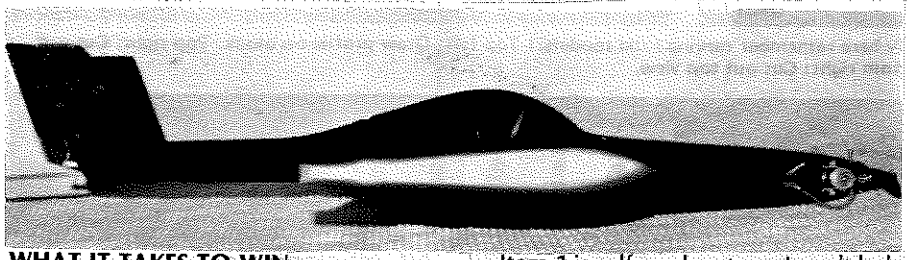
SPINE-TAILED SWIFT

By JIM GILGENBACH . . . Much of this design came from a computor graphics system, and it bears the name of the fastest bird (in level flight) on this planet. A combination of old and new that can't lose!



WHAT IT TAKES TO WIN

There is a magic formula for winning on the WILLI circuit. The problem is most flyers follow only a portion of the formula and rely on luck for the rest. The secrets for winning are as follows:

1. ENGINE

a. You must have a strong COX .049/.051 engine capable of turning a COX 5-4 black plastic prop at least 21,000 RPM on the ground. No one has come up with a better prop than that COX 5-4 black prop and therefore this is the prop to use.

No engine modifications are allowed other than lapping the piston to the cylinder and crankshaft to the crankcase, but with care, you can get a stock engine to rev about 21,000 RPM without too much trouble.

b. The engine must run reliably. This can be accomplished by using a Kustom Kraftmanship or ACE needle valve or by removing the spring retainer from the standard needle valve and sliding a piece of silicone tubing over the needle valve and carb boss to eliminate air leakage past the needle valve threads.

The fuel tank location is very important. Keep the centerline of the tank at 0 to 1/8 inch below the fuel intake of the carb. The best way to accomplish this is to mount the engine with the cylinder horizontal.

2. PSYCHOLOGICAL REQUIREMENTS

Ignore all snide remarks made by fellow competitors about your equipment, flying skills, wife, or mother.

3. FLYING STRATEGY

a. Fly smoothly.

b. Fly as close to the pylons as possible but:

1. don't cut
2. don't cut
3. don't cut

4. AIRCRAFT

a. Fly an aircraft that is stable and predictable. The *worst* possible situation is trying to win a race with a squirrelly airplane.

b. Fly a clean airplane. By having an aircraft with lots of drag, you can lose up to 10% in speed, based upon the plane designs presently being used.

c. Fly an aircraft that is structurally sound to survive the high G turns and rough landings. If you severely damage your plane on landing, you're done for the day.

Item 1 is self-explanatory. I can't help you out with Items 2 and 3, but I have developed an aircraft which fulfills the criteria of Item 4. This aircraft is called the Spine-Tailed Swift, and for good reason; the Spine-Tailed Swift is the fastest bird (in level flight) on this planet.

SPINE-TAILED SWIFT DESIGN CRITERIA

The Spine-Tailed Swift (STS) aircraft was designed with the following criteria in mind:

1. It has to be fast. This meant using the 2-inch wide x 4-inch high fuselage rule at its minimal limit. In other words, design an airframe with the smallest frontal area possible. It also meant adding fillets where ever necessary to minimize drag. Utilization of a fiberglass fuselage was the only way to optimize streamlining.

2. It has to be stable not only in flight but also on the launch. I have seen many racers go into the ground at launch for no apparent reason, other than bad design and/or poor building accuracies. Having wing tip plates and two ailerons help to maintain stability. The CG location is also very important.

3. It has to be light. The WILLI rules state that the aircraft must be less than 20 ounces or more than 32 ounces. The STS weighs 20-1/4 ounces. Because of the basic formula, acceleration=force/mass, acceleration out of the turns will improve as the mass decreases.

4. It had to be durable. It must survive minor midair collisions or occasional bad landings. Again, the fiberglass fuselage is a definite advantage in this category.

CONSTRUCTION

1. WING

The wing design is unique only with respect to the slotted main spar concept.

STEP 1: Cut out all the ribs. I always make a plywood template for laying out the ribs on the balsa sheets. Stack all the ribs and pin together, then sand to the desired final contour. While they are pinned together, saw the slot for the main spar. For best alignment results, number the ribs as they are stacked so that later you can place them in sequence on the main spar.

STEP 2: Cut out the main spar RH and LH sections, stack, then sand them to size (measure frequently to maintain a minimum width of .750-inch to meet WILLI's 7/8-inch minimum wing thickness rule), and saw in the slots for the ribs.

STEP 3: Cut out the (4) 1/16 thick sheets used just ahead of the trailing edge. Lay down (2) of these pieces (one RH and one LH) onto a flat building surface and add the 3/32 x 1/4 rear edge strips, making sure you keep these parts flat.

STEP 4: Cut the (4) 1/16 leading edge sheets to size (leaving the width at 3 inches) and cut out the lightening holes. Also cut the leading edge triangular stock to length.

STEP 5: Form the (2) 1/16 music wire torque rods, making sure you add the bushings (made from a yellow inner GOLD-N-ROD) before you have both ends bent. Add the ball link control horns and solder to the torque rods.

STEP 6: Cut out the trailing edge. Cut the grooves to accept the torque rods and bushings. Make sure the rods do not extend beyond the front edge of the trailing edge. Put "VASELINE" on the torque rods where the bushings will be located, slide the bushings into location and "HOT STUFF" the bushings to the trailing edge using a little bit of baking soda as a filler. Notch the trailing edge area to allow adequate movement of the control horn.

STEP 7: Tape the wing plan down on a flat working surface and cover with waxed paper. Note that the wing plan is the *bottom view*. This was done to allow building right over the plan without worrying about where to stick the control horns when installing the trailing edges. (Unless you want to drill (2) holes through your building table.)

STEP 8: Position the top rear wing sheeting (with the 3/32 x 1/4 strip on) and the top leading edge sheeting for one wing half onto the plan and pin in place. Carefully place the two end ribs onto the rear wing sheeting and glue in place. (Note: I do most of my building with "Hot Stuff" so as to eliminate a lot of pinning of components in place.) Position the remaining ribs onto the main spar and then place this main spar onto the end rib and glue in place.

STEP 9: Hot Stuff the leading edge to the two end ribs. Now align and glue the remaining ribs to the main spar, rear wing sheeting and leading edge.

STEP 10: Glue the main spar to the top leading edge sheeting (remember that we are building the wing upside down, so the top wing sheeting is actually at the bottom of your assembly at this point). Pin the top leading edge sheeting to the building board at the main spar location only, then bend the sheeting up to the ribs and leading edge and glue in place. Trim off the excessive stock at the leading edge.

STEP 11: Position the trailing edge up

to the back of the wing assembly. Mark and cut the notches in the wing for the torque rod bushings. You will notice that there is still a gap on the side facing you. This is due to the fact that the commercial leading edge stock is cut to fit a flat bottom, not a symmetrical wing. Sand the front of the trailing edge to get a good flush fit and then glue to the wing, making sure that the TE lies flat on the building surface. Use 5-minute epoxy, but make sure you have vaseline on the rod to prevent binding.

STEP 12: Now glue the bottom rear wing sheet in place.

STEP 13: Remove the wing from the building board and sand the leading edge sheeting. Turn the wing over, position the bottom leading edge sheeting to the main spar and glue the sheeting to the main spar. Using the building board as a flat surface, roll the sheeting up to the leveling edge and "Hot Stuff' the sheeting to the ribs and the leading edge.

STEP 14: Add the cap strips and the center sheeting on the top and bottom.

STEP 15: Repeat steps 1 thru 13 on the second wing half.

STEP 16: Join the wing halves together, with the halves laying on their bottom surface. To do this, it will be necessary to block up the wing halves to allow clearance for the control horns. I used three machined steel squaring blocks of equal height for alignment and blocking up. Make sure the blocks you use are the same height and parallel otherwise you will build a twist into your wing assembly. On a 1/2A Pylon racer, this is probably the worst condition you can have. A twisted wing will cause a rolling condition that cannot be compensated for with the ailerons when flying at slow speed (especially true during launch) and the result will be "instant crash." I spend a lot of time checking the wing with an incidence meter to be sure I have alignment within a 1/2 degree from wing tip to wing tip. If for some reason, the two halves are not within this tolerance, I will cut the halves apart and re-glue. When the halves are joined per the above instructions, there will be a slight dihedral.

STEP 17: Cut out the clearance holes in the center sheets portion. Add the gussets to the wing joint.

STEP 18: Cut and sand the ailerons to size.

STEP 19: Sand the wing, making sure you maintain the .875 minimum thickness requirement.

STEP 20: Cut out the wing tips and install. For fillets between wing and tip with Hobby Poxy Formula 2 mixed with micro-balloons.

2. FUSELAGE

The fuselage is made by first forming a styrofoam plug then covering the plug with fiberglass and removing the styrofoam, leaving the fiberglass shell. The important thing to remember is that the fuselage is only as accurate as the plug, therefore the plug should be formed and marked with extreme care.

STEP 1: The first step is to cut out a piece of styrofoam to 4 inches wide x 22-1/2 inches long, and lay out the profile of the fuselage side onto the styrofoam. Also mark the wing centerline and the leading edge position.

STEP 2: Cut the styrofoam to the side profile. Make sure the front of the fuselage is perpendicular to the wing centerline and fuselage sides.

STEP 3: Lay out the fuselage top profile with a centerline to help maintain symmetry of the fuselage during the sanding operation.

STEP 4: Cut the fuselage to the top profile. Re-mark the wing centerline and leading edge position.

STEP 5: Make 1/8 plywood templates of the three fuselage cross sections. Also mark and cut out the two wing cross section templates from 1/8 plywood.

STEP 6: Bolt the two wing templates to the sides of the fuselage (I used control rods cutoff and bent to 2-1/4 inches long with 2-56 nuts). Align these templates carefully with the centerlines and leading edge position lines, because the fuselage contour is formed using these templates as the major guides.

STEP 7: Cut out the firewall, install the (3) 4-40 blind nuts, and 5-minute epoxy the firewall to the styrofoam, making sure the entire back of the firewall is coated with epoxy. When installing the firewall, don't forget to position it so that the locations of the blind nuts allows side mounting of the engine. Put oil-coated 4-40 screws through the blind nuts to prevent epoxy from plugging up the threaded holes.

STEP 8: Sand the fuselage to size with 60 grit paper on a sanding block using the contour templates frequently to maintain proper form. Be careful not to sand the wing templates or the firewall. Do not sand off the top and bottom or wing centerline.

STEP 9: As the fuselage is being made inside out, the front wing dowel assembly (F1 & F2) and the wing hold down screw assembly (F4 and F5) will have to be made and installed into the styrofoam at this point. Mark the fuselage and cut out to accept these assembles. Make the two assemblies, leaving excess material in the outside contour. Set the assemblies into the fuselage cutouts, mark the correct contours, remove and cut to your marks. Coat the parts completely with 5-minute epoxy and let harden. This is done to prevent the wood from soaking up any gasoline if used at the final operation for dissolving the styrofoam. Now reassemble the parts with waxed paper between F1 and F2, and F4 and F5. Place the assemblies into the fuselage cutouts and tack in place using 5-minute epoxy. After the epoxy has set up, sand the two assemblies to the exact contour of the fuselage.

STEP 10: Cut a 1/16 x 45 degree chamfer in the styrofoam around the back of the firewall. This will allow epoxy to form a fillet all around the back of the firewall when the fiberglass is added.

STEP 11: You are now ready to add the fiberglass cloth. First remove the two wing templates.

STEP 12: Mix up a batch of Hobby Poxy 2 mixed 50-50 with micro-balloons. I wish I could tell you exactly how much to mix up but I have no quantitative value. The only help I can give here is "mix up enough to coat a little bit more than one side of the fuselage." Cut out the following pieces of 6-ounce fiberglass:

a. 1 inch wide x 5 inches long (to wrap around the front of the fuselage overlapping the plywood firewall).

b. 3/4 inch x 5 inches long (to lengthen the top of the fuselage between the firewall and the wing).

c. 3/4 inch x 14 inches long (to strengthen the bottom of the fuselage from the firewall to past the back edge of the wing).

d. Two pieces approximately 80% larger than the fuselage side view. I normally just cut out these pieces freehand, using a modeling knife, with the fiberglass laying on my building board and the fuselage laying on the fiberglass. I then trim the excess off later. The idea is to have the fiberglass cloth overlap the top and bottom centerlines by a 1/2 inch.

STEP 13: Brush the epoxy around the nose O.D., including the firewall O.D., onto the top of the fuselage, from the front of the wing to the firewall, and onto the bottom, from the firewall to 2 inches past the rear of the wing. Now add the fiberglass strips to these areas, working the epoxy through the fiberglass with your fingers. Keep a spray bottle filled with denatured alcohol and several rags close by to clean the epoxy off your fingers and anything else you might get the epoxy on.

STEP 14: Brush the epoxy onto one side of the fuselage and over onto the other side approximately 3/4 inch past the top and bottom centerlines.

STEP 15: Apply the glass cloth to the fuselage side and work the epoxy through the cloth with your fingers. Also work out any wrinkles and make sure the cloth edges overlap the top and bottom centerlines by approximately 1/2 inch and are tacked down, i.e., not lifting up away from the fuselage.

STEP 16: Hang up the fuselage to harden with a piece of wire wrapped around one of the bolts in the firewall. Keep an eye on the cloth edges as they tend to lift up. If an edge does lift up, spray some denatured alcohol onto your fingers and work the cloth back into place.

STEP 17: Repeat steps 14 through 16 on the second side.

STEP 18: Using a sanding block with 60 grit paper, sand down the high spots, being careful not to sand through the cloth. Sand the firewall flat.

STEP 19: Glue and bolt the Fourmost mount to the firewall, using "Hot Stuff" or "Jet." Sand the mount to conform to the firewall shape.

STEP 20: Mix up another 50-50 batch of Hobby Poxy 2 and micro-balloons and apply a second coat.

STEP 21: When the second coat is cured, again block sand with 60 grit

sandpaper.

STEP 22: Install the engine and set up this fuselage assembly with the thrust line at 0 degree incidence on a flat working surface. Using the large squaring blocks, align the fuselage sides in the vertical plane. When you are convinced that you have the fuselage aligned as true as possible, mark the wing centerline on both sides of the fuselage, working off the flat working surface at a dimension of *5/8* inches above the thrust line. Remove the engine.

STEP 23: Now that you have the wing centerline marked, install the plywood wing templates to the side of the fuselage. Align the templates as accurately as possible to the wing centerlines with the leading edge of the templates at the break line between the two forward plywood fuselage formers F1 and F2. Tighten the studs holding these templates to eliminate movement.

STEP 24: Using a knife saw, cut through the fiberglass skin down to the break line between the plywood formers F1 and F2 located at the wing templates leading edges, and F4 and F5 at the wing template trailing edges.

STEP 25: Cut out the (2) 1/64 plywood wing saddles and tack in place to the fuselage around the wing template with "HOT STUFF" and baking soda. Be careful not to glue the saddles to the wing template.

STEP 26: Form the fillets between the wing saddle and fuselage with HOBBY POXY 2 mixed with micro-balloons. After this has set up, sand the fillets smooth.

STEP 27: With a sharp model knife, cut the fiberglass skin through to the styrofoam around the wing template.

STEP 28: Remove the wing template and poke out the styrofoam between the top and bottom fuselage halves. You should now be able to separate the two halves.

STEP 29: Remove the styrofoam from inside the two fuselage halves. You can remove the styrofoam in one of several ways. The styrofoam can be dissolved using a solvent such as gasoline, or it can be poked and scrapewd out using screw drivers, files, music wire etc. I would recommend that the poke/scrape method be used, as it is much safer.

3. WING/FUSELAGE ASSEMBLY

STEP 1: Position the fuselage top to the wing and try to install this assembly to the fuselage bottom. Trim the fuselage top until the three components fit together properly.

STEP 2: Assemble the three components and align the wing so that the wing tips are equidistant from the vertical centerline of the engine mount at the nose. Tack the top fuselage half to the wing using "HOT STUFF" and baking soda. You now have just two main components.

STEP 3: Disassemble the two components and build up fillets between the fuselage top and the wing, again using HOBBY POXY 2 and micro-balloons. When cured, sand the fillets smooth.

4. EMPENNAGE

STEP 1: Cut out the empennage parts and glue together. To insure proper alignment, use the two squaring blocks set at 120 degree angle. Clamp the two empennage halves to the blocks with the back edge down on a flat surface and the two halves butted together at the center. Now join the two halves together and add the 120 degree gusset to the middle.

STEP 2: Sand a 3/8 wide flat portion on the bottom of the joint. Make sure this flat is 30 degrees from each empennage half and that it is also parallel to the horizontal plane of the empennage halves. This can be checked using the squaring blocks and a standard square.

STEP 3: Form the (2) 1/32 diameter music wire control horns. Make sure you make a left and a right horn. Also modify a nylon snap link by cutting off and drilling a 1/32 diameter hole.

STEP 4: Cut out the two elevator surfaces. Cut out and drill these for accepting the wire control horns.

STEP 5: Cut out the hinges from the hinge material using scissors. Cut the slots for the hinges. Assemble all the empennage components and double check to make sure the wire control horns are located properly in relation to the exit hole in the back of the fuselage. If not, re-bend the wires or relocate the wires on the elevator surfaces.

STEP 6: When satisfied that the empennage assembly parts fit properly, disassemble and prepare for covering.

5. FINAL ASSEMBLY

STEP 1: Make the servo blocks and install the servos and control rods. Install the balsa former F3. Assemble the wing, fuselage and empennage (without gluing on the empennage) to make sure that everything fits and that there is no interference or binding of the control rods and surfaces.

STEP 2: Disassemble all the components and sand the entire aircraft dry with 320 wet-or-dry paper.

STEP 3: Cover the wing and empennage with Super Monokote. An easy way to cover the fillets at the wing tip is to first cover each fillet with a strip of Super Monokote approximately a 1/2 inch wide, then cover the tips. Finally, cover the bottom, then the top of the wing. With this method, there will be no wrinkles at the fillets and the job will look professional. Don't try to cover the fuselage portion which is connected to the wing. There are too many compound curves and you could make a mess. It should be painted.

STEP 4: Prime the fuselage bottom and top, which is attached to the wing, with K&B Super Poxy Primer and wet sand with 320 wet-or-dry.

STEP 5: Finish paint the fuselage top and bottom using either HOBBY POXY or K&B Super Poxy epoxy paint.

STEP 6: Assemble the wing to the fuselage and set up this assembly on blocks with the wing incidence set at 0 degree. Check the empennage saddle on the fuselage and modify if necessary to insure that the empennage saddle will also be at 0 degree incidence. Align the empennage and pin in place to the fuselage, making sure that the empennage surfaces are parallel to the fuselage centerline axis. Carefully remove the pins and empennage, mix up some 5-minute epoxy and add it to the empennage saddle. Now re-install the empennage to the fuselage using the same pin holes that were produced during the alignment procedure. Use a 30-degree triangle to set the proper angle of the empennage.

STEP 7: Install the engine and fuel tank using silicon sealer to seal around the fuel exits from the fuselage. Also put 1/4 inch thick foam on all (4) sides of the fuel tank in order to absorb vibration and minimize fuel foaming.

STEP 8: At this time you can install the "stinger" out the back to support the receiver antenna wire. I use the yellow inner tube from a Sullivan GOLD-N-ROD pushrod setup. Make sure the "stinger" doesn't interfere with the elevator controls. Place a piece of 1x4 long square foam inside the canopy and on the floor of the fuselage. Wrap the battery and receiver with 1/4 inch foam. Glue a piece of 1/4 inch foam into the battery pocket of the wing. Install the radio and again check to make sure there is no control binding or interference.

INITIAL FLIGHT INSTRUCTIONS

Before you attempt to fly this aircraft, make sure that everything is working properly. Make sure the CG is properly located without fuel in the tank. Run the engine and set it just a tad rich. It normally will lean out in the air. Make sure the engine will quit when the plane is inverted. Make a radio range check of the radio with the engine running. Preplan where you intend to fly and where and how you intend to land. The next recommendation will probably be questioned by the regular sport flyer, but I can assure you that you will be better off if you follow it. Do not attempt to make your first flight in dead calm air. You should have a steady breeze of 10 to 15 mph. This will improve your chances of saving the plane on launch in case it happens to be out of trim. Have an experienced flyer make the first flight and trim adjustments. Also make sure that someone other than the pilot launches the plane. The amount of control surface throws stated on the drawings suit my flying tastes, so you may want to increase or decrease them a slight amount, but *not* before the first flight. Start with the throws stated. I would suggest gluing a small piece of emery cloth to each side of the fuselage to prevent a poor hand launch.

The Spine-Tailed Swift will loop and roll with the best 2-channel aircraft, and has no bad characteristics, but remember that it was designed for one primary goal and that is "turning left and going fast." •