Work Completed

My fifth week of BME 4910 was spent working with molds and researching and contacting more companies for the team. My first task of the week was to make the mold for our second Kevlar shell. I started this by scrubbing the previous mold with a brush to remove any remaining flakes and loose pieces.

The mold for the second shell was made on top of the mold for the first shell. It was made in the same manner as the last mold was made. Mold Polish Step 1 was applied then removed. Mold Polish Step 2 was applied then removed. Four layers of parting wax were applied, allowing 45 minutes drying time in between each. The mold was left overnight between the 2nd and 3rd coats of wax. Three layers of PVA release film were then applied on the helmet, with 15 minutes of drying time in between each one. The fourth layer was not added until later because Jim needed the helmet to begin cutting the pinwheel shaped layers.

Since I had experimented with the practice fabric using the pinwheel design, I helped Jim get started with cutting the pinwheel shaped layers. We cut the Kevlar fabric into 8 rectangular pieces, each about one inch longer than the previous layer to allow for any bulk that may have formed. The pieces were then taped to the inside of the helmet and cut in strips and triangles to form around the helmet as shown in Figure 1.

![Figure 1. Cutting pinwheel shaped layers.](image)

This method of using the pinwheel design appears to be much better than the triangle method. As shown in Figure 2, the pieces conform to the shape of the helmet much smoother than the triangles did. This method should also be much stronger because there are large solid pieces, rather than many small pieces.
Jim cut eight layers of Kevlar, which were all taped in the correct orientation on the helmet mold. The layers were removed one at a time and labeled for layer number and orientation in order to prepare them for combination with the epoxy. Jim and Damian made the second shell in one run as opposed to the three sessions of triangle layering on the last helmet. They developed a method of painting epoxy on the bottom of a layer while it was flat on the table, then painting the top of it on the helmet while preparing the next layer. Their method was efficient as shown in Figure 3. The completed shell is shown in Figure 4.
While they were making the helmet, I tried to experiment with the molding clay for the neck guard. I ran into some trouble when the remnants of the mold on the inside of the shell were tearing off and sticking to the clay. I decided to spend some time cleaning the mold off the inside of the shell. It ended up taking much longer than I thought it would, but I was able to get most of the mold off by scrubbing it with a brush and water. The difference can be seen in Figure 5.

After the mold was washed off, I was able to experiment a bit with the clay. I think a shape similar to what I made in Figure 6 will be suitable for the neck guard, as long as it is concave to fit inside the back of the shell. We cannot make our final mold until we decide the exact shape for the rim of the helmet.
I contacted David Paller of the RIH Orthopaedic Foundation in Rhode Island regarding the helmet testing facility there. He responded with several questions about our project and said he may be able to help, but informed me that the lab may be under construction when we need it. I also contacted Dr. Peterson from the UConn Health Center to see if he knew of any labs in the area. He inquired into the nature of the testing and said he may have a colleague that could recommend a facility. I have not heard back from either contact since then.

I also spent some time researching companies that may be able to help make the EPS layer for us. Foam Pack Industries, Foam Control, Cellox, Foam Concepts, and Tri-state Foam all seemed like they may be able to make this for us. Many of these companies specialize in making custom designs for displays, which could apply to our project. However, many require CAD drawings, which we do not have because the EPS layer will be going into a helmet that was made by hand.

**Future Work**

Now that we have two shells made, it is time for us to shape and cut the rims of the helmets. The second shell also needs to be removed from the ACH. Jim contacted some of the foam companies and now we need to decide which method we want to go with so we can start working on the inside of the shell.

Once the shape of the rims has been determined, we will need to make the molds for the chin and neck guards. After that we will be able to start cutting the Kevlar and making the guards. The placement and shape of the guards will probably be the most difficult and time consuming process over the next few weeks.

**Hours Worked**

I spent about 11.5 hours on the project this week. It took roughly 5.5 hours to make the mold for the second shell. I also spent about 2 hours contacting testing companies. It took about
4 hours to research EPS companies, clean the mold off the first shell, and experiment with the clay mold.