Teaching Module V-Mixer
Design and Construction Instructions
Student: Sara Gettings
PI: Z. Otero Gephardt, PhD, PE
Department of Chemical Engineering
Rowan University

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.
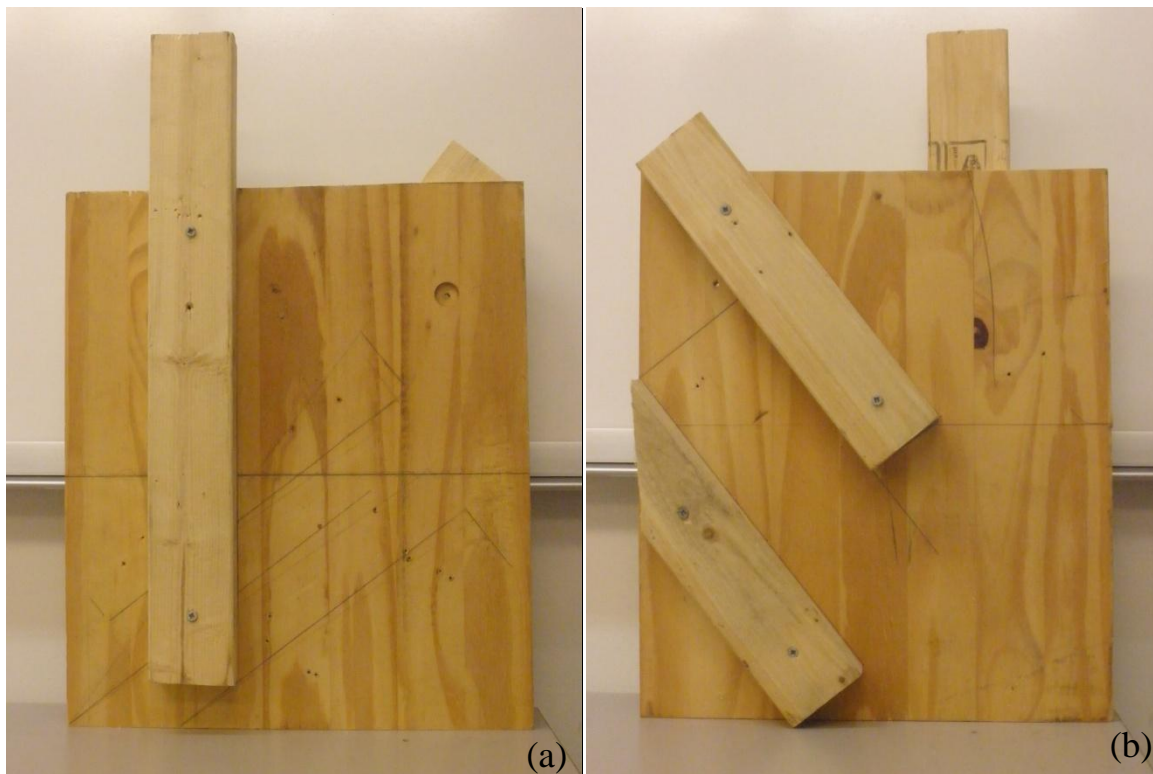

Figure 1: Cutting jig   (a) underside   (b) top

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. x14 in. wood square (thickness= ¾ 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 7¼ 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
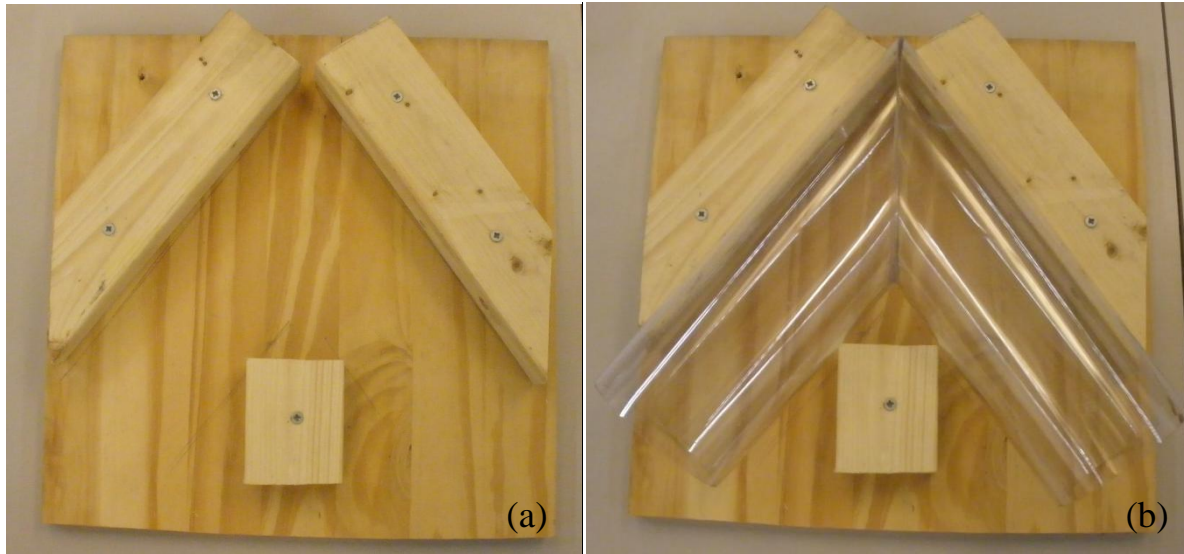- Use two screws to secure each piece to the square, one at each end

Figure 2: gluing preparation (a) gluing jig   (b) gluing pieces

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
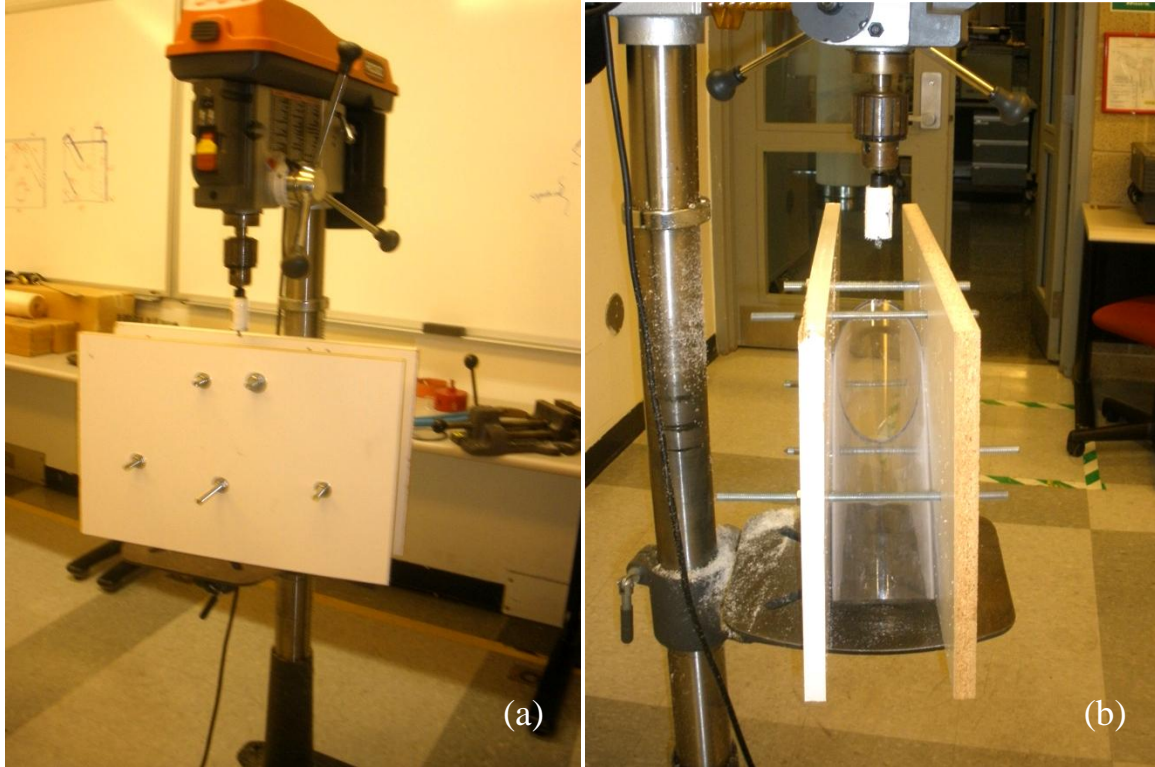- Place a washer on each bar between the board and the nut (10 nuts and 10 washers are needed)

Figure 3. Drilling jig (a) set at drill press (b) side view at drill press

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)
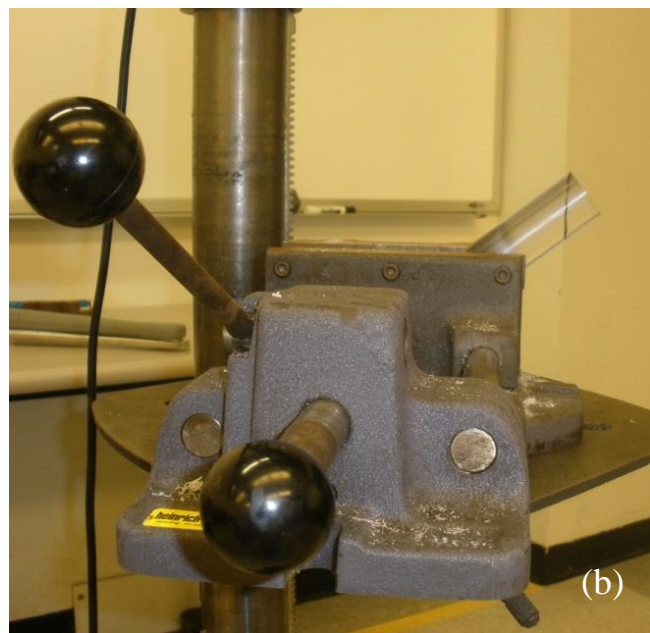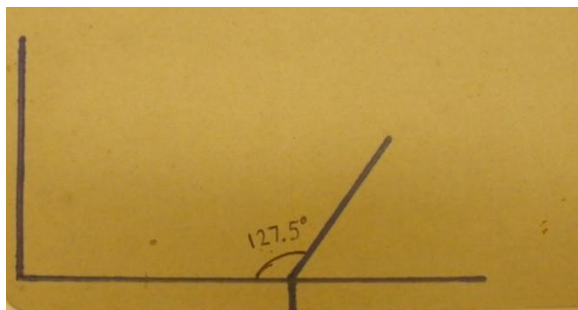

Figure 4. Rod construction   (a) design   (b) on drill press

  ➢ **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 counter-clockwise. 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
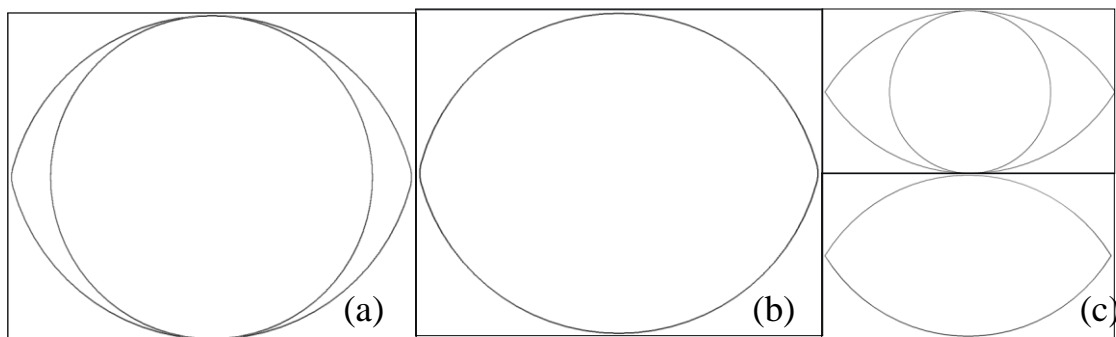

Figure 5: Lids and tabs (a) large tab (b) large lid (c) small tab (top) small lid (bottom)

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.