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SPACE SHUTTLE (Reprinted from the February 1992 issue of RCM) #1110

It was back nine years ago when I watched the Columbia return and touch down on the runway so nice. Was it possible for me to build one like this? It was really a challenge because so far there was not such an R/C model available. I learned that someone had already made such a model, but it had to be carried aloft by another airplane. It was simply a glider with a very poor glide ratio. What I preferred, was an R/C model that could take off by itself and fly like a conventional aircraft. Since then, I worked hard on this project. I figured that the wing was too short to provide adequate lift, the fuselage was so bulky that it created drag, and it was impossible to place an engine in the nose which also created a lot of problems since it was not a conventional aircraft.

It took me about one year to design model #1, a close to scale model with fixed landing gear. A K&B 61 engine was nestled inside the fuselage so I cut a big cheater hole at the bottom of the fuselage. The wingspan was 41¼" and the all-up weight was 9¾ lbs. How did it fly? Actually, it couldn't rotate from the surface because of the poor design of the air intake. I realized that there was an inadequate volume of intake air supplied to the propeller and a quick modification was done. I removed the hatches which could be opened to start the engine and the model soon picked up ground speed and rotated. It was airborne for a few seconds and then stalled. I did not have a chance to react. It seemed that it was tail heavy. The model was repaired and the weight distribution was rearranged. The next time out, I was very happy to achieve a complete and safe flight. The handling quality was very poor. I had to further improve upon it. I worked hard to figure out every negative factor. The wing was too short, it was a piece of cake to build a longer one. The fuselage was so bulky that it created drag and also reduced propeller efficiency, which was the real problem. After months of hard work and waking up several times in the middle of the night, I finally got an idea, I could design the fuselage to be a lifting body.

I gave considerable thought to figuring a layout that was as efficient as possible, yet not too complicated to build and repair (of course). Number 2 model had a smaller boxy like fuselage, and was powered by an O.S. 25 FSR engine which was mounted at the tail, swinging a 9 x 6 pusher prop. A crazy idea that I had was to build a constant thickness, flat plate wing, so I could concentrate to study the behavior of the lifting body. In order to provide sufficient volume of air to feed the propeller, I cut openings at the windshield (thinking about windows without glass). I installed two intake flaps at the fuselage sides, and cheater holes at the bottom. My theory was that airflow being accelerated by the prop, passed through the top surface of the fuselage and would form an undistributed laminate layer which should provide a certain amount of lift.

A test flight was amazing and proved my concept. The ugly little thing could fly, and even flew better than its big brother. On the following experiment, I gradually sealed the windshield, relocated the bottom cheater hole, tested different C.G. locations, changed the engine thrust line, which resulted in **up thrust** and **left thrust.** Yes, forget about right thrust and down thrust from the old books. The overall handling was satisfactory except whenever I chopped the throttle, the plane didn't glide well but rather sank like a hang glider. I then knew it was time to redesign the wing.

Number 3 model was modified from #2, employing a 6% flat bottom wing. With this wing, take-offs and landings were greatly improved. At this point, even though I had installed a tuned pipe, I was asking for more and more power and the 25 size engine just did not fulfill my goal.

Number 4 model was modified from #3. It was equipped with an O.S. 45 FSR engine with a tuned pipe, and two dummy thruster cowls were built on the tail for better scale realism. After several test flights, the engine thrust line was reset, bottom cheater holes were relocated to the rear and a 10 x 6 Graupner pusher prop was replaced by a 9 x 7.

Now the model was capable of loops, rolls, inverted flying, and straight up for a few hundred feet. It flew like a sportster. However, during an airshow in 1985, it was mid-aired by a Tigermoth, both models totaled; just a month before the "Challenger" exploded.

The design was registered in 1987. The model presented in this article is based on model #4. If the RCM readers are interested in the aerodynamics and more flight characteristics, a separate article will follow if time allows.

CONSTRUCTION

Although the Shuttle is intended for experienced pilots the structure is simple. Retractable landing gear and a tuned pipe may be added with some modification. Some of the details may be different from conventional structures, so please read the instructions carefully before you start. Unless specified, use lightweight balsa and plywood to keep the final weight to a minimum.

Fuel Tank/Engine Pod:

Cut out the following parts from their appropriate materials: pod top, pod sides, bottom hatch, hatch tongue, screw block, and firewall.

Position your engine mount on the firewall as seen in the rear view, on sheet one, of the plans. Drill holes for blind nuts and fuel lines. Assemble the pod according to the plan and reinforce the inside with 1/4" triangle stock. Add the front block and sand it to shape. Assemble the hatch and fit it to the pod. Sand the entire assembly smooth and set aside until later.

Fuselage:

Cut out the following parts from their appropriate materials: fuselage sides, fuselage doublers (front and rear), intake flap doublers, fuselage side stringers, fuselage side stiffeners, and servo rail mounts.

Glue the above mentioned parts to the fuselage sides as seen on the plans. Note: Be sure to make a left and right side.

The following parts are required to frame up the fuselage: fuel tank/engine pod assembly, fuselage sides, formers F-1 through F-7, nose gear plate, fuselage top stringers, tapered tail block, and some 1/2" triangle stock.

Mark the location of all formers on the inside of the fuselage side assemblies. Glue F-2 in position being careful to keep the fuselage square. Slide the pod assembly in place. Note: The pod top will seat into slots in rear doubler, see sheet one. Glue all remaining formers in place making sure the fuselage is kept straight while the glue sets. Note: **Tack** glue the nose gear plate in its proper position to help form the front section of the fuselage. Add remaining parts; tapered tail block, 1/2" tri-stock and fuselage top stringers. Note: The fin will fit into a slot created by the top stringers (see plan). Cover top of fuselage with 1/8" soft balsa sheet.

Nose/Canopy:

Cut out parts C-1 through C-5, balsa nose block, cabin floor blank, and chin block. Prop up rear of fuselage so chin block will lay flat on your building board. Align inner contour marks with fuselage sides and glue in place. Now glue the cabin floor blank to the sides and formers, as shown on the plans. Glue C-1 through C-4 in place at this time. Add top nose sheeting, C-5 and 1/2" tri-stock to the fuselage at this time.

Cut out C-6 and position on top of the C-5/tri-stock assembly. Cut out windshield blanks and glue them in place. Trim the top of the windshields level with C-6 and add 1/2" top sheet. Glue nose block in position, fill any gap or imperfections and sand entire nose/canopy section to shape.

Nose Gear:

Remove the nose gear mounting plate from the fuselage, mount a suitable nose gear assembly to it and reinstall into the fuselage using gussets. Remove wheel/wire assembly so bottom sheet can be glued in place. Cut a hole in bottom sheet to clear the wire/spring.

Wing:

The wing construction is very simple. Build the wing in one piece on a flat building board. The top and bottom skins are constructed from 1/16" x 36" balsa sheets. Trim the bottom skin to shape, cut an opening for the cheater hole and the main landing gear block. Mark the positions of the leading and trailing edges, main spars, and all ribs.

Glue the hardwood main landing gear block in place. Add the bottom spar, lower center section gusset, and all ribs at this time.

Sand the leading edges of all ribs to an angle and add the leading/trailing edges. Glue top spars, gussets, and wing bolt doublers in place.

Carefully sand all ribs, gussets, doublers, and leading edges to shape so top skin will fit level.

Tailor top wing skin to shape. Cut oversize and mark position of spars and ribs on top so you may pin down accurately.

Use aliphatic glue to join the top sheet to the wing. Several pieces of balsa stick at the leading edges will help keep the top skin firmly in place.

When top sheet is dry, sand excess top skin flush with edges of wing, add wing tips and wing cheater hole liner.

Leading Edge Extension:

The L.E.X. is assembled from 1/4'' sq. balsa sticks, 1/16'' sheets, a 3/8'' x 1⅛'' balsa block, and a 3/8'' sq. spruce stick.

Using typical wing mount hardware, mount the wing to the fuselage making sure it is straight and square.

Remove wing, place wax paper between wing/fuselage and remount wing. Glue 3/8'' sq. spruce and balsa block to fuselage. Add front cheater hole liner and bottom sheet to the fuselage and sand edges clean. Build L.E.X. front section over plans, sheet with 1/16'' balsa and glue to fuselage sides as seen on plans.

When dry, shape L.E.X. and wing leading edge to sections shown.

Miscellaneous:

The dummy thruster cowls are constructed from T-1 through T-5 and 1/8'' x 3/8'' balsa strips. Glue T-2, T-3, and T-4 to fuselage sides at positions shown on plans. Plank with balsa strips, cut away excess and add T-1 and T-5. Sand to final shape.

Cut fin and rudder from 1/4'' sheet. Note grain direction at top of fin and bottom of rudder. Use aileron torque rod hardware to actuate rudder, see plan.

The elevons are carved from 3/8'' balsa sheet. Carve bottom side only, keep the top surface flat.

The intake flaps are one of the tricks on this model. These flaps are closed by gravity when the model is at rest, to add scale realism. Once the engine is running, air flow opens the flaps inward allowing more air in to feed the propeller. The degree of opening is self adjusting depending on the flying condition.

The flap itself can be cut from the fuselage side or a separate sheet used. Glue two pieces of 1/8'' x 1/2'' balsa to the flap as reinforcement. Sand the edges so it will swing freely.

The radio hatch is made from lite ply with holes in the corners for attachment screws. Glue some lite ply to the inside of the fuselage for the screws to grab.

Covering:

Sand all surfaces smooth. Use black and white MonoKote for the whole job except the U.S. National Flag. If you wish to copy a particular Shuttle,. you will need to find the proper information.

Paint fuselage interior from the intake flaps back to the tail with resin or hot fuelproof paint, etc.

Final Assembly:

Install rudder torque rod to the fin, and glue the fin in place on the fuselage. Install the engine using a five degree thrust plate behind the engine mount to achieve the proper thrust, see detail on plan.

An opening will need to be cut in the left side to allow engine clearance and glow plug removal.

A 9 x 7 pusher prop is used. Be sure to keep prop clearance to a minimum of 1/2'' because the prop, especially a nylon prop, may bend forward while spinning. Add a plywood spacer between the firewall and engine mount if necessary. Connect a piece of 1/16'' wire to the main needle valve for an extension.

The fuel tank must face forward in its compartment. Route fuel lines through firewall and secure fuel tank hatch with two screws.

Install all landing gear and wheels according to plan.

Radio:

Epoxy servo rails in place and construct a sliding tray for one servo. (If using electronic mixing, mount all four servos on two forward rails.)

Connect servos to their appropriate control surfaces using NyRod. Secure the pushrods to the fuselage with small brackets made from this aluminum. Rudder pushrod is secured to formers F-4, F-5, and F-6. Connect the nose gear using 1/16'' wire and ball links. (Setting the nose wheel a few degrees to the right will compensate for the left thrust.)

Epoxy hinges to intake flaps and fuselage. Add a small piece of plywood to the flaps, keeping them from swinging outward.

Control Set-Up:

Set the elevons 1/2'' up, trim to provide necessary reflex. This is a fundamental trim requirement for most flying wing type aircraft. Set control throws 1/2'' both ways for aileron movement, and 5/8'' both ways for elevator. Rudder movement should be 1'' in both directions. All measurements should be taken at the root of the control surface.

Balance:

With the fuel tank empty (assume the fuel tank capacity is 8 oz. or 240cc). The C.G. point is 13'' from the trailing edge. I prefer this unusual way of measuring from the T.E., as it is easier to measure from the trailing edge since it is a straight line. It is very handy to mark the C.G. points at the fuselage above the intake flaps so that you can support the model with your fingers. Move the NiCd battery or receiver to achieve the correct balance. Since I installed a J'TEC Snuffler which adds a little more weight to the tail, I moved the battery to the nose and placed receiver in front of the servos. One very important step is to laterally balance the model, as you usually do for a pattern ship. Turn it upside down, mark a centerline at the bottom, support the model at the line with your fingers, one at the tail and another one near nose gear. Add weight at the lighter wingtip. I had to add almost 3/4 oz. of lead to the right wing tip to compensate for the engine cylinder and muffler.

Pre-Flight Check:

Check that all bolts, screws, and propeller are secure. Check all pushrods to ensure there is no slop. Check all servo movements, C.G. point, and R/C range test as usual.

Test Flight:

Here comes the most exciting moment. Fill up the tank, it is handy to turn the model sideways to prime the engine, turn on your R/C equipment, connect glow plug wire, and use an electric starter. Grip the intake opening by another hand so that it does not move. Anyway, there are always a lot of volunteers willing to help you. Let them hold the model by the nose when you start. Once the engine is running, adjust needle valve and **dip the nose down** to check for lean running. I did not install a fuel pump which is optional. This is a very important step to prevent the engine from leaning out. You may have to readjust the idle jet because airflow blows away from the carburetor. For safety purpose, it is better to stop the engine before you adjust the idle jet. Always keep your hand away from the spinning propeller. The engine I used on this prototype was an ASP 40 ABC. I chose this engine simply because it has a good hp/$ (horse power per unit price). Once you tune up the engine, try taxiing on the runway and get used to the ground handling. Then, gradually advance to half throttle to practice high speed running. Reset the nose gear if necessary to obtain straight tracking. It is a little bit difficult to run on a rough surface as the nose gear may bounce and wander. Some down stick would probably help. Check the cheater hole before you attempt to get airborne. When I test flew it at the Ajax flying site last fall, it could not pick up enough ground speed, and I found that the cheater hole was blocked by a piece of leaf.

Now it is time to get airborne. Taxi it to the end of runway, gently advance throttle, use rudder to maintain tracking. It takes about 150 ft.-200 ft. of smooth runway, or 200 ft.-300 ft. on a grass surface, to rotate. This varies with the engine power, model weight, and wind condition.

Make sure you have enough space for the first attempt to take off, let it have a long take-off roll to pick up speed. The nose does not come up by itself, it will take a bit of back stick to get the nose off, then you are flying immediately. Once it becomes airborne, ease off elevator for a shallow climb and trim the control surfaces after it gains a safe altitude.

Flying Characteristics:

First of all, you have to get used to its extraordinary appearance and the black and white color. Do not let the unusual profile confuse you. The roll rate is quite high and it can perform more than one roll per second. I usually cut the throttle back to make a smooth turn. The rudder response is also positive, and you can couple the rudder to aileron control if you so desire. Elevator response is a little bit sluggish, always pick up speed before performing a loop. Inverted flight is possible by pushing the stick far forward. Generally speaking, it flies like a sport flier once you get used to it.

Before any attempt to land, reduce power and try a low pass. Low speed characteristics are simply amazing. It does not tip stall and slows to an easily controlled nose high attitude. It might be a surprise to most people as they think it should land as fast as a missile because of the short wingspan. As a matter of fact, due to the lifting body design which provides lift as well as drag, it can land as slow as most models. Make a rectangular approach at reduced throttle, gently let it flare out toward the runway, gradually reduce power because its sink and climb rate is being controlled by throttle. Never chop the stick to the bottom. Keep a high idle for a straight and level touch down on the main gear. Then chop the throttle. If you chop down too early, it will bounce on the surface hard.

Try not to run out of fuel in the air. Whenever this happens, the fuselage provides considerable drag. Bear in mind it is not a glider, keep up speed by pushing down elevator. Look for the nearest spot to land and pull the nose up just before touch down.

Precision Trimming:

The up and left thrust shown on the plan is for construction reference. Since the engine is installed at the 8 o'clock position, the actual angles are less than indicated. Furthermore, different engine and propeller combinations vary the torque, even a different type of wheel may tend to pull the nose down, so it is necessary to adjust the thrust line. Do not be discouraged, the pattern fliers always seem to enjoy changing engine thrust line for the best result.

Start at a straight and level flight, chop the throttle. If it shows a nose up descent, increase up thrust until it glides with slightly nose down. Repeat the procedure again to test the side thrust. If it tries to turn to the left at reduced throttle, increase left thrust. Make sure you have balanced the model laterally before you test the side thrust.

This is absolutely not a beginner's model. Don't expect it to fly as easy as a Falcon 56 or Piper Cub. Even an experienced pilot may take a while to get used to it. However, if you are tired with the traditional designs and want to try something different, this is the answer. Whenever it shows up at the flying site, everyone will stop flying to watch. It is really a challenge.

Good flying, good luck and let me hear from you. Parker Model Ltd., 52 Waller Street, Whitby Ontario, Canada L1R 1Z8. □

SPACE SHUTTLE 40

Designed By:
Parker Leung
TYPE AIRCRAFT
Stand-Off Scale
WINGSPAN
37½ Inches
WING CHORD
NA
TOTAL WING AREA
500 Sq. In.
WING LOCATION
Bottom of Fuselage
AIRFOIL
6% Flat Bottom
WING PLANFORM
Delta
DIHEDRAL EACH TIP
0
OVERALL FUSELAGE LENGTH
44 Inches
RADIO COMPARTMENT SIZE
Ample
STABILIZER SPAN
NA
STABILIZER CHORD (incl. elev.)
NA
STABILIZER AREA
NA
STAB AIRFOIL SECTION
NA
STABILIZER LOCATION
NA
VERTICAL FIN HEIGHT
10¼ Inches
VERTICAL FIN WIDTH (incl. rud.)
7½ Inches (Avg.)
REC. ENGINE RANGE
.40-.46 2-stroke
FUEL TANK SIZE
8 Ozs.
LANDING GEAR
Tricycle
REC. NO. OF CHANNELS
4
CONTROL FUNCTIONS
Elevons, Rudder, Throttle

BASIC MATERIALS USED IN CONSTRUCTION

Fuselage ..... Balsa & Ply
Wing ..... Balsa
Empennage ..... Balsa
Wt. Ready To Fly 92-94 Ozs. (5 Lbs. 12-14 Ozs.)
Wing Loading ..... 27 Oz./Sq. Ft.

BILL OF MATERIALS:

Balsa Blocks:
3" x 3" x 2½" — 1 pc.
2¾" x 2¾" x 2¼" — 1 pc.
Balsa Sheeting:
1/16" x 3" x 36" — 10 pcs.
1/8" x 3" x 42" — 4 pcs.
1/8" x 3" x 36" — 4 pcs.
1/4" x 3" x 36" — 1 pc.
3/8" x 3" x 36" — 1 pc.
Balsa Triangle:
1/4" x 1/4" x 36" — 1 pc.
1/2" x 1/2" x 36" — 1 pc.
Balsa Stick:
1/8" x 1/4" x 36" — 4 pcs.
1/8" x 3/8" x 36" — 2 pcs.
1/4" x 1/4" x 36" — 2 pcs.
1/4" x 3/8" x 36" — 1 pc.
3/8" x 3/8" x 36" — 2 pcs.
Hardwood Strip:
3/8" x 3/8" x 36" — 1 pc.
Plywood:
Lite ply 1' x 3' x 1/8" — 1 pc.
Other:
1 — set nose gear
1/8" piano wire for main gear
2 — sets aileron linkage
1 — pc. safety spinner nut
1 — 8 oz. fuel tank
2 — 2¼" wheels
1 — 2" wheel
1 — 40 size engine mount
4 — pcs. wing bolt and mounting block
1 — set landing gear straps, flat
Plus:
Covering material, NyRods, hinges, bolts, collars, clevises, glues, fuel tube, pusher prop and engine, etc.