# Cornell ESW Prefabricatable Oven

Las Mujeres Solares de Totogalpa have expressed interest in designing a cooker that can be easily shipped to new locations as their business expands. Furthermore, Richard Komp PhD, Director of Skyheat Associates, described an instance in Peru when people who constructed ovens could not transport the ovens to their homes due to the unwieldiness of carrying a large, heavy oven up a mountain on a llama.

The goal of our group is to design, construct, and test a box cooker that can easily be manufactured and shipped. The new design will involve new, lighter materials - such as thInner fiberglass pipes in place of wood for a frame, and a rugged replacement for the glass panel. The new design will also make the actual manufacturing of the solar cooker into an easy process. One source of inspiration would be Ikea products and how easily all Ikea furniture could be built. One of the ways we hope to make the cooker easier to ship and transport is to make it out of prefabricated parts. Of course, to design and create a solar oven that is easily transportable and assembled, the overall mass of it must be reduced.

# Second Prototype

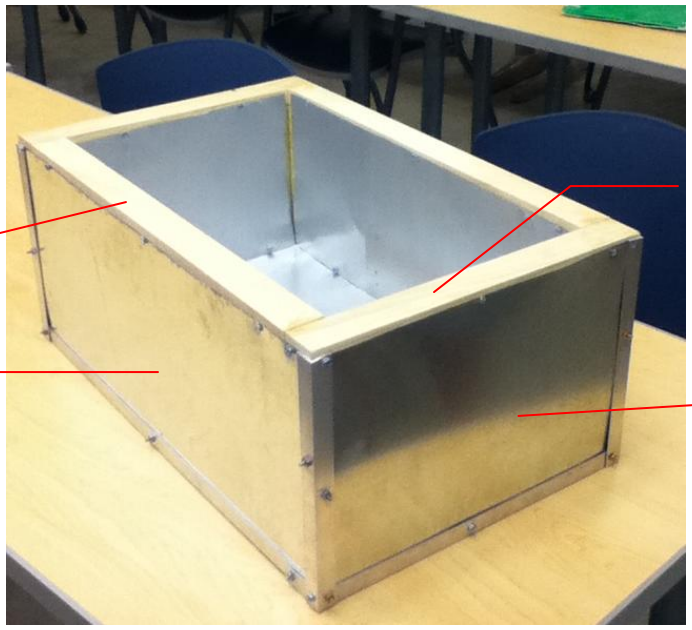
Our second prototype is very different from our first prototype. The new design still features an inner and outer box. However, this design will not hinge the boxes or use any pop rivets. Instead, angles bent into rectangular frames will form the main strucuture of the outer and inner box. The walls will be bolted to the angle frame. The insulation used will be high density fiberglass board, compared to the fiberglass batting used in the first oven. This fiberglass board will give some structure to the oven, thus requiring less supporting structures. The new design also features a top opening door. The size of the second prototype is much smaller than our first prototype. The cooking volume of this design will be 19”x11”x7.375”( LxWxH), and the oven’s total volume is 22”x14”x11”.

## Construction Manual

Overview of Design:

This oven will consist of an inner and outer box constructed out of sheet metal. Angles will be bent to form bottom frames for the boxes. Angles will also be attached to the corners of the outer box to reinforce the structure. High density fiberglass insulation board will be used as insulation and will occupy the space between the outer and inner boxes.

The following labels explain the meaning of “side” and “front/back” in terms of the oven




## Materials (all dimensions in inches unless otherwise indicated):

| Part Name | Material | Quantity | Dimensions |
|---|---|---|---|
| Top Covering Sides | Wood | 2 | 10x2x1 |
| Top Covering Front/Back | Wood | 2 | 22x2x1 |
| Door Sides | Wood | 2 | 14x1.5x0.75 |
| Door Front/Back | Wood | 2 | 19x1.5x0.75 |
| Cooking Plate blocks | Wood | 5 | 1.5x1.5x0.5 |
| OUTER BOX Angle Bottom Frame | Aluminum Angle | 2 | 38 |
| INNER BOX Angle Bottom Frame | Aluminum Angle | 2 | 32 |
| OUTER BOX Vertical Angles | Aluminum Angle | 4 | 9.5 |
| OUTER BOX Side Walls | Steel Sheet | 2 | 14x9.5 |
| OUTER BOX Front/Back | Steel Sheet | 2 | 22x9.5 |

| | | | |
|---|---|---|---|
| Walls | | | |
| OUTER BOX Bottom Plate | Steel Sheet | 1 | 22x14 |
| INNER BOX Side Walls | Aluminum Sheet | 2 | 11x7.375 |
| INNER BOX Front/Back Walls | Aluminum Sheet | 2 | 19x7.375 |
| INNER BOX Bottom Plate | Aluminum sheet | 1 | 11x19 |
| Black Plate | Aluminum sheet | 1 | 10x18 |
| Bottom Insulation | Fiberglass Board | 1 | 22x14 |
| Side Insulation | Fiberglass Board | 2 | 11x7 |
| Front/Back Insulation | Fiberglass Board | 2 | 22x7 |
| Wire Frame | Steel Wire | 2 | 6 ft. |
| Plastic Glazing | High Temperature Cooking Bags | 2 | n/a |

## Procedure:

First cut all the metal pieces to the required dimensions. It is recommended that you do not initially cut the wood and insulation pieces. Due to mistakes and imperfect cuts, the final wood dimensions may need to be altered to fit the design.

*Bottom Angle Assembly*

1) Take the 38 inch angle and mark 2, 14, and 22“ long portions. Using a machinist square or other 45 degree angle make a 90 degree at the 2 and 14“ markings.

2) Using a vertical band saw (or a hack saw) cut on the outside of the line such that the final angle is greater than 90 degrees. There should be 2 of these cuts at the 2“ and 14“ mark. File the cuts down so that they are smooth.

3) Repeat steps 1 and 2 for the other 38“ angle

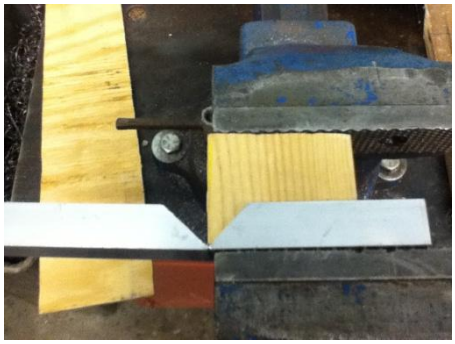
4) Now take the 32“ angle and mark 2, 11, and 19“ long portions. Using a tri-square make a 90 degree angle at the 2 and 11“ markings.

5) Repeat step 2 with the new angle.

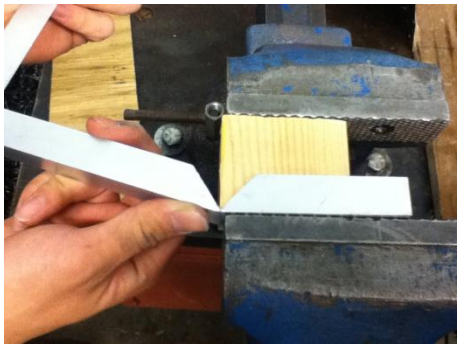
6) Repeat steps 4 and 5 for the other 32“ angle.

*Bending Angles*

1) Take a block of wood and align the corner with the center of the 90 degree cut.



2) Using your hands, grasp the angle firmly and bend it around the corner of the wood.



3) Using a hammer, lightly tap the angle close to the corner (locations indicated by arrows) of the wooden block, so that it conforms to the wooden block. This will make sure the angle is bent exactly 90 degrees. Take care to not bend the corner too tight, which will fracture the metal at the bend.

*Assembling the Frame*

1) Take the two 38“ long angles that now have been bent, and form a rectangle that is 22x14. The outer box bottom plate should be able to fit into this frame. If not, future dimensions will need to be altered to fit.

2) Clamp the two angle pieces together after they are in a rectangle. Drill a hole through the overlapping pieces of angle on each side of the rectangle and bolt the frame together. Make sure the hole is at least an inch from the corner, as we will need to bolt the vertical angles later.

3) Now place the front wall so that it is against the innerside of the bottom frame. Drill a hole through the wall where the wall meets the hole near the corner. Now drill 3 holes through the wall and angle, and then bolt the wall into place.

4) Repeat step 3 for the front wall.

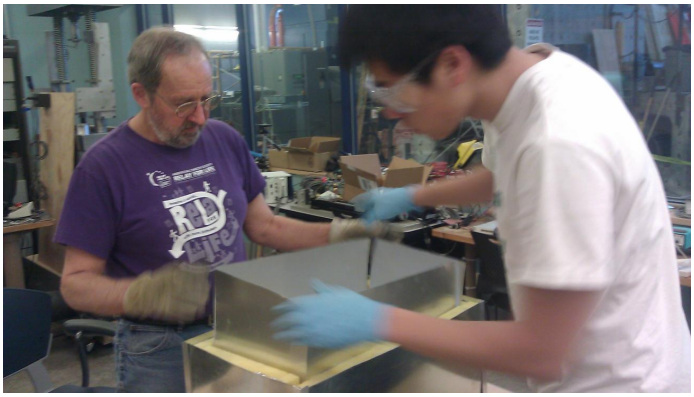
5) Align the 9.5” inch vertical angle with the corner of the outerbox. Drill a hole at the bottom and bolt into place. Now drill a hole at the middle. Bolt all the new holes that have been drilled. The following is an image of what the corner of the outerbox should look like.

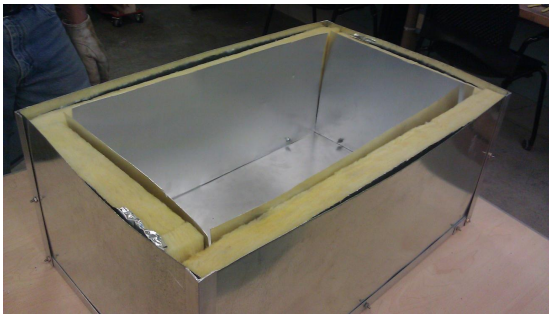
6) Assemble inner bottom frame using steps 1-5 but now using the inner box angle components and inner box walls (Note: There are no vertical angles for the inner box)

*Insulation and Wood*

1) Place the bottom insulation at the bottom of the outer box. Now place the side insulation alongside the side walls, and the front and back insulation alongside the front and back walls.

2) Slide the innerbox into the outerbox.

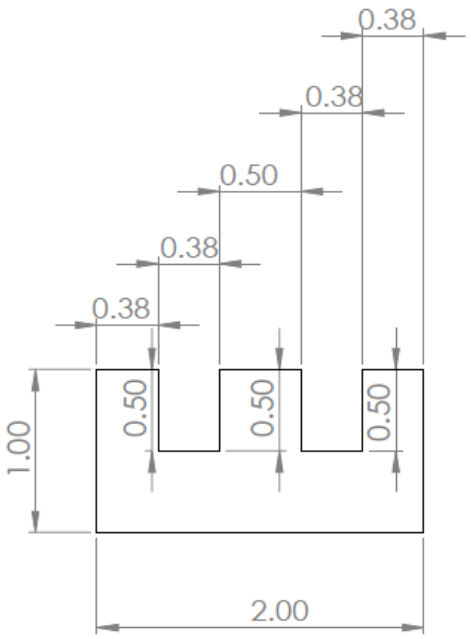




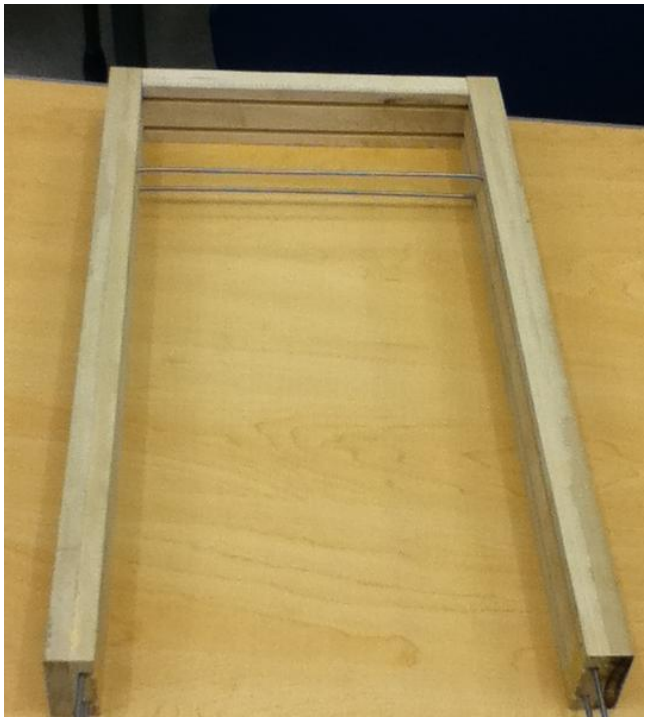
3) Put the Top Covering Sides and Back/Front pieces where the insulation is exposed. Make sure the pieces are level and drill into place: First drill the vertical angles to the wood, then drill the wood to the outer walls at the center of the walls. Then drill the wood to the inner walls.

*Door*

1) Cut the slots in the Door Sides and Front/Back pieces as shown in the diagram below.




2) Using wood glue, attach the Door Front/Back pieces with one Door Side piece with the slots facing inwards. The door should look like the following:

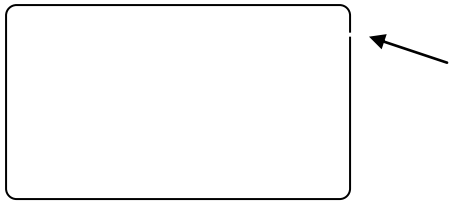


3) Once the glue has cured, center the door on top of the oven. Using two hinges, attach the door to the back top wood pieces.

*Wire Frames/ Glass Covering*

1) Bend the wire in a 90 degree angle 1 inch from the end of the wire by hand. Insert this corner into one of the corners of the door.

2) Using the door as a guide, continue to bend the wire at the appropriate points until you have a rectangular frame that fits into the door slots. The frame should look something like this



3) Using a high temperature resistant tape, tape the frame together at the location of the arrow.

4) Take one of the high temperature bags and slide the wire frame into the bag.

5) Run a soldering iron about a ¼ inch away from the wire frame along all sides of the frame to create a seal and cut off the excess plastic.

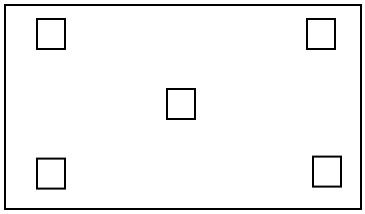
6) Repeat steps 1-5 for the second piece of wire.

7) Slide the wire frames into the door.

8) Screw the other Door side piece to the door to finish the oven.

*Black Plate*

1) Take the 10x18 piece of aluminum sheet metal and paint it black using a high temperature paint.
2) Attach 1.5x1.5x0.5 wooden blocks to the plate in the following arrangement.



3) Attach the plate to the bottom of the inner box.

## Notes about our construction process

Difficulties during construction process:

We didn't cut the sheet metal pieces too well so the oven had many mismatched dimensions. Having straight cuts will make the construction process a lot smoother.

Our top door covering were too small since the final dimensions of the oven were not the anticipated dimensions. It is recommended to cut the top covering and door frame after the main oven has been assembled to ensure a proper fit.

It is difficult to bend angles into perfect plate dimensions. Many other components depend on the dimensions of the angle bottom frame, so it is very important to be very precise when constructing the angle frames.

There were multiple gaps in the corners of our inner box due to mismatched dimensions and mistakes during the construction process. These gaps can be sealed with some reflective tape.

The front and back top covering wood was able move since the frame consists of four separate pieces. It is a good idea to glue the side pieces to the front and back pieces for a more rigid and stable oven.

The outer walls need to be higher so that it will align with the top wood covering or even be taller than the wood covering.

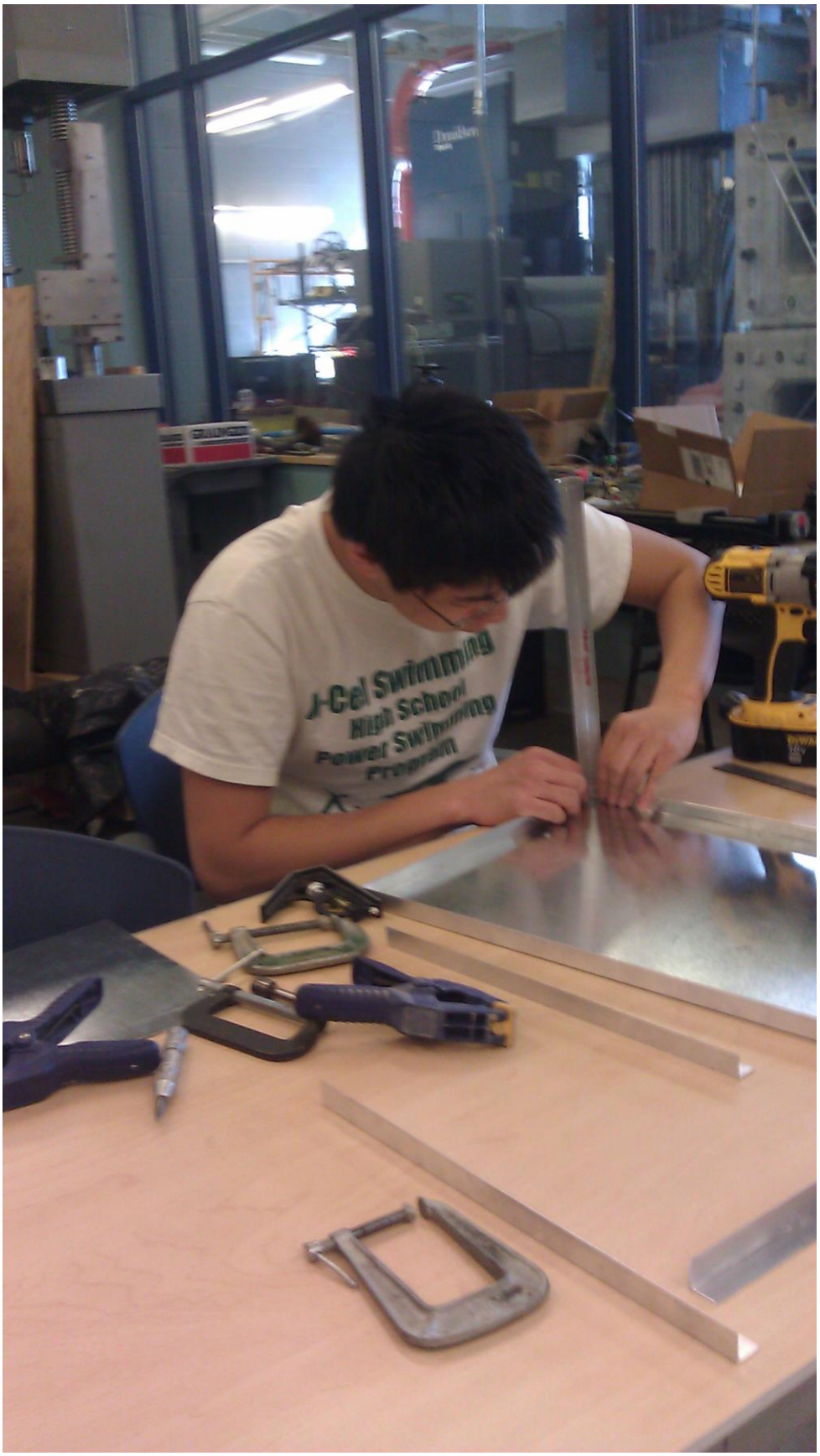
## Things that can be improved

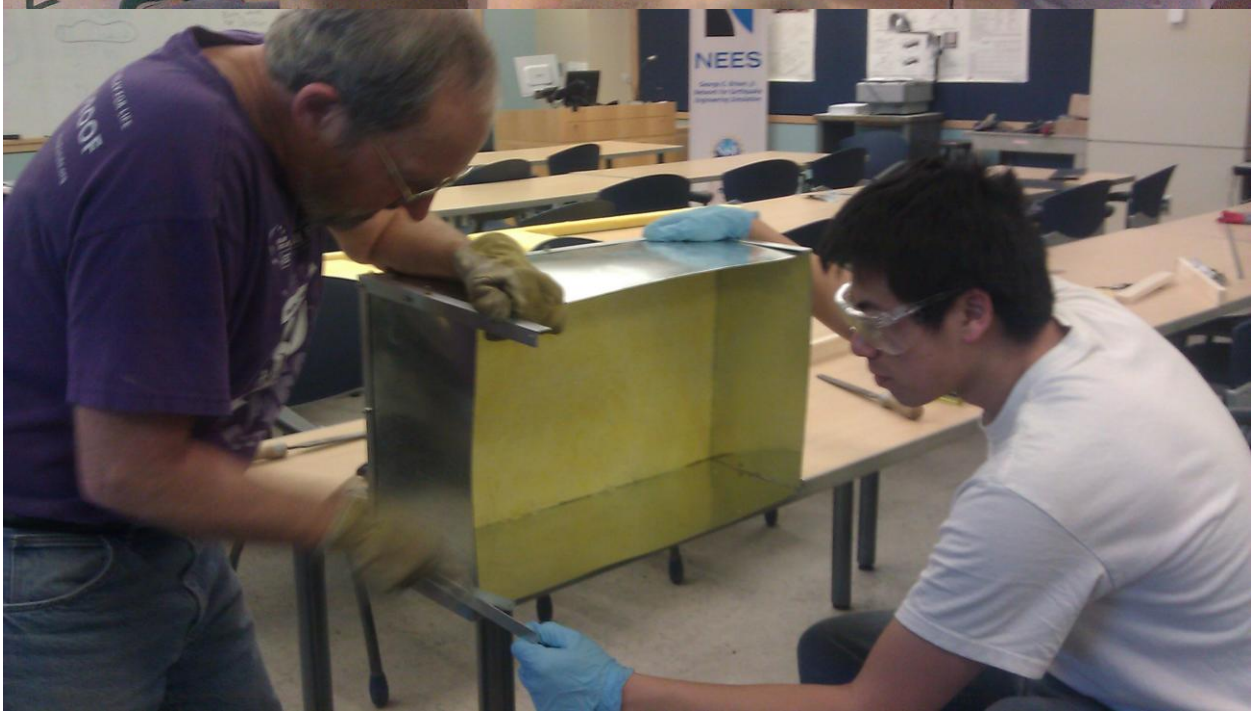
Since it is pretty lightweight, we should make the cooking area bigger so that it can fit 2 pots more comfortably

## Additional notes

If fiberglass board is not available, regular fiberglass batting could also be used in this design. Must add wooden supports for bottom plate, but everything else should work.

Additional Pictures


J-Cel Swimming
High School
Power Swimming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