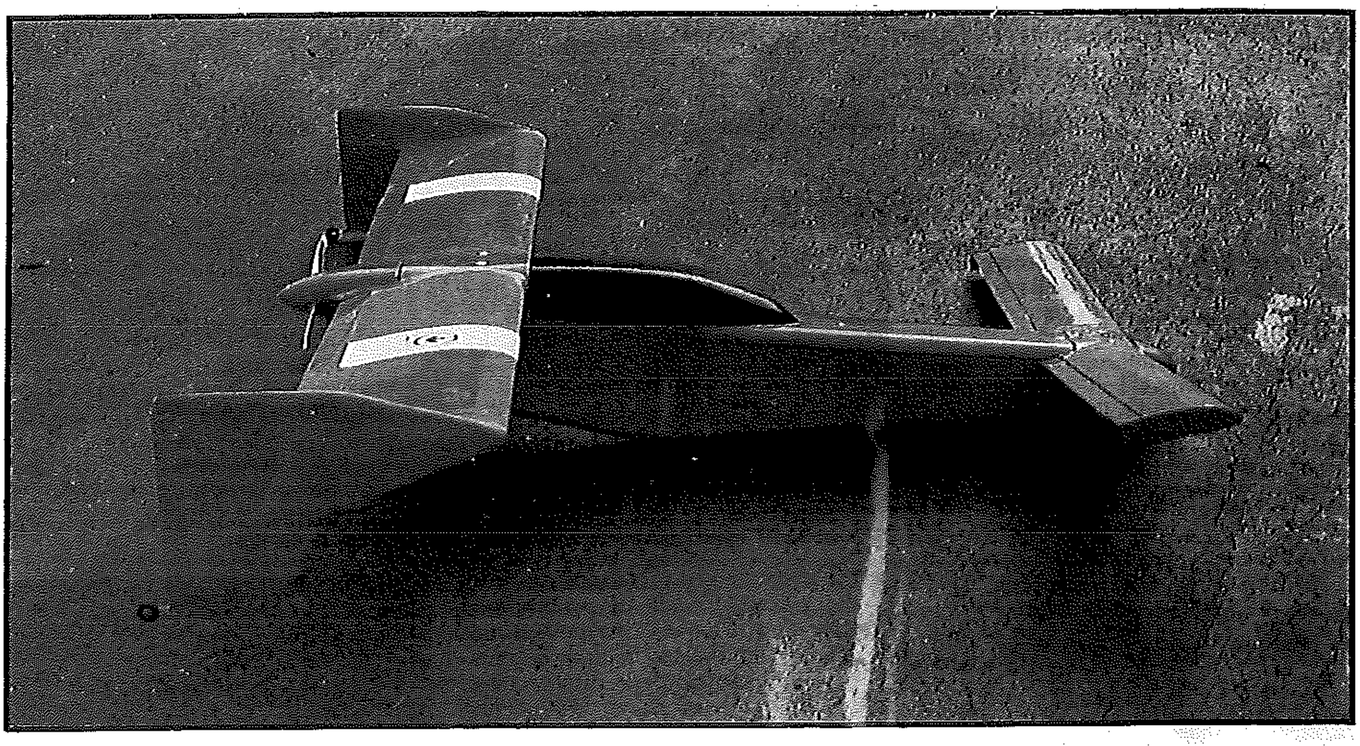

Swan

Designed by A.G. Lennon

INTRODUCTION

• The Swan was designed in the winter of 1984-85, and was built in the spring of 1985. The following summer was devoted to test flying, modifications, and the inevitable repairs. Finally, in October 1985, this model aircraft flew to the author's satisfaction.

During test flights, takeoffs were good, climb was excellent, directional and longitudinal control and stability superb; flap deployment (of both fore and aft flaps) was adjusted to provide a good glide, flaps down. Surprisingly, deploying the flaps had no effect on longitudinal trim; the model seems to "levitate" as it slows down. This is in sharp contrast to conventional models which require down-elevator trim to avoid nosing up when the slotted flaps are fully deployed. The annoying and persistent problem was a gentle "wing-rocking" at low speeds. The model seesawed around itslongitudinal axis about 10° each way.

This mild instability did not increase in amplitude or become uncontrollable, and disappeared when the aircraft accelerated under power.

Experienced canard fliers advised that this wing rocking was characteristic of canards; the cure was to speed up the model. This, the author did not accept. Landings at high speed are difficult and potentially damaging, and had no place in flapped canard design philosophy.

A variety of cures were attempted. First, the CG was moved forward 1/4 inch, by addition of ballast, and the foreplane's incidence upped by 1/4°, the rocking persisted.

Next, chordwise wing fences of 1/32-inch plywood were installed at the outboard ends of the flaps and test flown without beneficial results . . . and were removed.

NASA drooped leading edges ahead of the ailerons were installed; again to no avail . . . and were removed.

Finally, the author did what should have been done originally. He checked the incidence of both fore and aft wings and found the aft wing at a full 1° *above* design incidence.

The incidences were adjusted to those shown in the drawings, and the CG moved forward slightly to the drawing position; by addition of a small amount of ballast.

In subsequent test flights, the model flew beautifully with no wing rock. Flaps were effective and slow speed, nose-high touchdowns on the aft wheel were made. Half-flap deployment resulted in shorter take-off runs and higher rates of climb.

The original linkage for lowering both fore and aft flaps simultaneously (which is mandatory) but still permitting overriding pitch control, proved reasonably effective, but not ideal. Several types were tried during the test flying period. Finally, the arrangement shown in the drawings proved very satisfactory.

The elevator servo is mounted on a slide and is moved back and forth by the flap servo which both lowers the aft flap as it rotates counterclockwise and moves the elevator servo backward, thus simultaneously lowering the forward flap. However, the elevator servo operates independently but under radio command, to raise or lower the forward flap for pitch control, without regard for its location on the slide.

Forward flap deployment of 20° balanced 35 to 40° of aft flap deployment and resulted in a slow, slightly nose down glide, which could be steepened to roughly 45°, nose down, without much acceleration due to the high flap drag. This permits slow approaches and slower, nose-high touch downs under good control. This arrangement permits considerable flexibility in adjusting the deflection angles of both sets of flaps, through the use of different holes in the flap and elevator servo arms, and in the inboard aft flap horn.

The Swan will not stall or spin; the only other limitation is its limited ability to fly inverted. This is characteristic of canards using cambered (as distinct from symmetrical) airfoil sections on both fore and aft wings. The foreplane section is NACA 4415 and the aftplane NACA 2415.

CONTROLS

The author uses a six channel Futaba transmitter, receiver and five S128 servos. The flap servo is controlled by the slide switch that permits flap deflection proportional to the switch's movement. A retract snap-switch would necessitate only two flap positions; full up or full down.

To minimize the amount of ballast to properly locate the CG, all servos, a 700 mAH battery and the receiver, are located as far forward as possible in the fuselage.

The connection from servos to ailerons, aft flaps and engine are Sullivan flexible "Gold-N-Rods." The rudder servo and rudders are linked by fine nylon stranded cord that permits outward rudder action only. The elevator servo is linked to the foreplane slotted flap by ball joints and push rod.

The drawings show Futaba S128 servos. The servo mounts may require modification to suit other servo types.

LANDING GEAR

This is "Bicycle Type," and both wheels have spring action for shock absorption.

The forward wheel is steered by the rudder servo for directional control on the ground.

Small wheels below and behind the rudders stabilize the model as it taxis.

ENGINE INSTALLATION

An inverted, pusher, OSMAX .45 FSR, with Tatone exhaust manifold, is employed. This arrangement permits fully cowling the engine. The easily removable lower portion of the cowling provides ready access to the carburetor and glo-plug. The fuel tank is a 6-ounce Du-Bro which fits precisely.

The low-drag, recessed NASA "scoops," plus the exit below the spinner provide adequate engine cooling. With the model stationary, a full tank of fuel was consumed, at high engine rpms, on a hot summer day, with no adverse affect.

The glo-plug is provided with an on-board circuit for both engine starting and for glo-plug heating at low rpm, for consistent inverted engine operation. While this latter feature is optional, the on-board 1-1/2-volt battery and its holder reduce the amount of ballast needed.

Inserting the plug in the jack, well away from the prop, for engine starting is both safer and more convenient.

ENGINE COWLING

The original cowling of the Swan was a fiberglass-and-epoxy lay up. This proved to be too flexible and difficult to fit properly. A more satisfactory balsa and plywood version is shown in the drawings, that consists of six pieces of 1/2-inch balsa, plus 3/8-inch triangular stock. It is split horizontally, the upper half epoxied to the engine bulkhead, and the lower retained by three Goldberg flat holddowns, permitting its easy removal by hand.

This built up balsa version has been used on several models very successfully. Note the 1/32-inch ply formers that control cowling inner and outer contours at the parting line and stiffen the balsa edges.

FUSELAGE

The readily removable canopy extending from the foreplane to the aft wing is very convenient. It permits access to servos, control linkages, landing gear and on-board glo-plug battery.

FOREPLANE

This is a built-up balsa structure, and is stress skinned. The slotted flaps (flapevators) are torque-tube actuated and serve as both elevators and flaps, in conjunction with the aft wing slotted flaps. Ply end plates act as modified Hoerner tips, and protect the foreplane on the ground.

AFT PLANE

The trailing edge of this built-up, stress skinned surface is taken up with ailerons and slotted flaps, both actuated by torque tubes.

Ailerons are differential in action; have double-MonoKote, gap-sealing hinging, and are static balanced with lead wire to avoid flutter. The flaps have external hinging in streamlined enclosures.

Because the inner portion of this wing operates in the foreplane's downwash, it is at a higher angle of incidence (2.5°) than is the outboard portion (1°). To accomplish this, the spars, both main and aft, are jogged; the change in incidence taking place between ribs E and F. Jigging, to be described later, permits easy and accurate assembly.

FINS AND RUDDERS

These are located at the aft wing tips and toe-in 2°. They are stressed skin structures with 1/32-inch sheet balsa skins, are light, and surprisingly strong.

Rudders open outward only, the one on the inside of the turn. The servo cord pulls the rudder out against a small spring that neutralizes the rudder when the rudder control stick is centered.

BALLAST

The Swan, with its upswept aft wing requires roughly 10 ounces of ballast in the hollowed-out balsa nose block, in the form of lead shot. The model's CG should be at the location shown . . . with a full fuel tank.

GLO-PLUG HEATING AT LOW RPM

The engine servo's two-armed lever is cut from a round 1-3/8 inch diameter servo wheel. The width of the shorter arm controls the period the glo-plug is lit. The roller lever switch is mounted on balsa to center the roller on the lever. (See *Model Aviation*, January 1988, "Glo-Plug Heater" P. 103)

No separate on-off switch is employed in this circuit, since by moving both engine stick and trim lever down fully, the on-board circuit is cut.

CONSTRUCTION

The author "kits" the model by making all components to drawing, in the following order:

(A) Metal components, wire, tubing, sheet brass, etc.

(B) Plywood parts, traced from the drawings on the plywood.

(C) Balsa components.

Assembly of each major component (foreplane, aftplane, fuselage, cowling) is composed of sub-sub-assemblies, sub-assemblies and final assembly.

Do not drill and tap fore and aft plywood hold downs and canopy hold downs until final assembly, using holes in the wings' center section and canopy as drill templates.

FUSELAGE

(1) Assemble 1/8 sq. strips to bulkheads No. 1 and 3.

(2) Assemble balsa bulkheads Nos. 5, 6, and 8

(3) Install motor mount on bulkhead No. 9 and cement 3/16-inch dowels.

(4) Install nose wheel gear and wheel on bulkhead No.4.

(5) Install main wheel gear and wheel on bulkhead No. 7.

(6) Assemble NASA scoops to fuselage side.

(7) Cement 1/4x1/2-inch strips, 1/4 sq. strips and 3/4-inch triangular stock to fuselage sides. Add doublers between bulkheads 8 and 9. A series of small saw cuts on the inside of the curve will facilitate bending the 3/4-inch triangular stock.

(8) Assemble sides and bulkheads and tank mounts.

(9) Add bottom skin.

(10) Install receiver battery and foam between bulkheads 1 and 3, add cover, and install plywood foreplane hold-down.

(11) Install plumbed tank and add aft wing plywood hold down.

(12) Build canopy on fuselage.

(13) Add hollowed out nose block and canopy front block.

(14) Sand corners to drawing radii.

(15) Add ventral fin.

(16) Install plywood servo mounts, and glo-plug battery ply base and holder.

(17) Add plywood base to jack and radio switch and epoxy in position (after soldering glo-plug wiring to the jack).

(18) Install bottom and sides of receiver box. Add foam and receiver. Do not install top until servos are installed and connected to the receiver. Run the antenna through holes in bulkheads 6, 7, and 8.

(19) Complete glo-plug wiring as per diagram.

AFT WING ASSEMBLY

(1) Assemble the two aileron torque tubes, and the flap torque tube, adding bearings, ply bearing supports, stops and horns, with collars. Note that the flap torque tube is one piece.

(2) Assemble ply flap supports to ribs C and E over the drawings to accurately locate the pivot hole. Sand to streamline cross section.

(3) Assemble right and left hand main and aft spar components over the drawings. Correct alignment is critical.

(4) Build a wing assembly jig composed of two pieces of 1/2-inch plywood, 5 inches wide by 27 inches long. Butt the inner ends together and elevate the outer ends 1-3/8 inch to provide the 3° dihedral.

(5) Install the strips under the spar locations as shown in the drawings. The aft spar strips should be on the edge of the plywood base so that the flap supports overhang.

(6) Position the flap torque tube assembly on the jig.

(7) Install the lower left and right, fore and aft spars.

(8) Add the ribs, and upper left and right, fore and aft spars and leading edge spars.

(9) Install the aileron torque tube assemblies. Epoxy ply bearing supports to the appropriate ribs for both flap and aileron torque tubes.

(10) Install the inner nyrod ariel tubing in the L.H. wing only.

(11) Add the plywood aft wing center section reinforcements for both main and aft spars.

(12) Add the intercostal balsa webbs to both fore and aft spars.

(13) Add inner nyrod rudder cord guides and install cord assembly (clevis with cord CA'd or epoxied in it) and flap and aileron push rod assemblies.

(14) Ensure that at all times the spars are in firm contact with the building jig, using weights to insure alignment.

(15) Add the upper skin. Use liquid ammonia brushed on the top surface to aid in bending the balsa to contact the ribs, E and F particularly. Pin the skin to the leading edge, main and aft spars, and use weights to insure good contacts. Allow the cement to dry thoroughly overnight.

(16) Remove the assembly from the jig,

and add the bottom skins (notched to clear flap supports). Replace the assembly on the jig, weighted down, and again allow the cement to dry thoroughly. Check to insure that bottom skin contacts the jig properly.

(17) Install the slanted webb ahead of the aileron (see aileron cross section on plates).

AFT FLAP ASSEMBLY

1. A jig of 1/2-inch plywood 3 inches wide and 15 inches long is required. Cut slots 1/4 inch wide x 1-1/2 inches long on one edge to accommodate the plywood pivot ribs at ribs C and E.

2. Install the lower skin on this jig, add pivot ribs, horn rib and balsa end ribs. Insure that the pivot rib spacing agrees with that of the flap supports.

3. Cement upper skin to lower skin at the leading edge, allow cement to set, and wrap it around the ribs. Soften with liquid ammonia.

4. Clamp, weigh down, and pin thoroughly until cement is fully set.

AILERONS

1. Using the flap jig, assemble the bottom skin, horn rib, balsa ribs and leading edge.

2. Add the top skin and lead wire mass balance.

WING AND FLAP SANDING AND FITTING

It is recommended that 1/32-inch ply templates be made for wing and flap leading edges and for the shroud curvature of both fore and aft wings. These will permit accurate sanding of these areas.

It is also suggested that the pivot holes in the pivot ribs of both sets of flaps be left undrilled so that the flaps may be positioned in the flap supports accurately. The incidence gauges will assist this operation. Once located, the pivot holes may be drilled 1/16 on the foreplane and 3/32 on the aft plane and subsequently enlarged to 3/32 and 1/8 to take the brass tube bushings.

FOREPLANE AND FLAPEVATORS

(1) The wing jig, less the rails, is used as the foreplane jig but elevated to the 6° dihedral (1-3/4 inch at 16-1/2 inch from the center line.)

(2) Follow a similar procedure to that of the aft wing.

(3) Add the plywood Hoerner tip plates.

(4) Flapevator assembly follows that of aft wing flaps.

FINS AND RUDDERS

(1) The triangular brass rudder horns, the rudder push rods and the ply rib No.4 with the outboard wheel gear and wheel assembly installed on ply rib No.4 are the sub-assemblies.

(2) Add the inner skin and the 1/4-inch balsa wing-to-fin joiner.

(3) Rudder assembly follows that of the ailerons.

(4) Add nose block and top and bottom blocks and sand to shape.

COWLING

This structure is composed of six pieces of 1/2-inch balsa sheet; two upper sides and the top, two lower sides and the bottom, plus 3/8-inch triangular stock.

(1) Assemble front ply holddown plate and two Goldberg flat hold downs.

(2) Assemble rear ply components and 3rd Goldberg flat hold down.

(3) Install engine on its mount, less needle valve.

(4) Assemble six pieces of 3/8-inch triangular stock and the two 1/32 ply parting line facings.

(5) Sand vertical ends to fit the engine installation, allowing for rear ply ring and spinner skirt overhang of prop drive washer.

(6) Add ply ring and lower aft ply cowl retainer.

(7) Install the cowling lightly cemented to bulkhead No. 9.

(8) Sand outside contours of cowling to bulkhead No. 9, spinner ring and 1/32 ply facings.

(9) Install spinner temporarily to check 1/16th gap between spinner skirt and cowl spinner ring.

(10) Cut openings for needle valve and exhaust stacks.

(11) Remove cowling and spinner and trim inside to drawing contours. (The author uses a Dremel high speed drill and small sanding drum to do this operation quickly, but dustily.)

(12) Install Tatone muffler on engine.

(13) Epoxy upper portion to bulkhead No. 9. Epoxy front holddown plate to lower portion. Locate and install No. 2 shoulder screws in bulkhead No. 9.

(14) Add ventral fin extension to lower cowl, and align with forward portion.

(15) The wing root fairings are added after final assembly.

WING INSTALLATION

Install the aft wing on the fuselage and align it carefully. Drill the wing holddowns using the spar holes as drill templates. Remove the wing and tap the holes as per drawing. Repeat this procedure for the foreplane, and the canopy.

At this point both wings are uncovered, flaps and ailerons have not been installed. Remove both wings from the fuselage and install the center section fairings, replace the wings on the fuselage, install the canopy and sand the fairings to fit the fuselage contours.

SERVOS AND CONTROL LINKAGE

Install the elevator servo slide and all five servos. Install the four outer sheaths of the Sullivan nyrods for aft flap, engine and ailerons. Install and connect the inner rods and clevises. Installation of the rudder cords will take place during final assembly (they should now be in the aft wing). Connect rudder servo to the nose wheel steering arm. Note that the rudder cords cross-over between bulkheads 7 and 8.

FLAPS, AILERONS AND RUDDERS INSTALLATION

MonoKote was used to cover this model. Ailerons and rudders were hinged during the covering process using the double MonoKote hinge shown. This provides a gap seal as well as a strong hinge.

All four flaps were covered before installation. Insert the pivot ribs in the flap supports and install the pivot pins. A dab of epoxy on the pin ends will retain them securely. Connect the push rods to all four flap horn ribs as shown.

FIN AND RUDDER INSTALLATION

These covered surfaces are epoxied to the aft wing end ribs after connecting the rudder cords to the brass rudder horn.

The shaped wing-to-fin joiner permits easy alignment.

COVERING AND PAINTING

As mentioned, MonoKote was used for covering. The following surfaces were painted: nose block, cowling, foreplane end plates, and fin block tops and bottoms.

ALIGNMENT

Assemble the model, and place it on the stand. Install wing root fairings, on the cowling.

Adjust the model's position, fore and aft, on the stand so that the forward canopy is at 5.5° to the horizontal (see fuselage side view).

Install the foreplane incidence gauges on the foreplane with elastic bands.

Similarly, install the aft plane gauges on the flapped portion of the aft wing.

The author uses a Robart incidence gauge; resting the lower ends of the two vertical legs on the raised ends of the balsa incidence gauges.

The incidence should be those shown on the drawings. (The notches in the Robart gauge are designed for symmetrical wing sections and will give incorrect readings on semi-symmetrical wing sections.)

Repeat the process for the outboard portions of the aft wing. (The incidence blocks are useful for adjusting ailerons and flaps to neutral.)

It is important that these incidence readings agree with the drawings.

Add ballast to the nose block to bring the CG to the design location . . . tank full of fuel.

FLIGHT TESTING

Adjust the flap deflection, so that when the foreplane flap is at 20°, the aft flap is at 30 to 35° deflection.

With model at a fair altitude, engine idling, deploy the flaps, gradually. There is enough overriding action on the foreplane flap via the elevator servo to keep out of trouble.

If a slightly nosedown glide is achieved, well and good. If not, adjustment of the aft flap deflection should be done after landing the model, flaps up.

Control response is that of a "normal" airplane . . . the only problem is adjusting one's response to the "backward" flying airplane. •