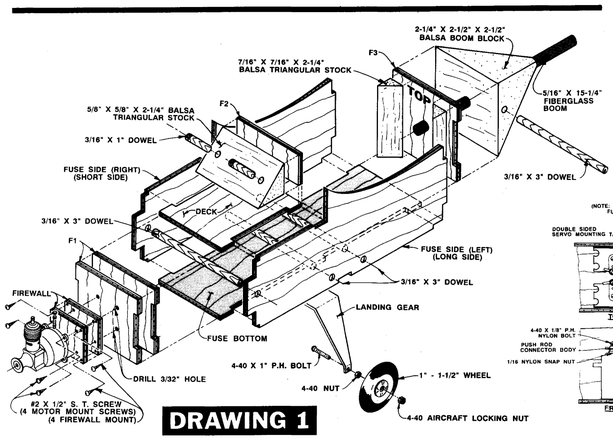
GRASSHOPPER CONSTRUCTION

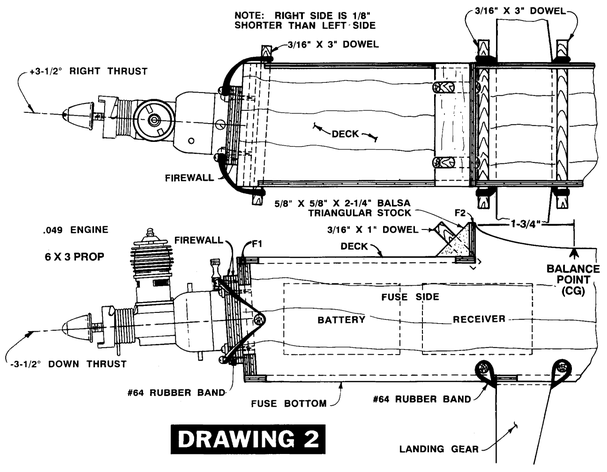
The Grasshopper is a quick-to-build airplane that offers more fun for the dollar than anything else we know of in the R/C hobby. It uses two standard-sized servos for rudder and elevator control and an inexpensive reed-valve .049 engine which is ample power for a good climb-out and moderate aerobatics. Its rugged, rubber-band together design will survive mishaps that would destroy most others. So, spend an evening or two putting the Grasshopper together and you'll be ready to have a ball!

Common modeling tools will be needed: knife, drill (1/16", 3/32", and 3/16"), screwdriver, and masking tape. We recommend medium CyA glue and Setter for the fuselage and five minute epoxy for the wing. You may also use carpenter's glue (aliphatic resin) throughout. BUT, you must use either epoxy or carpenter's glue on the wing...most other glues will attack the foam. The fuselage and tail may be finished with the plastic covering films available or simply spray painted with inexpensive enamel. The wing is to be finished according to the separate sheet furnished.

We would suggest going ahead and punching out all the die cut parts. Clean up any frayed edges with a sanding block. You will be able to identify all the parts by referring to the drawings; it would be wise to label them with a soft pencil. Definitely mark "TOP" on F3 as indicated.



DRAWING 1



DRAWING 2

I. FUSELAGE CONSTRUCTION

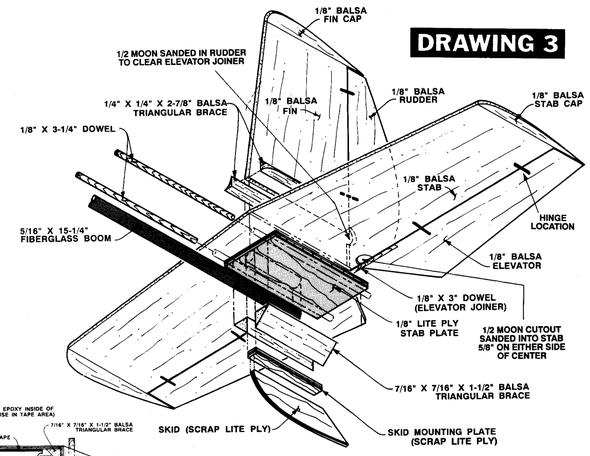
The fuselage is simply a box to hold the wing, engine, and radio with a fiberglass arrow shaft extension to hold the tail; this configuration is commonly called "pod and boom". We will begin by building the box.

[ ] Glue the two lite ply firewall parts together, keeping the "tic" marks on the outside and lining up the edges.
[ ] Glue the two F1 parts together, lining up the edges.
[ ] Study Dwg. 2 to determine the relationship of the holes you are going the drill. Using a 1/16" drill bit, drill the eight holes in the firewall where indicated by the "tic" marks. Keep the drill perpendicular to the firewall's surface.
[ ] We are going to use the four inner holes on the firewall to locate the position of four holes to be drilled in F1. Center the firewall on F1, making sure the long dimension of the firewall is going up and down. Use your 1/16" drill bit to transfer the location of the four inner holes to F1. Remove the firewall and drill the holes you just marked on F1 to 3/32".
[ ] Drill three 3/16" holes in each fuselage side where indicated by the "tic" marks.

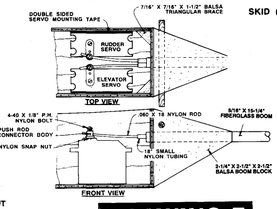
In the following step, MAKE SURE that F3 is installed so the hole is closest to the TOP of the fuselage!

[ ] Without using glue, assemble the fuse sides (NOTE: the RIGHT side is 1/8" shorter than the LEFT side), F1, F3, Fuse Bottom, Deck, and F2. Trim and sand if needed for a good fit. Hold the assembly together with masking tape.

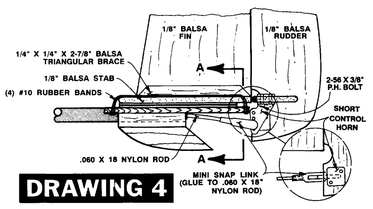
[ ] When satisfied with the fit, glue the fuselage together. If you are using CyA glue, simply run a bead of glue on the inside of every joint and cure with the Setter. If you are using carpenter's glue, you will need to untape and disassemble, apply glue, and reassemble using tape to hold together.
[ ] From the furnished length of 7/16" X 7/16" triangular shaped balsa, cut two pieces 2-1/4" long. Glue them in the corners formed by the fuse sides and F3 to strengthen this joint.
[ ] Glue the 5/8" X 5/8" X 2-1/4" triangular shaped balsa in the corner of F2 and the Deck.
[ ] Now drill two 3/16" holes in this balsa "windshield", located 7/16" in from either side, centered top to bottom. Keep the drill perpendicular to the surface of the "windshield" which would be 45° to the Deck. Drill on through the F2/Deck wood.
[ ] A "razor", "coping" or "hack" saw is handy for this step, or, if you have one, an electric jig saw is quickest. From the length of 3/16" dowel furnished, cut two pieces 1" long. These will be the front wing hold-down dowels to be inserted later in the holes you just drilled. Now cut four more 3/16" dowels, 2-7/8" long. They will be the rear wing hold-down, engine, and landing gear dowels. Slightly round the edges of each of these dowels with sandpaper and set aside for now.
[ ] Securely and carefully glue the specially shaped and drilled balsa Boom Block onto the rear of F3. The large hole drilled lengthwise in the block needs to line up with the hole in F3 and the block should be square and lined up with the sides. If everything is correct, the smaller hole drilled crosswise in the block should be nearer to the top of the fuselage.



DRAWING 3



DRAWING 5



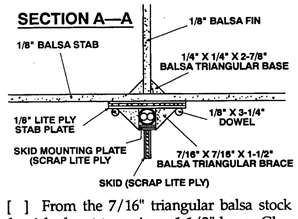
DRAWING 4

II. TAIL ASSEMBLY

[ ] Locate the 1/8" X 3" X 14-1/8" Stab. Use a soft pencil to mark a center line perpendicular to the rear edge of the Stab on both the top and bottom surfaces. (The rear edge is the straight edge.)
[ ] Centered 5/8" on either side of this line, sand two 1/2 moon cutouts into the rear edge of the Stab. Some sandpaper wrapped around the fiberglass "boom" or a pencil works well for this purpose.
[ ] In a simlar fashion, sand a 1/2 moon cutout in the front (straight) edge of the rudder, centered 4-3/8" down from the top.

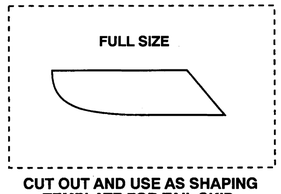
[ ] On a waxed paper covered flat surface, glue both Stab Caps onto the ends of the Stab with the front of the cap flush with the front of the stab. Pin or weigh the parts down to keep them flat as the glue sets.
[ ] With them in the proper position relative to the stab, securely join the two elevator halves with a 3" piece of 1/8" dowel cut from the length furnished. Keep the leading edge of the elevators straight and make sure there is about 1/16" clearance between the elevators and the stab caps. **Also, be careful not to glue the elevators to the stab.**
[ ] Glue the Fin Cap to the Fin as you did the Stab Caps to the Stab.
[ ] Now block-sand the tail surfaces smooth and round the edges with Fine (220 grit) sandpaper.

[ ] Locate the 1-1/2" X 2-5/8" lite ply Stab Plate and draw a center-line on both sides lengthwise. Also, on one side of this plate, mark a parallel line 5/32" on each side of this center line, leaving a 5/16" gap between these lines. This will be the "bottom" side.

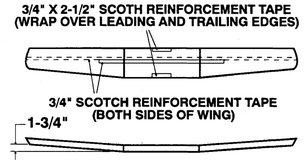


[ ] From the 7/16" triangular balsa stock furnished, cut two pieces 1-1/2" long. Glue them on the stab plate with the right angle edges on the lines you just drew with the ends flush with one edge of the plate. This will leave a 5/16" channel for the "Boom" to fit into. (Study Section A-A).
[ ] With sandpaper, roughen up the outer surface of both ends of the fiberglass boom for about 3".
[ ] Glue the stab plate assembly to the boom in the channel you just created. The end of the boom should be flush with the end of the triangular stock, leaving about 1-1/8" of the stab plate sticking out beyond the boom.
[ ] From the 1/8" dowel furnished, cut two pieces 3-1/4" long. Glue them to the bottom of the stab plate, butted up against the edge of the triangular stock and with 5/16" sticking out both ends.
[ ] From scrap lite ply, cut a piece 5/16" X 1-1/2". Glue it between the triangular stock braces and up against the boom to form a skid mounting plate.
[ ] Using the template furnished elsewhere, cut a Skid out of scrap lite ply. Glue it on to the skid mounting plate.

[ ] Locate the two 18" lengths of nylon tubing. Slide them into the fiberglass boom, side-by-side. Start from the rear (stab plate end) and continue until both ends of the tubing are flush with the rear end of the boom; there will be excess material out the front of the boom. Note: this should be a tight fit. If it is too tight, use some soapy water on the tubing for lubrication. If the tubing is loose in the boom, you will need to glue it in place so it can't move around. Look at Section A-A and observe the orientation of the tubes. Trim the excess tubing sticking out the front of the boom to about 1/2" long.
[ ] Temporarily install the stab onto the stab plate using four #10 rubber bands.
[ ] Locate your fuselage "pod" and slide the front end of the boom into the hole in the balsa boom block until it goes through F3 and protrudes about 1/8". (Don't glue yet!) You'll have to thread the excess nylon tube through the hole first.
[ ] Using a heavy book or some other weight, hold the fuselage assembly down flat on the work surface. Making sure the fuselage pod is sitting square to your work surface, adjust the stab so it is parallel to the work surface. This procedure should insure that the stab will be parallel with the wing when it is installed. Now, you need to securely glue the boom into the boom block; the easiest way is to wick thin CyA glue into the joint from both ends while it is sitting on the bench. If you don't have thin CyA glue, we suggest using 30 minute epoxy; you will have to disassemble, apply the epoxy to the boom, and reassemble, letting the glue set while you have it aligned on the bench as before.



CUT OUT AND USE AS SHAPING TEMPLATE FOR TAIL SKID.



WING DIHEDRAL DETAIL

III. WING CONSTRUCTION

NOTE: Use only epoxy or white/carpenter's glue for wing construction. Any other type glue will attack the foam and ruin the wing.
[ ] The correct dihedral angle is cut into the three wing panels for you. All you need to do is glue them together on your waxed paper covered work surface with the center section down flat. The bottom of the ends of the outer panels should be blocked up to 1-3/4". Make sure you wipe off any excess glue before it sets.
[ ] After the glue has set, use some fine (220 grit) sandpaper and lightly sand the wing, just enough to knock off the little bumps on the foam. Remove any residue caused by sanding.
[ ] Obtain a roll of Scotch brand 3/4" fiberglass reinforced strapping tape; it is readily available at WalMart or K-Mart. Starting on the bottom of one wing tip, run a continuous length along the center of the bottom of the wing (about 3-1/2" forward of the trailing edge) to the other tip; don't pull too hard and warp the wing, but don't let any slack occur either. Stick the tape down to the surface as you go. Repeat for the top surface of the wing. Now apply another length of tape on both sides of the wing right in front of the one already down. It should extend about 3" beyond the dihedral joint.

This tape serves the important purpose of acting as a spar and keeping the wing from flexing under flight loads. **It must be there!**
[ ] Also wrap a 2-1/2" length of tape around both the leading edge and trailing edge right in the center of the wing. They serve as protectors for the rubber bands.

IV. FINISHING

Read the enclosed sheet on Foam Wings to determine your preference for finishing this wing.

The fuselage and tail may be finished with the plastic covering films available or simply spray painted with inexpensive enamel. If you are spray painting, go ahead and glue the Fin to the center of the Stab, keeping it perpendicular to the stab. From the material furnished, cut, sand, and add the 1/4" triangular shaped balsa braces as shown in Drawing 3, Section A-A, and Drawing 4.

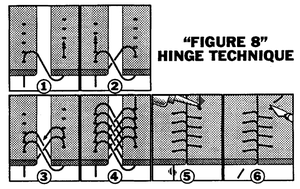
If you are using plastic film covering material, cover all the components and glue the fin/stab/braces together after the covering is complete. Do not apply any covering material where the joints will be.

In any event, do not hinge either the elevators or the rudder until finishing is complete.

V. FINAL ASSEMBLY and RADIO INSTALLATION

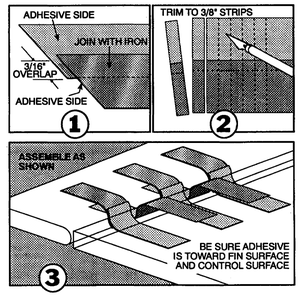
[ ] Glue the 3/16" dowels you previously prepared into the fuselage.
[ ] Study Dwgs. 1 and 2 and mount the engine using the furnished No. 2 X 1/2" self tap screws. Notice that the engine is mounted using the set of four inner holes in the firewall; screw them all the way in tight. There will be about 3/16" of the screws sticking out the back of the firewall; they go into the holes in F1 to provide alignment. Next, screw the four remaining screws into the set of outer holes in the firewall until the tip of the screw is flush with the back of the firewall, leaving about 1/4" of the screw exposed. A rubber band hooks over one of these screws, goes around the dowel, and hooks over the other exposed screw. The engine should be tightly rubber banded on with at least two rubber bands on each side; this will keep the engine in place for normal flight and yet will give on impact so crash damage is minimized. Always make sure these rubber bands are secure before starting the engine!

[ ] Referring to Dwg. 1, secure the wheels to the landing gear using the four 4-40 bolts, nuts, and locking nuts furnished. The landing gear is also rubber banded to the fuselage. Note: You can leave the landing gear off altogether if desired to save weight and the expense of buying wheels. The Grasshopper is rugged enough to belly land without damage.



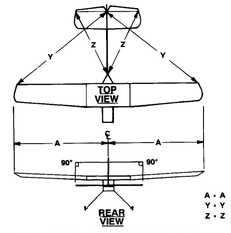
[ ] The elevators and rudder can be hinged one of two ways; either a "Figure 8" thread hinge or an "X" hinge using the covering material.
[ ] If you chose the thread hinge, obtain some heavy button and carpet thread. Using a 1/16" or smaller drill bit, drill a series of five holes in each of the surfaces, 1/8" in from the edge and 1/8" apart. Keep them directly opposite one another. Drill a series of holes at each location indicated on the plans (two for the fin and four for the elevators).

Take a 8" length of thread and harden one end for about 1/2" with thin CyA; it will act as a needle. Tie a knot in the other end. "Sew" the hinge as follows. Move the surface into position. Thread the hardened end through one of the outer holes then bring it back through the gap between the surfaces and thread it through the hole opposite the first one. Repeat for all five holes. Snug the thread so the surfaces are tight together and lined up. When satisfied, put a drop of thin CyA on the thread where it exits each hole.



[ ] If you chose the "X" hinge technique, a piece of glass is handy. Cut two pieces of the covering material 1/2" wide by about 10" long. Remove the protective backing from the material. Overlap these two strips adhesive-to-adhesive along the edge about 3/16" and secure them together with an iron. Here is where a piece of glass is handy to work on because the film won't stick to it. Now cut them into pieces about 3/8" wide.

Use them to hinge the surfaces in an "X" fashion. Each hinge location grouping should consist of at least four alternating hinges.



WING/STAB ALIGNMENT DETAIL

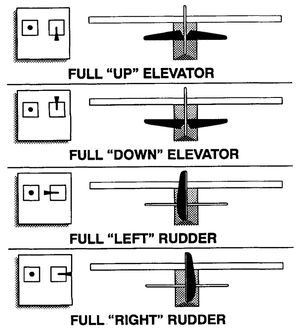
[ ] To install the radio, study Dwgs. 2, 4, and 5.
[ ] Rubber band the tail assembly onto the stab plate. We have furnished some No. 10 rubber bands for this purpose.
[ ] Locate the two 1/16" X 18" nylon rods. Roughen one end of each rod with sandpaper for about 1/2". Use some medium CyA and Setter to glue a clevis (snap link), on the end of each rod. Leave about 1/16" of the rod sticking out on the inside of the clevis and apply a ball of glue on this. When set, test your glue joint by tugging and twisting on the clevis.
[ ] Thread the plain end of each of the rods into the tubing previously installed in the boom, starting at the rear.

[ ] Locate the two control horns furnished and trim off the mounting plates. Snap the clevises onto each of them into the third hole from the bottom.
[ ] Move the horn/clevis assembly into place positioning the horns on the rudder and elevator. (Dwg. 4.) Locate the horns so the rod is as straight as possible after it exits the tubing. When satisfied, secure the horn to the surface by drilling two 3/32" holes through the surface and using two 2-56 X 3/8" bolts and the mounting plates.

[ ] We recommend using the furnished double sided servo mounting tape to secure the servos in the fuselage. Begin by smearing a coat of epoxy on the inside surface of both fuselage sides in the servo area; this will produce a smooth surface for the servo tape to stick to. Stick two lengths of servo tape onto the proper side of each servo, but do not remove the backing paper, yet.
[ ] Study Dwg. 5. Note that the nylon pushrod is connected to the servo arm with an "EZ" Connect. The body of the EZ Connect attaches to the servo arm with a nylon "Snap Nut". Then, in turn, the pushrod is secured by means of a 4-40 set screw....this is where you get adjustability to make your trim adjustments. Also realize that if you don't have servo reversal capability, the pushrod needs to come off the side of the servo that will produce proper control surface movement in relationship to transmitter stick input. Attach the EZ Connect bodys to the two servo arms with the snap nuts. Slide them onto the nylon rods and then install the arms onto the servos; remove the backing paper from the servo tape, move the servos into position, and stick them in place. With your rudder and elevator in neutral, tighten the EZ Connect's set screw down onto the rod.

[ ] The battery pack is wrapped in foam and placed in the front compartment, the receiver is placed ahead of the servos, and the switch and charge jack can be installed in any convenient spot.

[ ] When you have the radio installed and hooked up, turn it on and check the direction and amount of movement of the rudder and elevator. They should be as follows:



Rudder Throw: 5/8" right, 5/8" left.
Elevator Throw: 5/32" up, 5/32" down.
(These are measured at the rearmost point of the surface.)

[ ] Rubber band the wing on and check the Center of Gravity/Balance Point. The plane needs to balance 1-3/4" back from the leading edge of the wing. Do so by putting your index finger tips at this point under the wing, close to the fuselage. If the plane is not level, adjust the battery location until it does balance level. If maximum relocation of the battery does not achieve balance, you will have to add weight either to the nose or the tail. In any event, always keep the battery as the forwardmost component of the radio system; if not, it can become a damaging pile driver in the event of a crash.

VI. FLYING

If the Grasshopper is your first attempt at flying R/C, you have made a wise choice because it is relatively easy to fly and almost indestructable. BUT, we recommend you have an experienced R/C'er inspect your airplane and coach you through the first few flights. It could save you from dissappointment.

Pick a relatively calm day for the first flight.

We recommend a test glide over tall grass before powered flight. Launch the airplane directly into the wind with a firm toss, with the wings level and the nose slightly nose down; aim the nose at a spot on the ground about 100 feet in front of you. **NEVER throw the airplane with the nose pointed upward,** either now or under power, if you do, it will probably stall and crash. The airplane should gently glide straight out with no tendency to dive or stall; a small amount of rudder or elevator trim should correct any deviation.

If not, check the plane over for proper alignment according to the Alignment Detail, make sure the plane balances at the Center of Gravity (CG), and make sure there are no warps in the wing or tail surfaces. If everything checks out and the plane still dives, shim the front of the wing up from the wing saddle 1/16" at a time until you get a flat dive. If the plane still stalls, do the opposite by shimming the rear of the wing up in the same manner.

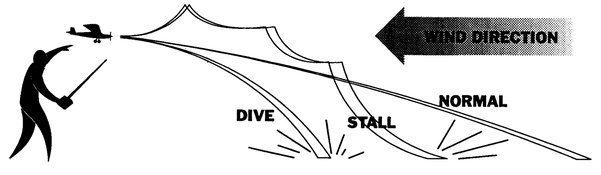
If the plane tends to peel off right or left, check again for warps and a properly assembled wing. Also, make sure one tip of the wing is not significantly heavier than the other by removing it from the plane and balancing it in the center. If it is, use a nail poked into the light tip to balance it. If it continues to uncontrollably go left or right, about the only possibility is a mis-built wing that has the tip panels joined in such a way that results in a twist. The only way to correct this is to remove the strapping tape, cut the joints apart, and rejoin properly. If worst comes to worst, replacement wing kits are available.

On the first powered flight, only fill the tank 1/2 full and start the engine according to the manufacturer's instructions. (One of the main secrets to a good running 1/2A engine is to make sure that you have fresh fuel with at least 25% nitro content.) Again, firmly launch the plane, aiming the nose at a point on the ground about 100 feet in front of you. It should assume a straight, gentle climb out. Don't overcontrol! Be gentle with your turns and only use the elevator when necessary. Try to always keep the airplane upwind from you and don't let it get too far away. When the engine quits, don't panic. Just let the plane glide down, keeping your control inputs to the minimum. Judge the descent of the plane so you can land into the wind; as you approach the ground, gradually feed in up elevator to flair the plane so it slows down and assumes the proper attitude for landing.

As you move up on the learning curve, don't do anything radical until you have mastered the ability to control the plane without any surprizes. Only when you have reached this level should you try things such as loops, rolls, and spins.

If you do have a crash, because of the rubber band-on technique of engine, wing, landing gear, and tail attachment, damage should be minimal. Five minute epoxy should repair any problem.

We hope that you find building and flying the Grasshopper a successful, rewarding, fun experience. If you have any comments, we'd appreciate hearing from you.



DRAWING 6

"Safe flying and soft landings from the crew at Ace R/C!"

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