Build, Assembly, and Debug Plan

Team: P15001: Active Ankle Foot Orthotic

Build, Assembly Plan

Muscles

The following section details the instructions for building a McKibben Muscle

1. Cut the braded expandable sleeving to the desired length using scissors:

Figure 1: Cut Sleeving

2. Cut the inner tubing to desired length. Note: latex tubing shown here; application may be easier with an angled cut.

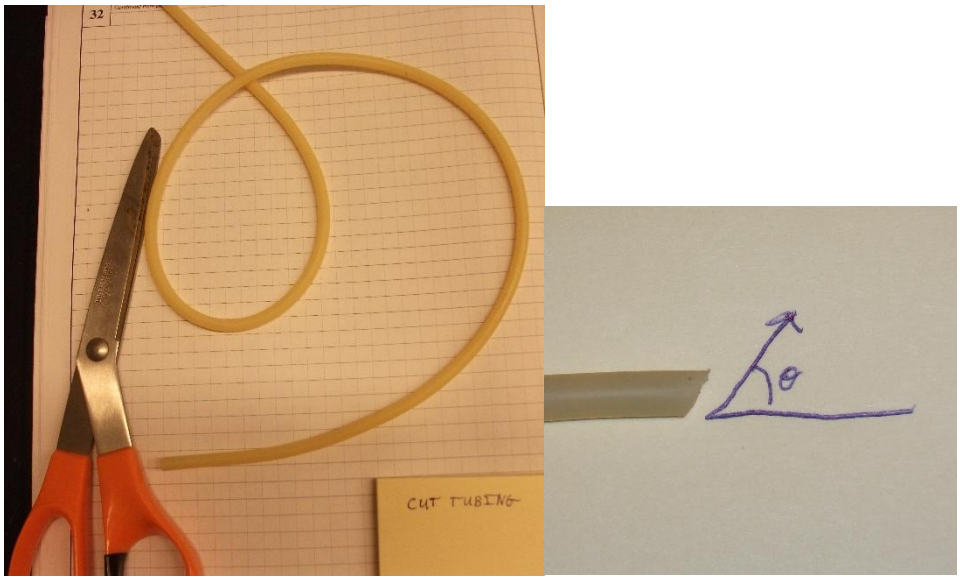

Figure 2: Cut Tubing

3. Cure the sleeving by using a heat gun or a flame:

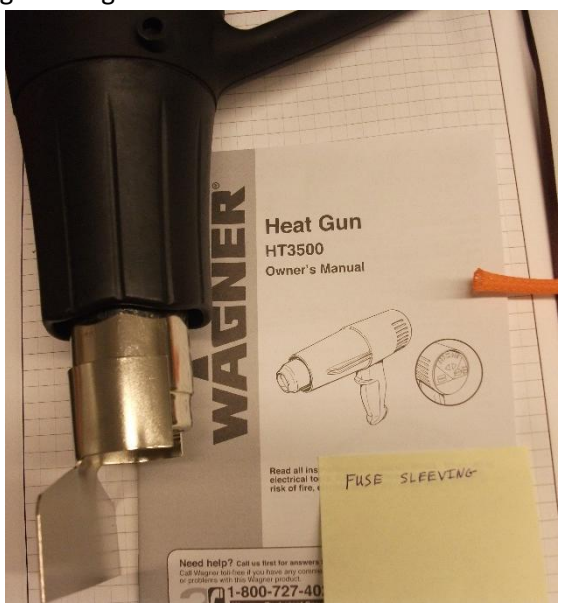

Figure 3: Fuse Sleeving

4. Attach tubing to upper inlet port. Note: Small Philips-head screw drivers may be helpful if used gently; be careful not to puncture or weaken the tubing.

Figure 4: Plug and Inlet Port Attachment

5. Insert Sleeving and secure upper inlet port using specified fastener. Note: zip-tie shown here.

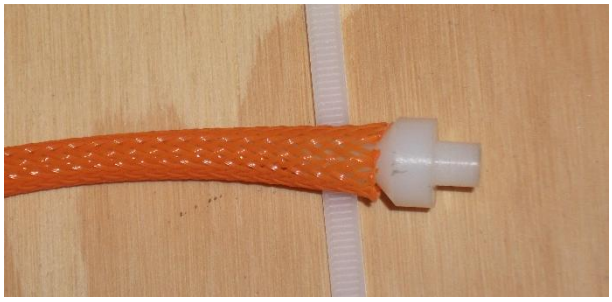

Figure 5: Upper Sleeving Attachment

6. Attach tubing to the base plug and secure using specified fastener. Note: worm clamp shown here; other fasteners may require insertion before attaching base plug.

Figure 6: Attach and Secure Base Plug

7. Attach supply tubing. Note: Alternative design or additional support may also be used.

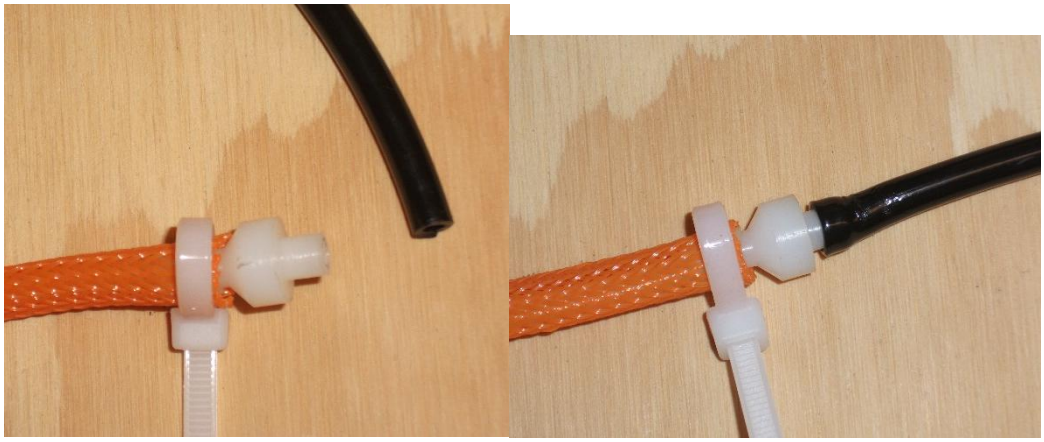

Figure 7: Attach Supply Tubing

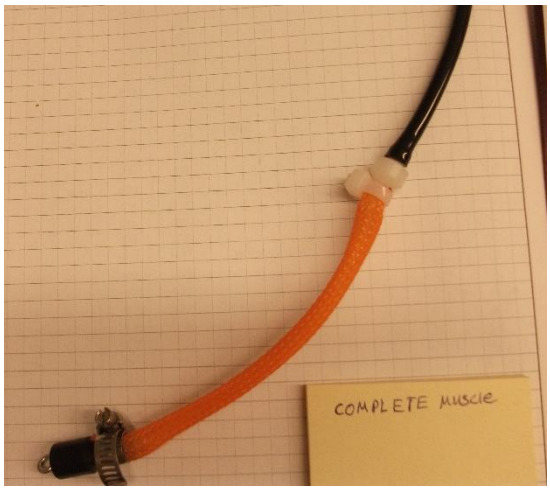

Figure 8: Completed Muscle

Upper Muscle Attachment Fittings

The upper muscle attachment shall be machined using scrap Delrin in the machine shop of GLE.

Base

Acquire spare Delrin in the machine shop and machine according to the Muscle Upper Attachment Base drawing as picture below in Figure 9.

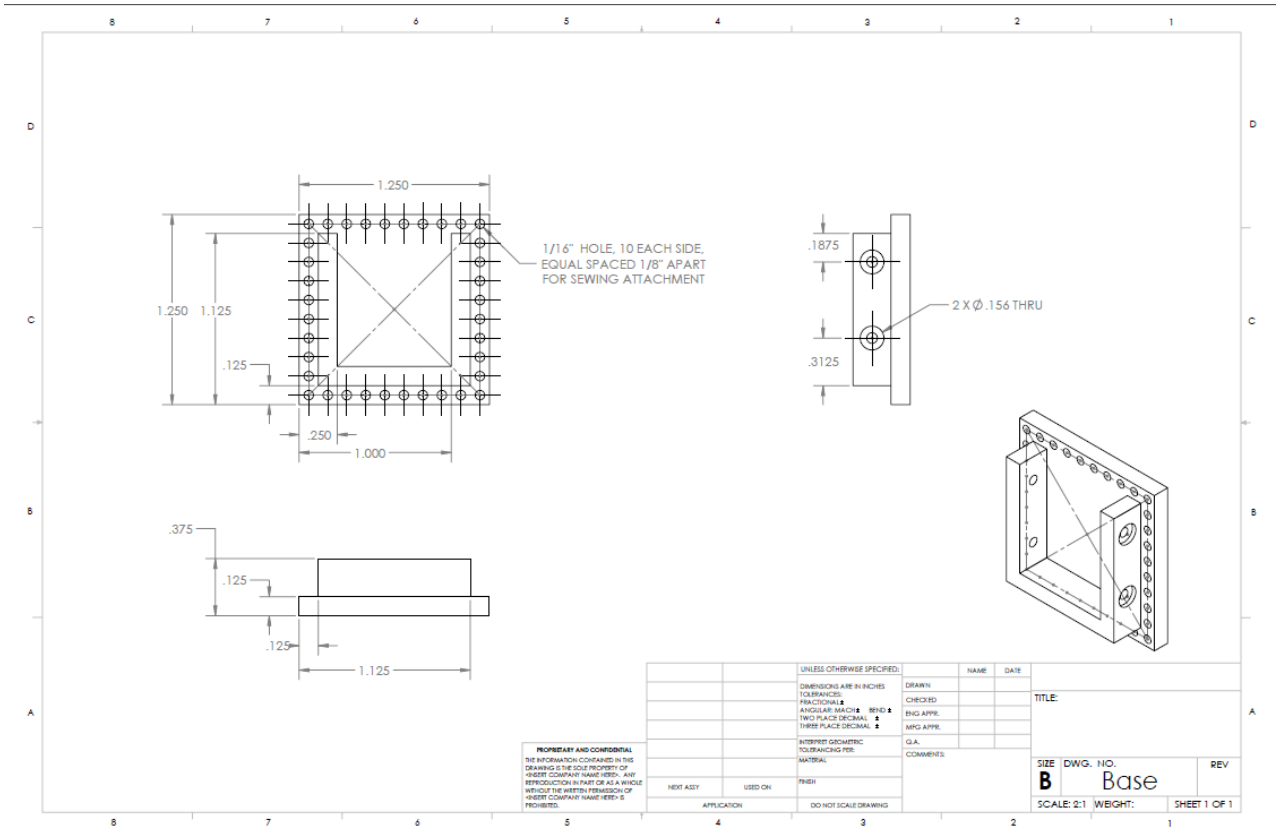

Figure 9: Upper Muscle Attachment Base

The following steps may be taken as a general guideline for this machine shop procedure:

1. Cut the Delrin stock down to a block of appropriate height dimensions using the belt saw
    a. The belt saw may also be used to cut near net length and width dimensions
2. Transfer the component to a machining station and trim edges to appropriate dimensions
3. Cut as required to obtain the shape as drawn
4. Insert a small drill appropriate for making holes that can be easily used for sowing purposes
5. Turn the part on edge and drill two appropriately dimensioned holes for attachment screws
6. Obtain screws from the machine shop and check fit

Integrated Plug

Acquire spare Delrin in the machine shop and machine according to the Muscle Upper Attachment Base drawing as picture below in Figure 10.

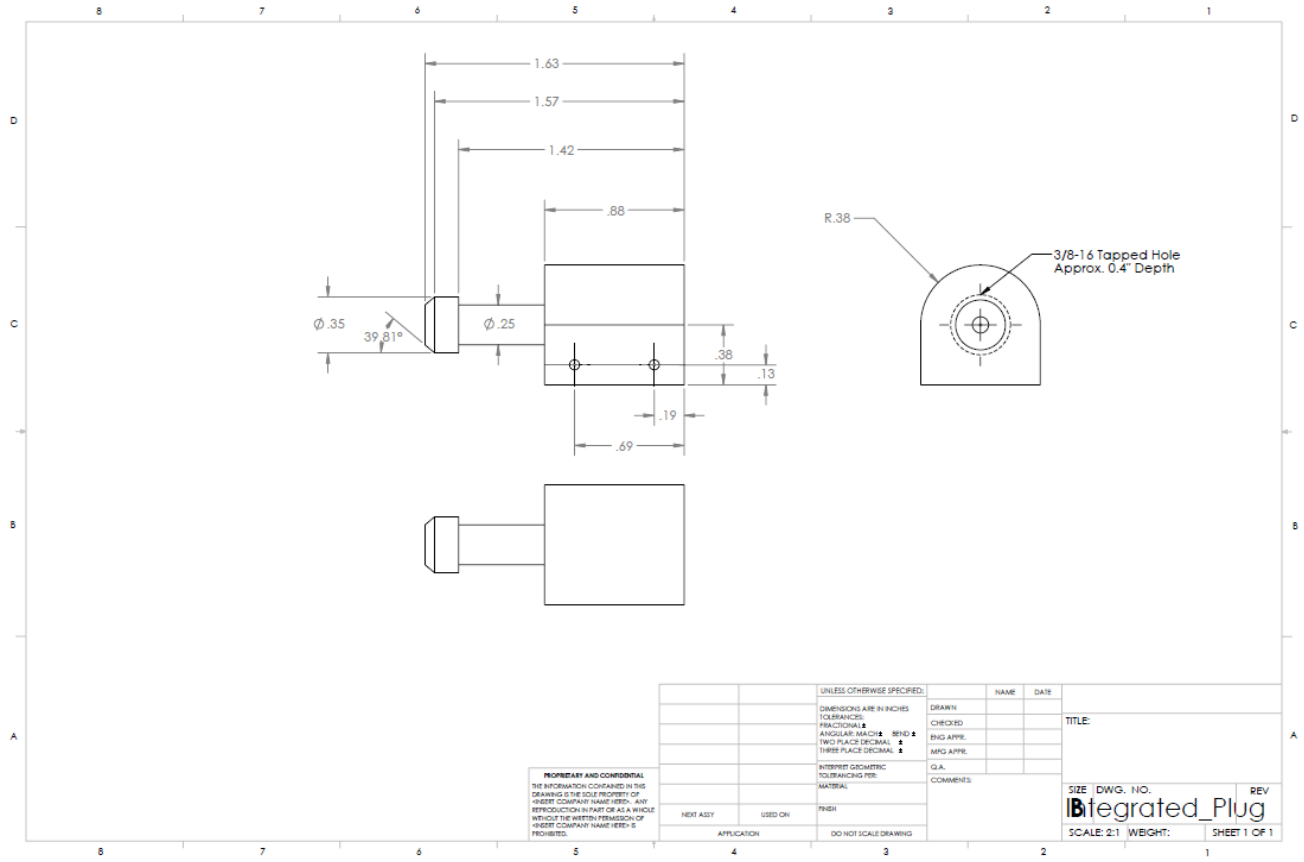

Figure 10: Upper Muscle Attachment Integrated Plug

The following steps may be taken as a general guideline for this machine shop procedure:

1. Cut the Delrin stock down to a block of appropriate height dimensions using the belt saw, leave an extra 2" for grip
2. Transfer the component to a machining station and trim the surface in order to create a flat platform to grip
    a. This can be accomplished by touching down on the lowest portion of the surface and cutting the rest of the face to the same height
    b. It is recommended that the part not be made into a square cross-sectional rectangle since the Delrin in the shop is too narrow.
3. Transfer the component to a four grip lathe and center such that the axis of rotation falls in a location equidistant to three edges.
    a. This may be checked using lab equipment
4. Cut the plug end of the component and drill a 1/8in center hole
5. Transfer the component to the belt saw and remove excess grip section
6. Return component to the lather and drill a 5/8in hole for the quick connect screw
7. Transfer the component to the machining station to drill side screw holes as appropriate
8. Place component in a vice and tap pipe threads into the air inlet hole
9. Trim and sand as desired

Mechanical Assembly

Once the upper and lower plugs are machined, the following assembly instructions should be followed:

1. Sew the Upper Muscle Attachment Base to the compression sleeve in a location that is approximately 2in below the top.
2. Construct the optimized muscle according the Muscles build plan using the Upper Muscle Integrated Plug as the inlet plug
3. Secure quick connect and air hose to the inlet port
4. Secure the muscle to the base via screws
5. Apply AFO to the leg and adjust as required
6. Attach the lower muscle plug to integrated strap attachment and tighten as necessary
7. Ensure local component housing is properly attached and secure
8. Fuse the ends of an approximately 6' length of wire sleeving and feed electrical wires and air hose into the sleeve
9. Attach safety pins to the sleeving at 1-2' intervals so that the user may affix power supply line to outer clothing and avoid snags

Debug Plan

Electrical

The following section will outline how the different sections of the electrical side of the project, specifically the code, will be debugged during testing. Overall, the code has enabled serial prints. For most of the debug, this will be enough as long as the arduino can be connected to the computer.

Gait Information Storage

The EEPROM can be read at any time by uploading the code that reads the EEPROM. This will read all the addresses that are being used in this system. If the EEPROM needs to be cleared, this can also be done here. During normal code operation, the serial prints will output what is being read from the EEPROM and what is being written to the EEPROM

Heelstrike Sensing

The Heelstrike sensor is just a variable resister and can be monitored during operation. As for the code, when the serial writes are enabled, the output of the ADC can be monitored and also the output of the function of if there has been a Heelstrike. If the delay is too large from Heelstrike to when the output is seen by the arduino, then a resistor divider can be used. This will change the threshold in the code, but that is a simple change.

Distance Sensing

The distance sensor also has a serial output function that will display what the Distance sensor sees. This is more difficult to use because the distance sensor should be monitored during movement. This is overcome by attaching the SD card which can save the output of the distance sensor. This can be examined after a run.

Low Battery Alert

The low battery alert also has serial writes that will output the information from the ADC to the serial monitor. If they system is not detecting a low battery alert soon enough, the threshold in the code can

be changed. If the alert is spiking, then more filtering can be used. If the input to the ADC is too high, a different resistor divided can be using.