Close the throttle at a safe height, and pull back on the stick gradually. The model should slow down. Continue to pull back on the stick; watch the nose raise higher and higher until it starts to rock from side to side. This is an indication that it's going to stall. Correct aileron or rudder properly to let it keep going and rocking. It's very interesting to fly like this without worrying about the tip stall. Even though I applied aileron and rudder to force it into a spin, it only entered a spiral dive and recovered very quickly, as soon as the sticks were released.

Landing:

Practice several slow, low passes to get used to its low speed feeling. The elevons are always responsive because of their location just aft of the prop. Adjust throttle for proper descent; it should touch down on the main wheels, and is able to land as slow as a trainer. Seeing is believing.

Build the model and your efforts will soon be paid off. It is always a pleasure to receive feedback from readers, especially to share any improvements on the structure and performance. If you have any suggestions, please write to me at: P.O. Box 298, Ajax, Ontario L1S 3C3, Canada. Or e-mail:

parker@sprint.ca

Or visit my Web site:

www.parkermodel.com

✈