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OVERVIEW

These instructions will guide you through the process of creating a scale model (1" = 1') of a simple, single wide manufactured home (13' 4" x 52'). The design model (Waldon) was provided by Homes of Merit (Lake City, FL).

The process makes use of the Transformative Laboratory Center (TLC) equipment, including the CNC router, laser cutter/engraver, and 3D printer.

With this model, students will be able to manipulate components in a variety of ways to help them understand scale, structural relationships, and the manufactured construction process.

MATERIALS

3

3/4 in. plywood base: 2- (20"x30") pieces, 4- (2"x28.5") pieces, 4- (2"x20") side pieces

24 gage, thin steel sheet: 2- (20"x30")

3/8 in. 4x8 ft. sheet Medium Density Fiberboard (MDF)

1/4 in. 4x8 ft. sheet of veneered plywood

5x2 ft. vinyl floor plan sticker or paper base floor plan (optional)

20"x60" paper to print floor plan on (optional)

Magnets:
    1/4 x 1/8 in. – wall sections to base

    1/8 x 1/16 in. – trusses to walls

3D printer material

Spray paint

Spray adhesive

Super glue

Construction screws: #8 -1 3/4" in length (for base)

Hinges/Hardware 2- (2 in.)

Sandpaper 120 grit

Forstner bit 1/4 in.- walls

Forstner bit 1/8 in. - trusses

Application tape

EQUIPMENT

Laser engraver

The laser cutter is used to etch the framing details precisely and legibly onto each wall surface, showing students plan-level detail without compromising the strength of the material.

3D printer

The appliances that are placed in the model scale are created using the 3D printer.

CNC router

Wall panels are cut from MDF stock on the CNC router.

Drill press

The press is used to create holes in the walls and trusses which magnets will be placed in to hold pieces together.

Hand held drill/impact driver

Note: If unsure how to operate machinery, consult the manufacturing manual or a knowledgeable advisor.

MASTER LIST OF FILES

WD_Router.dwg

WD_LaserTruss.dwg

WD_LaserWalls.dwg

WD_VinylFloorPlan.dwg

WD_Drawings.dwg

Appliances

WD_Tub

WD_Toilet

WD_BathVanity

WD_WaterHeater

WD_BaseCabinets

WD_UpperCabinets

WD_Fridge

WD_Stove

Note: All appliance files will be .stl

## CREATING THE BASE/STORAGE UNIT (OPTIONAL)

Base floor- Cut ¾" plywood to correct size (20"x 30") and pieces (2)

Sides- Cut ¾" plywood to size (2"x 28.5") (4)

Ends- Cut ¾" plywood to size (2"x 20") (4)

1.   With construction screws and a drill/screwdriver, screw all end pieces to the side pieces to form a rectangle. Make sure the pieces are secured.

2.   If you are joining the two pieces together, install hinges/hardware on the two conjoining sides.

3.   Cut steel with tin snips, or other device made for cutting steel, into correct sizes (20"x30") (2).

4.   Apply super glue to wood frame, then place steel on top side of wood base and let cure

Note: When the two sections of the base are folded in half it should form a box/enclosure which can be used for storage and easy transportation.
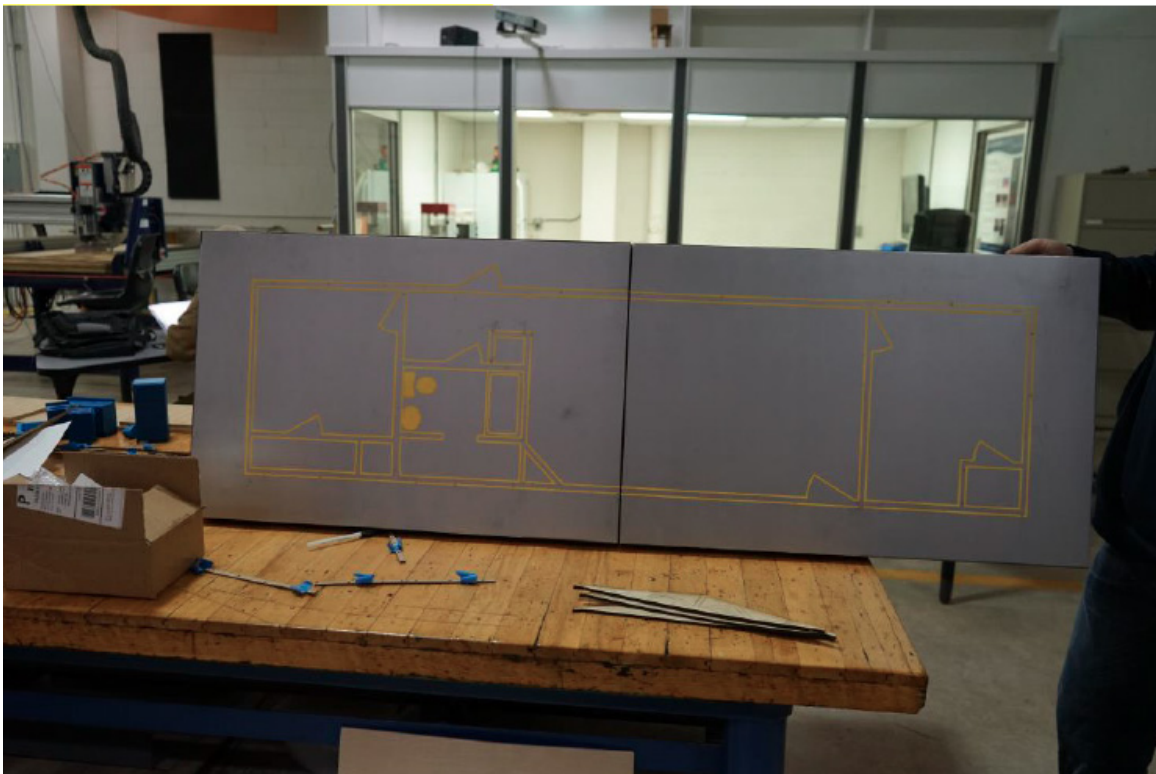
CREATING THE FLOOR PLAN LAYOUT

CUTTING THE VIYNL

1.   Set up page size to be larger than the floorplan (23" x 48" page size).

    a. Ensure all line widths are 'hairline' .

    b. Text should be outlined with a hairline and set to 'no fill'.
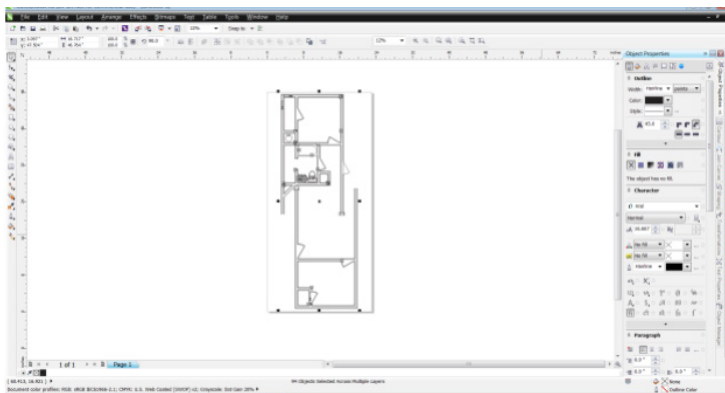
2.   Select 'File, Print'.

3.   Select 'Preferences', set page size to match CorelDRAW page size (23x48) (both should match actual material size).

4.   Hit 'Print'. The machine will then begin cutting.

5.   Once cutting is complete, seperate the excess vinyl from the floorplan items.

6.   Apply Application Tape to the floorplan

7.   Line up floorplan on base and apply. Remove only application tape.

CREATING WALL UNITS

CUTTING WALLS ON THE CNC ROUTER

You will use the CNC machine and Medium Density Fiberboard (MDF) to cut out the walls.

1.   Lay MDF on CNC table and line up edges.


2.   Secure MDF to the table with a drill and construction screws. To do this, screw the corners to the bed of the machine.

3.   Open Partworks software to program the machine.

       a. Setup software to match material size to be cut.

       b. Import file with layouts of all the walls.

       c. Draw circles to define holddown screw locations (1" circle to allow buffer).

       d. Switch between drawing and toolpath mode (icon with blue arrow).
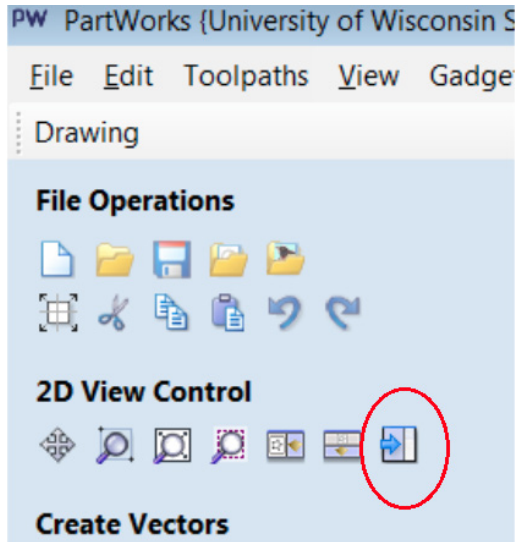

    e. Click 'create drilling toolpath'
         i.   Select circles for holddown screws.
   ii. Enter cut depth of drill to be 0.150".
         iii. Hit calculate.
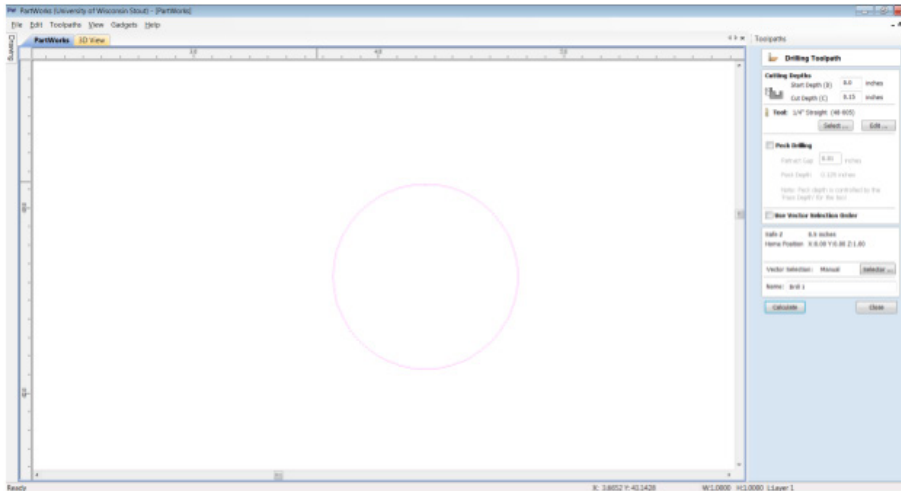
   f. Create new profile toolpath for cutting.
     i. Set cut depth 0.030" deeper than material thickness.
     ii. Select tool from library (¼" diameter used).
     iii. Select cutting process to be 'outside' the line.
     iv. Add tabs to each part.
     v. Calculate toolpath.

   g. Save toolpaths.
     i. Save drill toolpath separate from cutting toolpath.
     ii. Ensure all needed toolpaths are selected and in correct order.
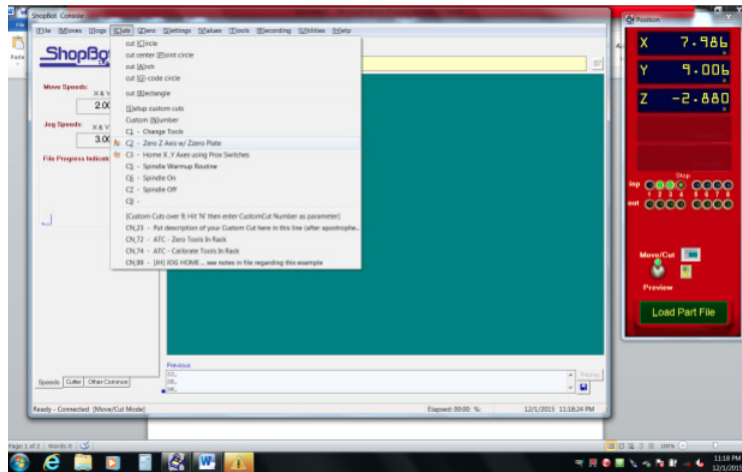
4. Switch to ShopBot3 software to set up machine.

   a. Set machine to be home at 0,0. Home X Y axis using Prox Switches to set the machine.
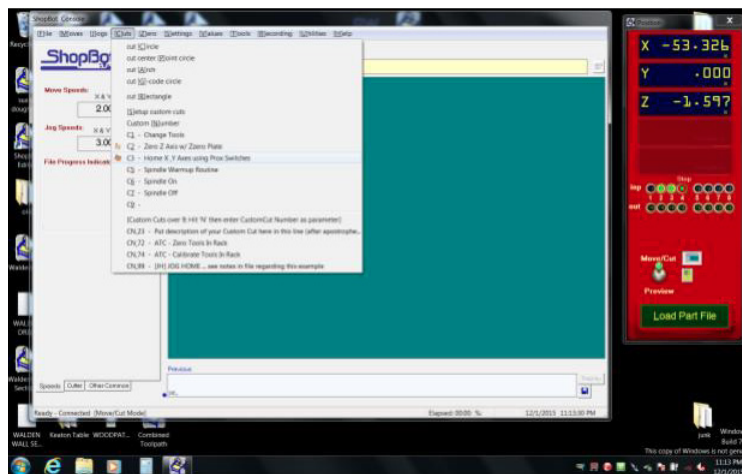
   b. Program 0: Set X Y zero to define program 0,0 location.
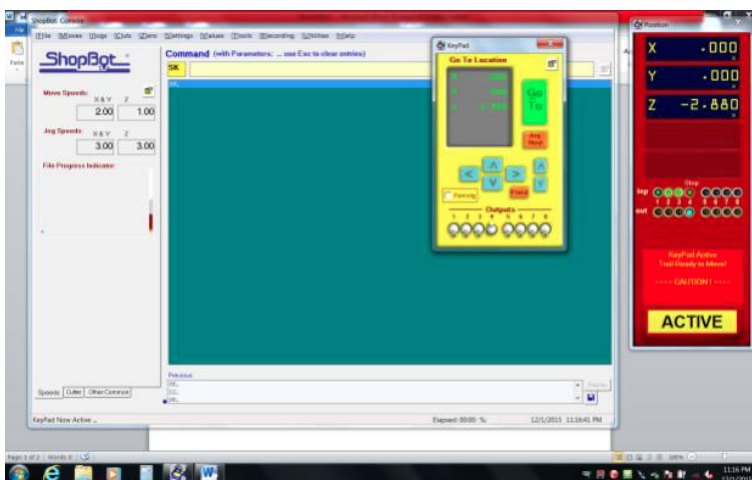
c. Z 0: Use Z 0 plate to define Z 0 location. Install Z 0 plate on top of material and under cutting bit and connect wire. Find the command in menu to start process.

d. Set router to appropriate depth.

5.   Run screw hold down program to locate where the rest of the screws are needed. Install screws in marked locations to hold sheet down.

6.   On the computer, click "load parts file", and select program to cut out wall profiles.
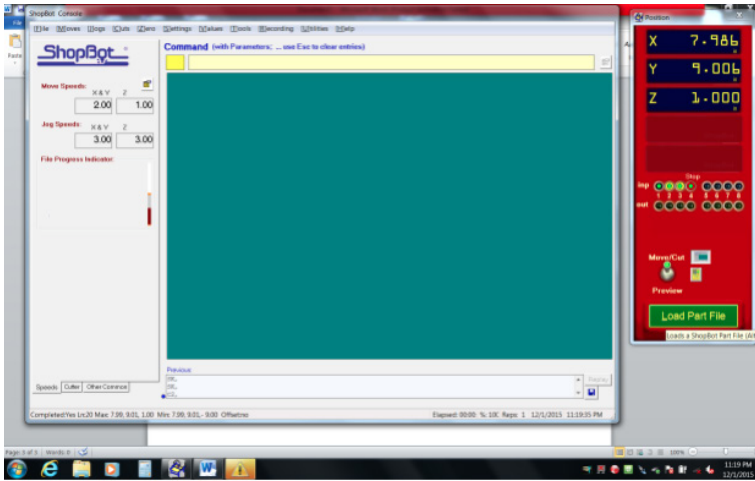
7.   Allow CNC Router to cut out the pieces.

AFTER CUTTING

1.   While the walls are still in place on the CNC table, take a pencil and label with numbers. (Refer to WD_Router.dwg)

2.   To remove walls, use a chisel and mallet to knock off tabs still attaching desired piece to MDF board.

3.   Sand lightly to remove any leftover tab debris.

Note: Marking the walls with their number will help avoid confusion when engraving them. (Refer to WD_ Router.dwg)

4.   Move over to laser engraver to etch in details of the walls.

CREATING A KNOWN CORNER

This process creates a corner that the machine and computer can use to correlate to each other.
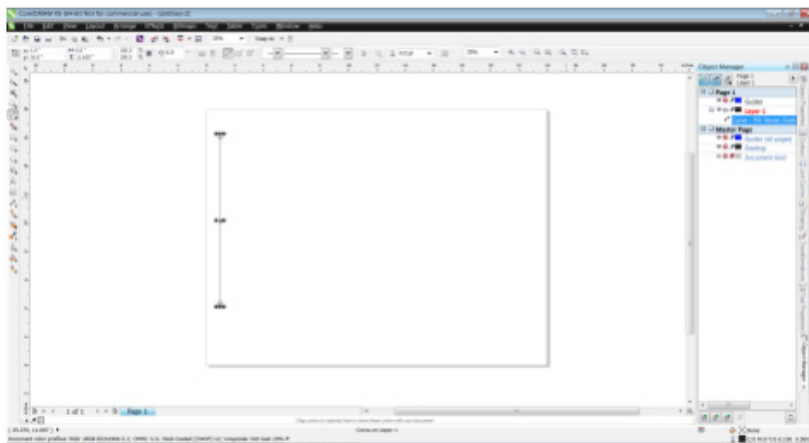
1. Open CorelDRAW and setup page size to match bed size (24" wide x 18" tall).
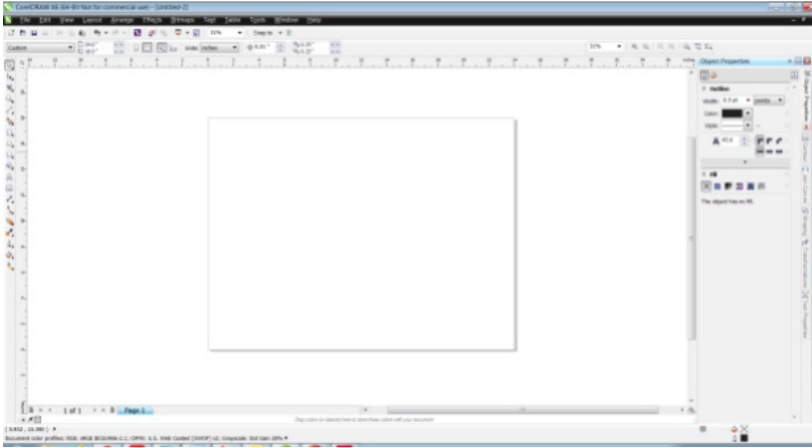
2. Draw 'L' to create false corner on machine. This will be cut into corrugated material to define a known point on both computer and machine.

    a. Location of corner is x=1, y=16, as seen in top left corner, defined by square box icon and numbers.

    b. On the X-axis, measure 1" to the right.

c. Measure 16" up on the Y-axis. This is your new corner point. This point ensures a precise starting point for a wall or building section, resulting in an accurate/scaled model piece.
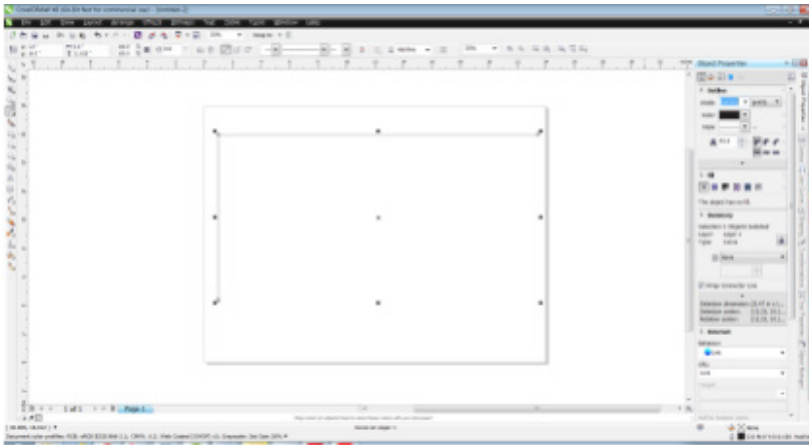
d. All axis measurements are to be taken in the lower left corner.

3.   Lay the corrugated material on the engraver table.

Note: These engravings need to be precise. Creating a new coordinate point away from the original place will make the process easier to monitor.

4.   Ensure corner drawn on previous step is set to hairline.

5.   Click file, print to set up machine for cutting.

        a. Edit preferences to define speed and power relative for material.

   b. Send to machine by hitting print.
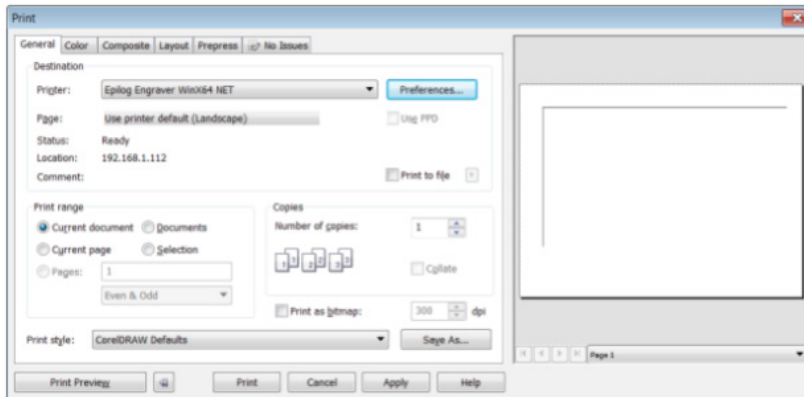
        c. Hit green 'go' button on machine to start cutting.

6.   Once false corner is created, leave corrugated template in machine. This is the new location to locate wall sections on machine and drawings on computer.

ETCHING FRAMING DETAILS

Grab wall sections from router, carefully noting which wall is being marked and which side is facing up.

1. In CorelDRAW, you will need to dock 'Object Manager'. All wall images will then be stacked on top of each other. You will need to show or hide layers to be engraved into the material based on which wall is in the engraver. This is where labeling the walls is helpful. Set top left corner to X=1", Y=16", the same location as the false corner.
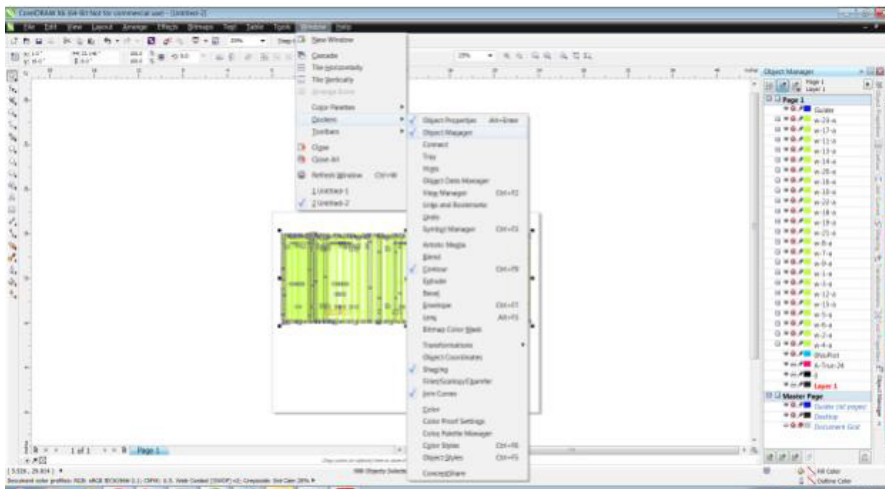
2. Move stack of drawings to location of the new false corner.

3. Place a wall unit on the engraver bed.

     a. Fit the unit snug against the new false corner created with the corrugated material. Ensure the top left corner of wall is placed into corner, and divots are on the bottom.
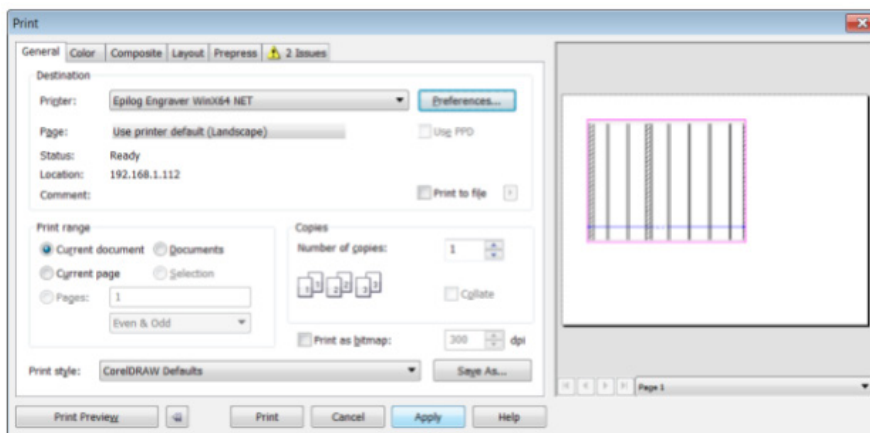
4.   In CorelDRAW, 'show' correct layer. A side is up when cut on router.

Note: The 'show' icon is the human eye next to the + icon.
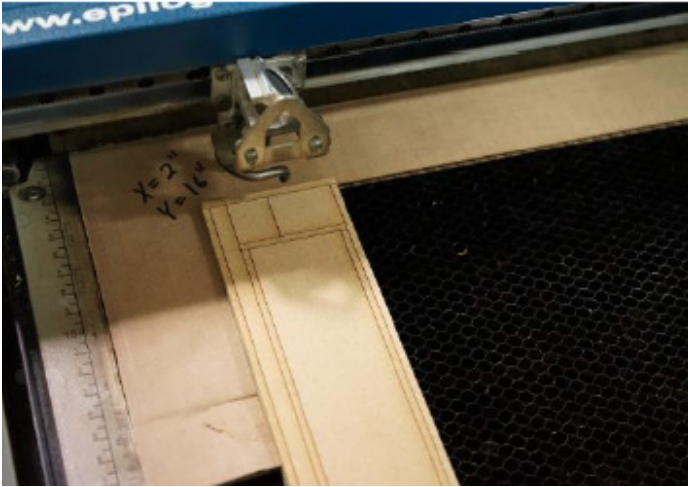
5.   Set up machine settings.

a. Choose "file, print". Adjust the settings (90/80/500). The settings are adjusted so the lines are engraved instead of cut through material.

b. Send to machine using 'print'. Hit go on the machine to etch details of side A.

6.   Engrave the material.

6.   Flip wall on the engraver bed.

          a. 'Show' 'B' side in CorelDRAW.

          b. Send program to laser and hit go.

7.   Repeat the process for all insides and outsides of walls.

Note: Notice the file naming conventions. Each wall has two wall-detail files, a side A and side B.

PLACING THE MAGNETS

Be sure to double check that the polarity of the magnets match with the correct side, so that the magnets will attract (N-S, S-N).

Drill set up

Small divots are cut into ends of the pieces during the cutting process. locate these divots and measure to the center. This is where you will drill the holes.

You will use a 1/4 in. Forstner Bit to drill the holes in wall units, and use a 1/8 in. bit to drill holes for the trusses at a depth of 1/8 in.

1.   Use a drill press to drill two holes for the magnets.

        a. Use press to drill holes in wall bottom.

b. Add a drop of glue to each hole and press the magnets in.

Note: Make sure correct magnet size is used for each application. (See below for size references)

Magnets 1/4 x 1/8 in. –used to attach wall sections to the base.

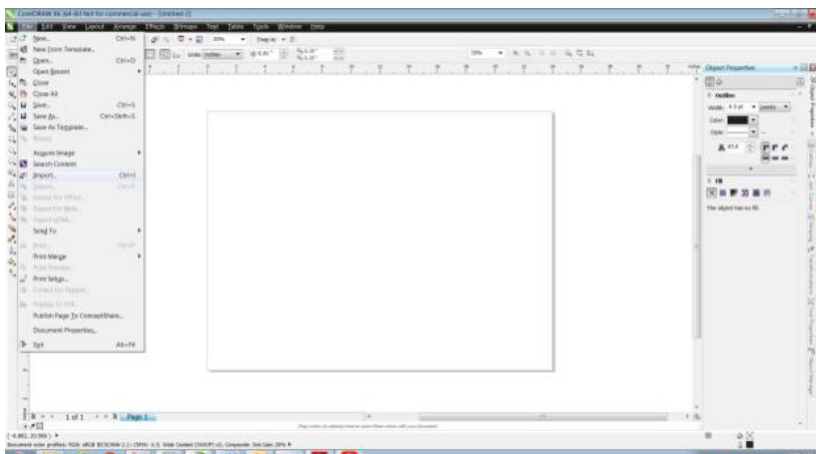Magnets 1/8 x 1/16 in. – used to attach the trusses to the walls.

CREATING THE TRUSS UNITS

Cutting and Engraving On The Laser Engraver

The trusses will be created entirely through use of the Laser Engraver.

1.   Take a 1/4 in. sheet of plywood.

2.   Import the MD_Truss.dwg file. (See master list, page 5)


3.   Locate top left corner (0,18) and delete the outer bounding box. Change line width of the outer edges to be hairline. Change interior details line witdth to a wide line (3 pt.).
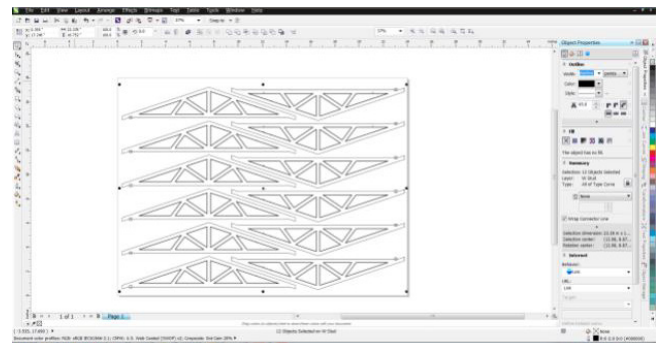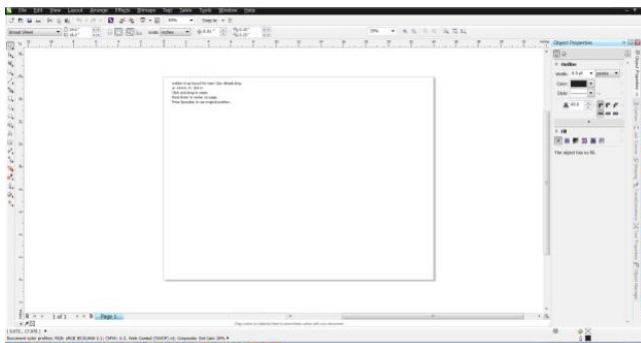
4.   Set cutting depth for cutting through 1/4" wood material.

5.   Check vector settings and cut out the outlines of the trusses using the laser engraver.
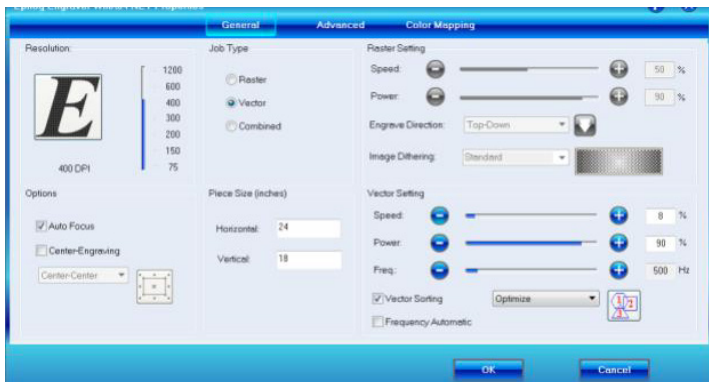
6.   Leave cut pieces in the machine. Invert the line widths (change outer to 3 pt., inner to hairline). Set up machine for vector engraving to add interior details. Add to both sides. Check the vector engraving settings.
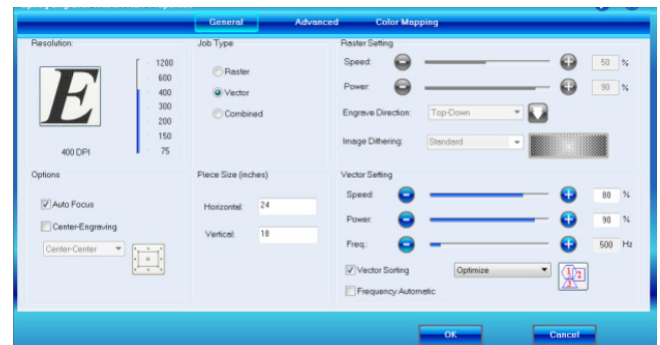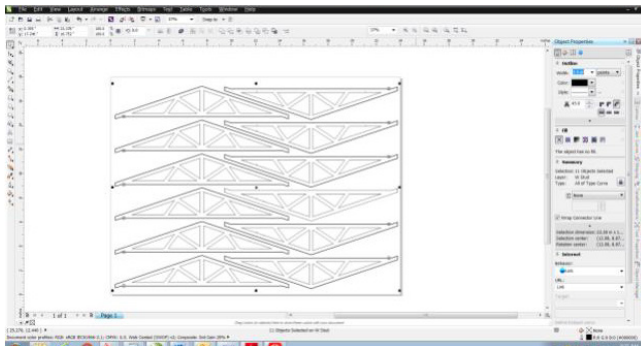
7.   Engrave the details of the truss units onto the plywood sheet using the same machine.
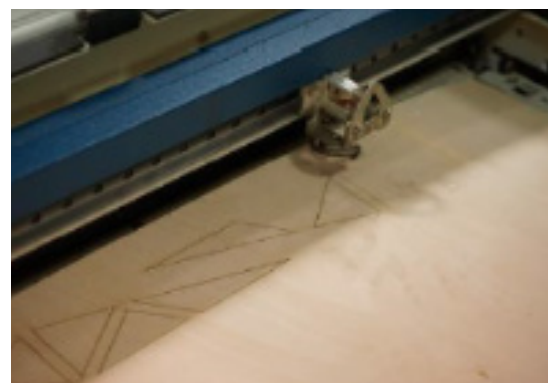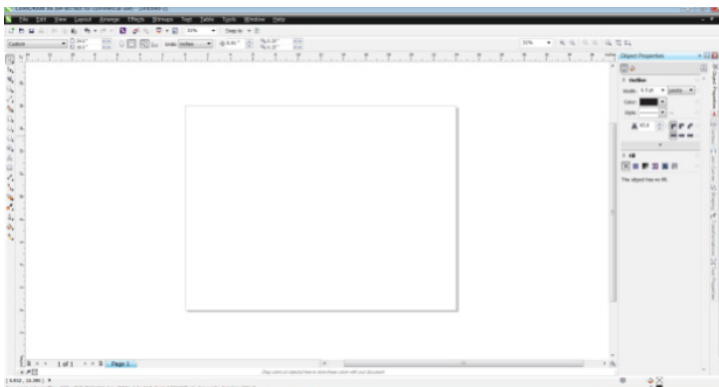
8.   Place the magnets. Repeat the process that was done for the wall units. (See page 20 for reference)
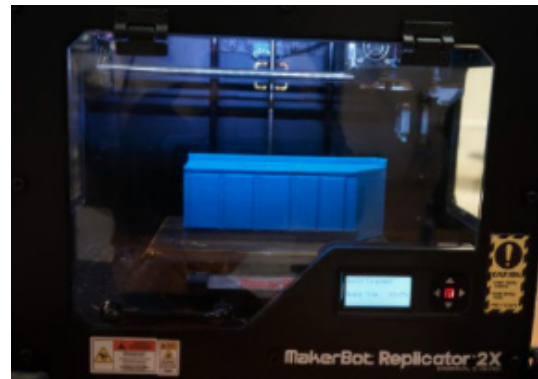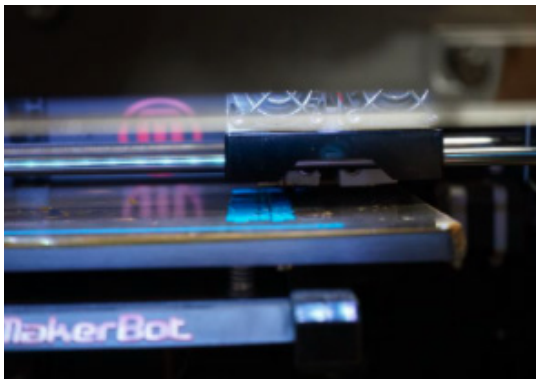
CREATING THE 3D APPLIANCES

Open MakerBot Desktop software.

1.   Click 'Add File" and select .stl of desired object from the files provided. (See master list, page 5)

2.   Verify the dimensions and scale to be used.

3.   Place material in 3D Printer.

4.   Begin printing. There are two ways to print on this machine; while connected to the machine, or by saving to an SD card.

       If connected to the machine:
           a. Hit "print in the top right corner
           b. Hit "start Printing" once processing is complete
           c. Wait for parts to complete

       If saving to SD card:
           a. Hit "export print file"
           b. Install card in machine
           c. Use GUI to "print from SD"
           d. Wait for parts to complete

5.   Repeat this process until all the appliances have been created.

Refer to appliance list below:

       a. Tub
       b. Toilet
       c. Bath vanity
       d. Water heater
       e. Base cabinets
       f. Upper cabinets
       g. Fridge
       h. Stove