

Construction of Square Model Rockets

The initial step in building a square rocket is to choose the body diameter. To approximate a BT-55 size rocket the following calculations are needed:

1. BT-55 outside diameter is 1.325 inches with cross sectional area of 1.379 square inches.
2. A square with the same area has sides of 1.174 inches. For convenience in construction measurements, use 1.25 inches for a side of the rocket. This gives an area of 1.5625 square inches.
3. A circle with an equivalent area has a diameter of 1.410 inches. Use this diameter when running Open Rocket to check the performance of the rocket.

There are four main sub-assemblies in a square rocket: the body prism, the nose pyramid, the fins and the motor mount.

Construction of the body prism

The body prism should be the first sub-assembly to be built.

1. Obtain an empty cereal box. A “Giant” or “Family” size box holding 20 ounces is best. For reference, a box that is 13-1/2” high by 9-1/4” wide by 3” deep will be used, but any size box can be used. The larger the box the thicker the sides will be and the better for construction.
2. Open the top and bottom flaps of the box and lay it flat.
3. Note that one of the long edges has a thick strip approximately 1/2” wide representing the overlap that was used during construction of the box. Cut this edge off and open the box out so that it is one layer thick. Remove the wide strip.
4. Remove the top four flaps and the bottom four flaps. There should now be one large rectangular piece about 24” by 13” with three slight ribs running along the width. Make sure this piece is rectangular with all four corners measuring 90 degrees. Trim if necessary.
5. There are now three options for body length:
 - a. Cut across the width for a 13” long body.
 - b. Cut across the width twice and use a coupler to join them into a 26” body.
 - c. Cut lengthwise for a 24” body with three small ribs.
6. For the lengthwise 24” body option, lay the box panel with the printing face down and the 24” side running top to bottom.
7. Starting from the left edge, using a bone knife or similar tool, score the cardboard parallel to the 24” side 1-1/4” from the edge. Make a second score line 2-1/2” from

the edge and a third score at 3-3/4" from the edge. Now, cut the panel at 5" from the edge. This gives a piece that is 24" by 5" with score lines dividing it into four sections each 1-1/4 "wide.

8. Using a square table with edge or wall, fold the body along each of the three score lines so the brown, unprinted side is on the outside of the body prism.
9. Using an 8-1/2" by 11" sheet of 110 lb. cardstock, make 1/2" connector tabs. Make a score line 1/4" from the long edge of the cardstock. Then cut 1/2" from the same edge. This makes a strip 1/2" by 11" with a score line running down the middle lengthwise. Fold the strip along the score line to make a connector tab. Make two more of these. Since the body prism is 24" long, cut 2" from one of the strips and use it along with the other two 11" strips to complete the body as explained in the next step.
10. Before glueing the connectors to the body, use sandpaper to roughen a 1/4" strip along both long edges of the body prism on the printed side.
11. One at a time, glue the connector tabs to the edge of the body prism with the center score line right at the edge of the body. Make sure the orientation is correct so that the other long edge of the body prism will match up to the other half of the connector.
12. Wait for the glue to dry. Then, working rather quickly, glue the second edge of the body prism to the remaining half of the connector tab. It helps to use clothespins to hold the ends together while adjusting the alignment of the middle section.

Construction of the nose pyramid

The rocket nose consists of three separate sections: the pyramid, the collar, and the shoulder. The pyramid can be any length. These instructions are for a 6" pyramid.

1. To make the nose pyramid, a template is required. From scrap cardboard from the cereal box flaps, cut a rectangle that is 1-1/4" by 6". Mark the midpoint of one of the short edges. This will be 5/8" from each adjacent corner of that edge.
2. Draw lines from the midpoint to each opposite corner. Cut along both of these lines, to get the template which is an isosceles triangle 6" high with a 1-1/4" base.
3. Using the leftover piece of the cereal box and the template, make the nose pyramid. Place the cereal box cardboard with the printed side down. Lay the template along the left edge of the cardboard with the apex pointing toward the top and trace around it with a pencil.
4. Slide the template to the right so that the left edge of the template is exactly aligned with the right side of the tracing and then trace around it again. Note that the bottom sides of the two tracings should not be in a straight line but should make an angle of about 168 degrees with each other.

5. Move the template to the right as previously and trace around it again. Move it one last time and trace so that there are four tracings.
6. Using the bone knife, score the three lines where the tracings intersect. Cut out the entire tracing and crease on the three score lines.
7. Make a 5" connector tab as previously and join the two edges of the pyramid. Put a small amount of glue at the top 1" tip of the pyramid and try to close it as well as possible. After all of the glue has dried add more glue to the top if needed to close the opening.
8. To make the nose collar, cut a piece of cardboard 1" wide by 5" long. Place it printed side down.
9. Make three score lines, 1-1/4", 2-1/2" and 3-3/4" from one of the narrow edges.
10. Crease each score line and use a connector tab to join the two narrow edges.
11. Check to verify that the edge of the collar exactly matches the bottom edge of the pyramid.
12. Glue 1" connectors to each of the four sides of the pyramid at the bottom edge and let the glue dry.
13. Put glue on the four exposed tabs and carefully slide the collar onto the pyramid making sure that each of the four edges of the collar are aligned with the corresponding edge of the pyramid. Work through the bottom of the collar to make sure the tabs are properly seated on the collar. With the collar resting on a level surface, the pyramid should be pointing straight up.
14. The nose shoulder is made similarly to the collar, only it is 2" high and the sides are each 1-3/16" wide. Cut a piece of cardboard 2" wide by 4-3/4" long. Score at 1-3/16", 2-3/8" and 3-9/16" from one end.
15. Crease along the score lines and glue together with a 2" connector.
16. When the glue is dry, place a mark in the middle of the shoulder 1" from both ends. Check that one end of the shoulder will slide into the collar close to the middle mark and that the other end will slide into one end of the body prism with a snug fit. The collar and body prism should be touching with no gap. Mark which end goes into the collar and which end goes into the body. Also, mark the end of the body prism. If the shoulder is loose, glue a strip of paper around it until the fit is snug. The fit with the body prism is more important, since that is where the rocket will split apart during ejection. The shoulder will eventually be glued into the collar, but not right now.
17. Now make a bulkhead to go into the shoulder, by setting the shoulder upright on a piece of cardboard and tracing around the outside of it, twice.
18. Cut both bulkhead pieces out by cutting just inside the trace lines. Glue the two pieces together so that all four edges are even.

19. When the glue is dry, fit the bulkhead into the shoulder about 1/4 ". If it is too large to fit, trim the edges slightly until it does fit. Do not glue yet.
20. Drill a small hole about 1/16" in diameter near the center of the bulkhead.
21. Make an attachment loop from piano wire. Use size 13-1/2 wire which is 0.032" in diameter.
22. Cut a piece of wire about 2" long. Using needle nose pliers form a loop in the middle of the wire leaving a half inch straight section at both ends.
23. Insert both ends of the wire into the hole in the bulkhead and spread them apart so they lay flat against the bulkhead.
24. Cut a piece of cardboard about 3/4" square and glue it over the ends of the wire onto the bulkhead. Make sure the cardboard does not extend past the edge of the bulkhead.
25. Insert the bulkhead into the shoulder about 1/4" and glue on both sides.
26. Insert the shoulder into the collar about halfway and glue, making sure the wire loop is facing out.
27. The bottom half of the shoulder should fit snugly into the body prism. If it is too loose, glue a strip of paper to the shoulder as needed.

Construction of the motor mount

The motor mount will be sized for a low-powered 18mm motor. It consists of a motor tube, motor block, motor clip, two centering rings and a hold down strip. It is strongly suggested to use Elmer's glue for making the motor tube and motor block.

1. A jig is needed to make the motor tube. There are two types.
 - a. Clean the insides of two used motors and glue them end to end with the sides flush.
 - b. Use two of the short yellow tubes that are used to correctly position the motor block in the motor tube and glue them end to end with the sides flush.
2. Cut a sheet of paper 3-1/2" by 12" long. This could be two 6" long pieces.
3. Start wrapping the paper around the jig making sure it is tightly wound. Glue the end of the paper to itself but make sure not to glue it to the jig. Twist the jig or slide it back and forth to make sure it is not being glued.
4. Wrap the rest of the paper around the jig and glue the end down. If using two pieces of paper, glue the first piece down after wrapping and then wrap the second piece. Make certain that both ends of the tube remain even while wrapping. Remove the jig and set the motor tube aside to dry.
5. Use a standard piece of 8-1/2" by 11" paper of any color to make the motor block. Cut three strips 11" by 1/4". Cut one in half and discard one half.

6. Obtain a 1/2" dowel and wrap both long strips and the single one-half strip around the dowel to make a ring, keeping the sides even. Glue each strip beginning and ending making sure not to glue the paper to the dowel.
7. When finished, slide the ring off the dowel, place it on a hard, flat surface and press down to make the sides even. Spread a slight film of glue on each side of the ring to prevent it from distorting. Set the motor block aside to dry.
8. Use size 13-1/2 piano wire (0.032" diameter) to make the motor clip. Cut a 4" length of wire. Using needle nose pliers make a 1/4" oval loop at one end. Bend the loop so it is perpendicular to the rest of the wire. With the loop setting flat on a horizontal surface, the rest of the wire should be vertical. Measure 3" along the wire from the loop and bend the end of the wire (about 1/2" long) perpendicular to the 3" section and pointing in the same direction as the loop. Set the motor clip aside.
9. The motor mount centering rings are made from cereal box cardboard.
10. Measure the inside of the bottom of the body prism and cut four squares that are slightly larger than this measurement. They will be trimmed to fit later.
11. Sand the printed sides of each square and glue them together in pairs printed side to printed side.
12. Place one of the squares on a flat surface. Take the motor tube and stand it on end in the center of the square. Make sure there is the same amount of the square showing on all four sides of the tube. Do not squeeze the tube and distort it into an oval. (A rocket motor can be slipped into the tube to make sure it is not distorted) Trace around the tube. Remove the tube and check that there is a circle centered in the square.
13. Using a hobby knife cut the center circle out of the square. Stay just inside of the traced line. Insert the motor tube through the center hole to check the fit. Do not distort the tube. (A rocket motor can be slipped into the tube to make sure it is not distorted) If the tube does not fit use the knife to enlarge the hole evenly until the tube does fit.
14. Prepare the second square the same way as the first one.
15. Take one of the squares only, and using the knife cut a slit about 1/8" from the edge of the center circle toward the adjacent corner. The slit should be wide enough so the wire motor clip can move back to allow the motor to be installed into and then removed from the rocket.
16. Cut out a 1" square from paper, cardstock or scrap cardboard to serve as the hold down strip.
17. Take the motor tube and choose one end to be the top. Put a ring of glue 3/4" inside this end. A popsicle stick is handy for this. Insert the motor block into the other end and push it 2-1/2" in so it contacts the glue. The short yellow spacer tubes are good

- for this step. Be sure to remove the tube quickly or it could get stuck inside and a new motor tube and block will be needed. Wait for the glue to dry.
18. Make a small hole 2-3/4" from the bottom of the motor tube. This is for the end of the motor clip and should be just above the motor block.
 19. Insert the motor clip into the small hole so that the clip is flush against the motor tube. Make sure the loop at the bottom end extends toward the center of the tube. The short piece of wire that extends through the hole can point in any direction.
 20. Slide both centering rings onto the motor tube. The one with the slit for the clip goes at the bottom about 1/4" from the end of the tube. Make sure the wire goes into the slit. The other centering ring goes just below the small hole at the top. Check that the motor clip is straight up and down.
 21. The sides of one of the centering rings must be parallel to the respective sides of the other ring. If they are not, the motor mount will not fit into the body prism. To check that they are parallel, place the assembly on a flat surface, press down on both rings and make sure they are both touching the surface with no gaps. Confirm that the loop is still pointing correctly and the clip is straight against the tube. Glue both rings to the tube. Do not get glue into the slit on the bottom ring, the clip wire must be free to move. Before the glue dries, check that everything is aligned properly.
 22. Place the clip hold down strip over the wire just below the top centering ring and glue it in place. Make sure it does not restrict the wire from moving into and out of the slit on the bottom ring. If it does, cut the hold down strip smaller.
 23. After the glue has completely dried, try inserting the motor mount into the body prism (insert into the end that was not marked for the nose pyramid) so the bottom of the motor tube is flush with the bottom of the body prism. (A rocket motor can be slipped into the tube to make sure it is not distorted) If it will not fit, do not force it. Trim whichever sides are too large. Try to remove the same amount from opposite sides of the ring so that the motor tube remains centered in the ring. Trim small amounts at a time until the assembly just slides in easily but does not get too loose.
 24. Remove the mount and measure the distance from the bottom of the tube to the top ring. Place a ring of glue into the body prism at a slightly less distance so the ring will slide through the glue when inserted. Insert the motor mount assembly about halfway. Tilt slightly to one side and place glue on the bottom 1/4" of the body prism all the way around except avoid getting glue near the motor clip wire, it must be free to move. Push the mount all the way in until the motor tube and body prism are flush with each other.
 25. Once the glue is dry, tip the rocket upside down and place more glue between the centering ring and body prism, remember to avoid gluing the clip wire.

Construction of the fins

The square rocket will have four identical fins. The fins will be clipped delta type, 2" at the root, 1" at the tip and 3" long. They will be two ply and have two ½" wide flanges attaching them to the body prism.

1. Each fin starts with a strip of cardboard 7" by 2". Have the printed side facing down.
2. Starting from one end of the strip move ½" and draw a line across the strip.
3. Move 3" more and draw another line. This should be right in the middle of the strip. Mark a dot in the middle of this line, 1" from the top and bottom of the strip.
4. Move 3" more and draw another line which should be ½" from the other end.
5. Draw a line from the middle dot to the top of each line located ½" from an end.
6. Cut along both of these lines.
7. Use a bone knife to score all three lines and then crease the lines. The center fold will be a mountain fold, the two folds near the ends will be valley folds.
8. Lightly sand all of the printed surfaces.
9. Glue the two fin sections together, printed side to printed side. The ½" flange sections should be perpendicular to the fin, one on each side.
10. Make four fins.
11. Glue the flanges of one fin onto each side of the body prism at the bottom end. Make sure each fin is centered on the body and is perpendicular to it. The leading edge of each fin should slope downward to the tip, and the trailing edge should be perpendicular to the body at the base.

Finishing

To finish the rocket, make launch lugs in a similar method to that used for the body prism. Make them an inch long with 4 sides 3/16" wide. Glue the first side directly to the last side, no connector tab is needed. An alternate method is to make a strip with five panels, overlap the first and last sections and glue them together. Make two lugs and place one at the bottom of the rocket and one near the center of gravity. Make sure they are perfectly aligned with each other. Add a standard shock cord and paint. Prepare for launch with a parachute and wadding.

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