Work Completed:

This week work was done in the machine shop to complete the mechanical aspects of the arm. On Monday March 19, 2007 I worked on attaching the gripper device to the hand plates which had been previously machined to hold the spoon. First I used the belt sander to sand down each of the edges on the connectors. The connectors were pieces that we had cut out for the grippers, but no longer needed them. I also rounded the edges. The next step was to take the two connectors and put them in the vice on the milling machine. After Rich help me find the exact center of the two pieces by using an indicator. With this device it is possible to find the lowest spot and then make sure that it stays at zero on the other side. After a bit of trial and error the spot was found and the indicator was replaced by the center bit.

The third step of this process was to create a program on the computer connected to the miller that would give the position of each spot that we wanted to drill at. We decided to drill each hole .125” away from the center on the y axis then on the x-axis the holes were place 1.250” apart. Finally when the actual holes were being drilled, they went .450” down in the z-direction. In this program, once the four sports were created you hit set followed by run then start and finally go. After the first hole you just had to press go to get to the three other spots.

To connect the hand plates to the gripping device screws needed to be flush with the hand plates while screwing to the connector. The first step in the drilling process was to use the center drill bit to start each hole. Next using the 8 x 32” drill bit block the smaller diameter drill bit was placed into the spindle and tightened. In each of the four hole sites it was used to drill the holes .450” deep. Once all of the holes were made in the pieces, the drill bit and colic were removed form the spindle. The center drill was placed in the spindle and the threading device was put on top of the holes. Once enough z-direction pressure was placed on the threader, the spindle was locked into placed. Next I took the side handlebars and started to thread the material going around three times and then retreating back twice. I continued this process until I bottomed out. When all the holes were completely threaded I took the air gun and washed each of them out.

Next the two hand plates were placed into the device holding the spoon to give an accurate account of how far apart we needed everything. Next we set up another program in the computer of the miller that would place the two holes in the hand plates 1.250” apart. First we used the center drill to start the two holes, followed by the larger diameter drill bit. With this drill bit the hole were made directly through both hand plates. To the screws flush with the inner hand plate face, a cone-like drill bit was used to make the top of the hole wider. On the first try of doing this, Rich made the hole on the incorrect side. We corrected it by turning it over and doing it in the correct place. Once we get ready to paint the device, we can putty up the small hole and hopefully no one will notice. Once the holes were completed the hand plates were successfully screwed to the connectors.
using a Phillips head screw driver. Fig 1 shows the finished hand plates. In Fig. 2 is the finished hand plates with spoon attached.

At first we were just going to connect the connector at the back of the hand plate to the gripping device. Once the connection was completed, it was prevalent that there would be a stronger connection if we actually connected the gripping pieces to the top of the connector. To do this we need to make longer gripper ends. This can be seen in Fig. 3. Using material from the extra material bin, I measured out two pieces that would work for the ends. First I cut them out using the band saw. Next I shaved down the edges and smoothed the corners using the belt sander. I cleaned the areas I had been using in the machine shop and returned to the senior design lab.
In the senior design lab I used the drill press with our drill bit that we had been using for the entire project. I clamped the pieces into the vice with the connector on the top with its previous holes. Next I drilled three holes into the new gripper ends, one connected to the top part of the connector near the spoon, one to the bottom of the connector near the spoon handle and one connected to the gripper contraption. Since the connector was a bit thinner that the gripper ends, I traveled back to the machine shop where I sanded it down using the belt sander. Also Rich helped me sand down the spoon handle a bit to make the hand plates shut completely.

The final part of the day was spent putting the connector on to the gripper ends. I tried adding another segment at the end of the grippers, but that caused a lot of movement of the gripper hand plates which would be hard to control. With trial and error I decided to take that segment out. The only other worry I have about the grippers is that they will be too heavy, causing problems when we attach them to the actual arm itself. The completed gripper can be seen in Fig. 4.

On Tuesday March 20, 2007 we finished the mechanical parts of the gripper. First we used a put the gears in the center of the plate in a straight line corresponding to the center line of the two hand plates. Next we measured the outside diameter of the gear
shaft. Using a larger drill bit, we placed it in the drill press after first using a center bit to start the hole. Once the two holes were made the gears were popped in and worked perfectly. The next step was to attach the gripper segment with the top of the gear. First we picked out screw that would be short enough to just go through the gripper piece and the gear itself. Using the drill bit with a smaller diameter a hole was made into the gear. Next the threading device was placed into the drill shaft and using the same method as above threads were installed into the hole in the gear. The final drilling step was to use the larger diameter drill bit to make the hole in the gripper piece. Once this was completed the screws were used to attach the gripper piece to the gear. This completed the gripper working unit. This can be seen in Fig. 5 and 6.

Figure 5: The completed grippers closed

Figure 6: The completed grippers opened

Another project that was attempted with no success was to attach the small motor to the gear. Due to a difference in the shaft size, the motor would not fit into the gear. We tried to pull the top off with no avail. Since the attachment point was not working we
decided to postpone the work until another day. The final arm thus far can be seen in Fig. 7.

Figure 7: The assistive robotic arm completed to this point

Future Work:
Next week the main goal will be to get the grippers in working order. We will need to figure out a way to attach the oversized shaft to the gear on the motor plate. The solution to this would be to first take off the oversized shaft on the small motor. Then we want to machine a small thumbtack device which would have a thin circular top that would lie on the top of the gear and attach to a metal rod that would run through the gear to the motor. This would be a snug fit making sure that the gear would move with the shaft. Another goal for next week is to practice painting the PVC pipes with spray paint. This way we will not have to rush around doing it at the end of the project. The final goal for next week is to figure out a method to attach the gripping device to the actual arm itself without interfering with the pulley system. In regards to the pulley system we need to eliminate friction at the elbow joint in order for the pulley system to be effective.

Project Review:
This week the plan changed a bit on how to attach the hand plates to the grippers. First instead of the original plan to use a glue to secure the hand plates to the grippers, we used flat head screws that sat flush with the inside face of the hand plates. Also in the original design I planned on attaching the grippers to the end of the hand plate. Instead I attached it at the front and the back to add more support. Finally in the original design we did not plan for the shaft of the motor to be too big to put inside the gear shaft. Now we are brainstorming different ways to get the two parts working in tandem.

Hours worked:
12 hours