Work Completed:

Once all the components of the gripper were machined and placed together, Megan and I decided that each component was too wide. When we tested the device in action, many of the components towards the bottom of the gripper were contacting one another and thus hindering the fluid motion of the gripper.

On Wednesday, Megan and I went to the machine shop to resize each of the pieces. In order to make sure each piece was uniform, lines were measured and drawn on each panel. Each screw hole was used as a reference and one-centimeter lines were drawn on each side. All excess material beyond these one-centimeter lines would be removed.

When arriving at the machine shop, we had originally planned to use the bandsaw for this process. Upon speaking to the staff of machine shop, we decided that the bandsaw did not offer enough control for the small amount of material that we were planning on removing. Instead, it was suggested that we use the belt sanding unit to thin each piece. The belt sander is much more practical for this process since it has the capability of providing a smooth and straight edge.

Megan and I alternated sanding each piece. The machine was simple and quick to use. Each piece was held against the belt sander with equal pressure applied to each area. The piece was held against the sander until the reference line reached. Next the piece was turned over and the bottom was quickly sanded to remove an excess material and burrs. Since PVC is not a conductor of heat we were able to hold each panel with our hands. Once these steps were completed, all edges of each panel were again rounded to ensure safety for our client. The larger square panel that will function as a connection for many of the panels and gears was also decreased in size by one inch. The same belt sanding process was also used for this piece.

Figure 1: Megan belt sanding each panel.
After each panel was thinned, we then tried to reassemble the gripper to see if no pieces were contacting one another. When we tried to assemble the device, we realized that at the section where support panels are located above and below the connector panel, the screw holes did not line up. The following day, we went back to the machine shop to make two new panels with the excess PVC that we had. We had traced the two other panels onto the PVC so that they would be exactly the same size when cut. Since this PVC sheet was large we first roughly cut out the new panels with the band saw. Once this was done, belt sander was used to smooth and round the edges of the two new panels.

Now that the panels were made, we now needed to place screw holes in each one. This was done using the drill press in the senior design laboratory. To ensure that each screw hole would be precisely aligned with its corresponding top screw hole, we taped the two panels together and mounted each in the vice of the drill press. Each corresponding panel would function as a template when placing the new screw holes. When drilling, we let the drill first go through the already existing screw hole and then through the solid panel. New screw holes were also made in the large connector panel.

The day before, I had gone to Mansfield supply to purchase screws that were long enough to fit through the three panel connection. The previous screws we had purchased were not long enough. The new screws I purchased were size 625 and one inch long. I also purchased lock nuts instead of the typical metal nut as suggested in our weekly meeting. Once all this was completed, the gripping unit was then reassembled with the new panels. The gripping unit no longer looked as ostentatious and looked less like a children’s toy.

*Figure 2 – The gripping unit before the pieces were thinned*

*Figure 3 – The gripping unit after the pieces were thinned*
After the grippers were assembled, we then weighed each component on a scaled located in the Chemical Engineering Senior Design Laboratory. The following table contains the weights of each component of the arm.

<table>
<thead>
<tr>
<th>Various Weights of Arm Components</th>
</tr>
</thead>
<tbody>
<tr>
<td>Component</td>
</tr>
<tr>
<td>Grippers</td>
</tr>
<tr>
<td>Joint Connectors</td>
</tr>
<tr>
<td>Lower Arm</td>
</tr>
<tr>
<td>Upper Arm</td>
</tr>
<tr>
<td>Motor</td>
</tr>
</tbody>
</table>

Knowing these weights and taking into account the distances that each of these components are located from the shoulder; we can calculate the moments at the shoulder. This calculation was done with the gripper holding a weight of 1.5 and 2.5 pounds in full extension. This calculation was made when the arm was in full extension since it is the worst case scenario. When the arm is in full extension, its center of gravity will be located furthest from the chair. This position thus requires the most torque. If the gripper is holding 1.5 pounds, the torque requires is 93.335 lb*in. If the grippers are hold 2.5 pounds, the torque required is 125.33 lb*in.

After this calculation was completed, we went forth and purchased a motor from the Electric Motor Warehouse website. The motor purchased was similar the one accounted for in our final report. The motor purchased cost $186.00 and provides a torque of 162 lb*in. Since all motors on this site cost the same price, we decided to purchase the motor with higher torque. The amount of torque available in the model below the one purchased was questionable as to whether it would provide enough power. We have now spent $341.45 and have $408.55 remaining in our budget.

Figure 4 – Components from which the torque was calculated
Future Direction:

Once we receive the purchased motor this week, we hope to try to get the grippers functioning. We are also just working with one motor for the now since we are contemplating if we actually need three motors. While we know we will definitely need to two motors, we are questioning if there is a way to program the microcontroller so that the device can function with only two. This will help our budget but and also eliminate weight from the entire device.

Project Progress:

This week our gripping device was transformed. The size of each component was greatly decreased. We have also decided from this that the end gripping panels should also be reconstructed. Reconstructing the end gripping panels will allow us to ensure that they are exactly the same size. Doing this will also make the final product more appealing to the eye.

Total Number of Hours Worked: 12 Hours