**Project Identity**

Biomechanics Gait Analysis Lab  
Week 7  
October 19, 2006  
Angela Ensor, Kimberly Carr, Omar Chawiche

**Work Completed**

**Angela Ensor**

On Thursday, October 12, we used the Biomechanics laboratory to use the Tinius Olsen machine to apply force to the first FSR insole to get the value of $R_f$ that will eliminate the saturation of our FSR up to (or greater than) 350lbs. We placed the insole on the round grips and began to apply pressure, but the one of the round grips had grooves carved into it and, as the force increased, the sharp edges of the grooves cut into the insole and eventually bent the FSR, thereby irreversibly damaging the FSR. Ultimately, we decided that the Tinius Olsen machine was our best option for determining $R_f$ and for calibrating the FSR insoles and, after brainstorming solutions, we decided that placing two hard plates (with a larger area than the insole) on either side the insole would protect it from damage. We were given two hard plastic plates that we agreed would be adequate for the level of force that we needed to achieve.

On Friday, October 13, we placed one half of an insole between the two hard plastic plates and put them between the two grips on the Tinius Olsen machine. Because the end of the FSR must be in the middle of the grips, for even force application, and the top grip can rotate, I saw that we had to place an extra insole padding on one end (between the plates) to keep the top grip flat to apply an even force. This process worked and we were able to apply more than 350lbs of force evenly onto the insole without damaging it. We applied force until the output was saturated, so that there was no change in voltage as more force was applied. We backed down the force, adjusted the potentiometer on our circuit board, and began to slowly apply force until the voltage output saturated. We repeated this process until the voltage changed up through and beyond 350lbs. We determined that a 9kΩ resistor would work for the circuit to provide a varying voltage output beyond 350lbs.
This week I worked on obtaining conduit for our lead wires that extend 4 feet from our FSR insoles. We decided that spiral wrap would provide the best properties for our project since it is flexible, easily removed, and allows us to see the wires, which are color coded. Bill Prueshner provided us with a sample of spiral wrap. I commenced a search at the Mansfield Supply, Home Depot, and Lowe’s Home Improvement, but was not able to find spiral wrap in the lengths that we require.

I began a search online and found GE Supply has the spiral wrap listed. I called them and spoke with Rich, who informed me that they don’t keep spiral wrap in-stock and would have to order from the manufacturer. After he contacted the manufacturer, he found that they require a minimum $100 order and the spiral wrap is about $20 per 100 feet. He requested that they send us the sixteen feet that we need for our four FSR insoles, since they give away five feet sample and it is for an undergraduate design project. The manufacturer (Hellerman-Tyton) is only willing to give us a 12 foot sample, so I will give them a call to see if I can convince them to give us the additional 4 feet.

After reviewing our Linx Technologies requisition with Bill Prueshner on Friday, we adjusted our order for the remainder of the telemetry devices that we need from Linx Technologies. Bill sent us an e-mail on Tuesday, October 17 to make the order was correct and I replied that evening that it was correct, as we had discussed on Friday. Unfortunately, Linx Technologies refused to sell us the devices, so we had to place an order with Digi-Key on Wednesday and requested to have it overnighted. I updated our budget sheet this week, which is shown below.

<table>
<thead>
<tr>
<th>Company</th>
<th>Item/Description</th>
<th>Quantity</th>
<th>Price Each</th>
<th>Amount</th>
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<td>Footswitches (pair) - Men's Size 9</td>
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<td>195.00</td>
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<td>B&amp;L Engineering</td>
<td>Footswitches (pair) - Women's Size 7</td>
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<td>B&amp;L Engineering</td>
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<tr>
<td>Digi-Key</td>
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<tr>
<td>Digi-Key</td>
<td>916 MHz transmitter (TXM-916-ES)</td>
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<td>Digi-Key</td>
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<td>Digi-Key</td>
<td>418 MHz Antenna (ANT-418-SP)</td>
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<td>2.08</td>
<td>4.16</td>
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<tr>
<td>Digi-Key</td>
<td>916 MHz Antenna (ANT-916-SP)</td>
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<td>Digi-Key</td>
<td>Encoder (LICAL-ENC-MS001)</td>
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<td>Digi-Key</td>
<td>Decoder (LICAL-DEC-MS001)</td>
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<td>8.20</td>
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<td>Tekscan</td>
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<td>Shipping and Handling Charges</td>
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</table>

**Total:** 827.64
Throughout the past week, we have been continuing to build our FSR footswitches. We placed one FSR sensor on the toe and one on the heel (Figure 1). For the insoles we used SOF® Comfort Insoles (Figure 2). The men’s FSR footswitches are completed and ready to be calibrated.
On Thursday, October 12, 2006 we met with David Kaputa to talk about using the Tinius Olsen Testing Machine (UTM) H50KS (Figure 3) to place the 350 lbs load on the FSR sensors so that we can determine what voltage and reference resistor values we need for the drive circuit. We used a 20kΩ potentiometer in the drive circuit (Figure 4) and tested the women’s toe FSR but unfortunately, the grooves in the metal press cut through the insole and damaged the sensor before we were able to determine the correct voltage and reference resistor for the circuit.
On Friday, October 13, 2006 we used thick plastic plates to sandwich the footswitch between so that the UTM does not damage anymore sensors. This technique worked well and we were able to determine that the reference resistor should be $9\,\text{k}\Omega$ and the input voltage should be $-5$ Volts. We wanted to keep the input voltage at $-5$ Volts so that we can use a negative 5 volt regulator (UA7905) to convert the $-9$ Volts from the battery to $-5$ Volts. The updated ExpressSCH schematic for the 418 MHz transmission is shown in Figure 5 below.
We also had to order the KH evaluation kit, 916 MHz transmitter, receiver, and antenna as well as the encoder and decoder parts from Digikey instead of from Linx Technologies because there were policy issues with the 916 MHz transmitter/receiver being sold with the KH evaluation kit.

Omar Chawiche

On Thursday of last week, we finished one of the FSR insoles, so we decided to use the Tinus-Olsen machine that is in the biomechanical lab, in order to determine which voltage and resistor are necessary so the FSR can hold over 350lb. We set up the circuit for the FSR in the lab by the machine and we started to apply compression force on the insole and at the same time record the reading of the voltmeter that is giving the output voltage. At one point passing 300lb, we noticed that the voltmeter is not showing any reading so we realize that due to the circles on the compression pieces of the machine, the insoles get damage in which broke the sensor.

On the next day we repeated the same process but this time we used two flat ceramic plates that we put on top and bottom of the insole so it will prevent damaging the sensor. We started by applying a small amount of force per second and keep track of the output voltage reading, and once the voltmeter stop showing any change, we started adjust our potentiometer by decreasing the resistance until the force applied passed the 350lb. The testing on the second time ended very successfully and we determine that the resistor we need to use in the circuit in order for the sensor be able to hold over 350lb, was 9 Kilo ohms. Based on these results we adjust the schematic of our circuit that we did last week.

After damaging the insole and the sensor in the first time, we decided to buy more insoles and place an order for more FSRs. Since our circuit for the force sensitive resistor require to use a negative five volts, we decided to buy a voltage regulator that could transform a nine volts that’s coming from a 9v battery to a -5v. Also for the fact that our microprocessor can only take a 5v input, we decide to get another kind of voltage regulator that will transform the 9v to +5v.

On Tuesday of last week, we received the sensors that we ordered the week before, so we complete making our insoles
except for the one that we damaged during testing.

We were doing some research trying to find a small diameter tube that we could run the wires through for protection. Angela went to Mansfield supply store and a couple more hardware stores trying to find these tubes but without any luck.

During the past week Lisa tried to place our order from Linx Technologies for the evaluation kit and the other component. But Linx company refuse to sell us the transmitter/receiver 418 evaluation kit with the 916 transmitter/receiver so we decided to order everything from DigiKey company and the order was placed for an overnight shipping, this way it will save us some time.

Also during the past week, more research was done on trying to understand the encoder and decoder that we are going to use along with 916KH transmitter/receiver.

![Figure 1: Encoder/Decoder for the 916-ES Transmitter/Receiver](image)

**Future Work**

**Angela Ensor**

We need to test our telemetry set-up on Friday, provided that the order is received by then. We need order a replacement FSR and to finish making the FSR insoles next week. We also need to start calibrating the FSR insoles. We should also attach the FSR circuitry to the NI DAQ.
devices and create a LabVIEW program to show a graphical output of Resistance vs. Force.

Kimberly Carr

This Friday we need to determine how to analyze the data from the footswitches in LabVIEW™. We also need to test the 418 MHz transmitter and receiver assuming that we get the parts from Digikey by then. We also need to get the code template for the microprocessor so that we can perform A/D conversion.

Omar Chawiche

Our next step after receiving the order this week is trying to put our circuit together for one foot and tested along with the FSRs and the footswitches. Also we are going to try to program the microprocessor for the circuit. In addition we will focus on the lab View program and try to calculate all the parameters possible from the footswitches.

Project Review

Angela Ensor

We are continuing to make progress and should have some outputs in LabView from the FSR insoles in the next week. Our most difficult tasks ahead are the telemetry and data analysis. However, we are confident that we will be able to get the project completed on time.

Kimberly Carr

Right now we are making good progress with the FSR footswitches but we are definitely behind on the telemetry aspect of this design project and we need to put more effort into testing our circuit once our parts come in so that we can begin to design the PCB for it.

Omar Chawiche

Overall we are behind in the time line and we still have five weeks left before the due date. We are putting more effort and more hours than before, so we are hoping that we could at least finish the circuit along with testing for one foot. If we could program the microprocessor and
finish our circuit within the next two weeks, I believe we will be able to finish this project on the due date.

**Hours Worked**

<table>
<thead>
<tr>
<th>Angela</th>
<th>Kimberly</th>
<th>Omar</th>
</tr>
</thead>
<tbody>
<tr>
<td>12 hours</td>
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