1. Construct cutting jig (Figure 1)

- Cut 14 in. x 16¼ in. wood rectangle (thickness = ¾ in.)
- Cut the following lengths of 2½ in. x 1½ in. wood rectangles: 19 in., 11¼ in., and 10¾ in.
- From one corner of 10¾ in. rectangle cut diagonally toward the opposite side a length of 3¾ in. obtaining an angle of approximately 35°
- Using two screws, attach the 19 in. piece to the underside of the board 1½ in. from the bottom and 2¾ in. from the right edge (may need adjustment depending on vertical band saw used)
- Attach two other pieces (using two screws each) to the front side of the board, against the left edge, at a 37.5° angle. The inner top corner of the 11 ¼ in. piece should sit at top left corner of the board, with outer corner of piece protruding slightly over the top edge. The 10¾ in. piece should be parallel to the 11¼ in. piece, 3¾ in. below it. The bottom outer corner of the 10¾ in. piece should align with the bottom edge of the board.

Figure 1: Cutting jig (a) underside (b) top
2. Cut tubes

- Set cutting jig on vertical band saw, using bottom piece of wood as guide
- Place one (1) ft piece polycarbonate (Lexan®) tube (outer diameter = 4 in., thickness = 1/8 in.) on the cutting jig. The tube should protrude so that it is aligned with the band saw blade
- Using the guide bar on the jig, slide the jig toward the blade while holding the tube firmly in place. Continue motion until cutting is complete
- Trim the straight side of the tube so the longest length measures 9 in. (short arm) or 10 in. (long arm)

3. Grind tubes

- Use a grinding wheel to smooth and even out the cut edges until they align (V shape) without gaps. Maintain cut angle during process

4. Construct gluing jig (Figure 2)

- Cut a 14 in. x 14 in. wood square (thickness = 3/4 in.).
- Cut a 2½ in. x 3½ in. wood rectangle (thickness = 1½ in.).
- Use one (1) screw to attach rectangle 1½ in. from the bottom edge of square, centered between sides
- Cut two (2) 10½ in. x 2½ in. wood rectangles (thickness = 1½ in.).
- Mark one (1) edge of the long side at 7½ in. and cut from the mark to the opposite corner at an angle of approximately 40° (direction closer to mark)
- Make this cut on both wood rectangles
- Arrange the two pieces so that the diagonals are facing opposite sides of the square and are parallel to the edges of the square (will result in a vertex centered above the rectangular piece attached to the square). Diagonals should be approximately ½ in. from the edge of the square and the corners of the opposite side. Vertex should protrude slightly over the edge of the square
- Use two screws to secure each piece to the square, one at each end
5. Glue V-mixer tubes

- Check for good fit for one short and one long tube with smooth cut
- Apply solvent cement (WELD-ON - 4 FAST SET clear water thin solvent cement for acrylics) to the angled cut ends of both pieces using a small brush
- Secure pieces together in the “V” shape and apply pressure
- Set “V” in welding jig (Figure 2 b). Use duct tape to maintain pressure

6. Construct drilling jig (Figure 3)

- Cut two (2) 21 in. x 14 in. wood rectangles (thickness = ¾ in.).
- Drill five (5) holes in both boards as follows:
  - one (1) hole centered on long side (10½ in. from either end) and 5 in. from rectangle bottom
  - two (2) holes ½ in. higher than first hole and 6½ in. to the side – one (1) hole to the left and one (1) to the right
  - two (2) holes 2¼ in. from top. Each hole 9 in. from the side - one (1) hole to the left and one to the right, leaving a space of approximately 3 in. between holes
- Attach the two boards together using five (5) lengths of threaded bar (between 8 in. and 12 in.), one in each hole
- Place a washer on each bar between the board and the nut (10 nuts and 10 washers are needed)
7. Drill V-mixer hole

- Set “V” shaped tube in drilling jig, with vertex facing up ("V" must be straight)
- Tighten nuts on one side of the jig (tighten slowly and in small increments to ensure boards remain parallel to each other)
- Once “V” is secure, center the jig on the drill press
- Drill a hole at the “V” vertex (1 1/8 in. hole saw attachment)

8. Cut and glue vertex outlet connector tube to “V” tubes

- Cut a 2 in. piece polycarbonate tube (inner diameter = 1 in.)
- Using the vertical band saw, cut a “v” out of the 2 in. piece to fit the vertex hole drilled in the “V” tubes
- Fit vertex outlet connector to the vertex hole. If necessary, use sandpaper to smooth the edges
- Apply solvent cement (WELD-ON - 4 FAST SET clear water thin solvent cement for acrylics) to both pieces. Fit pieces together without forcing
- Apply pressure until set (Approximately 3 min. for WELD-ON )
9. Construction of shaft and connection to V-Mixer

The shaft attaches the mixer to the motor. It is made from 1¼ in. polycarbonate rod.

- Cut a 4½ in. length of polycarbonate rod (D= 1 ¼ in.) using vertical band saw

  ➢ Cut out rounded angle on shaft (Figure 4)
  - Draw a straight line, at least 6 in. long on cardboard
  - Draw a second line intersecting the first line at a 127.5° angle; 3½ in. from either side of the original line. The second line should be 2-3 in. long.
  - Line up the 4½ in. piece of rod with the straight line. Position it so that you can see both ends of the diagonal and use the diagonal to draw a line with a marker on the rod at the same angle
  - Set the rod at drill press so the diagonal line on the rod is perpendicular to the floor
  - Cut down the diagonal line ( 4 in. hole saw attachment)

![Figure 4. Rod construction](image)

  ➢ Drill shaft attachment hole
  - Turn shaft piece so that flat side faces up
  - Center piece at drill press and drill (depth = 1½ in.) with 5/8 in. drill bit

  ➢ Drill set-screw hole
  - Lay shaft piece horizontally on drill press and drill a set hole about ¾ in. from the flat edge
Thread set-screw hole
- Tap the set-screw hole (3/8-16 tap).
- Turn the tap one full revolution clockwise followed by a half revolution counterclockwise. Repeat sequence until hole is completely tapped
- Screw 3/8 in. set-screw

Glue shaft
- On long tube, approximately 1¼ in. above the bottom of the “V” connection and opposite it, draw a circle (Diameter = 1¼ in)
- Sand surface of “V” in the circle
- Apply solvent cement (WELD-ON - 4 FAST SET clear water thin solvent cement for acrylics) to sanded portion of the “V” tube and to the angled part of the shaft
- Press the pieces together and hold until set

Epoxy connections
- Reinforce and fill any gaps in the connection of the “V” with epoxy
- Do same for the connection of shaft connector with the “V”

10. Cut lids and tabs
- Designs can be developed using AutoCAD® or SolidWorks® (Figure 5)
  - 41/8 in. circle, elongated on two opposite sides by ½ in.
  - the elongated portions of the 41/8 in. circle only, with edge of the circle as one of the sides
  - 1¼ in. circle, elongated on two opposite sides by ½ in.
  - the elongated portions of the 1¼ in. circle, with edge of the circle as one of the sides

Figure 5: Lids and tabs (a) large tab (b) large lid (c) small tab (top) small lid (bottom)
11. **Cut rubber gasket**

- Hold lid down firmly with one hand on a piece of rubber (thickness = 1/8 in)
- Cut along edge of lid with Xacto® knife using other hand

For cleanest edge, use one cut for entire lid. Use same process for large and small lids.

12. **Drill holes in lids and tabs**

- Drill hole in each tab using hand drill (1/8 in. drill bit) approximately 1/8 in. from the outer edge
- Drill hole as above to each side of the lid. Holes should align with holes in tabs, allowing enough room for small bolt head

13. **Glue tabs to “V”**

- Lay lid on top of the “V” tubes
- Line tabs under lid against side of “V” tube
- Mark on tube where tabs start and end
- Sand tube surface where tabs will be attached
- Apply solvent cement (WELD-ON - 4 FAST SET clear water thin solvent cement for acrylics) to both, inside edge of tab and sanded tube section.
- Clamp tab to the tube and allow to set

Follow the same procedure for the connector tubes and small tabs.

14. **Glue rubber to lid**

- Make a hole in rubber gasket (small Xacto® knife) aligned with hole in the lid
- Set lid on top of gasket to ensure the holes and edges are aligned correctly
- Apply clear drying household glue to the lid and place gasket on top
- Allow glue to dry completely before using lid

Follow this process is for both the large and small lids.

*This work is part of a publication in progress.*